Lower Thames Crossing

6.3 Environmental Statement Appendices
Appendix 14.7 - Water Framework Directive

APFP Regulation 5(2)(a)

Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

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Lower Thames Crossing

6.3 Environmental Statement Appendices
Appendix 14.7 Water Framework Directive

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1 Executive summary

1.1.1 This Water Framework Directive (WFD) Assessment has been prepared for the proposed A122 Lower Thames Crossing (the Project). The assessment has been prepared in several stages, with each stage having been reviewed by the Environment Agency.

1.1.2 This report presents Stage 4 which assesses the potential risk of Project activities causing deterioration of water bodies within the Zone of Influence (ZoI), including several surface water bodies, the Thames Middle transitional water body and a number of groundwater bodies. The Project activities and affected water bodies were screened into the assessment at Stages 1 and 3.

1.1.3 The assessment has been informed by several desk-based and numerical modelling studies, detailed in Section 2 of this report, and has used data from the Project's Flood Risk Assessment (Application Document 6.3, Appendix 14.6).

1.1.4 The assessment takes account of a suite of embedded mitigation, good practice and essential mitigation measures that are secured by several control documents within the Development Consent Order, including the Environmental Masterplan (Application Document 6.2, Figure 2.4), the Register of Environmental Actions and Commitments (REAC), forming part of the Code of Construction Practice (CoCP) (Application Document 6.3, Appendix 2.2) and Design Principles (Application Document 7.5).

1.1.5 There are three WFD surface water bodies within the ZoI: the Mardyke, the Mardyke West Tributary and the Mardyke East Tributary. These are illustrated on Drawing 2 in Annex C. All of these water bodies are currently at moderate overall status and are designated as heavily modified by human activity. Effects of Project construction and operational activities have been assessed for effects on biological quality, hydromorphology and physico-chemical quality/specific pollutants. A negligible risk of deterioration at the water body scale has been concluded.

1.1.6 Where effects on surface water bodies cannot be completely avoided, for example, where floodplain storage is lost under the footprint of the Project, or watercourse culverting is necessary, the Project design includes compensatory measures. These include wetland and watercourse creation, and removal of existing culverts.

1.1.7 There is one transitional water body within the ZoI, the Thames Middle water body, which is currently at moderate overall status and is designated as heavily modified by human activity. Effects of Project construction and operational activities have been assessed for effects on biological quality, hydromorphology, habitats and protected areas (including Invasive Non-Native Species) and physico-chemical quality/specific pollutants. A negligible risk of deterioration at the water body scale has been concluded.

1.1.8 There are four WFD groundwater bodies within the ZoI illustrated in Drawing 3 in Annex C, one to the south and three to the north of the Thames Middle water body. Three of these share poor quantitative and chemical status, however the South Essex Lower London Tertiaries water body is currently achieving good status for both.

1.1.9 Project activities such as ground treatment, cuttings, dewatering, below ground utilities works and infiltration drainage have been assessed for the potential to cause changes to groundwater levels, flows, water balance and groundwater chemistry. Modelling studies have demonstrated the proposed design and mitigation measures to be robust, and a negligible risk of detriment is concluded.

1.1.10 Several protected areas within the Project's ZoI have also been appraised. These include sites with international nature conservation designations that fringe the Thames Middle water body, such as the Thames Estuary and Marshes Ramsar site and Special Protection Area (SPA). There are also two Sites of Special Scientific Interest (SSSI), a Local Wildlife Site (LWS), Cranham Marsh Nature Reserve, and several Sites of Importance for Nature Conservation (SINCs). The assessment concludes that there would be no change to water balance or existing water chemistry at these sites and that they would not be detrimentally affected during construction or operation of the Project.

1.1.11 It is concluded that none of the activities associated with the Project would prevent or undermine future actions to bring water bodies to good status, and no instances have been identified where a Regulation 19[1] derogation is required within this assessment.

[1] Regulation 19 of The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 (WFD Regulations), as amended by the Floods and Water (Amendment etc.) (EU Exit) Regulations 2019 (WFD EU Exit Regulations).

2 Introduction

2.1.1 This report presents the findings of the last stage (Stage 4) of a Water Framework Directive (WFD) Assessment that has been prepared for the proposed A122 Lower Thames Crossing (the Project).

2.1.2 It has been prepared following completion of the following stages:

a. Stage 1: A scoping note setting out the Zones of Influence (ZoI) of the Project and identifying WFD water bodies and associated protected areas situated within the ZoI, screening-in those water bodies that would be subject to further assessment.

b. Stage 2: Collation of baseline water body status data, specific objectives and measures set by the Environment Agency, for the screened-in water bodies located within the ZoI.

c. Stage 3: A study to review the relationship between the components of the Project and the screened-in water bodies. At this stage any elements of the Project considered to have no potential to cause detriment to water bodies were screened out. All other elements were screened-in and taken forward to Stage 4.

2.1.3 The Stage 1, 2 and 3 reports are provided in Annex A and have been reviewed by the Environment Agency, who have provided comments in relation to the Stage 1 and Stage 3 reports. The table in Annex B summarises these comments as well as the Project's response to each. Please note, there were no comments received on the Stage 2 report. Since completion of Stage 1 of the assessment, further baseline data has been published via the Environment Agency's catchment data explorer website. This dataset has been reviewed and any changes to baseline conditions are reported in Sections 4, 5 and 6 of this report.

2.1.4 Since completion of the Stage 3 report in December 2019, the Project design has evolved and any changes to the screening of Project activities are reported in Section 3 of this report.

2.1.5 The methodology for this Stage 4 assessment comprises an appraisal of the potential for the screened-in components of the Project to cause detriment to the current status or objectives and measures set for the WFD water bodies in the defined ZoI. This report summarises the assessment findings and provides conclusions regarding the compliance of the Project with the WFD.

2.1.6 A preliminary version of this report was issued to the Environment Agency in August 2021 and subsequent updates were shared in July 2022. The feedback received, which is also summarised in Annex B, has been incorporated into the drafting of this final Stage 4 report.

2.1.7 Additional information and assessment of specific components of the Project that were requested by the Environment Agency as part of their review of the preliminary Stage 4 report (as noted in Annex B) were incorporated into this final Stage 4 report.

2.1.8 Full details of the liaison with the Environment Agency are included in the Statement of Common Ground between (1) National Highways and (2) the Environment Agency (Application Document 5.4), which also provides evidence of an agreement in principle for the Water Framework Directive Assessment.

2.1.9 The assessment has been informed by the results of several desk-based and numerical modelling studies completed at a simple or detailed level, in accordance with the standards set out in the Design Manual for Roads and Bridges (DMRB) LA 113 Road Drainage and the Water Environment (Highways England, 2020). The detailed findings of these assessments are provided in the following reports and technical notes that support the Environmental Statement (ES) (Application Document 6.1), namely:

a. Operational Surface Water Drainage Pollution Risk Assessment (Application Document 6.3, Appendix 14.3) - a Project-wide operational drainage surface water pollution risk assessment using the Highways England Water Risk Assessment Tool (HEWRAT) and the Metals Bioavailability Assessment Tool (M-BAT).

b. Freshwater Ecology report (Application Document 6.3, Appendix 8.4) - presenting the results of the aquatic desk-based study and field surveys carried out between 2012 and 2022.

c. Hydromorphology Assessment (Application Document 6.3, Appendix 14.4) - a desk-based hydromorphology impact assessment reporting on the potential for likely significant effects on the hydromorphology of watercourses during the construction and operation of the Project.

d. Hydrogeological Risk Assessment (Application Document 6.3, Appendix 14.5), which comprises the following supporting assessments:

    i. High level assessment of hydrogeological risks linked to embankments and cuttings – providing a simple assessment of risks and identifying the requirements for further detailed assessment to be carried out as part of the hydrogeological risk assessment.

    ii. High level assessment of hydrogeological risks linked to underground utilities corridors – providing a simple assessment of risks and identifying precautionary commitments to prevent effects on groundwater bodies.

    iii. Detailed infiltration basin assessment south of the River Thames – providing the results of a detailed assessment of the pollution potential of routine highway drainage discharges to ground to the south of the River Thames. This also includes an assessment of the potential for these infiltration drainage basins to cause groundwater mounding.

    iv. Detailed infiltration basin assessment, North Portal to A13/A1089/A122 Lower Thames Crossing junction – providing the results of a detailed

assessment of the pollution potential of routine highway drainage discharges to ground from an infiltration basin and swales. This also includes an assessment of the potential for the infiltration basin to cause groundwater mounding.

v. Ramsar site numerical model – groundwater modelling to quantify potential effects of the ground protection tunnel on groundwater drawdown and the potential for saline intrusion. The operational effects of the main tunnels on the groundwater regime are also reported. Modelled predicted drawdowns are from comprehensive numerical modelling, mostly of the Chalk aquifer, and based on ground investigation data.

vi. Filborough Marshes (part of the Thames Estuary and Marshes Ramsar site) water balance – calculating water inflows and outflows and determining the overall annual change in storage within the shallow water system; and assessing interactions between surface and groundwater bodies.

vii. North Portal numerical model – groundwater modelling to quantify potential effects at the North Portal including an assessment of the effects of dewatering on groundwater drawdown and saline intrusion Modelling was also used to assess the groundwater level and flow effects of proposed soil mixing. Modelled predicted drawdowns are from comprehensive numerical modelling, mostly of the Chalk aquifer based on ground investigation data.

viii. A122 Lower Thames Crossing/M25 junction numerical model – providing an assessment of the potential effects on groundwater drawdown associated with the construction and operation of the cutting at the A122 Lower Thames Crossing/M25 junction.

2.1.1 The findings of an assessment (Appendix 10.7: East Tilbury Landfill Risk Assessment Technical Memorandum, Application Document 6.3) concerning the potential pollution risk linked to the Projects interaction with the East Tilbury landfill site was also used to support this WFD appraisal.

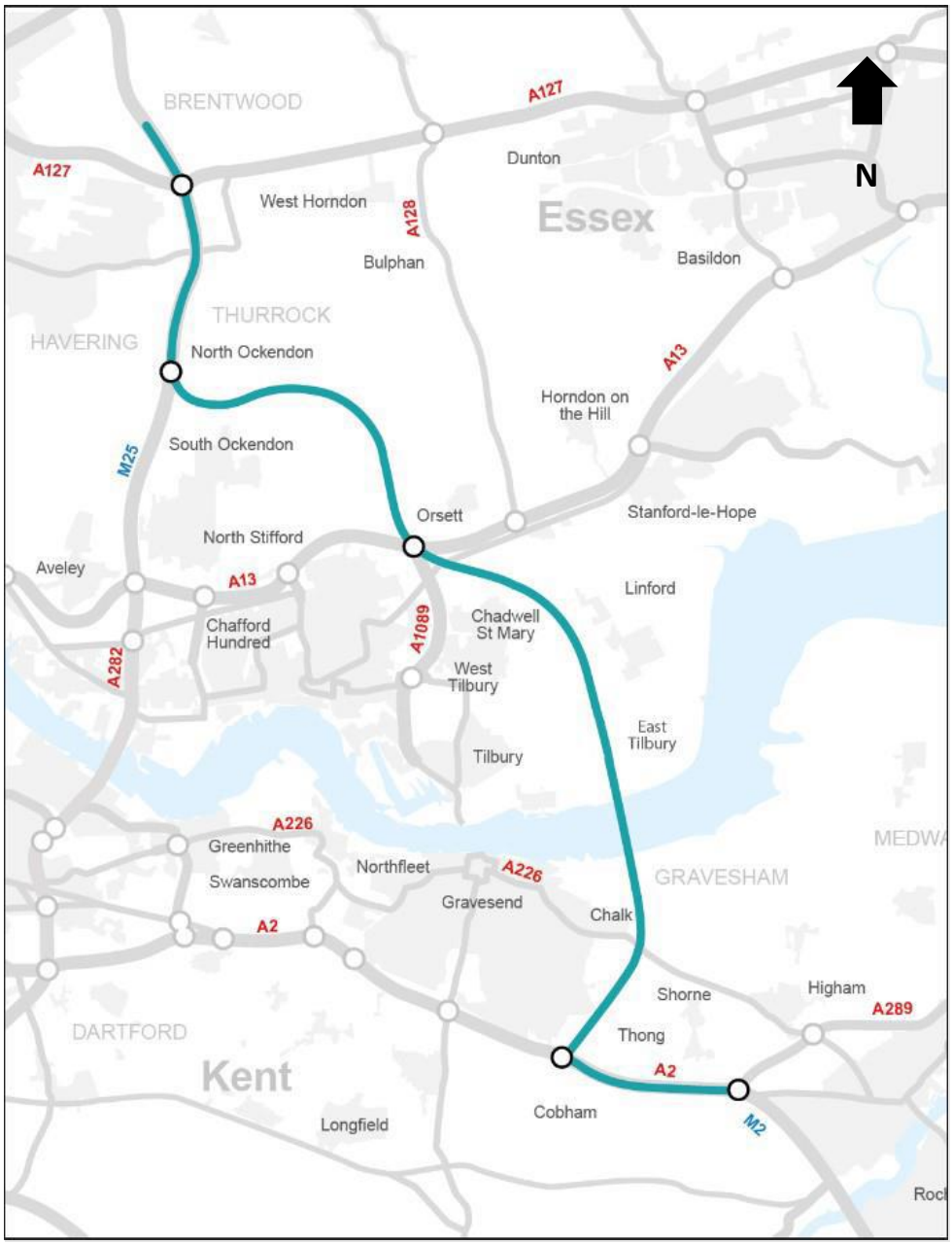
2.1.2 Data from a Flood Risk Assessment (Application Document 6.3, Appendix 14.6) was also used to support this WFD Stage 4 appraisal.

3 Screened-in Project components

3.1 Overview

3.1.1 The Project would connect the A2/M2 in Kent, east of Gravesend, crossing under the River Thames through two bored tunnels, before joining the M25 south of junction 29. The route is 31km, including a 4.25km tunnel, and is illustrated in Plate 3.1. The route crosses through the catchments of several WFD surface water bodies, beneath a transitional water body and has the potential to interact with four WFD groundwater bodies.

Plate 3.1 Lower Thames Crossing route



3.1.2 Construction of the Project is expected to take place over a period of approximately six years, and the road has an operational lifetime of 120 years.

3.1.3 During Stage 3, Project components and construction activities were screened for having the potential to impact on one or more of the status classification elements of WFD water bodies and associated protected areas. Table 3.1 provides a summary, accounting for comments received by the Environment Agency (detailed in Annex B). The Project previously included the option of constructing a new jetty or using the existing jetty at Goshem's Farm for movement of materials during construction. This element of the Project has been removed and is therefore not assessed here.

3.1.4 Since completion of Stage 3, the Order Limits of the Project have been extended to include land to accommodate habitat creation sites proposed as compensation for the effects of nitrogen deposition, and to accommodate works to supply water from the River Thames to an area of wetland habitat creation at Coalhouse Point.

3.1.5 The design and management regimes for the nitrogen deposition mitigation sites will be developed as part of the detailed design, in accordance with the Project's control plan documents including the Outline Landscape and Ecology Management Plan (OLEMP) (Application Document 6.7), Design Principles (Application Document 7.5) and the Environmental Masterplan (Application Document 6.2, Figure 2.4). A key design principle (LSP.27) provides for protection of existing surface water features and underlying groundwater bodies, preventing physical disturbance of surface waters and preventing groundwater and surface water pollution during the planting and management of vegetation and landform. On this basis, the nitrogen deposition mitigation habitat creation activity has been screened out of this Stage 4 assessment.

3.1.6 The proposed wetland habitat at Coalhouse Point, comprises shallow scrapes and a network of ditches, illustrated in Figure 2.4: Environmental Masterplan (Application Document 6.2). Water supply to these features would be secured from the River Thames, via a self-regulating tide gate (or equivalent structure) passable by eels, constructed in the sea wall.

3.1.7 The construction working area needed to install the structure would be small (approximately 50m by 35m) and while the works would result in the temporary loss of intertidal habitat, given the scale of the works and the dynamic nature of the tidal regime, any loss would naturally re-establish within a short time scale.

3.1.8 Construction impacts would also be managed by a series of commitments, secured via the Register of Environmental Actions and Commitments (REAC), forming part of the Code of Construction Practice (CoCP) (Application Document 6.3, Appendix 2.2), to working methods such as soft start piling to gradually increase piling energy (hence noise and vibration) and to timing works to suit the tidal cycle and periods of low water. These measures would reduce noise and vibration impacts.

3.1.9 Once operational, the footprint of the proposed structure would not extend beyond the footprint of an existing flood bund and therefore the Project would not result in any permanent loss of intertidal habitat, or impact on the hydrodynamics or water quality of the Thames Middle water body. This

component of the Project has therefore been screened out of this Stage 4 assessment.

3.1.10 Table 3.1 provides an overview of the Project components and construction activities that have been screened into this Stage 4 assessment.

Table 3.1 Summary of screened in Project components or construction activities

Component or construction activity	Risks	WFD element affected
Structures spanning watercourses, e.g. viaducts.	Shading, leading to loss of instream/bankside vegetation.	Biological quality elements
Watercourse culverting (new and extensions), realignment and drainage outfall installation.	Aquatic/riparian habitat loss and creation of barriers to fish passage. Changes to channel bed/bank form, lateral connectivity with floodplains, flow dynamics and sediment transport processes.	Biological quality elements Hydromorphology
Watercourse crossings for utilities diversions.	Riparian habitat loss and temporary impacts on hydromorphology. Receipt of silted or otherwise contaminated runoff causing pollution.	Biological quality elements Hydromorphology
New road construction, road widening and general construction activity including stockpiling of construction and excavated materials.	Aquatic or riparian habitat loss and fragmentation. Receipt of silted runoff from work sites, hydrocarbons and other construction wastes causing pollution. Increase in impermeable land cover, changing rates and volumes of runoff received by watercourses, loss of floodplain connectivity and storage. Changes to groundwater recharge patterns and quantities.	Biological quality elements Physico-chemical or specific pollutants Hydromorphology Groundwater chemical status Groundwater quantitative status
Operational road drainage via surface water outfalls, soakaways and swales.	Chronic and acute (spillage induced) pollution of watercourses, groundwater bodies receiving drainage discharges, and supported protected sites. Changes to groundwater recharge patterns.	Physico-chemical changes or specific pollutants Biological quality elements Groundwater quantitative status Groundwater chemical status

Component or construction activity	Risks	WFD element affected
Ground treatment for ground stability and to allow tunnel boring machine (TBM) interventions, including a ground protection tunnel south of the River Thames and soil mixing[2] at the northern tunnel entrance compound.	Reduced water levels in the ditch network due to induced groundwater drawdown in the shallow soils Risks to surface and groundwater quality.	Biological quality elements Physico-chemical or specific pollutants Hydromorphology Groundwater quantitative status Groundwater chemical status
Set-up and operation of construction compounds (see Annex C, Drawing 1)	Pollution risks linked to slurry treatment, plant refuelling and concrete pre-casting etc, particularly at the southern tunnel entrance compound and northern tunnel entrance compound; foundations opening pollution pathways to groundwater.	Physico-chemical or specific pollutants Biological quality elements Groundwater chemical status
Discharge of rainfall runoff from the southern tunnel entrance compound during the construction phase	Pollution risks to the ditch network within the Thames Estuary and Marshes Ramsar site from chalk fines and suspended sediments.	Physico-chemical Biological quality elements
Construction and use of haul roads (see Annex C, Drawing 1)	Routes cut off surface water flow paths and cross watercourses, inducing physical/, hydrological, or hydromorphological change. Receipt of silted or otherwise polluted runoff.	Hydromorphology Biological quality elements Physico-chemical
Receipt of treated discharges of dewatering effluents from the North Portal excavation and operational	Adding built development spanning the intertidal zone (pipeline and northern outfall), and potential hydrodynamic effects and water quality deterioration due to release of sediment that may be contaminated.	Biological quality elements Physico-chemical or specific pollutants and priority hazardous substances Hydromorphology

[2] Soil mixing includes mixing of in-situ material with cementitious binders to form a material with improved strength and lower compressibility than the original soil.

Component or construction activity	Risks	WFD element affected
discharges of tunnel drainage.		
Noise and vibration during tunnel construction and operation.	Disturbance of marine benthic invertebrates and fish.	Biological quality elements
Temporary dewatering or permanent groundwater control.	Lowering of groundwater levels and reduction in groundwater contributions to surface water bodies, Groundwater Dependent Terrestrial Ecosystems (GWDTE) or groundwater abstractions. Saline intrusion.	Groundwater quantitative status Groundwater chemical status Protected areas
Below ground utilities diversions	Opening of pollution pathways and disturbance to groundwater flow paths.	Groundwater quantitative status Groundwater chemical status
Foundations – piling, diaphragm walling and other below ground construction, including tunnelling	Barrier to or diversion of groundwater flows, in places reducing groundwater contributions to surface water bodies, GWDTE (if present) or groundwater abstractions, or in other places causing groundwater levels to rise increasing flood risk. Also potentially opens pathways for pollution.	Groundwater quantitative status Groundwater chemical status Protected areas
Earthworks – embankments, cuttings and other excavations.	Mobilising existing poor quality groundwater or ground contaminants from their soil source, their transport and delivery to aquatic systems.	Groundwater chemical status Physico-chemical or specific pollutants Biological quality elements
Aquatic habitat creation	Introduction of Invasive Non-Native Species (INNS)	Biological quality elements
Construction and operational traffic	Generation of airborne particulates (dust) the deposition of which causes pollution.	Physico-chemical or specific pollutants Biological quality elements

3.1.11 Following feedback from the Environment Agency, further information on specific components of the Project was requested for inclusion within the Stage 4 assessment report as follows:

a. Ground protection tunnel south of the River Thames

b. Southern tunnel entrance construction compound drainage proposals

c. Northern tunnel entrance construction compound drainage proposals

d. Tunnel drainage proposals and details of pollution containment measures within the operational drainage design

3.1.12 In addition to the requested information listed above, further details on the Project's junction with the M25 including the deep cutting, the Project's infiltration drainage arrangements and proposed utilities works have been summarised below.

3.2 Ground protection tunnel south of the River Thames

3.2.1 As detailed in Annex B, the Environment Agency requested further details on the ground protection tunnel south of the River Thames and its proposed construction methodology. The tunnel would allow ground treatment (grouting) to increase ground stability and allow tunnel boring machinery interventions without breaking ground in the Thames Estuary and Marshes Ramsar site.

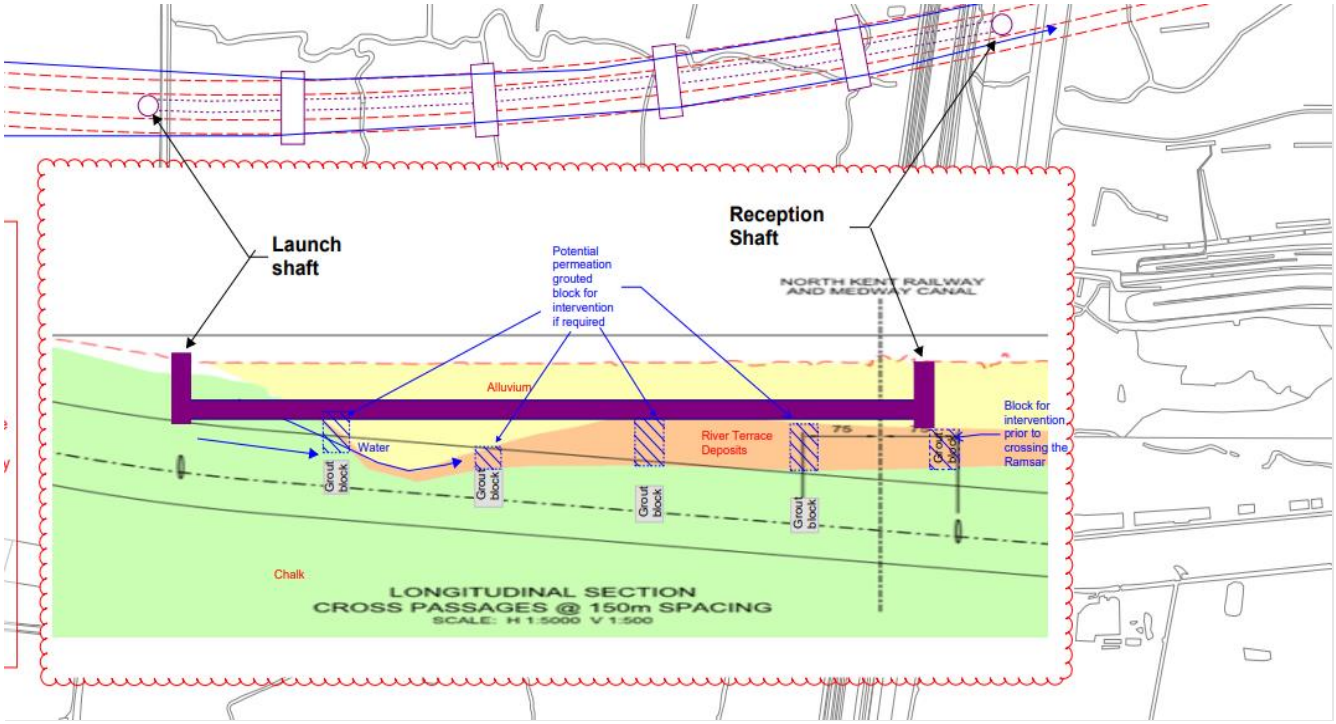
3.2.2 The ground protection tunnel concept consists of a launch shaft of approximately 9.7m outer diameter (OD) and 9m inner diameter (ID), located just south of Lower Higham Road in an agricultural field. The shaft would be 16m deep, excavated using wet excavation techniques and a grout plug formed in the base.

3.2.3 From this launch shaft, a tunnel of approximately 5.8m OD would be driven using an earth pressure balance machine (EPBM) under the Ramsar site, from the Thames Medway Canal to the Metropolitan Police Firing Range, above the alignment of the main crossing tunnels. The tunnel would be concrete, segmentally lined and gasketed, with annulus grouting to reduce the leakage of groundwater into it to negligible rates.

3.2.4 A second shaft for the reception of the EPBM would be sunk in the Metropolitan Police Firing Range, with the same dimensions and construction as the launch shaft. The proposed construction methods for the shafts and the 800m long tunnel would control groundwater ingress to negate the need for dewatering. Permissible inflow rates (0.2 litres per square metre per day (l/m^2/day) for the shafts and 0.1l/m^2/day for the ground treatment tunnel) would be specified as a contractual requirement.

3.2.5 On completion of the works, both the shafts and the temporary tunnel would be backfilled and subject to an appropriate future inspection regime. This would leave no temporary works in the upper 2m of ground and the shaft sites would be returned to their original use. Plate 3.2 shows the proposed tunnel alignment and its cross section.

Plate 3.2 Proposed ground protection tunnel alignment and cross section



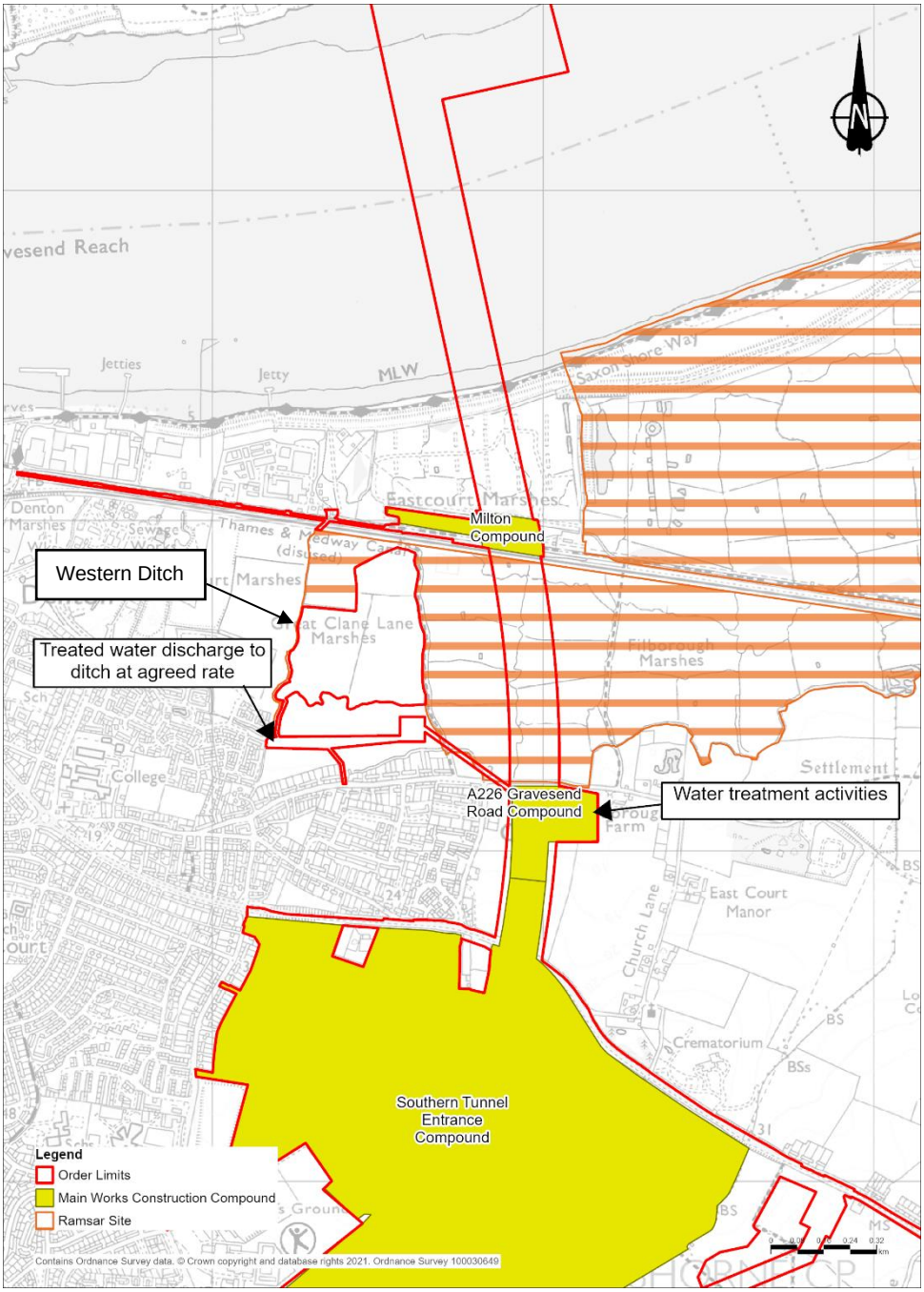
3.2.6 The potential for this component of the Project to impact on both surface and groundwater WFD water bodies and associated protected areas is assessed in Sections 4, 6 and 7 respectively.

3.3 Southern tunnel entrance compound drainage

3.3.1 The Project is required to manage rainfall runoff from the large (approximately 155ha in area) southern tunnel entrance compound. The compound would generate sewage from welfare facilities and small volumes of construction process water, to be managed via suitable connection to the existing sewer network in Gravesend. Much larger volumes of rainfall runoff would be generated from the areas of hardstanding that are created, and from areas used for stockpiling of chalk arisings. After consideration of several options, a number of potential solutions were presented to the Environment Agency and Natural England. Details of the engagement are presented in Road Drainage and the Water Environment (Application Document 6.1), Chapter 14, Section 14.3, Table 14.1. In agreement with these bodies the following temporary drainage solution was selected. Runoff would be segregated, with runoff from areas of the compound that have a low risk of entrained chalk and sediment fines, collected and allowed to infiltrate to ground via vegetated soakaways, to replicate the existing hydrological regime. Where there is a higher risk of entrained chalk fines, runoff would be collected, attenuated and treated using a lagoon system in the compound.

3.3.2 The water would then be piped across Lower Higham Road and discharged into a ditch (referenced herein as the western ditch) that would convey the discharge to the River Thames via an existing outfall. This is illustrated in Plate 3.3.

Plate 3.3 Ditch network and proposed works at Filborough Marshes



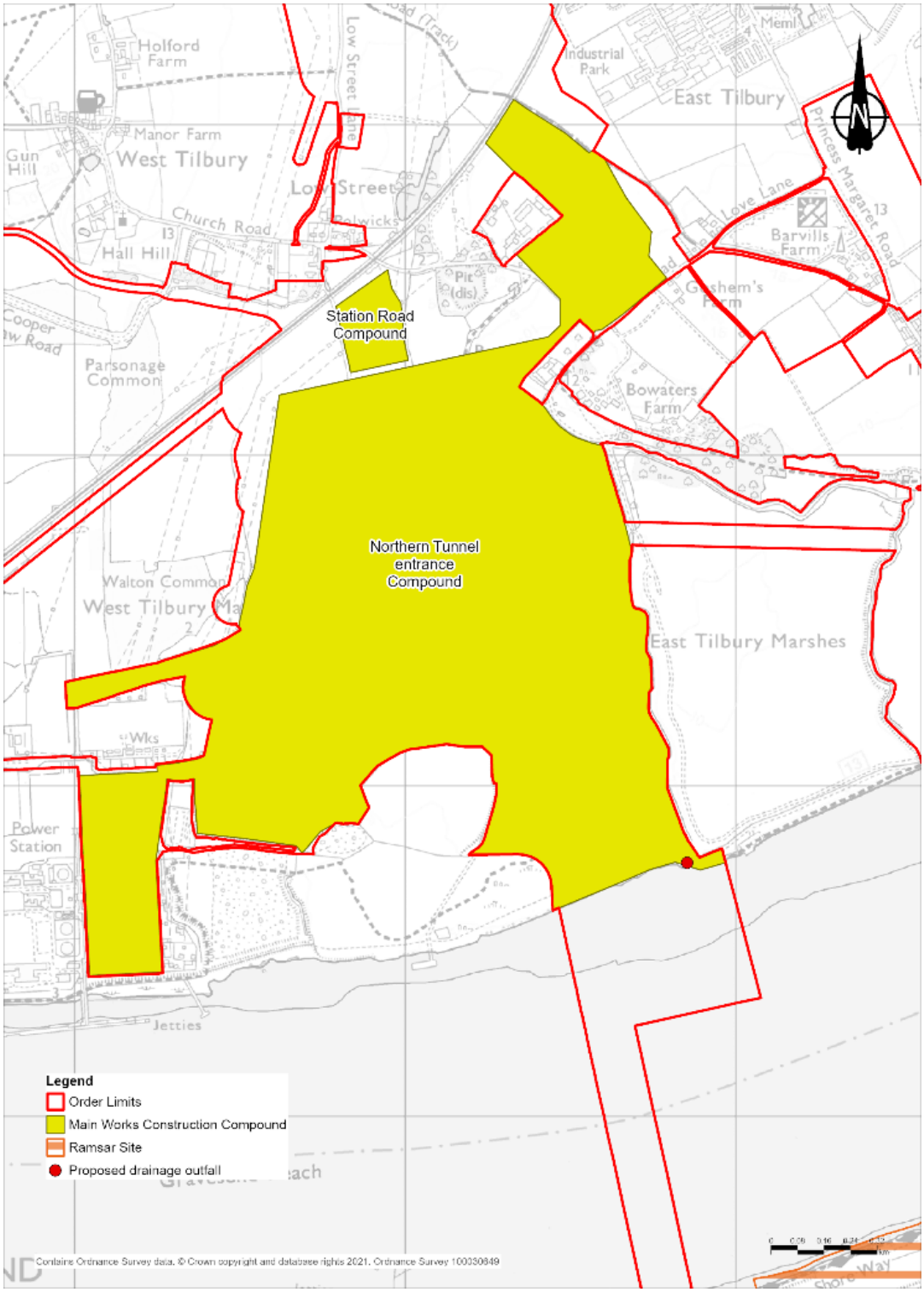
3.3.3 The potential for this component of the Project to impact on both surface and groundwater WFD water bodies and associated protected areas is assessed below in Sections 4, 6 and 7 respectively. As construction of a new outfall to the River Thames would not be necessary, there would be no additional effect pathway or disturbance of intertidal habitats linked to the Thames Middle transitional water body (biological quality element). Effects on the hydromorphological quality element of this water body would also be avoided. Given the proposed discharge treatment standards, it is assessed that there would be no risk of deterioration of the physico-chemical and specific pollutant elements of this water body either.

3.4 Northern tunnel entrance compound drainage

3.4.1 The large northern tunnel entrance compound would also generate significant volumes of water, comprising rainfall runoff in addition to larger volumes of sewage from welfare facilities and construction process water, for example, generated by dewatering of groundwater from excavations, as well as from the TBM slurry treatment plant. Subject to agreement, sewage would be discharged via a dedicated pumping station to existing sewer pipes at the north of the compound and flow to the Anglian Water treatment works to the east of the Tilbury2 port development.

3.4.2 It is proposed that following appropriate treatment, process wastewater would be received by the Thames Middle water body. This decision has been made in consultation with the Environment Agency, Marine Management Organisation (MMO), Natural England and the Port of London Authority, as detailed in Marine Biodiversity (Application Document 6.1), Chapter 9, Section 9.3, Table 9.4. To facilitate the discharge, a new temporary pipeline and outfall structure would be required as an existing outfall within the Order Limits is in poor structural condition and has insufficient capacity to convey the Project discharge. A buried pipe would be installed within a shallow sheet pile trench approximately 300m long across the intertidal zone, with a precast outfall structure with a flap valve at mean high water. The outfall would be located approximately 20m to the west of Diver Shoal Groyne 4. This location is illustrated in Plate 3.4.

Plate 3.4 Location of proposed northern tunnel entrance compound discharge pipeline



3.4.3 Dewatering and slurry treatment would commence in Spring 2025 and reach a peak in terms of the volumes generated, in late-2026 (with dewatering taking place in total for a duration of approximately 46 months). The outfall would be decommissioned at the end of the construction period. The impact of this component of the Project on surface and groundwater WFD water bodies, the Thames Middle transitional waters and associated protected areas, is assessed below in Sections 4, 5, 6 and 7.

M25 cutting

3.4.4 At the junction with the M25, the northbound carriageway of the Project would cross under the existing M25. The proposed underpass dimensions are approximately 80m long, 20m wide and 5.5m high and its base would vary between approximately 15.25mAOD and 15.8mAOD. The effects of this cutting on the groundwater regime during construction and operation of the Project were assessed. The findings of the detailed groundwater assessment presented in the Hydrogeological Risk Assessment (Application Document 6.3, Appendix 14.5) are summarised in Section 6.

3.5 Infiltration basins and swales

3.5.1 To the south of the River Thames, during the operation of the Project it is proposed to discharge highway runoff to ground. Existing infiltration basins situated on the A2/M2 would be upgraded and several new infiltration basins, both single and in cascade arrangement, would be constructed. To the north of the River Thames one new infiltration basin is proposed at the A13/A1089/A122 Lower Thames Crossing junction. Near the junction, swales are also proposed to capture highway runoff and facilitate infiltration to ground. Swales are also proposed in the vicinity of the A122 Lower Thames Crossing/M25 junction. The Project infiltration drainage features are described in more detail and are illustrated in Annex N and Annex O of the Hydrogeological Risk Assessment (Application Document 6.3, Appendix 14.5). Detailed assessment of these infiltration drainage features was undertaken. The results are summarised in Section 6.

3.6 Utilities

3.6.1 Modifications to energy infrastructure are required as part of the Project, including upgrade, replacement and rerouting of electricity, water, gas and telecommunications utilities. Four utilities diversions constitute Nationally Significant Infrastructure Projects (NSIP) in their own right and works are summarised in Chapter 2: Project Description (Application Document 6.1), Appendix 2.1: Construction Supporting Information (Application Document 6.3) and illustrated in Figure 2.2: Project Proposals (Application Document 6.2).and Figure 2.5: Construction Information (Application Document 6.2).

3.6.2 It is estimated that 95% of the proposed total underground utility corridors would comprise shallow (within 3m depth) open cut trenches. Nevertheless, where assets are below ground level the potential for impacts on groundwater flows and levels, and groundwater quality has been assessed. The results are summarised in Section 6 and more detail is provided in Annex Q of the Hydrogeological Risk Assessment (Application Document 6.3, Appendix 14.5).

3.6.3 Using the understanding gathered from the studies listed in Section 2, with due consideration of the embedded design components and mitigation principles that would be adopted, each of the tabled activities has been assessed for the potential to cause deterioration in WFD water body status. Deterioration is defined as a reduction in a quality element by one class, for example, from good to moderate status, or where a water body is in the lowest class, where

there is any detrimental impact on the status of a quality element (Environment Agency, 2017)[3].

3.7 Tunnel Drainage and Pollution Containment Measures

3.7.1 The tunnel drainage design includes capacity to deal with tunnel wall wash-down water, firefighting water, runoff from vehicles during wet weather outside the tunnel, and for any seepage through the segmental lining joints. Water collected within the tunnel would be channelled to a low point sump in each bore and pumped from that location to the North Portal for discharge via an outfall to the River Thames.

3.7.2 Contaminated discharge from major incidents, firefighting and maintenance activities would be pumped to an impounding sump at the North Portal for specialist disposal. Routine runoff would be pumped to an impounding sump and would then go through a treatment process before discharge to the River Thames. The design incorporates pollution control devices that comply with the DMRB CG 501 (National Highways, 2022).

3.7.3 Surface water runoff from the tunnel approaches would be collected in a separate sump such that it does not enter the tunnel. Each sump, one at the North Portal and one at the South Portal, would have pumps installed to discharge the collected water. The surface water runoff which is collected at the northbound sump would be pumped to an underground storage tank proposed to be located beneath the parking area adjacent to the North Portal building. This runoff would be discharged by a pumping main into the River Thames. The surface water runoff collected at the southbound sump would be pumped to an infiltration basin situated to the south east of the southern tunnel portal. The tunnel portals and approach structures have been designed to exclude groundwater, hence avoiding it entering the drainage system.

3.7.4 In other areas of the Project, the drainage design would also incorporate measures for pollution containment. The project includes commitments (RDWE025, RDWE034 and RDWE035) that would ensure protection of the groundwaters and surface watercourses that are proposed to receive operational drainage. These stipulate that drainage infiltration basins and retention ponds would be designed in accordance with the provisions of DMRB CD532 (National Highways, 2021), and DMRB CG501 (National Highways, 2022).

3.7.5 DMRB CD532 (para 3.6) requires that soakaway design shall incorporate measures necessary to provide spillage and pollution control to protect receiving groundwater and clause 4.4 states that the design of the soakaway and its immediate surroundings shall allow access for emergency personnel and equipment to be able to mitigate the effects of a spillage. DMRB CG501 provides for similar safeguards with regards to the design of surface water retention ponds.

[3] https://www.gov.uk/guidance/water-framework-directive-assessment-estuarine-and-coastal-waters

4 Assessment – WFD surface water bodies

4.1 Introduction

4.1.1 In response to comments received from the Environment Agency at Stage 1 of the assessment, the scope of the assessment includes all main rivers with the potential to be physically altered or to otherwise deteriorate because of the Project's construction or operational activities. The surface water bodies located within the Project's ZoI are presented in Drawing 2 in Annex C.

4.1.2 Some of these watercourses do not have a WFD status, so in line with Environment Agency advice (see Annex B), the assessment has focused on how the Project design has embedded measures to prevent their deterioration. The baseline condition of watercourses has been characterised through several surveys and assessments.

4.1.3 There are numerous ordinary watercourses within the ZoI, some of which the Project would cross, realign, or discharge drainage to. These watercourses have been subject to the appropriate assessments to identify the potential for effects on water quality, hydromorphology and flood risk. They have also been ecologically surveyed and assessments are presented in the Environmental Statement (Application Documents 6.1 to 6.3). The embedded design measures described below would be adopted to mitigate the effects of the Project and avoid deterioration of these watercourses.

4.1.4 Since preparation of the Stage 1 report in December 2017, which collated baseline data describing the status of the WFD water bodies within the ZoI, a new set of data has been published by the Environment Agency, most recently updated in May 2022. Review of the data has identified that the water bodies overall and ecological statuses remain as moderate, while each of the water bodies currently fail with regard to their chemical status. The reasons for the failures are common to all the water bodies and are attributed to three priority hazardous substances, namely mercury and its compounds, polybrominated diphenyl ethers (PBDE) and perfluorooctane sulfonate (PFOS). PBDEs are used in a wide array of products. PFOSs were used to treat carpets, textiles and upholstery, and while their use has been phased out are very persistent in the water environment.

4.2 Update to address Environment Agency review comments

4.2.1 Following the Environment Agency's review in July 2022, additional assessment of the effects of the Project was completed on the following surface water bodies:

a. The water bodies (ditch network) in Filborough Marshes (part of the Thames Estuary and Marshes Ramsar site).

b. The West Tilbury Main, which would be culverted to facilitate the Project.

4.2.2 With regard to the water bodies in Filborough Marshes, as described in Section 3, rainfall runoff from parts of the southern tunnel entrance compound is proposed to be discharged into the western ditch. Also, the reception shaft of the ground protection tunnel and a satellite construction compound would be situated near water bodies in this location. Risks to water body status associated with these components of the Project are assessed below.

4.2.3 On the West Tilbury Main, the Environment Agency raised concerns regarding the disconnection of the water body by constructing a culvert that may make several kilometres of upstream habitat inaccessible for fish and other organisms. To address these concerns, the earthworks design has been modified to reduce the culvert length, and the Project has committed to several embedded design features to reduce the potential for a barrier effect, details of which are described below.

4.3 Avoiding deterioration

4.3.1 The Project as submitted with the DCO application includes a range of environmental commitments under the following categories:

a. Embedded mitigation: measures that form part of the engineering design, developed through the iterative design process.

b. Good practice: standard approaches and actions commonly used on infrastructure development projects to avoid or reduce environmental impacts, typically applicable across the whole Project.

c. Essential mitigation: any additional Project-specific measures needed to avoid, reduce or offset potential impacts that could otherwise result in effects considered significant in the context of the Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 (the EIA Regulations), including deterioration of WFD water bodies.

4.3.2 Embedded mitigation measures are secured by inclusion in the Design Principles (Application Document 7.5), or as features on Figure 2.4: Environmental Masterplan (Application Document 6.2).

4.3.3 Good practice and essential mitigation measures are documented in the REAC. The REAC forms part of the CoCP (Application Document 6.3) and the measures are secured by Schedule 2, Requirement 4 of the draft DCO (Application Document 3.1). Each entry to the REAC has an alpha-numerical reference code e.g. [RDWE0XX] and relevant extracts that would safeguard surface water bodies are provided below.

4.3.4 Relevant secondary consents (from the Environment Agency and MMO) would also be secured. Details of the secondary consents relevant to protecting WFD water bodies are provided in the Consents and Agreements Position Statement (Application Document 3.3).

Embedded design measures

4.3.5 Measures are embedded into the design of the Project to prevent deterioration of surface water bodies. The following paragraphs describe key principles and measures secured through the DCO application.

4.3.6 The design integrates clear span crossings of watercourses and avoids culverting unless there is no practicable alternative. Viaducts have been selected as the preferred option for spanning the channels of the Mardyke and its first order tributaries, the Golden Bridge Sewer and Orsett Fen Sewer. This is the lowest impact means of crossing watercourses, avoiding physical channel bed or bank disturbance, protecting existing hydromorphological regimes, as well as preventing ecological barrier effects and minimising losses of riparian habitats. This method of crossing also offers the best solution in terms of maintaining floodplain connectivity and minimising floodplain storage losses.

4.3.7 Described in Design Principle S12.05 (Application Document 7.5), where the Project crosses the statutory main rivers Mardyke, Orsett Fen Sewer and Golden Bridge Sewer. To protect river banks and facilitate access by the Environment Agency to these watercourses to undertake maintenance activities, a bankside access track is incorporated into the design of the crossings, the width of which would be subject to consultation with the Environment Agency.

4.3.8 Drainage of operational areas on greenfield sites would be designed to ensure that post development surface water runoff rates do not exceed existing rates (LSP.16). Where this attenuation is provided via ponds, the ponds would be designed to appear as naturalistic elements within the wider setting, with planting provided to soften edges where this is appropriate, and ditches would be used to convey runoff in preference to pipes (LSP.17). This strategy would protect receiving watercourse flow regimes as well as preventing increased scour near drainage outfalls and changes to sediment deposition/accretion in downstream reaches.

4.3.9 Realigned watercourse channels would be constructed to reflect the size and form of existing channels to accommodate baseline flow and sediment regimes. The Design Principle S9.10 commits to, where practicable, constructing realigned channels that are more naturalised in form and that follow historic ditch patterns, promoting morphological and habitat diversity.

Essential mitigation

4.3.10 The operational drainage design would include treatment measures for highway runoff designed in accordance with DMRB CG 501 (National Highways, 2022) and DMRB CD 532 (National Highways, 2021) to meet the requirements specified for each outfall to surface watercourses identified in Appendix 14.3: Operational Surface Water Drainage Pollution Risk Assessment (Application Document 6.3) (RDWE025). With reference to DMRB CG 501: Design of Highways Drainage Systems (Version 2.1.0), Table 8.3.2N1, (National Highways, 2022) these measures offer the highest practicable treatment efficiencies for sediments and solubles.

4.3.11 In some locations culverting cannot be avoided. For example, on the West Tilbury Main where topography and contaminated land issues prevent a clear

span crossing design, and on the Mardyke West Tributary, where an existing culvert requires extending.

4.3.12 Where culverting cannot be avoided, new culverts would be sized to maintain the current land drainage regime and to convey flood flows, inclusive of allowance for climate change as detailed in Appendix 14.6: Flood Risk Assessment (Application Document 6.3), without causing any detriment to baseline flood risk. Culvert inverts would be buried below existing bed levels to allow baseline bed levels, slopes and bed materials to be maintained (RDWE013). Bankside vegetation would be reinstated at culvert entries and exits following the completion of construction works as soon as conditions are suitable for planting (RDWE009).

4.3.13 The West Tilbury Main culvert would be partially submerged at its downstream end to prevent perching, and a resting pool for coarse fish would be provided immediately downstream of the culvert, with a minimum depth of 0.3m (RDWE031). This culvert would also integrate a fish pass aid designed for eels and elvers, incorporating some form of matrix, such as bristles, to assist their migration by crawling/climbing instead of swimming (RDWE030). At the culvert entrance planting would be designed to ensure no sharp light/dark interface, to encourage continued fish passage. This would be achieved by planting with a scrub mix that would include alder. Root barriers would be installed to protect the structural integrity of the bank as appropriate (RDWE021).

4.3.14 On the Mardyke West Tributary, where extension of an existing culvert is required, the new culvert would have the same dimensions as the existing structure. The culvert extension design has been discussed and agreed with the Environment Agency. Further details are provided in Part 10 of the Flood Risk Assessment (Application Document 6.3, Appendix 14.6).

4.3.15 To reduce the potential for scour and associated hydromorphological change, highway drainage outfall headwall arrangements would be set back from the banks of the receiving watercourses and outfall designs would accord with DMRB CD 529 (RDWE011).

4.3.16 Collectively, the measures described above would allow existing hydraulic and sediment transport regimes to be maintained, as well as providing culverts that are passable for fish and eels.

4.3.17 Invasive species would be identified prior to construction and would be removed or treated to prevent their spread, following the CIRIA guidance in Invasive Species Management for Infrastructure Managers and the Construction Industry (Wade *et al.*, 2008) (TB005).

4.3.18 To prevent impacts on the physico-chemical and dependent WFD biological quality elements of the surface water bodies located in Filborough Marsh, treatment of runoff from the southern tunnel entrance compound would be provided prior to discharge into the system. Runoff would be treated to the standard specified within the discharge consent granted by the Environment Agency (RDWE033).

4.3.19 As described in commitment RDWE033, a runoff collection and management regime would be designed, implemented, and operated until full reinstatement of the compound area is complete. Taking advantage of the sloping topography, treatment and storage would be facilitated using a series of ponds or lagoons

and weirs within the Order Limits. These are proposed to be located north of the A226, leading to a final pond within the southern tunnel entrance satellite compound.

4.3.20 There is also a commitment to provide sufficient attenuation storage volumes within the compound area to allow controlled discharge at no more than the one in two year greenfield rate or $2ls^{-1}$; whichever is greater (RDWE033). This measure would avoid effects on the hydromorphology element of receiving water bodies, as well as safeguard biological quality elements that rely on existing flow and water level conditions.

4.3.21 Launch and reception shafts and the ground protection tunnel would be constructed using the techniques described in Section 3, to form a lined tunnel with a specified maximum leakage rate compliant with the Lower Thames Crossing tunnelling specification (RDWE018a). This would minimise water ingress to avoid changes to the local hydrological regime.

Construction good practice

4.3.22 Some construction activities would last for a short duration (under one year) and have the potential to cause only temporary and localised effects on the water environment, which would be negated following a short period of recovery. These low-risk activities, identified in the Stage 3 assessment, including for example landscaping works, traffic management and some utility diversions, are excluded from this assessment.

4.3.23 Where larger-scale utilities diversions are required, watercourses would be crossed using trenchless techniques, in order to avoid disturbance to channel form, flow regimes and riparian habitats and species, unless other techniques are agreed with the Environment Agency or Lead Local Flood Authority, where relevant (RDWE008).

4.3.24 Other activities in the construction programme would take place over a longer duration and have higher risks of causing deterioration of WFD water bodies. However, adopting best practice measures for establishing and then managing activities at construction compounds would prevent pollution incidents. These measures are described in the CoCP (Application Document 6.3, Appendix 2.2).

4.3.25 The locations of the proposed compounds and haul roads are illustrated in Drawing 1 in Annex C. Compounds would serve a range of different functions and provide for a range of facilities. Typically, these would include materials and aggregates storage, parking, plant management and refuelling, offices and welfare facilities and vehicle/wheel wash areas. In the southern and northern tunnel entrance compounds, and at the compound from which construction of the box under the M25 would be managed, specialist plant and equipment would be situated. In addition, there would be a series of utilities hubs, that would provide for laydown and temporary storage facilities to support utilities diversions works.

4.3.26 Hardstanding would be required for all areas accommodating offices, plant and material storage, welfare, workshops and security provision. Compounds and utilities hubs would operate for varying durations and once a compound or hub

is no longer needed it would be decommissioned and the area reinstated to an agreed hand-back condition.

4.3.27 The paragraphs below list construction good practice measures which would be adopted by the Contractor to prevent deterioration of WFD water bodies.

4.3.28 Water supplies to the compounds would be sourced from the mains, and wastewater generated from the compound welfare facilities would be discharged to sewer, subject to the agreements with the utility providers or in locations where a sewer connection is not practicable, collected and tankered offsite for disposal at a licensed treatment facility (RDWE005).

4.3.29 Surface water drainage would be provided for all surfaced roads and yards, buildings and any other hard or impermeable surfaces. Berms and bunds would be constructed to manage surface water runoff where necessary to protect watercourses, prevent ponding and to keep general runoff separate from contaminated runoff. Rainfall runoff from areas where there is a risk of contamination would be managed using temporary drainage systems and would be subject to treatment prior to discharge to any surface watercourse or drain. Rainfall runoff from areas of low contamination risk would be captured and re-used where practicable, e.g. to supply wheel wash facilities or for dust suppression, to reduce consumptive water use (RDWE006).

4.3.30 Work site drainage systems would incorporate pollution control systems designed in line with Control of Water Pollution from Construction Sites C532 (CIRIA, 2001) or as agreed with the Secretary of State. Watercourses near work sites would be regularly inspected for signs of siltation or other forms of pollution in line with CIRIA C741 guidance (CIRIA, 2015) and pumped groundwater, process effluents and construction site runoff would be tested to ensure compliance with discharge consent requirements (RDWE006). These systems would be inspected and maintained to ensure they continue to operate to their design standard, safeguarding surface water quality (RDWE002).

4.3.31 Water discharged into the Thames Estuary and Marshes Ramsar site from the southern tunnel entrance compound would be treated to the standard specified within an environmental permit granted by the Environment Agency and released at greenfield runoff rates. The runoff collection and management system would be operated until full reinstatement of the compound area is complete (RDWE033).

4.3.32 Compounds would be set out to minimise pollution risks to the surface water bodies in proximity to them (GS004 and GS005). This commitment specifies that pollution prevention equipment would be readily available and that protocols to deal with any accidental spillages as soon as they are identified, would be put in place. The commitment also describes requirements for refuelling of plant and the storage and transfer of any potentially contaminating liquids and materials.

4.3.33 Haul roads would be constructed up to a width of 15m with two-way travel or segregated one-way travel. Topsoil stripped during the construction of the haul road would be stockpiled adjacent to the haul road to a maximum height of 2m. Haul roads would be enclosed within hoarding/fencing. Their design would avoid cutting off existing surface water flow routes and inducing change to

catchment hydrology. Pollution from haul road runoff would also be prevented through suitable drainage and treatment arrangements.

4.3.34 Where bank protection is required during construction work, this would where practicable, take the form of soft or natural riverbank protection, such as coir or other biodegradable geotextiles (RDWE010).

4.3.35 As stipulated by Schedule 2, Requirement 4 of the draft DCO (Application Document 3.1), the Contractor would be required to develop an Environmental Management Plan (Second Iteration) (EMP2) which complies with the measures secured through the CoCP (Application Document 6.3, Appendix 2.2). All activities would be required to operate in accordance with the EMP2.

4.4 Compensating for unavoidable effects

4.4.1 Some effects on the surface water environment cannot be completely avoided by design within the constraints that apply, namely the loss of floodplain storage volume and the culverting of watercourses.

4.4.2 Compensatory flood storage would be provided to offset the volume of floodplain storage displaced by the Project, as described in the Flood Risk Assessment in Appendix 14.6 (Application Document 6.3). The compensatory storage would be formed and expanded in stages during construction of the Project. The compensatory storage, illustrated on Figure 2.4: Environmental Masterplan (Application Document 6.2), may be used to offset any temporary loss of floodplain storage, provided that the volume of compensatory flood storage available always equals, or exceeds, the total volume of displaced floodplain storage (RDWE037).

4.4.3 Where culverting cannot be avoided on two main rivers (the West Tilbury Main and Mardyke West Tributary) and several ordinary watercourses, there would be losses of bankside and in-channel vegetation. Mitigation for channel and freshwater habitat loss is centred around land in the Mardyke catchment at Orsett Fen (Drawing 2 in Annex C). The landscape currently comprises arable agricultural fields, with ditches at field boundaries; the Mardyke flows adjacent to the western boundary. A design has been developed for a range of freshwater habitats, including a network of ditches and open water bodies, and associated riparian vegetation, to create a net gain in water body reprovision and opportunities to create freshwater habitats of better quality than the habitats lost through culverting. These features are illustrated in Figure 2.4 Environmental Masterplan (Application Document 6.2). Some compensation would also be provided in the West Tilbury Main catchment, associated with removal of three existing culverts on the watercourse (RDWE046), and reinstating another reach (approximately 125m) by undertaking works to unblock an existing culvert (RDWE047).

4.5 Contributing towards improvement in water body status

4.5.1 The Project presents opportunities to contribute to improvements in the baseline status of some of the supporting elements of surface waters in the study area.

4.5.2 An ordinary watercourse in the Mardyke catchment is currently in culvert. Subject to securing landowner agreements and other permissions, a reach of this culvert would be broken out, providing for a net increase in the open channel reach on this watercourse of approximately 500m. This would provide for potential improvements in hydromorphological diversity, as well as creating habitat for macroinvertebrates, macrophytes and fish.

4.5.3 As illustrated on Figure 2.4 Environmental Masterplan (Application Document 6.2) other areas of wetland habitat creation are also proposed. Adjacent to the Mardyke West Tributary, where a narrow area of land is proposed for use as floodplain compensation storage provision, the proposed landscape design includes planting with marshy grassland. This would provide for habitat creation for riparian macroinvertebrates and macrophytes contributing to the biological quality status of the watercourse.

4.5.4 In the Mardyke catchment, as described above, wetland restoration and wet woodland planting is proposed on land adjacent to the Mardyke viaduct, combining habitat improvement in this area with the provision of floodplain compensation storage.

4.5.5 At Coalhouse Point, brackish wetland creation is proposed on land that is currently in agricultural use. The ditch network created would provide for macroinvertebrates and macrophyte habitat, as well as habitat for eels and some fish species.

4.6 Residual effects

4.6.1 The three WFD classified water bodies located within the ZoI (the Mardyke, the Mardyke West Tributary and the Mardyke East Tributary) currently have an overall status of moderate and are all designated as heavily modified by human activity. Those watercourses not specifically designated, but included in the scope of this assessment, are assumed to share similar qualities, given that they have comparable physical and hydrological characteristics and drain similar catchments.

4.6.2 The overarching objective for these watercourses, described in the Thames River Basin District River Basin Management Plan (RBMP) (Environment Agency, 2015), is for no deterioration of their status. No measures are identified in the current RBMP cycle to contribute to improving water body status. However, the South Essex Catchment Partnership has a masterplan for restoration of the Lower Mardyke. Proposals are to improve 1km of the Lower Mardyke by creating new berms to form a narrower river channel with faster flow, exposing river gravels and creating new breaches/channels to enhance and restore 20 hectares of riparian habitat. The South Essex Catchment Partnership is also involved in a Defra funding bid to introduce natural flood management approaches in the Stanford-le-Hope region, in the upper catchment of the Mardyke.

4.6.3 In the consultation draft update to the Thames RBMP (Environment Agency, 2021) the objective of the majority of surface water bodies to achieve good ecological status (or potential) by 2027 has been set, with a longer-term goal for all surface water bodies to attain good chemical status by 2063. However, the draft plan notes that it is unlikely that existing funded measures and new

initiatives currently in development, will be sufficient to achieve all the objectives of the river basin management plan by 2027.

4.6.4 The tables below provide a summary of the assessment of the residual effects of the Project on each of the WFD qualifying elements for surface waters within the ZoI.

4.6.5 Table 4.1 provides a focus on biological quality elements. In summary, on the Mardyke, Project surveys and sampling undertaken in 2018 were used to calculate the WFD metric for macroinvertebrates, and these metrics have been verified using more recent Environment Agency survey data. Data from summer sampling classified downstream reaches of the river as bad, due to the low number of species present. The autumn classification was high, which is attributed to the increased accessibility for sampling. At sites further upstream, the Mardyke was classified as moderate for both sampling seasons. The macroinvertebrate communities present are considered typical of what would be expected in a slow-flowing, lowland river. Macrophyte growth was observed to be abundant. More recent data from the Environment Agency (updated May 2022), reports a status of good for macroinvertebrates, and high for macrophytes.

4.6.6 A variety of fish species, albeit in low densities of generally less than one fish per $100m^2$, have been recorded as present in Environment Agency surveys, with the most recent undertaken in 2019. Nine different coarse fish species have been recorded in total. European eel was also recorded, with the highest density of 3.71 per $100m^2$ at a survey site on the Mardyke at Grangewaters.

4.6.7 No fisheries survey work was undertaken on the West Tilbury Main due to the nature of the watercourse being small and subject to periodic drying out. However, as a result of the connectivity with the Thames Middle water body via the Bowater's Sluice, and in discussion with the Environment Agency, a precautionary stance has been taken. It has been assumed that eels as well as minor coarse fish species are likely to be present in the West Tilbury Main such as roach and dace. Water quality conditions linked to salinity are suboptimal for many freshwater invertebrate families at some of the sites sampled on the West Tilbury Main system, and this may be a factor in the depressed scores recorded. These scores are corroborated by macroinvertebrate and macrophyte surveys undertaken in the spring and summer of 2022.

4.6.8 The Mardyke East Tributary, although located within the ZoI, would not be subject to any physical change and would not receive any construction or operational drainage discharges from the Project. It is considered that there is no potential for impacts on any of the WFD quality elements of this watercourse.

Table 4.1 Residual effects – biological quality elements for WFD surface water bodies

Water body	Project risks	Assessment commentary	Residual risk of deterioration at the water body scale
Mardyke	New structures	The design leaves existing channel bed, banks and riparian corridor undisturbed.	No risk

Water body	Project risks	Assessment commentary	Residual risk of deterioration at the water body scale
Orsett Fen Sewer Golden Bridge Sewer	spanning watercourses	Very limited change to existing light availability and shading due to the large, tall open spans of the proposed viaducts.	
West Tilbury Main Mardyke West Tributary	Watercourse culverting	Culverting equates to approximately 2% (56m) loss of open channel on the West Tilbury Main (Drawing 4, Annex C), offset by removal of 3 existing culverts and restoration of a 125m reach of open watercourse by unblocking an existing culvert. Culverting causes an open channel loss of less than 1% on the Mardyke West Tributary (26m). Barriers to fish passage and habitat fragmentation would be prevented through best practice culvert design, described in Section 4.3. There is no evidence in the literature to suggest that lighting conditions in long culverts prevents fish migration. Downstream drift of upstream macrophyte seeds and invertebrate larvae would still function. The location of the culvert low down in the catchment would lessen effects on upstream migration of winged invertebrates, with interruption limited to the very bottom of the catchment only. Loss of habitat for in-channel macroinvertebrates would be reduced by retaining natural substrates in culvert beds and compensated for by habitat reprovision within the Mardyke catchment and localised improvements on the West Tilbury Main. Loss of bankside/fringe habitat for macroinvertebrates and macrophytes would be compensated for as described in Section 4.4.	Fish – negligible Macrophytes – negligible Macroinvertebrates – negligible
Mardyke Mardyke (West Tributary) Orsett Fen Sewer	Receipt of operational drainage discharges	Pollution risk assessments confirm that in terms of both acute impacts and environmental quality standard (EQS) compliance for soluble and sediment-bound pollutants, the proposed	Negligible. There would be no deterioration in the baseline water quality of receiving watercourses, safeguarding their

Water body	Project risks	Assessment commentary	Residual risk of deterioration at the water body scale
West Tilbury Main		treatment measures embedded in the drainage design are effective4. Residual spillage risk does not exceed acceptable thresholds, as defined by LA 113 of the DMRB.	fish, macrophyte and macroinvertebrate assemblages.
All surface water bodies within the ZoI	Construction activity including establishing compounds, stockpiling of materials and spoil, as well as utilities diversions	Barriers to fish migration would be prevented by ensuring suitable watercourse crossings (RDWE008). The water quality of watercourses would be safeguarded using good practice techniques, secured by REAC commitments GS004, RDWE001, RDWE002. Riparian habitat local to work sites would be protected by suitable fencing and losses would be compensated for as described in Section 4.4.	Fish – negligible Macrophytes – negligible Macroinvertebrates – negligible
West Tilbury Main Mardyke Mardyke West Tributary	Freshwater habitat creation introducing INNS	A bio-security risk assessment will be undertaken and any measures the assessment identifies as necessary to avoid the introduction or spread of INNS would be implemented (TB005).	No risk
All surface water bodies within the ZoI	Generation of airborne dust causing smothering of vegetation and changes to water quality	Air quality modelling has assessed construction dust effects on ecological receptors within 200m of construction activities. Any dust effects are concluded to be not significant following implementation of standard mitigation and dust management protocols. Generation of particulates from road traffic during operation would be negligible in comparison to the construction phase.	Negligible
Filborough Marshes ditches	Pollution due to receipt of rainfall runoff from the southern tunnel entrance compound	As described in Section 4.3, discharges would be treated to achieve compliance with environmental permit requirements as stipulated by the Environment Agency.	Negligible
	Changes to hydrological regime (water	Rainfall currently infiltrates to ground and underlying deep aquifers, or reaches the ditches in Filborough	Negligible

Water body	Project risks	Assessment commentary	Residual risk of deterioration at the water body scale
	levels, flows) and to physical form of the western ditch channel due to receipt of rainfall runoff from the southern tunnel entrance compound	Marshes slowly, via overland or soil water runoff. The discharges of rainfall runoff from parts of the construction compound would result in an increase in the total volume of water entering the surface water network. Although the overall volumes of water would increase, consequential changes to flows and water levels in the ditch network would not be appreciable. This is due to the proposed management regime, described and secured by REAC RDWE033, which would restrict discharge to the ditch network to the one in two year greenfield rate or 2l/s. This would also limit changes to baseline flow velocities and prevent scour/erosion and changes to physical channel form.	
	Pollution from construction of the ground protection tunnel reception shaft and pollution risks linked to use of the associated satellite compound	As detailed in Section 3, the effects of this component of the Project would be minimised through the selection of appropriate construction techniques and through good practice construction compound layout and management.	Negligible

4.6.9 A hydromorphology desk-based study has been undertaken to review the baseline hydromorphological characteristics of watercourses and assess their sensitivity to morphological change. The report, provided as Appendix 14.4: Hydromorphology Assessment (Application Document 6.3) has identified that many of the watercourses within the ZoI have been subject to extensive modification for land drainage and flood defence purposes, resulting in limited hydromorphological diversity. They have low energy flow regimes, with the Mardyke and West Tilbury Main subject to tide locking, whereby discharge into the Thames Middle water body is prevented at high tide. Table 4.2 presents the assessment of residual effects of the Project on the hydromorphology element.

Table 4.2 Residual effects – hydromorphology of WFD surface water bodies

Water body	Project risks	Assessment commentary	Residual risk of deterioration at the water body scale
West Tilbury Main Mardyke West Tributary	Culverting – concrete box culverts for main river crossings and pipe culverts, (minimum diameter of 900mm) for ordinary watercourse crossings	Changes to channel gradients, flow dynamics and sediment transport processes would be prevented through culvert design, as detailed in Section 4.3.	Negligible
Mardyke Orsett Fen Sewer Golden Bridge Sewer	New structures spanning watercourses	Structures have been designed using information from a hydraulic model. The model has been used to identify key floodwater flow routes and quantify channel and floodplain water levels and floodwater extents. This information has informed the design of new crossing structures and disruption of key floodplain flow paths would be avoided, afflux has been reduced, and floodplain flow connectivity has been maintained.	No risk – the design would leave the bed and banks of watercourses undisturbed as well the riparian corridor (minimum width to be agreed in consultation with the Environment Agency as committed to by Design Principle S12.05) and enables floodplain connectivity.
West Tilbury Main	Watercourse realignment	Changes to channel gradients, flow dynamics and sediment transport processes would be prevented through design, as detailed in Section 4.3. Removal of two near-90-degree bends provide a more naturalised channel alignment.	Negligible
Mardyke Mardyke West Tributary Orsett Fen Sewer West Tilbury Main	Drainage outfall installation and receipt of operational drainage discharges	Drainage outfall headwalls would be set back from channel banks of receiving watercourses, with inflow ditches to convey discharges from the headwalls to the watercourses (RDWE011). Discharge rates limited to the 1 in 1-year greenfield rate (or 1l/s, whichever is higher) at all new outfalls. At existing outfalls, a	No risk – the design would prevent scour local to drainage outfalls.

Water body	Project risks	Assessment commentary	Residual risk of deterioration at the water body scale
		reduction of baseline discharge rates of at least 50% would be achieved (RDWE035).	
Mardyke Mardyke West Tributary West Tilbury Main	Construction and use of haul roads	The design would ensure key surface water flow paths are not blocked to prevent physical, hydrological or hydromorphological change.	Negligible
All surface water bodies within the ZoI	General construction activity, establishing site compounds and works to divert utilities	Increases in impermeable land cover and effects on rainfall runoff rates and volumes would be managed (RDWE006). Compensatory flood storage would be provided to offset the volume of floodplain storage lost to the Project, as described in Appendix 14.6: Flood Risk Assessment (Application Document 6.3). The compensatory storage would be formed and expanded in stages during construction of the Project and may be used to offset any temporary loss of floodplain storage provided that the compensatory flood storage provisions always offset the total volume of lost floodplain storage (RDWE037). Works to cross watercourses for utility diversions would be undertaken in accordance with appropriate consenting regimes.	Negligible
Filborough Marshes ditches	Changes to hydrological regime (water levels, flows) and to physical form of the western ditch due to receipt of rainfall runoff from the southern tunnel entrance compound.	Rainfall currently infiltrates to ground and underlying deep aquifers, or reaches the ditches in Filborough Marshes slowly, via overland or soil water runoff. This mechanism would be maintained to drain parts of the compound but due to the increase in impermeable land, discharges of rainfall runoff from the construction compound would result in an increase in the total volume of water entering the surface water network.	Negligible

Water body	Project risks	Assessment commentary	Residual risk of deterioration at the water body scale
		Although the overall volumes of water would increase, consequential changes to flows and water levels in the ditch network would not be appreciable. This is due to the proposed management, secured by REAC commitment RDWE033, which would restrict discharge to the ditch network to greenfield rates. This would also limit changes to baseline flow velocities and prevent scour/erosion and changes to physical channel form.	

4.6.10 The remaining WFD supporting elements link to water quality, in terms of physico-chemical characteristics and the presence of a defined list of substances that are classified as specific pollutants. Baseline data for 2019, available for the Mardyke and its east and west tributaries from the Environment Agency catchment data explorer (Environment Agency, 2022), indicates overall moderate physico-chemical status. Low dissolved oxygen and high nutrient concentrations (phosphate in particular) prevent good status. These conditions are attributed to point sources of pollution as well as rural land management practices. All three watercourses achieve high status for specific pollutants, meaning conditions associated with no or very limited deviation from 'natural'. Table 4.3 presents the assessment of residual effects on these two WFD supporting elements.

Table 4.3 Residual effects – physico-chemical and specific pollutant elements of WFD surface water bodies

Water body	Project risks	Assessment commentary	Residual risk of deterioration at the water body scale
Mardyke Mardyke West Tributary Orsett Fen Sewer West Tilbury Main	Operational road drainage via surface water outfalls	Risk assessments of chronic and acute pollution of watercourses confirm that the proposed treatment measures embedded in the drainage design are suitably robust. Residual spillage risk does not exceed acceptable thresholds defined by LA 113 of the DMRB.	Negligible
Mardyke Mardyke West Tributary	Construction and use of haul roads	Haul route runoff would be suitably treated where there is a	Negligible

Water body	Project risks	Assessment commentary	Residual risk of deterioration at the water body scale
West Tilbury Main		risk of this being received by surface waters (RDWE006).	
All surface water bodies within the ZoI	General construction activity, including utilities diversions and establishing site compounds	Pollution prevented via the measures and protocols described in Section 4.3.	Negligible
Filborough Marshes ditches	Pollution due to receipt of rainfall runoff from the southern tunnel entrance compound	As described in Section 3, discharges would be treated to achieve compliance with Environment Agency discharge consent limits (RDWE033).	Negligible
	Pollution from construction of the ground protection tunnel reception shaft and pollution risks linked to use of the associated satellite compound	The effects of this component of the Project would be minimised through the selection of appropriate construction techniques and through good practice construction compound layout and management (GS004).	Negligible
All surface water bodies within the ZoI	Earthworks, cuttings and excavations mobilising ground contamination that reaches surface waters	Ground investigation data would identify areas of contamination and suitable methods of working would be adopted to manage pollution risks. Further detail is provided in Section 5.	Negligible
All surface water bodies within the ZoI	Airborne pollution generated during construction and operation	Air quality modelling has assessed construction dust effects on ecological receptors within 200m of construction activities. Any dust effects are concluded to be not significant following implementation of standard mitigation and dust management protocols. Generation of particulates from road traffic during operation would be negligible in comparison to the construction phase.	Negligible

5 Assessment – transitional water bodies

5.1 Introduction

5.1.1 The Project design is such that there are relatively few direct or indirect impacts on the Thames Middle water body. The bored tunnels would be constructed at a depth below the bed of the water body. Three discharges are proposed, two via new outfalls on the north banks of the river and one via an existing outfall on the south bank, as detailed below.

5.2 Update to address Environment Agency review comments

5.2.1 In response to comments received from the Environment Agency, additional assessment was completed to investigate the effects of the Project on the WFD qualifying elements of the Thames Middle water body linked to the discharges generated during construction at the northern tunnel entrance compound and operational tunnel drainage, via new subtidal outfalls.

5.2.2 The results of underwater noise and vibration modelling, further detailed in Chapter 9: Marine Biodiversity (Application Document 6.1) and air quality nitrogen deposition modelling which is explained in Chapter 5: Air Quality (Application Document 6.1) have been used to inform the assessment of residual effects.

5.2.3 Details of how the design embeds measures to avoid deterioration of the WFD status of the Thames Middle water body, are provided below.

5.3 Avoiding deterioration

5.3.1 A suite of measures would be embedded into the design of the Project to prevent deterioration of the Thames Middle transitional water body. The following paragraphs describe key principles and measures secured through the DCO application.

5.3.2 The main tunnels would be constructed so that the crown of the tunnel is at sufficient depth below the bed of the River Thames to avoid the need for any works within the river to provide tunnel scour protection (RDWE041).

5.3.3 Three discharges to the water body have been included in the design. Two of these are temporary construction phase discharges, while one is needed during operation of the Project. On the north bank of the water body two new outfalls are required to facilitate discharges from the northern tunnel entrance compound and operational tunnel drainage. The tunnel drainage outfall would be constructed local to the existing Bowater's Sluice and the temporary outfall would be situated approximately 20m to the west of Diver Shoal Groyne 4 (see Plate 3.4).

5.3.4 To the south, it is proposed to discharge the treated runoff from parts of the southern tunnel entrance compound to the western ditch within Filborough Marshes which discharges to the River Thames via the existing outfall at the Denton New Cut. The discharge would be managed in order to achieve agreed water quality standards set by an Environment Agency discharge consent

(RDWE033). With these measures in place, there would be negligible changes to the hydromorphology, biology and water quality supporting elements of the Thames Middle water body associated with the temporary discharge.

5.3.5 To the north, to facilitate the temporary discharge from the northern tunnel entrance compound, a buried pipe would be installed within a shallow sheet pile trench approximately 300m long across the intertidal zone with a precast outfall or diffuser head. This would be located approximately 20m to the west of Diver Shoal Groyne 4.

5.3.6 Flows discharged from the temporary northern outfall would be generated by dewatering of groundwater at the North Portal during its construction, process water generated from the TBM slurry treatment plant, and runoff collected from the stockpiles and hardstanding within the North Portal construction area. Dewatering and slurry treatment would commence in Spring 2025 and reach a peak in terms of the volumes generated in late 2026 (total duration of approximately 46 months).

5.3.7 The preliminary operational drainage design also provides for a piped outfall to discharge much smaller volumes (typically 5l/s) of tunnel drainage during the operation of the two tunnels. This outfall would discharge into the Thames Middle water body during high tide near to the existing outfall of the West Tilbury Main (the Bowater's Sluice).

5.3.8 Deterioration of hydromorphology, biology and water quality supporting elements linked to the construction of the new pipelines and outfalls to discharge construction drainage from the northern tunnel entrance compound and tunnel drainage during the Project operation would be prevented. This infrastructure would be designed in accordance with the Deemed Marine Licence and a series of commitments in the REAC, namely RDWE023, RDWE026, RDWE028, MB001, MB002, and MB006 would also reduce the potential for effects.

5.3.9 Effluents generated during construction would be tested and receive treatment at the northern tunnel entrance compound to meet the required standards, governed by any limits detailed in the conditions of an Environment Agency discharge consent, secured through the Environmental Permitting (England and Wales) Regulations 2016 process (RDWE023).

5.3.10 Effects relating to the construction of the dewatering discharge pipeline would be controlled by the measures agreed with the MMO as detailed in the Deemed Marine Licence. The design of the discharge pipeline and outfall to the River Thames would provide for a subtidal mid-water discharge for effective dilution and dispersal, and to reduce disturbance to the intertidal zone (RDWE028). Works would be undertaken at low tide to reduce the transmission of noise and vibration, and generation of suspended sediments into the water column (MB001).

5.3.11 Where piling is required to construct the outfall, underwater noise and vibration effects would be reduced by limiting piling activities to low tide periods only, reducing the transmission of noise and vibration directly into the water column. Techniques such as soft start/ramp-up would be used for the first 20 minutes of piling operations and should piling activities cease for more than 10 minutes, the soft start/ramp-up technique would be repeated. Vibro-piling would

be used until first refusal; thereafter impact piling would be used to toe in the piles. Hammer energy would be reduced once an acceptable drive rate is observed (MB002).

5.3.12 A biosecurity risk assessment and method statement will be developed in line with the International Convention for the Control and Management of Ships' Ballast Water and Sediments (International Maritime Organisation, Ballast Water Management Convention, 2004; entry into force, 2019). This will outline the risks and control measures for managing the introduction of INNS (MB006).

5.3.13 Operational stage discharges of tunnel drainage would be captured and contaminated waters would be isolated to prevent pollution of the Thames Middle water body. Discharges would also be restricted to high tide conditions to maximise available dilution and mixing and to prevent scour/erosion of the intertidal zone (RDWE026).

5.4 Residual effects

5.4.1 The Thames Middle water body has a current overall water body status of moderate and is designated as heavily modified by human activity.

5.4.2 The overarching objective for this water body, described in the Thames RBMP (2016), is for no deterioration of the current status. No measures are in place, or proposed in the current RBMP cycle, to contribute to improving water body status. It is noted that for the biological quality elements to achieve good status, there would be significant adverse impacts on the current use of this water body for navigation, as well as detriment to current standards of flood protection.

5.4.3 The 2021 consultation draft update to the Thames RBMP sets an objective for the Thames Middle water body of achieving good status by 2027, although noting there is low confidence in achieving this, and good chemical status by 2063.

5.4.4 Table 5.1 to Table 5.4 below, provide a summary of the assessment of the residual effects of the Project on each of the WFD qualifying quality elements for transitional waters, namely hydromorphology, biology (fish, invertebrates, macroalgae, phytoplankton and angiosperms), habitats and water quality (physico-chemical, specific pollutants and priority hazardous substances). Linked protected areas and INNS have also been considered.

5.4.5 Table 5.1 provides an assessment of biological quality elements. The baseline attributes of the biology of the study area are described in detail in Chapter 9: Marine Biodiversity (Application Document 6.1). In summary, macroinvertebrate communities in the intertidal areas in the vicinity of the Project comprise the *Hediste diversicolor* and *Scrobicularia plana* biotope, and the sandy mud community dominated by the *Hediste diversicolor* and *Macoma* (*Limecola*) *balthica* biotope. Surveys have identified low abundances of molluscs and extremely high abundances of the amphipod shrimp *Corophium volutator* and *Oligochaete* worms across the area. Data from surveys carried out in 2017 and 2018 recorded diatoms as being the most diverse group of phytoplankton (also known as microalgae) present.

5.4.6 Reports of fish within the estuary include species of conservation importance (including *allis shad Alosa alosa*, *twaite shad Alosa fallax*, short-snouted seahorse *Hippocampus hippocampus*, *Raitt's sandeel Ammodytes marinus*,

European eel *Anguilla anguilla*, herring *Clupea harengus*, cod *Gadus morhua*, angler fish *Lophius piscatorius*, whiting *Merlangius merlangus*, smelt *Osmerus eperlanus*, plaice *Pleuronectes platessa*, Atlantic salmon *Salmo salar*, sea trout *Salmo trutta*, mackerel *Scomber scombrus*, and Dover sole *Solea solea*) and migratory species that use the river as a conduit to transit between the marine and freshwater environments. In addition, several commercially important species have been identified.

5.4.7 Published baseline noise data for the estuary indicates noise level in the region of 153 to 158dB re 1µPa (Edmonds and Moore, 2009). This indicates that biological communities in the area are already habituated to relatively high underwater noise levels. Modelling of the noise and vibration from tunnel construction was carried out using the Rupert Taylor Finite Difference Time Domain model FINDWAVE®.

Table 5.1 Residual effects – biological quality elements of the Thames Middle water body

Project risks	Assessment commentary	Residual risk of deterioration at the water body scale
Project discharges affecting phytoplankton, zooplankton and invertebrates through changes in salinity, changes in suspended solids and changes to water chemistry.	Effects would be restricted to the immediate area around the discharge locations. Within these very small areas there could be some inhibition of phytoplankton and zooplankton growth. However, this would not have any effect on abundance or diversity within the wider estuary. Due to the rapid mixing and dispersion of any discharges, any effects would be very small scale and are unlikely to be detectable above the ranges of natural variability.	Negligible
Project discharges affecting fish through changes in salinity, changes in suspended solids and changes to water chemistry.	Discharge rates and volumes would be very low in comparison to the discharge rate of the Thames. Treated effluents would be rapidly dispersed, and any effects would be highly localised around the discharge points and very small compared to the available habitat for fish in the wider context of the estuary. Changes to suspended solids levels are unlikely to be discernible above the naturally high background concentrations.	Negligible
Disturbance to fish and macroinvertebrates by noise and vibration during construction and operation of the Project.	As detailed in Chapter 9: Marine Biodiversity (Application Document 6.1), modelling was used to predict underwater noise and vibration levels for both construction (action of the TBMs) and operation (tunnel road noise) of the Project. The modelling produces results at a point above the TBM, representing worst case, and at the edge of the mudflats on the north and south of the Thames above the tunnel alignment. The results show that the highest levels of underwater noise associated with TBM operations are 130dB re	Negligible - modelled worst-case noise and vibration levels during both construction and operation fall outside of the published sensitivity thresholds for marine invertebrates (Roberts, 2015),

Project risks	Assessment commentary	Residual risk of deterioration at the water body scale
	1µPa (Sound Pressure Level), at a frequency of 100Hz, decreasing with increasing distance from the tunnel. Cumulative noise levels (SELcum) were derived from the modelling and at worst-case sound levels this reached 150dB re 1µPa.	(Roberts and Breithaupt, 2016), (Cook, 2017) and below the trigger for temporary threshold shift in fish that are the most sensitive to sound ((Popper et al., 2014).

5.4.8 Adjacent to the Order Limits, the Thames Middle water body has a width of approximately 900 to 1,000m. The estuary is macro-tidal, with tidal flow speeds of 2m/s, approximately two hours after high water on spring tides. Minimum flow speeds are reported in the region of 0.1 - 0.75m/s as low water approaches. The bed of the intertidal area is characterised by mudflats. Table 5.2 provides a summary of the assessment of the potential for changes to existing hydromorphological regimes.

Table 5.2 Residual effects – hydromorphology of the Thames Middle water body

Project risks	Assessment commentary	Residual risk of deterioration at the water body scale
Intertidal scour and erosion caused by discharging treated construction effluents	Risk avoided through design as detailed in Section 5.3. The northern outfall would be positioned at the edge of the intertidal zone to facilitate dispersion and mixing of the discharge sub-tidally, into the deep-water channel. To the south, discharging the effluent to the western ditch in Filborough Marshes ditch network at greenfield rates prior to outfall at the River Thames via an existing structure would lead to no appreciable change in hydromorphology.	Negligible
Hydromorphological change induced by discharge pipe construction	Risk avoided through design secured by commitment RDWE028, detailed in Section 4.3.	Negligible

5.4.9 The intertidal areas of the water body are typically characterised by mixed coarse sediments, mud and sandflats backed by seawalls, with some areas of saltmarsh.

5.4.10 Near to the Project there are extensive areas of intertidal habitat. These intertidal habitats provide foraging, breeding and nursery habitat for aquatic invertebrates and fish.

5.4.11 There is one international, two European and five nationally designated sites with habitats and/or WFD qualifying receptors that may be influenced by the Project's activities, due to their location within the average tidal excursion. Table

5.3 provides a summary of the assessment of the potential for deterioration of habitats and protected areas.

Table 5.3 Residual effects – habitats and protected areas (including INNS)

Project risks	Assessment commentary	Residual risk of deterioration at the water body scale
Direct intertidal habitat loss under the footprint of the marine works	Following the construction period and subsequent decommissioning of the temporary marine structure associated with the northern tunnel entrance compound, intertidal substrate and new hard structures would be available for colonisation. Once habitats have become re-established through the action of the tides, invertebrate fauna would be expected to move into the area rapidly from adjacent habitats.	Negligible
Habitat fragmentation caused by the marine works	There is no risk of the fragmentation of habitats or isolation of species and communities as the proposed marine structures would not form a complete barrier across the intertidal zone.	Negligible
Detriment to the functioning of protected areas	Some of the intertidal habitats and associated invertebrates are considered to be functionally linked supporting habitats for bird qualifying features of the Thames Estuary and Marshes Ramsar/Special Protection Area (SPA); Benfleet and Southend Marshes; Medway Estuary and Marshes; and The Swale Ramsar Sites/SPA. Habitats Regulations Assessment (HRA) screening has concluded that land take and disturbance effects from the marine works mean that a likely significant effect could not be ruled out and so have been considered within the Appropriate Assessment to demonstrate there would be no adverse effects on the integrity of the protected sites.	Negligible, following inclusion of mitigation measures as assessed by the HRA Appropriate Assessment.
Introduction or spread of INNS, e.g. the Chinese mitten crab, which has been recorded on the cooling water intake screens of the RWE Tilbury Power Station just upstream of the Project.	The most likely pathway for INNS to be introduced to water bodies within the Order Limits is from marine plant and vessels which can transport INNS as fouling on hulls and in ballast water. General marine traffic associated with the marine construction works also has the potential to transfer INNS that are currently present to other areas. The embedded mitigation, described in Section 4.3 and secured by REAC commitment MB006, has been proposed to reduce the likelihood of transmitting non-native species during the construction phase.	Negligible
Deposition of air pollutants (nitrogen, sulphur) generated during construction and	Air quality modelling has been undertaken to assess the effects of nitrogen deposition on sensitive receptors within 200m of the Affected Road Network (ARN). The model results demonstrate that localised changes in air quality caused by the	Negligible

Project risks	Assessment commentary	Residual risk of deterioration at the water body scale
operation of the Project, causing acidification	Project would be negligible, causing increases in nitrogen deposition that do not exceed critical loads. Further information is provided in Chapter 5: Air Quality and Chapter 8: Terrestrial Biodiversity (Application Document 6.1).	

5.4.12 The remaining WFD supporting elements relate to water quality, in terms of physico-chemical characteristics and the presence of a defined list of substances that are classified as specific pollutants. Baseline data from a long-term Environment Agency monitoring site at Gravesend show that some of the specific pollutants and priority substances tested for, are at levels exceeding or approaching WFD EQS limits. These include mercury, zinc, cyanide and tributyl tin compounds. Various polycyclic aromatic hydrocarbons are also reported at maximum concentrations that exceed the relevant EQSs, including benzo(b)fluoranthene, benzo(g,h)perylene and benzo(k)fluoranthene. Also, the data available likely significantly underrepresents the benzo(a)pyrene levels in Thames Middle waterbody, which is likely to be failing for this substance.

5.4.13 It is considered that this baseline reflects the urbanised and industrialised nature of the lower Thames Estuary. Some of the substances reported are persistent in the environment and bioaccumulate in organisms, which can pose a risk to health and fecundity.

5.4.14 Naturally high background suspended sediment levels have been recorded within the estuary. Baseline levels of suspended solids are variable with an average reported as 113.7mg/l which falls within the medium turbid water classification for WFD of 100 to 300mg/l. Table 5.4 presents the assessment of residual risks to the water quality supporting elements of the Thames Middle water body.

Table 5.4 Residual effects – physico-chemical and specific pollutant elements of the Thames Middle water body

Project risks	Assessment commentary	Residual risk of deterioration at the water body scale
Discharge of North Portal dewatering effluent, and southern tunnel entrance compound runoff during construction, and tunnel drainage during operation – freshwater influx.	Volumes of additional freshwater input would be insignificant in relation to the tidal discharge rate of the water body of approximately 15,000m^3/s. Strong tidal flows and mixing would rapidly disperse the discharged freshwater.	Negligible risk – the discharges would not lead to any detectable changes in the physico-chemical characteristics.
Discharge of North Portal dewatering effluent, and southern tunnel entrance compound runoff during construction, and tunnel drainage during operation –	Construction discharges would be treated to the required standards, governed by the conditions of an Environmental Permit, and tunnel drainage allows for treatment and emergency spillage containment. The	Negligible risk – the discharges would not lead to any detectable deterioration in

Project risks	Assessment commentary	Residual risk of deterioration at the water body scale
introduction of specific pollutants and priority hazardous substances.	strong tidal flows and mixing would rapidly disperse the discharged water.	status regarding specific pollutants.
Discharge of North Portal dewatering effluent, and southern tunnel entrance compound runoff during construction, and tunnel drainage during operation – suspended solids and associated contamination.	Discharge of suspended solids would likely not be discernible above the naturally high background suspended sediment levels within the water body. High tidal flows would rapidly disperse any small and temporary additional suspended sediment load.	Negligible risk – the discharges would not lead to any detectable changes in physico-chemical characteristics.
Discharge pipe construction – sediments mobilised which may release sediment-bound contaminants into the water column.	Works would be undertaken during periods of low water to reduce the resuspension of sediments. Any material re-suspended by the flooding tide would be rapidly dispersed and diluted.	Negligible risk
Deposition of air pollutants generated during construction and operation of the Project, causing acidification.	Air quality modelling has been undertaken to assess the effects of nitrogen deposition on sensitive receptors within 200m of the ARN. The assessment concluded that, with good practice mitigation measures in place, a significant air quality effect is not expected. Further information is provided in Chapter 5: Air Quality, and Chapter 9: Marine Biodiversity, (Application Document 6.1).	Negligible risk

6 Assessment – WFD groundwater bodies

6.1 Introduction

6.1.1 There are four WFD groundwater bodies within the defined ZoI, illustrated in Drawing 3 in Annex C, one to the south of the Thames Middle water body and the other three situated to the north. The Project includes several permanent components and construction activities that would interact with these underlying groundwaters, described in Section 3.

6.1.2 The effects of the Project on groundwater flows, levels and quality have been assessed through desk-based studies informed by historical data and published reports, in addition to numerical groundwater models focused on:

a. the ground protection tunnel and operational tunnels south of the River Thames

b. infiltration drainage basins located to the south of the River Thames and a basin and swales near the A13/A1089/A122 Lower Thames Crossing junction

c. the North Portal and its approaches

d. A122 Lower Thames Crossing/M25 junction

6.1.3 Models to assess the effects of the ground protection tunnel and main tunnels south of the River Thames and the North Portal, were completed using the latest available ground investigation data, including data from pumping tests in the Thames Estuary and Marshes Ramsar site. While data from a pumping test local to the North Portal has not been used to enhance the North Portal groundwater model, the data has been used to verify key modelling assumptions.

6.1.4 The southern groundwater model has also been used to investigate the risks of groundwater mounding due to infiltration of highway drainage during operation of the Project.

6.1.5 In addition, a detailed assessment of the potential for operational infiltration drainage to cause groundwater pollution was completed using the groundwater simulation software ConSim, developed on behalf of the Environment Agency (Environment Agency and Golder Associates (UK) Ltd, 2018). The model accounts for attenuation of pollutants within the unsaturated zone, dilution of pollutants by groundwater flow and the attenuating effects of degradation, retardation and dispersion in both unsaturated and saturated zones. Drinking Water Standards, set for the protection of public health, have been used to represent acceptable thresholds, and the model has computed the cumulative impacts of the infiltration basins proposed to the south of the River Thames, as well as the individual risk posed by each basin. The proposed infiltration basin to the north of the River Thames, at the A13/A1089/A122 Lower Thames Crossing junction has been assessed. Several swales, intended to drain side roads, have also been assessed.

6.1.6 A groundwater model was developed to estimate the groundwater seepage into the underpass and cutting excavation at the Project's junction with the M25 during construction. The model has also been used to assess the potential groundwater drawdown, including both temporary impacts during construction and any permanent impacts during operation.

6.1.7 An assessment of the potential impacts of below ground utilities corridors on the quantitative and chemical status of relevant WFD groundwater bodies has also been undertaken, using available design information and by developing conceptual models. This assessment has identified higher risk activities and receptors. Effects on these receptors would be avoided by the Project commitments detailed in Section 6.2 below.

6.2 Avoiding deterioration

6.2.1 To avoid deterioration of WFD groundwater bodies, a suite of measures, tested within the groundwater numerical models, are committed to in the application for development consent. Relevant secondary consents from the Environment Agency would also need to be secured, as detailed in the Consents and Agreements Position Statement (Application Document 3.3). The Project's commitments to safeguard groundwater are recorded in the REAC, relevant extracts of which are provided below.

6.2.2 A key element of the evolving Project design has been the location of the South Portal, which was moved approximately 350m south from the position presented during Statutory Consultation in 2018. This design change avoids the risk of deterioration of the quantitative status of the underlying WFD groundwater body (the North Kent Medway Chalk), as well as reducing the likelihood of opening a pollution pathway, causing deterioration of chemical status.

6.2.3 In addition to the two main crossing tunnels, as described in Section 3, construction of a 5.8m (OD) ground protection tunnel is proposed to enable the treatment of the ground to the south of the River Thames, under the Thames Estuary and Marshes Ramsar site, to facilitate safe TBM face interventions.

6.2.4 To ensure mitigation of the effects of excavations at the North Portal, the southern ground protection tunnel, and the main tunnel crossing to the south of the River Thames, as well as below ground utilities works, the following Project commitments have been made.

6.2.5 Construction of the North Portal and ramps would include deep barrier walls, e.g. diaphragm walls. During detailed design, further technical investigations and assessment would be undertaken to confirm any supplementary mitigation measures required to reduce groundwater ingress and drawdown that could mobilise contaminants from historical land uses The detailed design of the mitigation measures and any necessary monitoring would be informed by the modelling undertaken and consultation with the Environment Agency prior to the commencement of any excavation works and this is secured within the REAC (Application Document 6.3, Appendix 2.2) by commitment GS021. Failure of the diaphragm walls has not been assessed/mitigated for, as this situation is not considered to represent a reasonable worst case. The diaphragm walls would remain in situ post construction, and it is not proposed to breach them once the Project becomes operational.

6.2.6 The ground protection tunnel and shafts would be constructed using methods to minimise groundwater pumping and ingress. Methods would include wet excavation and grout plug placement to form the shafts; and use of mud pressure balance TBMs to form a lined tunnel with a specified maximum leakage rate compliant with the Lower Thames Crossing tunnelling specification (RDWE018a).

6.2.7 Water infiltration into the main tunnel bores and cross passages during operation would be reduced by inclusion of measures such as gaskets (for segmentally lined tunnels) and membranes (for sprayed concrete lined tunnels), compliant with the Lower Thames Crossing tunnelling specification. (RDWE027).

6.2.8 Construction of cross passages between the main tunnels would use groundwater control techniques, such as grouting or ground freezing, to reduce the requirement for dewatering and therefore local groundwater drawdown. (RDWE020).

6.2.9 The majority of utility corridors would be designed to be above groundwater and therefore would not cause temporary or permanent draining of groundwater and effects on groundwater levels, flows and quality. Where deep excavations are required below the water table then the works would be subject to Environmental Permitting Regulations (2016). In all cases, good practice measures, including obtaining necessary environmental permits, would be deployed to manage excavation wall stability and any water ingress, including water disposal. Following a precautionary principle, the REAC sets out Project commitments for utility corridors that have the potential to alter groundwater flows, levels and quality and therefore mitigation is proposed to reduce the potential effects. Details are shown in the Utilities Assessment (Groundwater)(Application Document 6.3, Appendix 14.5, Annex Q) and the REAC forming part of the CoCP (Application Document 6.3, Appendix 2.2).

6.2.10 Installation of a multi-utility corridor beneath the London, Tilbury and Southend railway would require works beneath groundwater. On completion of placing the utility diversion, the shaft walls would be removed, and the shafts would be backfilled with soil arisings in the same order as excavated in order to reduce change of the layered geology. Any groundwater removal during the works would be subject to Environment Agency environmental permitting regulations (RDWE056).

6.2.11 In relation to the above measures, the following paragraphs detail commitments that would also safeguard WFD groundwater bodies during the construction and operation of the Project.

6.2.12 Chemicals and materials, such as cement, grout and lubricants used during construction activities in proximity to any groundwater source protection zone (SPZ) would be stored, transported and used in a suitable manner to safeguard groundwater quality (RDWE019). This would avoid deterioration of chemical status of WFD groundwater bodies.

6.2.13 For protection of potable groundwater sources, no fuel storage or fuel filling shall be allowed within a published source protection zone 1 (SPZ1) or within the 50m default or other bespoke SPZ radius (agreed with the Environment Agency) of a private water supply well or spring (GS004 and GS005).

6.2.14 During operation of the Project, to safeguard groundwater chemical status, new infiltration basins and existing infiltration basins retained by the Project, would be fitted with treatment systems as identified in Part 7 of Appendix 14.6 of the Flood Risk Assessment (Application Document 6.3) (RDWE034).

6.2.15 Robust treatment systems would therefore be in place, intercepting suspended solids and sediment-bound contamination prior to infiltration of drainage discharges to underlying groundwaters.

6.2.16 A highway drainage retention basin situated near Chadwell St Mary would be fully lined to safeguard the water chemistry and quality of the underlying aquifer, as the basin is situated within the SPZ1 of a public potable water supply borehole (RDWE032). The basin would also be subject to inspection and maintenance (RDWE012) to ensure the efficacy of the lining over the Project's lifetime.

6.3 Residual effects

6.3.1 To the south of the Thames Middle transitional waters, the North Kent Medway Chalk has a current (based on cycle 2, 2019 data) overall water body status and constituent quantitative and chemical statuses of poor. To the north of the River Thames, one of the WFD groundwater bodies has poor overall status (the South Essex Thurrock Chalk) and one groundwater body, the South Essex Lower London Tertiaries, has good overall, quantitative and chemical statuses. The Essex Gravels has a poor overall status, attributed to poor chemical status. Diffuse pollution from deficient fertiliser and pesticide management practices on agricultural land are the key pressures cited in the RBMP, with leaking sewers and contaminated land also reported as reasons for not achieving good status for the North Kent Medway Chalk.

6.3.2 Within the RBMP, an objective has been set by the Environment Agency for the North Kent Medway Chalk and South Essex Thurrock Chalk water bodies to achieve good overall status by 2027. It is noted that it would be a disproportionate burden to achieve this sooner. The objective for the other WFD groundwater bodies in the ZoI is to maintain existing status. For the Essex Gravels it is noted in the RBMP that there is an unfavourable balance of costs to benefits associated with improving the chemical status of this water body.

6.3.3 No measures are in place, or proposed in the current RBMP cycle, to contribute to improving water body status. It is noted that measures to achieve the 2027 target statuses will be reported in the next cycle of river basin management planning (2021-2027).

6.3.4 The 2021 consultation draft of the Thames RBMP reports on measures linked to water resources charges schemes, applicable to all abstractors, and water industry national environmental programme projects as drivers of future status improvements.

6.3.5 In terms of their quantitative status, defined by the quantity of groundwater available as base flow to watercourses and GWDTEs, and as 'resource' available for use as drinking water and for other consumptive purposes, groundwater bodies within the ZoI to the north of the Thames Middle water body all have sufficient water available, with the exception of the South Essex Thurrock Chalk which has recently (2019) been downgraded to poor status with

regard to its quantitative water balance. Current rates of groundwater abstraction do not exceed the available groundwater resource and negatively impact on the water balance or result in saline or other intrusions of poor water quality.

6.3.6 To the south, the North Kent Medway Chalk groundwater body is reported to have an unfavourable water balance and insufficient water available to support the ecological status of associated surface water bodies with respect to water quantity.

6.3.7 Table 6.1 provides a summary of the assessment of residual effects on the quantitative status of groundwater bodies within the ZoI.

Table 6.1 Residual effects – quantitative status of WFD groundwater bodies

Water body	Project risks	Assessment commentary	Residual risk of deterioration at water body scale
North Kent Medway Chalk	Ground treatment for ground stability, for example, at cross passage locations, and to allow TBM interventions, including a ground protection tunnel south of the River Thames.	These works are generally confined to the shallow groundwater system, from which the deeper WFD Chalk water body is largely disconnected. With the proposed measures described in Section 6.2 in place and secured by REAC (RDWE0018a and 18b), modelling predicts a very minor and localised drawdown in the confined Chalk aquifer attributed to this temporary component of the Project.	Negligible
All groundwater bodies within the ZoI	Construction activity including stockpiling of construction and excavated materials leading to changes in groundwater recharge quantities and patterns.	Risk avoided by appropriate construction compound set-up and management of stockpiles in accordance with the CoCP (GS004), and suitable reinstatement of sites following works completion.	Negligible
All groundwater bodies within the ZoI	Embankments causing changes to groundwater recharge quantities and patterns.	Assessment concludes that recharge to WFD groundwater bodies in the ZoI would be insignificantly changed by the footprint of the proposed embankment earthworks.	Negligible
All groundwater bodies within the ZoI	Cuttings causing changes to groundwater recharge quantities and patterns, groundwater levels and flow directions.	Assessment concludes impacts on recharge patterns, groundwater levels and flows would be negligible or there would be no impact.	Negligible risk (see M25 cuttings entry below)

Water body	Project risks	Assessment commentary	Residual risk of deterioration at water body scale
Essex Gravels	Dewatering to facilitate below-ground construction impacting groundwater levels and flows at the M25 cutting and its surrounds, as well as impacts during Project operation due to permanent drainage of the cutting.	A modelling assessment, informed by available ground investigation data, concludes that construction of the cutting would cause a drawdown of up to 1.1m at nearby potential groundwater receptors in the worst-case scenario that assumes no seepage control measures are used during or after construction. The drawdown footprint is very much reduced, becoming limited to the corridor of land adjacent to the cutting, by control measures and can be eliminated by full lining of the cutting. The modelled worst case is considered unreasonable given some form of seepage control must be employed by the Contractor during construction to ensure slope stability and site safety. The exact means and methods of mitigation will be determined but a commitment to providing some form of seepage control mitigation is secured by the REAC (RDWE038).	Negligible
Groundwater bodies north of the Thames – South Essex Thurrock Chalk, South Essex Lower London Tertiaries and Essex Gravels	Ground treatment (soil mixing) and dewatering to facilitate tunnelling and other below-ground construction, impacting groundwater levels and flows – main tunnel and cross passages.	The Project design and construction techniques for the North Portal, main tunnel and cross passages would ensure negligible groundwater drawdown. Measures would be selected from the range reported in commitments GS0021 and RDWE0027, which are proven to be hydrogeologically effective. During operation, the resulting drawdown caused by seepage into the tunnels is very minor immediately above the main tunnel adjacent to the North Portal, reducing to negligible in surrounding areas. The maximum groundwater mounding predicted is negligible.	Negligible
All groundwater bodies within the ZoI	Underground utilities diversion works causing changes to groundwater flow patterns and groundwater levels.	Assessment has demonstrated no significant effects on groundwater flows or levels. Precautionary measures would be applied at higher risk locations associated with utilities works references G1b (RDWE051),	Negligible

Water body	Project risks	Assessment commentary	Residual risk of deterioration at water body scale
		MU12 and MUT2 (RDWE052), MU28 and MU33 (RDWE054) and MU37, MU38 and MU40 (RDWE055). The locations of which are illustrated on the Works Plans (Application Document 2.6). Where dewatering is necessary, works would be undertaken in accordance with the requirements of an Environmental Permit.	
North Kent Medway Chalk	Operational road drainage via infiltration basins causing changes to groundwater recharge patterns and groundwater mounding.	Assessment concludes that overall change would be insignificant due to the proposed highway drainage infiltration basins contributing to recharge to this groundwater body. There is no risk of basin failure due to groundwater mounding in any of the modelled scenarios.	Negligible
South Essex Lower London Tertiaries	Operational road drainage via an infiltration basin and swales causing changes to groundwater recharge patterns and groundwater mounding.	Assessment concludes that overall change would be insignificant due to the proposed infiltration basin and swales contributing recharge to this groundwater body. When hydraulic conductivity for the sand horizons in the Thanet Formation are assumed, there is no risk of basin failure due to groundwater mounding in any of the modelled scenarios.	Negligible

6.3.8 Chemical status is defined by the concentrations of a range of key pollutants, by the quality of groundwater feeding into watercourses and water-dependent ecosystems, and by the quality of groundwater available for drinking water purposes. Table 6.2 summarises the residual effects of the Project on groundwater chemical status.

Table 6.2 Residual effects – chemical status of WFD groundwater bodies

Water body	Project risks	Assessment commentary	Residual risk of deterioration at the water body scale
North Kent Medway Chalk	Ground treatment for ground stability and to allow TBM interventions, including a ground protection tunnel south of the River Thames.	The chemical status of the water body would be safeguarded, with groundwater model results indicating no change in salinity during construction or operation.	Negligible

Water body	Project risks	Assessment commentary	Residual risk of deterioration at the water body scale
Groundwater bodies north of the Thames - South Essex Thurrock Chalk, South Essex Lower London Tertiaries and Essex Gravels	Embankments, cuttings, and other excavations mobilising existing poor quality groundwater or ground contaminants from their soil source.	The Project design and construction techniques for the North Portal and other cuttings and excavations would limit impacts. A range of mitigation measures at the North Portal have been hydrogeologically tested using a groundwater numerical model. Results indicate that the potential for contaminants from historical land uses to be drawn towards the portal excavation can be effectively managed to prevent impacts on groundwater quality and suitable measures are secured by REAC commitment GS021.	Negligible
North Kent Medway Chalk	Chronic and acute (spillage induced) pollution, of groundwater bodies receiving drainage discharges and supported protected sites.	A detailed assessment of the risk of chronic groundwater pollution linked to infiltration drainage of highway runoff from the Project to the south of the River Thames has been completed. The assessment confirms that individually and cumulatively, the basins do not cause exceedance of values specified in the Drinking Water Standards for simulated pollutants (chloride, copper, lead and zinc) within the model domain, after 120 years of Project operation. Accidental spillage pollution risk to the south of the River Thames has been assessed as having a combined probability that is less than the threshold of 0.5% that is stated in the DMRB LA 113 standard as acceptable for drainage with the potential to affect sensitive sites, such as the Thames Estuary and Marshes Ramsar site.	Negligible

Water body	Project risks	Assessment commentary	Residual risk of deterioration at the water body scale
South Essex Lower London Tertiaries	Chronic and acute (spillage induced) pollution of groundwater bodies receiving drainage discharges.	A detailed assessment of the risk of chronic groundwater pollution linked to infiltration drainage of highway runoff from the Project to the north of the River Thames has been completed. The assessment confirms that the infiltration basin and swales cumulatively do not cause exceedance of values specified within the Drinking Water Standards for simulated pollutants (chloride, copper, lead and zinc) within the model domain, after 120 years of Project operation. Accidental spillage pollution risk to groundwater linked to the infiltration basin at the A13/A1089/A122 Lower Thames Crossing junction has been assessed and is significantly less than the acceptable threshold of a 1% annual chance.	Negligible
South Essex Thurrock Chalk	Dewatering at the North Portal causing changes to the saline interface.	A range of construction mitigation measures to limit impacts have been hydrogeologically tested using a groundwater numerical model. Results indicate that saline intrusion potentially induced by dewatering at the North Portal could be managed by the measures detailed in REAC commitment GS021, to limit any changes to a negligible magnitude. During the operational phase there would be no changes to the saline interface.	Negligible
All groundwater bodies within the ZoI	Set-up and operation of construction compounds - foundations opening pollution pathways to groundwater.	Risk avoided by appropriate construction compound set-up and management in accordance with the CoCP (GS004, GS005).	Negligible

Water body	Project risks	Assessment commentary	Residual risk of deterioration at the water body scale
All groundwater bodies within the ZoI	Below ground utilities works causing changes to the saline interface.	Assessment concludes no changes to saline intrusion would be caused by the deeper utilities works either south or north of the River Thames.	Negligible

7 Assessment – protected areas

7.1 Introduction

7.1.1 During Stage 1 of the assessment, several protected areas within the proposed ZoI with a potential surface or groundwater dependency were identified and screened in for further stages of assessment[5]:

a. Thames Estuary and Marshes Ramsar site and SPA

b. South Thames Estuary and Marshes SSSI, incorporating the Shorne Marshes RSPB Reserve

c. Mucking Flats and Marshes SSSI, part of the SPA

7.1.2 These sites, which fringe the Thames Estuary to the south and north, as illustrated on Drawing 2 in Annex C, provide a mosaic of grazing marsh, saltmarsh and mudflats that support internationally important numbers of wildfowl and waders. The ditch networks that flow through the sites are also of importance for their diverse range of wetland plants and invertebrates.

7.1.3 The Thames Estuary and Marshes Ramsar site/SPA at its closest is located approximately 1km north-east of the proposed South Portal. Filborough Marshes, part of the Ramsar site, is situated above the alignment of the main tunnels and the proposed ground protection tunnel. Mucking Flats and Marshes SSSI is located approximately 1.5km east of the North Portal.

7.1.4 In response to Environment Agency comments (Annex B), several additional protected areas have been included in this final assessment. These are a Local Wildlife Site referred to as Canal and Grazing Marsh, Higham; Cranham Marsh Nature Reserve and several Sites of Importance for Nature Conservation (SINCs) near Upminster.

7.1.5 The first site, Canal and Grazing Marsh, Higham has been included due to its proximity to the reception shaft of the proposed ground protection tunnel and the Milton compound.

7.1.6 The Canal and Grazing Marsh, Higham covers an area of just over 60 hectares and is situated at Eastcourt Marshes, between the River Thames and the Thames and Medway Canal as illustrated in Plate 7.1.

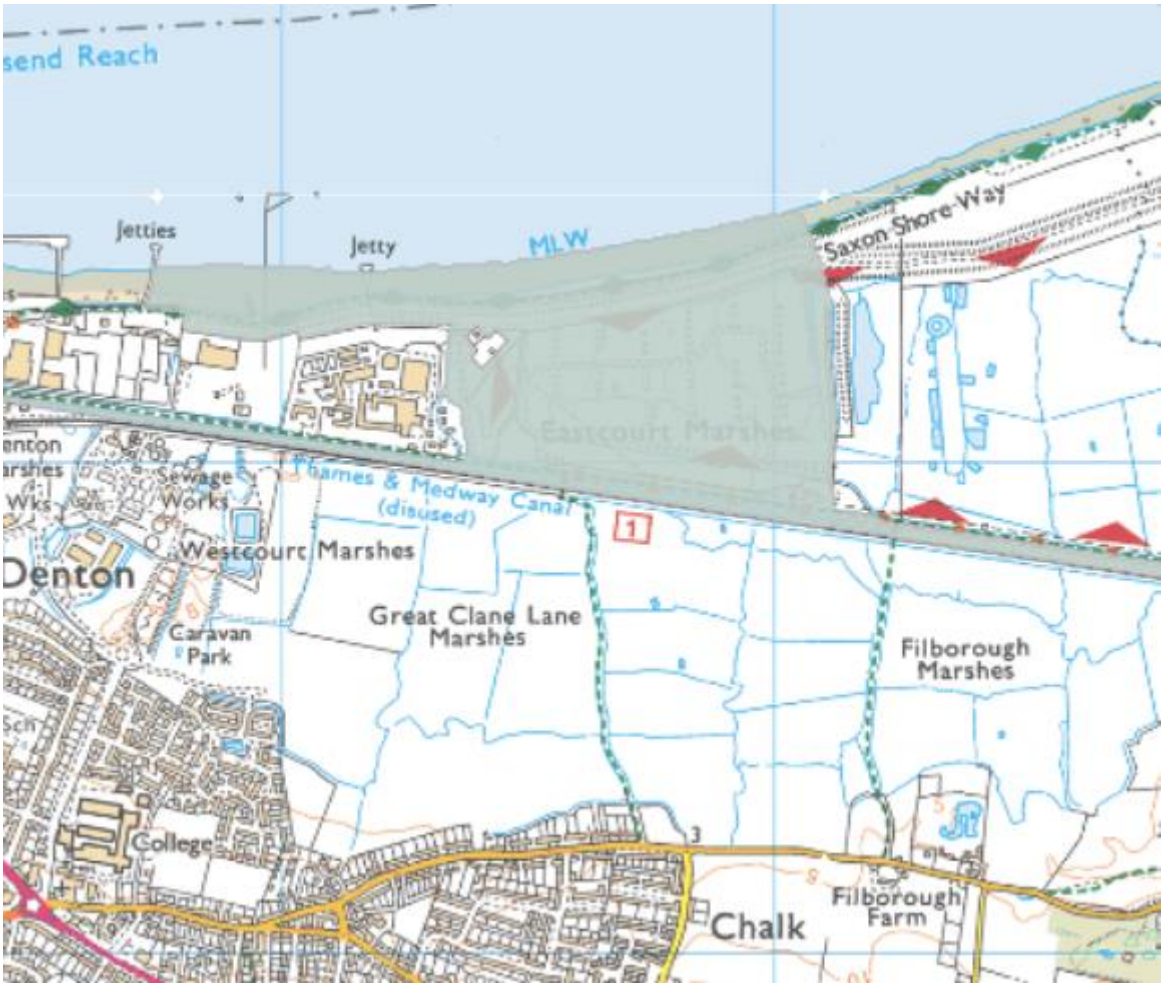
7.1.7 The other sites are situated in proximity to the Project's cutting beneath the M25 motorway. Cranham Marsh is a nature reserve comprising three parts, located in a shallow valley at the head of a tributary of the River Ingrebourne. The largest and most westerly end of the reserve comprises Spring Wood and adjacent grassland. This is connected to Middle Wood. Furthest east, and at its closest within 280m of the Order Limits, is Bonus Wood.

[5] Note there are also several Nitrate Vulnerable Zones (NVZs) within the ZoI. These are areas of land designated as being at risk from agricultural nitrate pollution, and in which there are rules governing the use of nitrogen fertilisers and the storage of organic manure. The Project has no element that would introduce additional agricultural nitrate pollution into the environment, therefore these protected areas were screened out of further assessment.

7.1.8 Habitats recorded in Phase 1 habitat surveys of the Middle and Spring Wood parts of the site include large areas of broadleaved woodland, which is not groundwater dependent. One small area of low groundwater dependency (Environment Agency, 2014) swamp habitat was recorded. The survey also recorded three discrete areas of fen (valley mire). This habitat is likely to be of high groundwater dependency (Environment Agency, 2014). Access permissions were not available to survey Bonus Wood, but the designation summary (Natural England, 2020) cites bluebell woods as a feature which typically requires humus rich soils that are well drained, suggesting that the wood is unlikely to be a groundwater dependent ecosystem.

7.1.9 The other sites supporting wetland features are the Hall Farm moat, paddock and St Mary Magdalene Churchyard Site of Importance for Nature Conservation (SINC) and the southern edge of Thames Chase Forest Centre SINC (including the Hobbs Hole pond). The locations of these sites are shown in Figure 14.2 - Groundwater Receptors and Resources (Application Document 6.2).

Plate 7.1 Local Wildlife Site at Higham – site shown by grey shading



7.1.10 Potential effects on these protected sites include:

a. Changes to their hydrological and groundwater regimes in terms of water quantity (impacts on water balance, changes to water levels and flows) during construction and operation.

b. Changes to the water quality of supporting surface and groundwater regimes during construction and operation, including via the deposition of dust and nitrogen during construction and from operational traffic, as well as from discharges of rainfall runoff from the southern tunnel entrance compound.

7.2 Avoiding detriment

7.2.1 The measures described in Sections 4, 5 and 6, to avoid deterioration of the surface, transitional and groundwater bodies within the Project's ZoI would also protect the integrity of the protected sites. Those measures of key importance link to managing construction compounds and work sites to avoid pollution incidents as well as the collection and treatment of rainfall runoff from these compounds prior to discharge into the water environment. Particularly relevant due to their proximity are the southern and northern tunnel entrance compounds, which would be established to facilitate construction of the South and North Portals, and the satellite compounds established to facilitate construction of the southern ground protection tunnel.

7.2.2 Those measures to prevent large scale groundwater ingress into excavations, reducing the magnitude and spatial extent of groundwater drawdown, as well as restricting discharges into the Thames Estuary and Marshes ditch network at Filborough Marshes to greenfield rates, are also essential. These measures would avoid deterioration of supporting water balances and hydrological regimes.

7.2.3 At the proposed M25 cutting, groundwater modelling has demonstrated that groundwater seepage control measures are highly effective in reducing any groundwater drawdown that is induced during construction.

7.2.4 The infiltration basins, described in Section 5, would be subject to routine inspections and maintenance to ensure the continued efficiency of their treatment and infiltration capacities, which may otherwise decline over time (RDWE012).

7.2.5 Precautionary commitments to working methods and design of below ground utilities corridors are also included to prevent effects on groundwater levels and flows which may make a contribution towards supporting designated interest features at the Thames Estuary and Marshes Ramsar site (RDWE053) and the Hall Farm moat, paddock and St Mary Magdalene Churchyard SINC and Fields south of Cranham Marsh SINC (RDWE057) are also included.

7.3 Residual effects

7.3.1 A water balance for Filborough Marshes, accounting for water movement into and out of the shallow water system has been calculated using local climatic data and understanding of horizontal permeabilities, developed from ground investigation data. Major outflows of water from the study area are confirmed as evapotranspiration from the soil and evaporation from the surface water ditches on the marsh. The water from the Filborough Marshes naturally drains north and into the Denton New Cut. There is a licensed abstraction from this watercourse to supply water to the canal when water supply allows.

7.3.2 With regard to sources of inflow, the dominant input has been confirmed as rainfall. Leakage from the canal is also likely to contribute to some extent, while groundwater flow is mostly horizontal and contribution to the system is small. Less than 2% of the total water input per month is estimated to come from diffuse shallow groundwater seepage. The assumed low permeability of the Alluvium impedes significant inflow of water from other aquifers.

7.3.3 Information from surveys of the flora of the ditch networks in Filborough Marshes and the neighbouring Shorne Marsh (RSPB Reserve) has been screened to confirm whether any of the plant communities recorded are indicative of a high groundwater dependency. The data reveals that the communities present have a low groundwater dependency.

7.3.4 The water balance and the vegetation data therefore both support that the marshes within the South Thames Estuary and Marshes SSSI and Thames Estuary and Marshes Ramsar site to the south of the River Thames do not qualify as GWDTEs. It is also noted that Environment Agency mapping of GWDTEs, updated in September 2020, does not include the South Thames Estuary and Marshes SSSI, the Thames Estuary and Marshes Ramsar site or Mucking Flats and Marshes SSSI.

7.3.5 Groundwater modelling predicts that Cranham Marsh falls outside the zone of groundwater drawdown induced by the M25 cutting and will not be adversely impacted in either the modelled unmitigated or with-mitigation (in the form of seepage control) scenarios. At the Hall Farm moat, paddock and St Mary Magdalene Churchyard SINC and the Thames Chase Forest Centre SINC, National Vegetation Classification (NVC) surveys, conducted in April 2022, identified that both sites contained small and very discreet (less than 2m by 2m) areas of fen (swamp and mire) marginal habitat and that both sites were generally species poor. Fen (swamp and mire) habitats are indicative of low groundwater dependency.

7.3.6 Nevertheless, as the groundwater model predicts potential for groundwater drawdown of up to 1.1m in the unmitigated scenario, the Project has made a commitment, under REAC reference RDWE038, to include measures to reduce groundwater drawdown beyond the M25 cutting, for example through the implementation of seepage control. These measures would be confirmed and their effectiveness demonstrated through monitoring of groundwater levels, surface water levels and, where feasible, flows during both construction and operation in the detailed design stage of the Project, in consultation with the Environment Agency.

7.3.7 Table 7.1 summarises the residual effects of the Project on protected sites.

Table 7.1 Residual effects – protected sites

Protected area	Project risks	Assessment commentary	Residual risk of deterioration at water body scale
Filborough and Shorne Marshes (Thames Estuary	Changes to the water balance (i.e.	Water balance shows water inflows are dominated by rainfall, with a lesser contribution from canal leakage. These	No risk

Protected area	Project risks	Assessment commentary	Residual risk of deterioration at water body scale
and Marshes Ramsar and SPA, and South Thames Estuary and Marshes SSSI)	quantities of water inflow) impacting habitat quality	inputs would not be affected by the Project. Groundwater inputs to sustaining the shallow water balance are minor. The ditches and shallow soils are expected to be largely separated from the confined Chalk aquifer due to the overlying silty-clayey alluvial sediments. Evidence for this is provided by recorded water level responses during the pumping tests, exploratory boreholes and groundwater hydrographs.	
Canal and Grazing Marsh, Higham (Local Wildlife Site)	Changes to the water balance (i.e. quantities of water inflow) impacting habitat quality	The water balance of the Grazing Marsh at Higham would be safeguarded by adoption of construction techniques for the ground protection tunnel and its shafts that prevent water ingress, secured by REAC reference RDWE018a.	Negligible
Cranham Marsh Nature Reserve and SINCs local to the A122 Lower Thames Crossing/M25 junction	Changes to the water balance (i.e. quantities of water inflow) impacting habitat quality	Updated groundwater model results show that Cranham Marsh is not located within the zone of groundwater drawdown induced by the M25 cutting. At the SINC sites, NVC surveys confirm low groundwater dependency, but groundwater drawdown of up to 1.1m would be reduced by seepage control measures, which modelling has demonstrated to be very effective and are secured by REAC reference RDWE038.	Negligible
Mucking Flats and Marshes SSSI, part of Thames Estuary and Marshes SPA	Changes to the water balance impacting habitat quality	The Mucking Flats and Marshes SSSI is located approximately 2km to the east of the proposed North Portal excavation, immediately beside and influenced by water levels in the River Thames. The shallow water system of the protected sites lies on Alluvium, which is typically of silty-clayey nature. The hydraulic connection of the protected sites' shallow water system to the confined Chalk aquifer is expected to be limited due to the low permeability of the Alluvium and influence of adjacent river water levels. Negligible changes to existing shallow water flow regimes would therefore result from the Project.	Negligible
Filborough and Shorne Marshes (part of the Thames Estuary and Marshes Ramsar	Changes to water chemistry caused by	Groundwater modelling shows that there would be no increase in salinity below these sites caused by the construction or operational presence of underground infrastructure.	Negligible

Protected area	Project risks	Assessment commentary	Residual risk of deterioration at water body scale
and SPA and South Thames Estuary and Marshes SSSI). Mucking Flats and Marshes SSSI, part of the Thames Estuary and Marshes SPA.	induced saline intrusion		
Filborough and Shorne Marshes (part of the Thames Estuary and Marshes Ramsar and SPA and South Thames Estuary and Marshes SSSI) Canal and Grazing Marsh, Higham (Local Wildlife Site) Mucking Flats and Marshes SSSI, part of the Thames Estuary and Marshes SPA	Changes to water chemistry caused by construction-induced pollution	Risk avoided by appropriate construction compound set-up and management in accordance with the CoCP (Application Document 6.3, Appendix 2.2), including measures for dust control. Modelling assessments of the North Portal indicate that following implementation of a suite of design measures, detailed in and secured by REAC reference GS021, there would be insignificant movement of contamination from the East Tilbury landfill site towards the Mucking Flats and Marshes SSSI, located to the east.	Negligible
Filborough and Shorne Marshes (part of the Thames Estuary and Marshes Ramsar and SPA and South Thames Estuary and Marshes SSSI)	Chronic (routine runoff) and acute (spillage-induced) pollution of groundwater bodies receiving drainage discharges	Infiltration basins have been subject to assessment of chronic pollution risk using HEWRAT. All score in the medium risk category. Further detailed assessment has confirmed that individually and cumulatively, the basins do not cause exceedance of water environment EQS values for the simulated pollutants (chloride, copper, lead and zinc) at the Ramsar site, after 120 years of Project operation. Accidental spillage pollution risk to the south of the River Thames has been assessed as having a combined probability that is below the 0.5% threshold specified by DMRB LA 113 for sensitive sites.	Negligible
All screened-in protected areas	Deposition of air pollutants generated during construction and operation of the Project, causing	In accordance with DMRB LA 105 guidance, air quality modelling has been undertaken to assess the effects of nitrogen deposition on sensitive receptors within 200m of the ARN. At the Thames Estuary and Marshes Ramsar site and South Thames Estuary and Marshes SSSI, the model results	Negligible

Protected area	Project risks	Assessment commentary	Residual risk of deterioration at water body scale
	acidification of surface waters	confirm there would not be an increase of nitrogen deposition greater than 0.4kg N/ha/yr. Based on the guidance, this chance constitutes an effect that is not significant. Cranham Marsh and the Canal and Grazing Marsh at Higham are located outside the nitrogen deposits assessment study area and therefore no risk to these sites is concluded.	

8 Summary and conclusions

8.1.1 The Project has been subject to a staged assessment to determine whether any elements of its construction or operation would cause deterioration of the status of surface, transitional and groundwater bodies, and the protected areas they support. The potential for future objectives set for water bodies in the RBMP to be compromised, has also been considered.

8.1.2 Measures embedded into the Project design, in combination with commitments to methods of construction and compound management, which are documented in the CoCP (Application Document 6.3, Appendix 2.2) would prevent or mitigate potential effects on surface, transitional and groundwater bodies. These measures are appropriately secured within the DCO application. In addition, as detailed in the Consents and Agreements Position Statement (Application Document 3.3) qualifying works would be subject to secondary consents from the Environment Agency under the Environmental Permitting (England and Wales) Regulations 2016, and the MMO, and would be undertaken in accordance with any conditions attached to these consents.

8.1.3 Where construction compounds are located in proximity to surface water bodies, commitments secured by the DCO would ensure appropriate compound layout, transport, use and storage of potentially polluting materials.

8.1.4 The spatial extent of effects on surface water bodies is concluded to be very localised. It is therefore concluded that there would be no deterioration of biological quality, hydromorphology, physico-chemical or specific pollutant supporting elements at the surface water body scale, at which WFD compliance is judged. In addition, the Project would not prevent the future attainment of the WFD objectives for each of the respective water bodies, nor pose barriers to implementing future measures described in the RBMP to achieve these objectives.

8.1.5 Physical works and discharges received by the Thames Middle transitional water body would be subject to consent from the MMO and the Environment Agency. Underwater noise and vibration modelling results demonstrate no significant disturbance or impacts on marine invertebrates and fish.

8.1.6 It is therefore concluded there would be no deterioration of the biological quality, hydromorphology, physico-chemical or specific pollutant supporting elements of the Thames Middle water body at the water body scale, at which WFD compliance is judged.

8.1.7 Groundwater modelling has demonstrated that once embedded, the available effective design measures prevent change or limit the spatial extent of any effects or changes to groundwater levels and flows to a very localised scale.

8.1.8 Modelling has also confirmed that proposed infiltration drainage features pose no risk to the deterioration of the chemical status of underlying WFD groundwater bodies.

8.1.9 Proposed underground utilities works have been assessed and it is concluded that there would be no significant impacts on groundwater levels, flow regimes or saline intrusion. Precautionary commitments have been secured, through the REAC, specific to the individual utilities corridors where works have the highest

potential to result in effects. These measures would reduce any minor effects and it is concluded there is no risk of water body deterioration.

8.1.10 The appraisal for groundwater bodies therefore concludes that there is a negligible risk of deterioration of the quantitative and chemical status at the water body scale, at which WFD compliance is judged.

8.1.11 The effects of the Project on the European designated sites within the ZoI, as well as sites with regional and local wildlife designations, have also been considered. It is concluded that these sites would not be detrimentally affected.

8.1.12 It is concluded that none of the activities associated with the Project would prevent or undermine future actions to bring water bodies to good status, and no instances have been identified where a Regulation 19[6] derogation is required within this assessment.

[6] Regulation 19 of the of Water Environment (Water Framework Directive) (England and Wales Regulations 2017 (WFD Regulations), as amended by the Floods and Water (Amendment etc.) sets out the conditions for derogation in the event of new modifications to the physical characteristics of a body of surface water, alterations to the level of bodies of groundwater or new sustainable human development activities.

Annexes

Annex A Stage 1, Stage 2 and Stage 3 WFD Reports

Lower Thames Crossing

Water Framework Directive Assessment Scoping Note

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Contents

Appendices

1 Introduction

1.1.1 This document presents a scoping note put together as a basis for consultation with the Environment Agency (EA) regarding the scope and methodology of a Water Framework Directive Assessment (WFDA) that is proposed in connection with the Lower Thames Crossing (LTC) project. This note has been prepared with reference to the recently published Planning Inspectorate Water Framework Directive advice note (Advice Note 18, June 2017) which encourages early engagement with statutory consultation bodies to agree and discuss:

- Assessment scope and methodology;
- Potential impacts of the proposed Development on water bodies within the relevant River Basin District (RBD)[1] and compliance with the objectives of the Water Framework Directive (WFD); and
- Mitigation measures to ensure WFD compliance.

1.1.2 It is proposed that the findings of the WFDA will be described in a standalone report and that the assessment will also inform the Water Environment chapter of the Environmental Statement prepared as part of the Development Consent Order (DCO) application.

1.1.3 The purpose of this document is to:

- Identify waterbodies within the Thames RBD with potential to be affected by the proposed Development, by proposing and providing justification for a Zone of Influence (ZoI) for the project;
- Identify the proposed Development activities that, prior to mitigation, pose a risk to the WFD status of waterbodies within the ZoI and WFD compliance of these waterbodies; and
- Provide a plan showing the ZoI and WFD waterbodies within this zone. This is included in Appendix A.

[1] River Basin District - an administrative area of land and sea, made up of one or more neighbouring river basins together with their associated groundwaters and coastal waters, which is identified under Article 3(1) as the main unit for WFD management.

2 Identification of Project ZoI & WFD Waterbodies

2.1 Thames RBD

2.1.1 The proposed Development is wholly located with the Thames RBD. Following consideration of the ZoI of the proposed Development (described in 2.2 below), the Thames River Basin Management Plan (RBMP), updated for the second cycle of the WFD in December 2015, has been reviewed to identify potentially affected WFD waterbodies. The EA's Catchment Data Explorer online tool (http://environment.data.gov.uk/catchment-planning/) has also been used to assist in this task.

2.1.2 The Thames RBD is divided into a number of surface water, artificial water and groundwater management catchments and those catchments that the proposed Development crosses through are:

- Medway surface water management catchment (south of the crossing of the River Thames);
- Essex South surface water management catchment (north of the River Thames crossing); and
- Thames groundwater management catchment (south and north of the River Thames crossing).

2.1.3 There are no relevant artificial water management catchments.

2.2 Proposed Zone of Influence

2.2.1 With regard to surface water bodies, the proposed ZoI of the project has been defined to include all WFD waterbodies[2] that could potentially be directly impacted. These are within the direct footprint of the proposed Development. Surface waterbodies that could potentially be indirectly affected will also be included, along reaches extending up to 1km downstream of the proposed Development footprint. This ZoI has been selected considering the physical nature and catchment hydrology of the WFD surface waterbodies local to the project, and following consideration of the distance over which project activities (see Section 3) can reasonably have the potential to cause significant effects/influence WFD status.

2.2.2 For the one estuarine (transitional) waterbody with potential to be affected, a ZoI encompassing the reach of the waterbody within the proposed Development footprint and extending up to 3km upstream and downstream is proposed. This is because the project activities proposed within this waterbody (see Section 3) are temporary and are relatively small in scale in the estuarine context. In addition, the dynamic nature of

[2] A WFD surface waterbody is defined as a discrete and significant element of surface water such as a lake, a reservoir, a stream, river or canal, part of a stream, river or canal, a transitional water or a stretch of coastal water. A body of groundwater is defined as a distinct volume of groundwater within an aquifer or aquifers (*European Commission, 2003 Common Implementation Strategy for the Water Framework Directive Guidance Document No 2: Identification of Waterbodies*).

the waterbody is considered to limit the spatial influence of these project activities.

2.2.3 It is proposed to include groundwater bodies that have direct and indirect connectivity to the proposed project activities. It is initially considered that a zone radiating 3km from the proposed Development application boundary is sufficient to capture any influence of proposed Development activities on groundwater bodies.

2.2.4 However, it should be noted that this ZoI will be refined, where necessary, based on the findings of a Water Features Survey (that is currently in progress) and three pumping tests. WR32 applications for these tests will be submitted and the results will improve our understanding of the potential requirements for groundwater control during construction of the project, and the potential effects of the project on environmentally sensitive sites such as the Thames Estuary and Marshes Ramsar site.

2.2.5 The proposed ZoI are illustrated in Figure 1 (Appendix A).

2.3 Surface Water Bodies & WFD Baseline Status

2.3.1 Surface water bodies within the proposed ZoI and their current WFD status are described in Table 1.

Table 1: WFD surface water bodies within the proposed ZoI

Waterbody ID	Name	2015 Waterbody Classification
GB106037028200	Mardyke	Hydromorphological designation: Heavily modified. Overall: Moderate Ecological: Moderate Chemical: Good
GB106037028080	Mardyke (West Tributary)	Hydromorphological designation: Heavily modified. Overall: Moderate Ecological: Moderate Chemical: Good
GB106037028070	Mardyke (East Tributary)	Hydromorphological designation: Heavily modified. Overall: Moderate Ecological: Moderate Chemical: Good

2.3.2 It is understood that the Thames and Medway Canal has been de-designated in cycle 2 of the WFD, under which many small waterbodies included in cycle 1 which were below the size thresholds set out in the WFD guidance have been declassified.

2.4 Estuarine Water Bodies & WFD Baseline Status

2.4.1 The estuarine (transitional) water body within the proposed ZoI and its current WFD status is described in Table 2.

Table 2: WFD estuarine (transitional) water bodies within the proposed ZoI

Waterbody ID	Name	2015 Waterbody Classification
GB530603911402	Thames Middle	Hydromorphological designation: Heavily modified. Overall: Moderate Ecological: Moderate Chemical: Fail

2.5 Groundwater Bodies & WFD Baseline Status

2.5.1 Groundwater bodies within the proposed ZoI and their current WFD status are described in Table 3.

Table 3: WFD groundwater bodies within the proposed ZoI

Waterbody ID	Name	2015 Waterbody Classification
GB40601G401100	South Essex Thurrock Chalk	Overall: Good Quantitative: Good Chemical: Good
GB40602G401000	Essex South Lower London Tertiaries	Overall: Good Quantitative: Good Chemical: Good
GB40601G500300	Kent North Medway Chalk	Overall: Poor Quantitative: Poor Chemical: Poor

2.5.1 The 2015 water body classifications defined in Tables 1 to 3 represent the baseline from which deterioration due to project activities is not permitted.

2.5.2 It is assumed that monitoring or surveys of these waterbodies to collect data to inform the WFDA will not be required and it is proposed that the scope of the assessment excludes any activities linked to the pre-construction Ground Investigation.

2.6 Protected Areas

2.6.1 A number of protected areas with the proposed ZoI have been identified that have a surface or groundwater dependency:

- Thames Estuary and Marshes Ramsar site;
- Thames Estuary and Marshes Special Protection Area;

- South Thames Estuary and Marshes SSSI;
- Coastal Streams to Lower Thames Nitrate Vulnerable Zone;
- Mardyke Nitrate Vulnerable Zone;
- Shorne Marshes RSPB Reserve;
- EA Groundwater Source Protection Zones; and
- Drinking Water Protected Areas Safeguard Zones (Groundwater).

2.6.2 It would be the aim that the LTC project (during both construction and operation) would not compromise the objectives or designated features of these safe guarding zones.

3 Proposed Development Activities

3.1.1 Activities with potential to impact on WFD waterbodies within the proposed ZoI are described, linked to the construction and operational phases of the proposed Development in Tables 4 and 5.

3.1 Construction Phase Activities

Table 4: Construction phase activities and potential risks to WFD waterbody status

Activities	**Risk**	**Waterbodies Potentially Affected**
Tunnelling; general construction and welfare provision	Increased demand for water resulting in lowering of groundwater levels/reduced surface water flows and reduction in habitat quality for qualifying features of European designated sites.	Surface waters, groundwater, protected areas
Excavation/ tunnelling linked groundwater control	Lowering of groundwater levels and risk of increasing saline intrusion.	Groundwater, protected areas
General construction	Discharges, spills and leaks of potentially polluting materials degrading receiving water quality.	Surface waters, groundwater, protected areas
Construction waste handling/treatment.	Discharge of potentially polluting materials/effluents degrading receiving water quality	Surface waters, groundwater, protected areas
Watercourse crossing or diversion	Physical modifications leading to adverse water quality, ecological and hydro-geomorphological effects.	Surface waters
Piling & dredging for jetty construction and subsequent jetty decommissioning works	Effects on sediment transport/deposition and hydrodynamic regimes and water quality degradation due to	Transitional waters

	disturbance of contaminated sediments.	

3.2 Operational Phase Activities

Table 5: Operational phase activities and potential risks to WFD waterbody status.

Activity	Risk	Waterbody Potentially Affected
Highway drainage: new outfall construction and/or soakaways.	Impacts on hydromorphology (scour and sedimentation); and groundwater levels.	Surface waters, groundwater, protected areas.
Highway drainage (routine and during accidental spillage events).	Water quality degradation and potential impacts on land that is functionally linked to European sites.	Surface waters, groundwater, protected areas.
Highway drainage: reuse of existing soakaways but draining larger highway catchment areas.	Impacts on groundwater quality and levels.	Groundwater, protected areas.
Deep structures forming a barrier to groundwater flow.	Long term changes in groundwater flow paths causing groundwater levels to fall or rise.	Groundwater, protected areas.
Cuttings below water table.	Groundwater level lowering.	Groundwater, protected areas.
Retention of excavated materials and tunneling arisings within the scheme boundary[3].	Water quality degradation and impacts on the land drainage regime.	Surface waters, groundwater, protected areas.

[3] location and manner of reuse has not yet been determined.

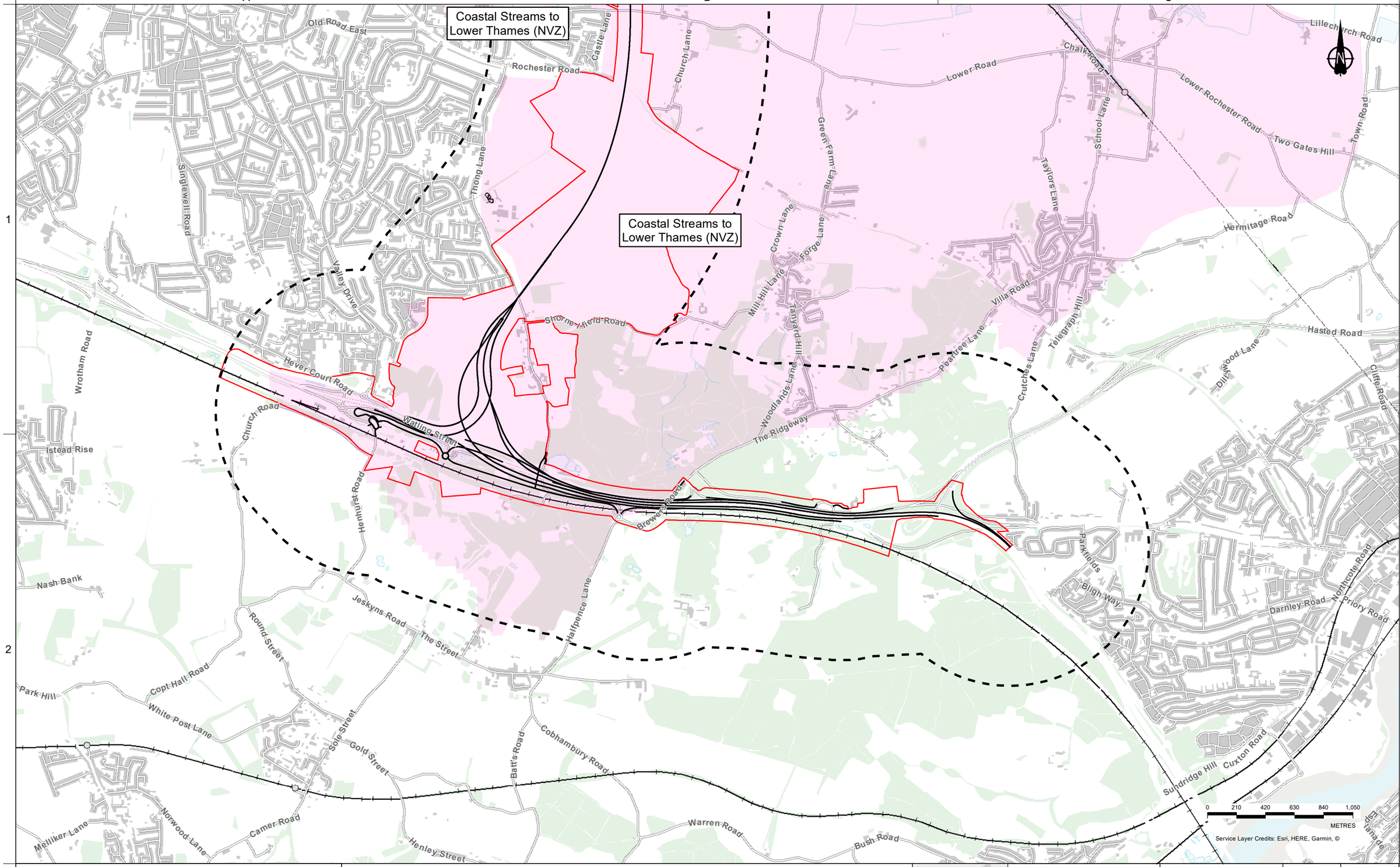
4 Relevant Technical Guidance

4.1.1 In addition to the Planning Inspectorate's Water Framework Directive advice note (Advice Note 18) referenced in Section 1, it is proposed that the following Environment Agency technical guidance documents will be referenced to guide the WFDA:

- Protecting and improving the water environment Water Framework Directive compliance of physical works in rivers Screening step 1.3: WFD deterioration & risk to water body status objectives, Technical Guidance 488_10_SD06, issued 22/12/2014.
- Assessing new modifications for compliance with WFD Operational Instruction 488_10.
- Assessing new modifications for compliance with WFD: detailed supplementary guidance 488_10_SD01.

Appendix A

Figure 1 – Water Framework Directive Waterbodies within the Proposed Zone of Influence: Surface water.



Legend:

- LTC Route Alignment
- DR2.8 Statutory Consultation Development Boundary
- Surface Water Zone of Influence (1km)
- Nitrate Vulnerable Zone

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P01	S2	18/09/2019	For Information	RM	LD	CSS

Client: highways england

Project: LOWER THAMES CROSSING

5TH FLOOR BEAUFORT HOUSE
15 ST BOTOLPH STREET
LONDON EC3A 7DT

Status: For Information

Original Size: A3

Revision: P01

Scale: 1:25,000

Drawing title: Water Framework Directive Assessment - Surface Water Proposed Zones of Influence

Drawing number: HE540039-CJV-EWE-SZP_EGNE00000000-DR-LE-30036

MXD Location: Z:\Environment\Volumes\EWE - Water Environment\HE540039-CJV-EWE-SZP_EGNE00000000-DR-LE-30036 - Water Framework Directive Assessment - Surface Water Proposed Zones of Influence.mxd

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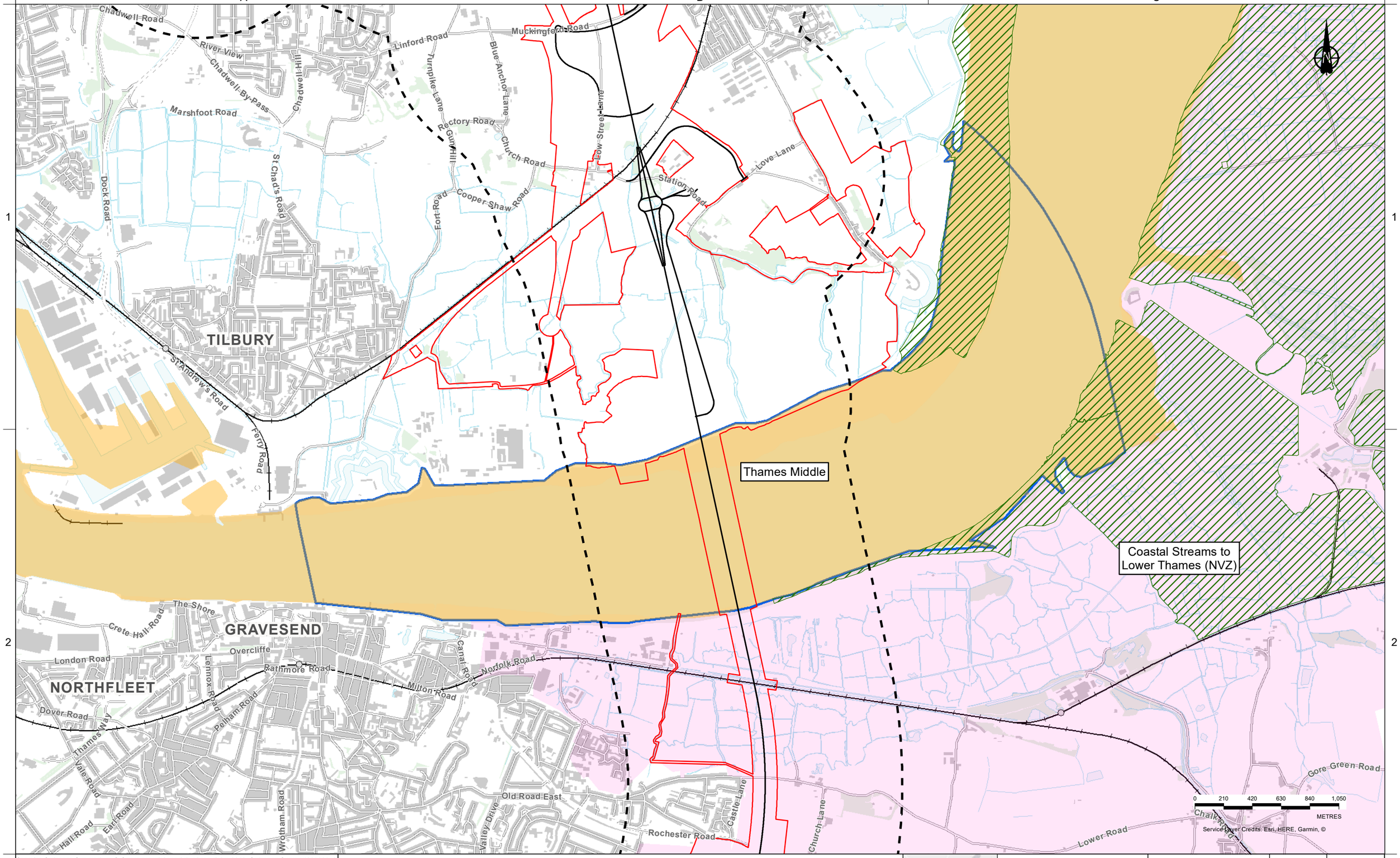

Legend:

- LTC Route Alignment
- DR2.8 Statutory Consultation Development Boundary
- Surface Water Zone of Influence (1km)
- Thames Estuary and Marshes (SPA)
- Moderate
- Estuarine Zone of Influence
- Nitrate Vulnerable Zone

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
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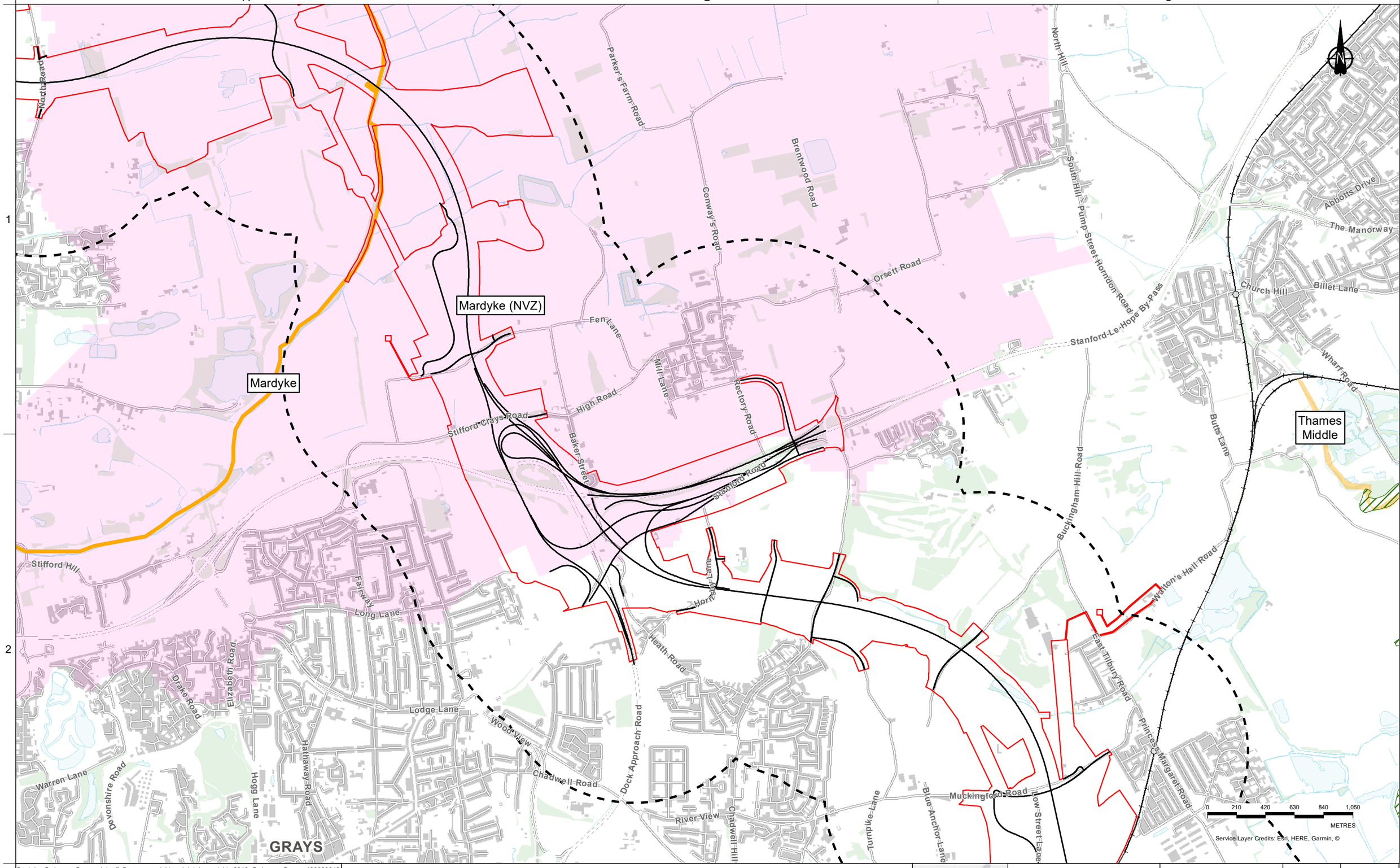

Legend:

- LTC Route Alignment
- DR2.8 Statutory Consultation Development Boundary
- Surface Water Zone of Influence (1km)
- Thames Estuary and Marshes (SPA)

Ecological Status of Surface Water

- Moderate
- Moderate
- Nitrate Vulnerable Zone

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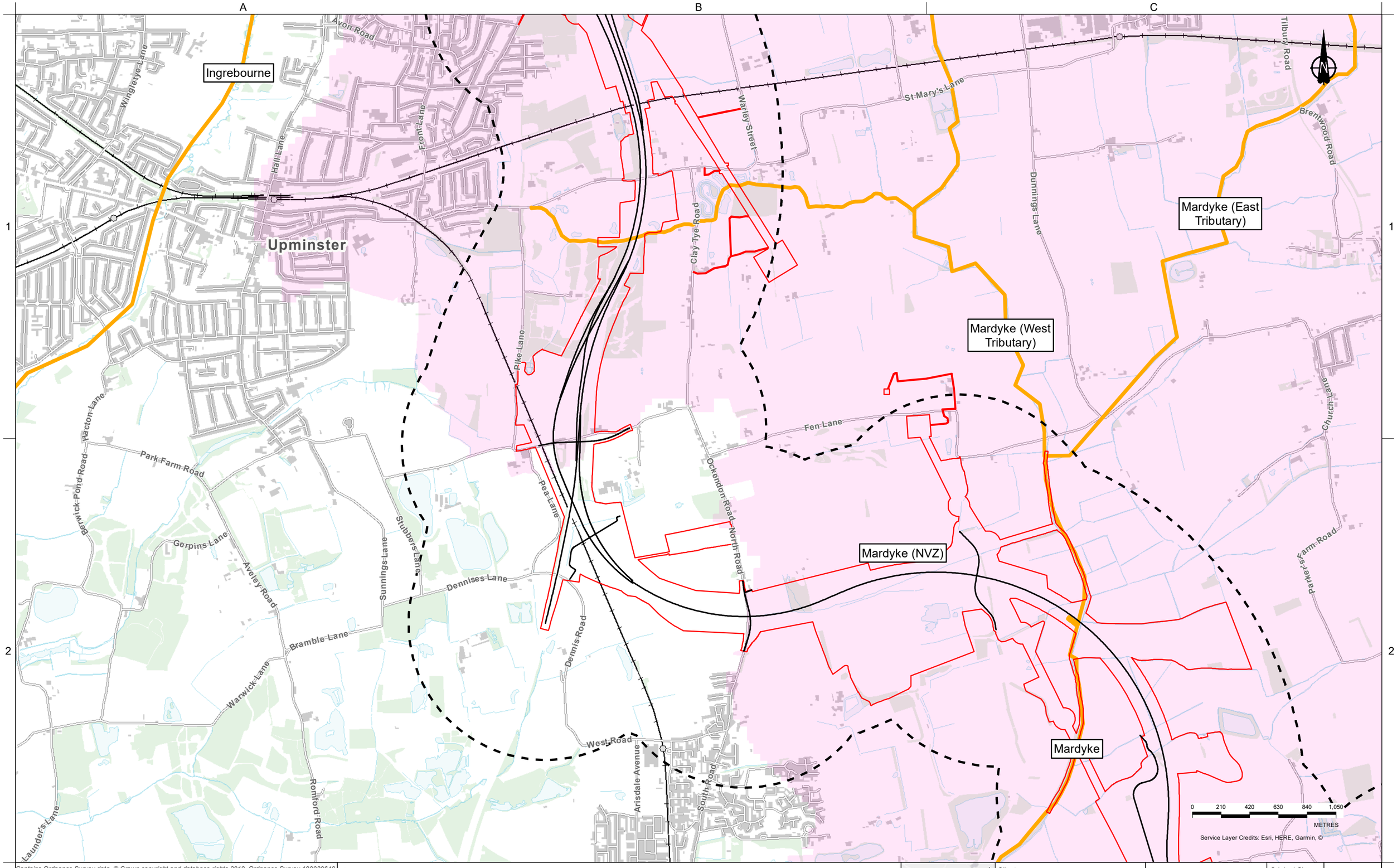

Legend:

- LTC Route Alignment
- DR2.8 Statutory Consultation Development Boundary
- Surface Water Zone of Influence (1km)

Ecological Status of Surface Water

- Moderate
- Nitrate Vulnerable Zone

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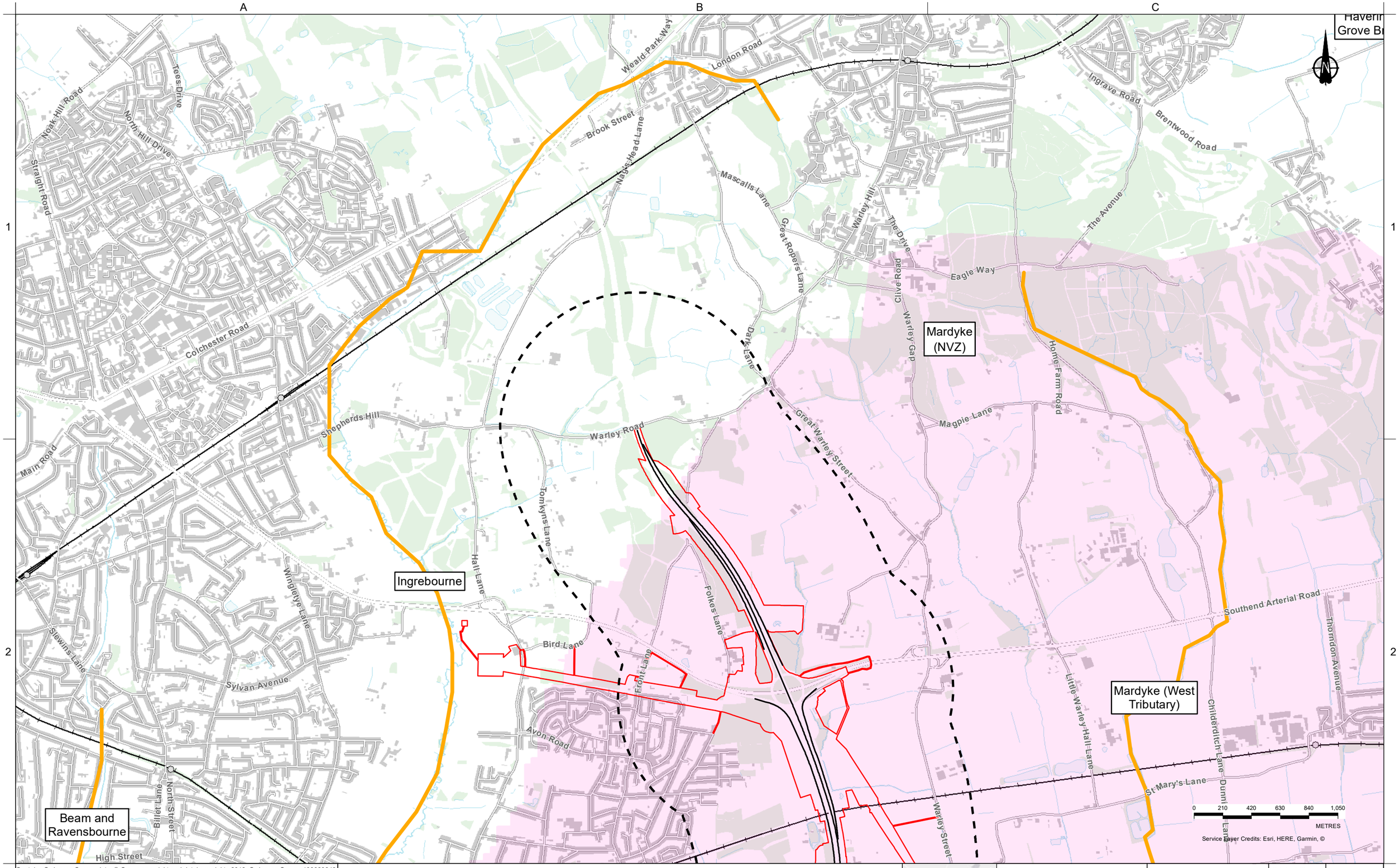

Legend:

- LTC Route Alignment
- DR2.8 Statutory Consultation Development Boundary
- Surface Water Zone of Influence (1km)

Ecological Status of Surface Water

- Moderate
- Nitrate Vulnerable Zone

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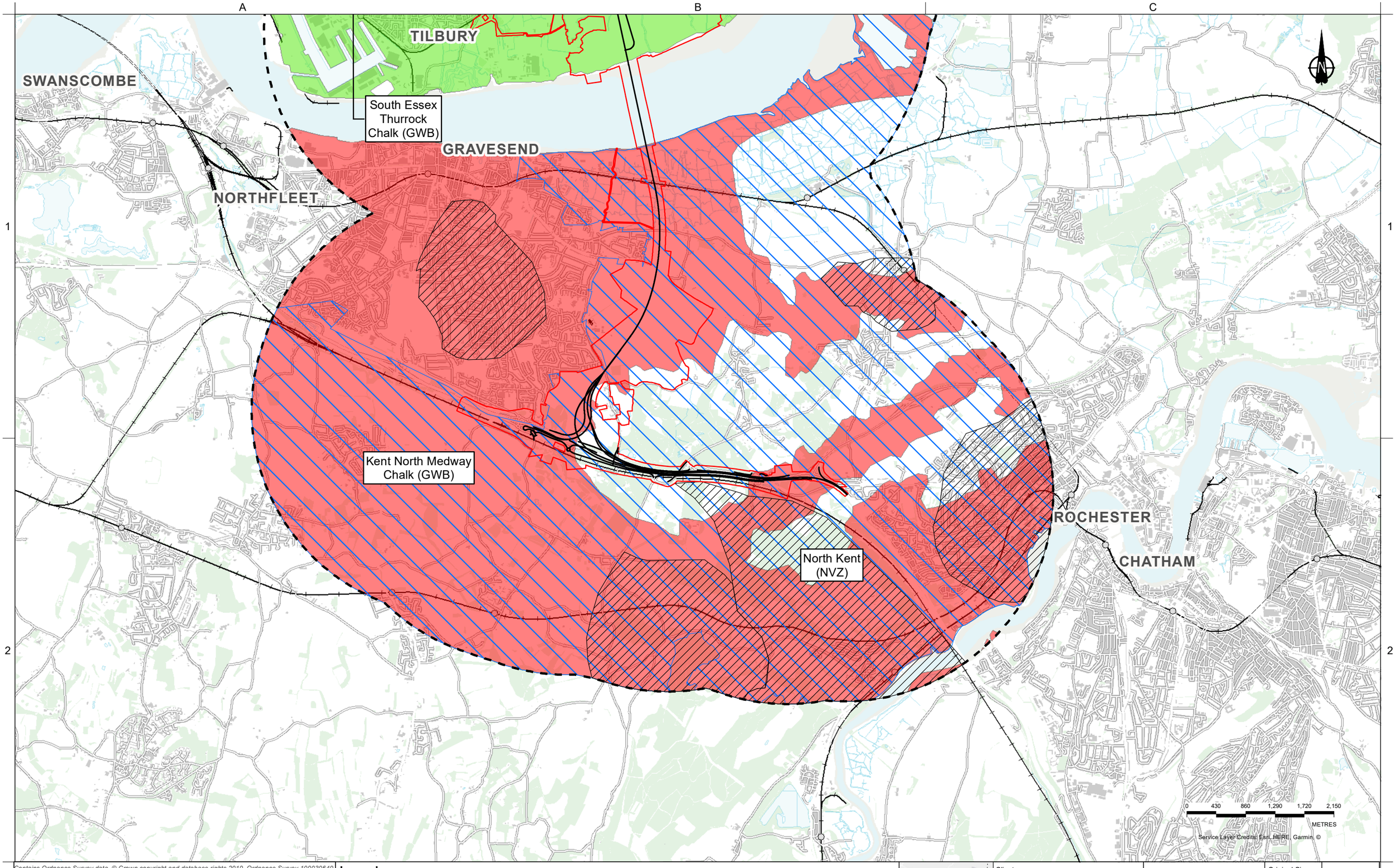
Do not scale

Figure 2 - Water Framework Directive Waterbodies within the Proposed Zone of Influence: Groundwater.



Legend:

- LTC Route Alignment
- Groundater Zone of Influence (3km)
- DR2.8 Statutory Consultation Development Boundary
- Drinking Water Protected Areas Safeguard Zones
- Groundwater Nitrate Vulnerable Zones (NVZ)

Overall Groundwater Body Status

- Good Status
- Poor Status

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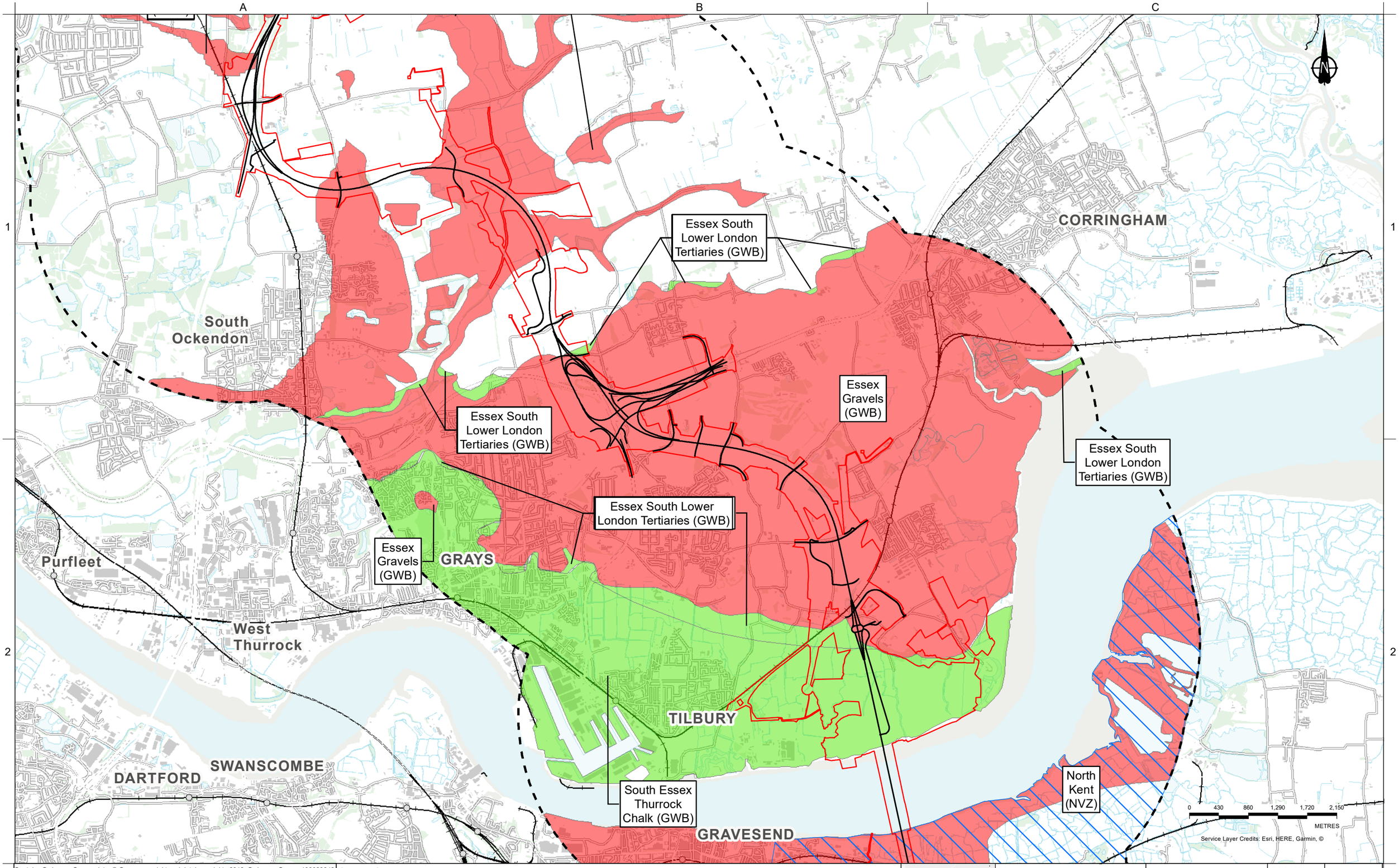

Legend:

- LTC Route Alignment
- Groundater Zone of Influence (3km)
- DR2.8 Statutory Consultation Development Boundary
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Overall Groundwater Body Status

- Good Status
- Poor Status

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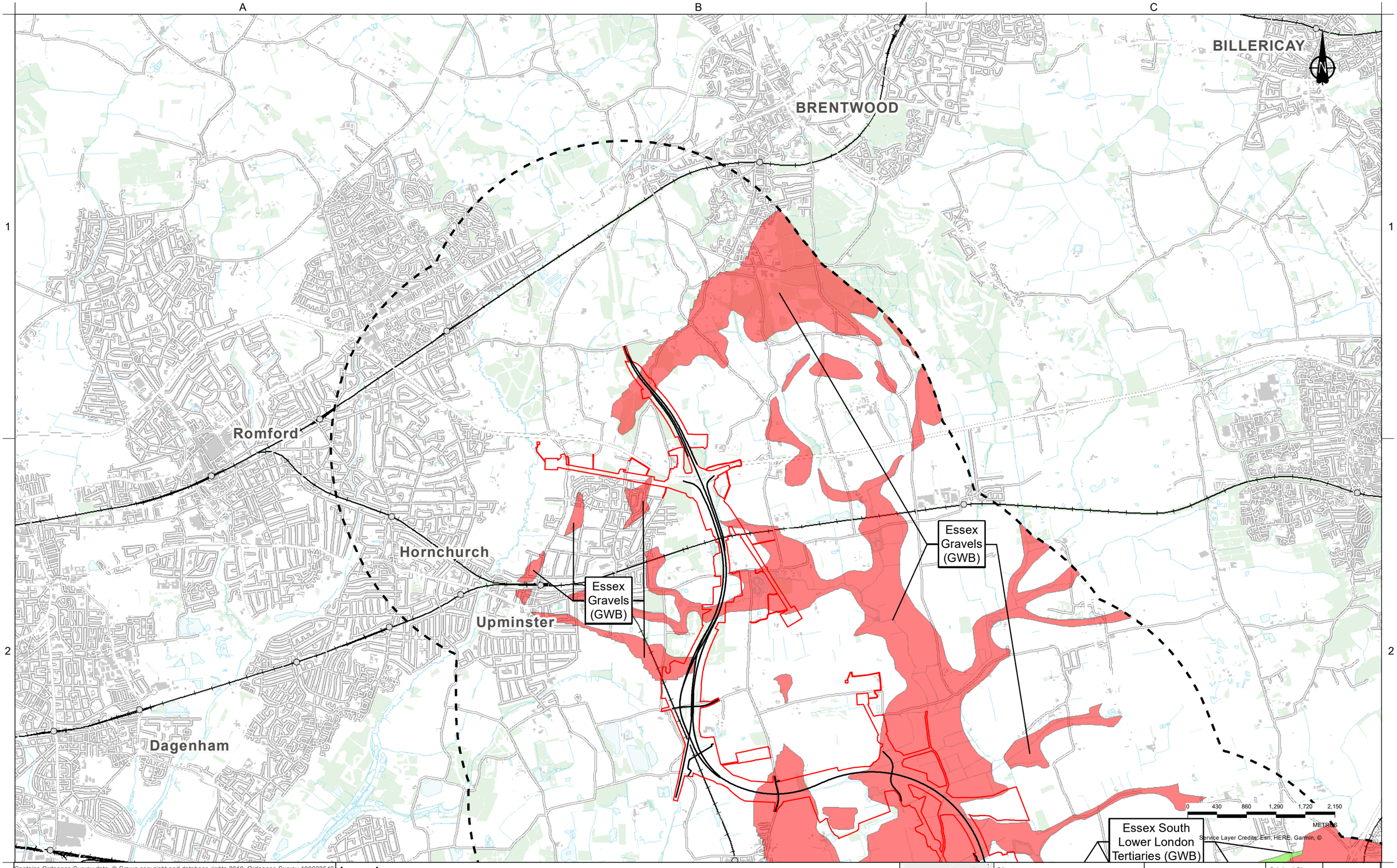

Legend:

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Overall Groundwater Body Status

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Lower Thames Crossing

Water Framework Directive Assessment
Stage 2

Document Number: HE540039-CJV-GEN-GEN-REP-ENV-00001

October 2019

Revision	Production Date	Prepared by	Checked by	Approved for release by
1.0	10.09.19	L. Driscoll	M Wilson	C Soubry Smith

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Contents

Appendices

1 Introduction

1.1.1 This document presents Stage 2 of a Water Framework Directive (WFD) Assessment that is being progressed in connection with the Lower Thames Crossing (LTC) project.

1.1.2 It has been prepared following completion of a Stage 1 scoping note, provided in Appendix 1. The scoping note has been reviewed by the Environment Agency. The Environment Agency's comments and the LTC Project's responses to these comments are provided in Appendix 2.

1.1.3 Stage 2 of the assessment methodology comprises:

- Compiling baseline data defining the current WFD status of those waterbodies screened into the assessment at Stage 1;
- Collecting information on specific objectives set for these waterbodies, as documented in the relevant River Basin Management Plan (RBMP); and
- Describing any mitigation measures or interventions proposed to improve the baseline status of screened in waterbodies during the current river basin management planning cycle.

1.1.4 The purpose of this document is to present the Stage 2 data for discussion with the Environment Agency.

2 Baseline Status of Screened in Waterbodies

2.1 Background

2.1.1 The WFD indicator of the health of the water environment is whether a waterbody is at good status (or potential). For surface waters and estuarine waterbodies, this overall status considers a range of quality elements relating to biological and chemical quality, which are assessed through information gathered via Environment Agency monitoring programmes. Surface water and estuarine waterbodies can be classed as having high, good, moderate, poor or bad status.

2.1.2 There are two elements of the classification for groundwater bodies. These consider water quantity (quantitative status) and water quality (chemical status). For each of these elements a groundwater body can achieve good or poor status, and both must achieve good for the groundwater body overall to achieve good status. In the classification of groundwater bodies, the WFD also assesses the interaction between groundwater, surface water and linked terrestrial ecosystems.

2.1.3 To achieve good status (or potential) every single element assessed must be at good status or better. If one element is below its threshold for good status, then the whole waterbody status is classed as less than good.

2.2 Surface Waterbodies

2.2.1 The surface waterbodies screened into the assessment during Stage 1 are illustrated in Figure 1 in Appendix 3. The figure also shows the Zones of Influence (ZoI) of the Project, which have been agreed as appropriate by the Environment Agency during Stage 1.

2.2.2 Information to characterise the baseline WFD status of these waterbodies has been collected from the Thames RBMP, updated for the second cycle (2015-2021) of the WFD in December 2015. The Environment Agency Catchment Data Explorer online tool (http://environment.data.gov.uk/catchment-planning/, accessed September 2019) has also been used to assist in this task.

2.2.3 In addition, field notes and photographs taken during the LTC water features surveys, undertaken in September 2017, July 2018 and July 2019, have been referenced to supplement the descriptions of baseline characteristics.

2.2.4 Three WFD surface water bodies were screened into the assessment in Stage 1:

- Mardyke (GB106037028200)
- Mardyke West Tributary (GB106037028080)
- Mardyke East Tributary (GB106037028070)

2.2.5 Baseline data for these waterbodies is summarised in Tables 1 to 3 below. As heavily modified waterbodies, WFD targets the achievement of good potential, rather than good status.

Table 1: Summary of WFD Baseline Data for the Mardyke

Mardyke	**GB106037028200**
Hydromorphological designation	Heavily Modified (by human activity)
Overall Waterbody Status	Moderate
Ecological Status	Moderate
Supporting elements	
Biological quality elements	Moderate
Fish	High
Invertebrates	Moderate
Macrophytes and Phytobenthos	High
Specific Pollutants	High
Hydromorphological Supporting Elements – hydrological regimes	Supports Good
Physico-chemical quality elements	Moderate
Ammonia	Good
BOD	Moderate
Dissolved Oxygen	Bad
pH	High
Phosphate	Poor
Temperature	High
Copper	High
Priority Hazardous Substances*	Good
Other Pollutants	Good
Chemical Status**	Good

** Endosulfan, Hexachlorobenzene, Hexachlorocyclohexane, Trifluralin, Aldrin, Dieldrin, Endrin, Isodrin & para DDT*

***does not require assessment for priority substances as no known discharges of these substances are made to the watercourse*

2.2.6 Photographs of the Mardyke, in the reach that the Project will interact with the watercourse, are provided in Plate 1 below.

Plate 1. Mardyke through Orsett Fen

Table 2: Summary of WFD Baseline Data for the Mardyke West Tributary

Mardyke West Tributary	GB 106037028080
Hydromorphological designation	Heavily Modified (by human activity)
Overall Waterbody Status	Moderate
Ecological Status	Moderate
Supporting elements	
Biological quality elements	Bad
Fish	Bad
Invertebrates	Moderate
Macrophytes	Poor
Hydromorphological Supporting Elements – hydrological regimes	Supports Good
Physico-chemical quality elements	Moderate
Specific Pollutants	High
Ammonia	Moderate
Dissolved Oxygen	Poor
pH	High

Mardyke West Tributary	GB 106037028080
Phosphate	Bad
Temperature	High
Other Pollutants - Triclosan	High
Chemical Status*	Good

**Does not require assessment for Priority Hazardous substances and Priority substances as no known discharges of these substances are made to the watercourse*

2.2.7 Plate 2 illustrates this waterbody, which in the location where the Project interacts with it, is in culvert beneath the M25 motorway in a concrete lined channel. Upstream of the culverted reach, the West Mardyke flows in a more natural channel.

Plate 2: West Mardyke at existing culvert where the M25 crosses the watercourse and upstream of the culvert.

Table 3: Summary of WFD Baseline Data for the Mardyke East Tributary

Mardyke East Tributary	GB106037028070
Hydromorphological designation	Heavily Modified (by human activity)
Overall Waterbody Status	Moderate
Ecological Status	Moderate

Mardyke East Tributary	GB106037028070
Supporting elements	
Biological quality elements	Good
Fish	High
Invertebrates	Good
Hydromorphological Supporting Elements – hydrological regimes	Supports Good
Physico-chemical quality elements	Moderate
Specific Pollutants	High
Ammonia	High
BOD	High
Dissolved Oxygen	Good
pH	High
Phosphate	Poor
Temperature	High
Other Pollutants - Triclosan	High
Chemical Status*	Good

**Does not require assessment for Priority Hazardous substances and Priority substances as no known discharges of these substances are made to the watercourse*

2.2.8 Although located within the defined ZoI for the assessment, the Project has no direct interaction with this waterbody.

2.2.9 Reasons for these waterbodies currently not achieving good potential are cited in the RBMP. On the Mardyke, general pressures include urbanisation and physical modifications for flood protection. Point source pollution from wastewater treatment works is attributed to contribute to the Poor status for Phosphate.

2.2.10 On the West Mardyke, wastewater treatment works and industrial discharges are deemed as probable causes of the Poor dissolved oxygen status. Fish and invertebrate populations are inhibited by physical modifications for flood protection, as well as pollution from wastewater treatment works discharges.

2.2.11 In contrast, on the East Mardyke, diffuse pollution from agriculture and rural land management practice is the predominant pressure.

2.2.12 The data in Tables 1 to 3 represent the baseline from which, to achieve compliance with the WFD, deterioration must not occur due to Project activities.

2.2.13 It is intended that those waterbodies that are not assigned a WFD ID within the Thames RBMP but are located within the ZoI (including land drains/ditches, unnamed watercourses and the Tilbury Main, an Environment Agency main river), be omitted from the WFD Assessment. An assessment of the potential effects of the Scheme on these water bodies will be made in the Environmental Statement (ES) (Chapter 14: Road Drainage and the Water Environment).

2.3 Estuarine Water Bodies & WFD Baseline Status

2.3.1 Transitional (estuarine) waterbodies are monitored for a similar suite of parameters. One estuarine waterbody has been screened into the assessment, illustrated in Figure 1 in Appendix 3, with details provided in Table 4. As a heavily modified waterbody, the WFD targets the achievement of good potential, rather than good status.

Table 4: Summary of WFD Baseline Data for the Thames Middle waterbody

Thames Middle	**GB530603911402**
Hydromorphological designation	Heavily Modified (by human activity)
Surface Area	4392km^2
Overall Waterbody Status	Moderate
Ecological Status	Moderate
Supporting elements	
Biological quality elements	Moderate
Angiosperms	Moderate
Fish	Good
Invertebrates	Good
Macroalgae	Good
Phytoplankton	Good
Hydromorphological Supporting Elements – hydrological regimes	Not Assessed
Physico-chemical quality elements	Moderate
Dissolved Inorganic Nitrogen	Moderate
Dissolved Oxygen	Moderate
Specific Pollutants	Moderate

Thames Middle	GB530603911402
Chemical Status	Fail
Priority substances	Good
Other Pollutants	Good
Priority hazardous substances	Fail*

*based on Tributyltin compounds

2.3.2 The overall status of this waterbody is classed as Moderate, despite a Fail for chemical status. This is because all chemical elements are considered Good except for Zinc compounds (a specific pollutant). This chemical compound has a status of below Good and is therefore contributing to the overall Moderate ecological potential for the waterbody.

2.3.3 Reasons for not achieving Good potential are cited in the RBMP as a combination of physical modifications, urbanisation, point source and diffuse pollution. Landfill leachate and sewage disposal are key point source pollution sources, impacting on dissolved oxygen status. The causes of elevated Zinc concentrations are reported as unknown, pending investigation. Tributyltin was used as a biocide in anti-fouling paint applied to the hulls of vessels. Its use is now banned, but it is considered to be present in contaminated river bed sediments and can be resuspended into the water column.

2.4 Groundwater Bodies & WFD Baseline Status

2.4.1 Groundwater bodies within the proposed ZoI and their current WFD status are described in Tables 5 to 8 and illustrated in Figure 2 in Appendix 3.

Table 5: Summary of WFD Baseline Data for the South Essex Thurrock Chalk

South Essex Thurrock Chalk	GB40601G401100
Surface Area	33.57km^2
Overall Waterbody Status	Good
Quantitative	Good
Quantitative status elements	
Saline Intrusion	Good
Water Balance	Good
GWDTEs* test	Good
Dependent Surface Waterbody status	Good
Chemical Status	Good
Chemical status elements	Good
Drinking water protected area	Good

South Essex Thurrock Chalk	GB40601G401100
General chemical test	Good
Chemical GWDTE*s test	Good
Chemical Dependent surface water body status	Good
Chemical saline intrusion	Good

Groundwater Dependent Terrestrial Ecosystems

Table 6: Summary of WFD Baseline Data for the Essex South Lower London Tertiaries

Essex South Lower London Tertiaries	GB40602G401000
Surface Area	7.57km^2
Overall Waterbody Status	Good
Quantitative	Good
Quantitative status elements	
Saline Intrusion	Good
Water Balance	Good
GWDTEs* test	Good
Dependent Surface Waterbody status	Good
Chemical Status	Good
Chemical status elements	Good
Drinking water protected area	Good
General chemical test	Good
Chemical GWDTE*s test	Good
Chemical Dependent surface water body status	Good
Chemical saline intrusion	Good

Table 7: Summary of WFD Baseline Data for the Kent North Medway Chalk

Kent North Medway Chalk	GB40602G401000
Surface Area	233.67km^2
Overall Waterbody Status	Poor

Kent North Medway Chalk	GB40602G401000
Quantitative	Poor
Quantitative status elements	Poor
Saline Intrusion	Good
Water Balance	Poor
GWDTEs* test	Good
Dependent Surface Waterbody status	Poor
Chemical Status	Poor
Chemical status elements	Poor
Drinking water protected area	Poor
General chemical test	Poor
Chemical GWDTE*s test	Good
Chemical Dependent surface water body status	Good
Chemical saline intrusion	Good

Table 8: Summary of WFD Baseline Data for the Essex Gravels

Essex Gravels	GB40503G000400
Surface Area	1274km^2
Overall Waterbody Status	Poor
Quantitative	Good
Quantitative status elements	Good
Saline Intrusion	Good
Water Balance	Good
GWDTEs* test	Good
Dependent Surface Waterbody status	Good
Chemical Status	Poor
Chemical status elements	Poor
Drinking water protected area	Poor
General chemical test	Poor
Chemical GWDTE*s test	Good
Chemical Dependent surface water body status	Good

Essex Gravels	GB40503G000400
Chemical saline intrusion	Good

2.4.1 Reasons for the North Kent Medway Chalk currently not achieving Good status are cited in the RBMP as diffuse pollution from poor nutrient and pesticide management practices on agricultural land, recognised by the designation of the North Kent Nitrate Vulnerable Zone, leaking sewers and contaminated land.

2.4.2 The Essex Gravels are currently not achieving Good chemical status, with causes cited in the RBMP as diffuse source pollution from agricultural and land management sources.

2.4.3 The 2015 groundwater water body classifications defined in these tables represent the baseline from which deterioration due to Project activities is not permitted.

3 WFD Objectives

3.1.1 The Thames RBMP sets out objectives for the future status of surface and groundwater bodies and targets a date for these objectives to be reached.

3.1.2 An overall objective of the WFD is to ensure no deterioration in the cycle 2 status of waterbodies. Where this status is less than Good, objectives may be set to improve on the status of qualifying elements, where it is technically feasible and cost effective to do so.

3.1.3 Table 9 presents a summary of the objectives set for screened-in WFD waterbodies.

Table 9: Summary of WFD Objectives for Screened-in Waterbodies

Waterbody	Objective
Mardyke	For those other elements that are currently at Bad or Poor status (Dissolved Oxygen and Phosphate), it is reported that there are disproportionate burdens and no known technical solutions to improving these statuses.
West Mardyke	Fish – Moderate by 2027 For those other elements that are currently at Bad or Poor status, it has been deemed technically infeasible to make improvements in status (no known technical solutions available), and/or solutions are disproportionately expensive with an unfavorable cost to benefit.
East Mardyke	Phosphate – Moderate by 2027
Thames Middle	To get biological elements to Good status would have significant adverse impacts on the use of this waterbody. Zinc – High by 2027 (cause of adverse impact currently unknown) Dissolved Oxygen – Good by 2027
North Kent Medway Chalk	Good overall status by 2027 (disproportionate burdens to achieving sooner)
Essex Gravels	Maintain existing status. It is noted that there is an unfavorable balance of costs to benefits associated with improving the chemical status of this waterbody.

3.1.4 To achieve compliance with the WFD, no Project activities must compromise achievement of these objectives.

4 Measures to Improve WFD Status

4.1.1 Information has been gathered from the Environment Agency Catchment Data Explorer website.

4.1.2 Within the surface and groundwater operational catchments that the screened in waterbodies are situated, there are currently no measures in place. It is noted that measures to achieve 2027 target statuses will be reported in the next cycle of river basin management planning (2021-2027).

5 Next Stages

5.1.1 The next stage of the WFD Assessment (Stage 3) will define the relationship between the Project components and the screened in waterbodies. Those elements of the Project that are not considered to be relevant, in terms of having the potential to impact on WFD waterbodies and associated protected areas, will be screened out. Those components of the Project that are considered relevant will be taken forward to Stage 4 of the assessment.

Appendix 1

WFD Stage 1 Scoping Note

Appendix 2

Stage 1 Environment Agency Comments and Project Responses

creating a better place

Environment Agency

Ms Alessandria Vinci
Lower Thames Crossing
Beaufort House
15 St. Botolph Street
London
EC3A 7DT

Our ref: KT/2017/123548/02-L01
Your ref: HE540039-CJV-GEN-GEN-SOW-ENV-00001

Date: 9 January 2018

Dear Ms Vinci

Water Framework Directive (WFD) assessment scoping note, dated December 2017

Lower Thames Crossing

Thank you for consulting us on the above scoping document. Please see our comments below.

Marine Water Quality

With regards to marine water quality, we confirm that the applicant has satisfactorily scoped the risks and the further WFD assessment work that is required from a marine water quality perspective. These risks mainly relate to the jetty works. Although it is not explicitly referred to, the applicant is aware of our WFD guidance for marine waters which is referenced in the Planning Inspectorate's WFD Advice Note 18 (June 2017): https://www.gov.uk/guidance/water-framework-directive-assessment-estuarine-and-coastal-waters.

Hydrogeology

General comments:
It is critical bodies that the next stage of investigations and reporting on groundwater quality and flow is comprehensive, in order to understand the potential impacts on groundwater. In particular, this will ensure that the possible impacts of dewatering are fully understood.

Dewatering could affect catchment flow paths and thereby impact on reliant surface waters. It could also change contaminant flow paths from specific source materials to change any current status quo and increase risks of significant impact on receiving waters bodies. We are keen to work with you to determine the next stage of investigations and subsequent reporting.

Section 2.2.3:
We are pleased to note that all WFD groundwater bodies (GWBs) will be included, and find the initial 3 km zone from the application boundary for the water features survey suitable. We

agree it is appropriate to allow an opportunity for review of the zone of influence based on the results of the survey and pump tests.

Section 2.5:
This should include the Essex Gravels WFD GWB which is of good quantitative but poor chemical WFD status (due to the drinking water protected area test). It would be useful to make it explicit in section 2.6 that the Thames Estuary SPA includes the Mucking Flats & Marshes SSSI. We are pleased to note that Source Protection Zones are included within this section.

Table 3.1:
The *'tunnelling; general construction and welfare provision*' activity with the risk of *'increased demand for water…lowering groundwater levels'* should also include the potential risk of increasing the chloride ion concentration in chalk groundwater (if there will be an increase in local abstraction from this aquifer).

The *'piling & dredging for jetty construction…'* activity which includes the risk of *'disturbance of contaminated sediments'* should also include groundwater bodies in the *'waterbodies potentially affected'* column if the activities have the potential to create a preferential pathways downwards into the secondary/primary aquifers along which contamination could be transported.

Biodiversity

The report suggests no additional monitoring will be carried out on the WFD waterbodies, however it does not provide a commentary on the protected areas.
WFD applies to all surface waterbodies and the protected areas may need additional data to be able to confirm which option(s) will be compliant with WFD and Habitat Regulations.

Please do not hesitate to contact me if you require any further information.

Yours sincerely

Niall Connolly
Planning Specialist

Direct dial 02084746765
Direct e-mail karolina.allu@environment-agency.gov.uk

Joanna Hodgson
Environment Agency
Orchard House
Endeavour Park
London Road
Addington
West Malling
Kent
ME19 5SH

17 September 2019

Dear Joanna

Thank you for your comments on our submitted Water Framework Directive (WFD) assessment scoping note, appended for reference. Please find set out below some further information surrounding the key topics raised. We look forward to working with you through our next stages of investigations and WFD assessment.

Marine Water Quality

We are pleased to note your agreement to the proposed scope of WFD assessment work that is required from a marine water quality perspective. Correspondence (email dated 16 November 2018) confirms your satisfaction with our monitoring scope that proposes that no sediment quality sampling is required. This is because no dredging is proposed as part of the marine works (jetty construction). We can confirm that, going forward, the marine element of the WFD assessment will be undertaken in accordance with the guidance provided in 'Clearing the Waters for All'.

Hydrogeology

We note that a detailed understanding of groundwater flow and quality is required to understand the effects of the Scheme on underlying WFD groundwater bodies and dependent surface waters and protected sites. In particular, you highlight that the potential impacts of groundwater control activities (dewatering) during construction and operation of the Scheme should be fully understood.

A summary of our ongoing and next stages of investigations is provided in Table 1. We hope this demonstrates our efforts to collect all necessary data to allow full consideration of the effects of the Scheme on the hydrogeology of the study area.

As requested, the Essex Gravels WFD groundwater body will be included in our assessment and we are pleased to note your satisfaction with the proposed 3 km zone of influence (ZoI) from the application boundary. We can confirm that this ZoI will be reviewed as our understanding of the potential effects of the Scheme develops.

Table 1. Summary of ongoing and proposed groundwater data collection and investigations.

Aim	Surveys and Investigations
Understanding baseline groundwater quality and levels	Observation boreholes from Phase 1 of the Ground Investigation (GI) are currently being monitored for water levels and sampled for field parameters (EC, pH, temperature, Redox) and water quality. Laboratory testing of samples is also being conducted. Testing has included parameters necessary to undertake a groundwater saline intrusion assessment. Some observation boreholes in the vicinity of the North Portal area were sampled for a general contamination check suite (not included in Table 2 below) of determinands, as well as for a number of field parameters. Determinands of this suite include major ions, metals, ammoniacal nitrogen, speciated TPH, speciated PAH and phenols. Laboratory testing has been included as part of the pumping tests completed to the south of the River Thames, downstream of the proposed South Portal location and within the Ramsar site. In addition, a selection of boreholes will also be tested for a regional groundwater laboratory quality suite (determinands summarised in the Table 2 below). Some of the borehole water level data loggers that were used during the pumping test south of the river Thames, were equipped with an EC sensor. A Phase 2 GI is underway and data (in-situ hydraulic testing (either packer tests or variable head tests), groundwater levels, quality) will be incorporated as soon as they become available. Data from all these sources will be compiled and assessed to develop a robust understanding of baseline groundwater quality across the ZoI.
Understanding of groundwater flow and the effects of dewatering	Pumping test boreholes downstream of the proposed location of the southern portal of the bored tunnel and at the Thames Estuary and Marshes Ramsar (south of the river Thames) have been drilled, and pumping tests completed in August 2019. Collation, processing and interpretation of this data is underway. Hydraulic testing (packer tests (in chalk) and variable head tests) are also available from selected boreholes of the Phase 1 GI. Additional pumping tests north of the River Thames are also planned, subject to available funding. Data from the proposed ground investigations and modelling studies will be compiled and assessed to develop a robust understanding of baseline groundwater flow and the effects of any proposed groundwater control activities on WFD waterbodies and protected areas within the ZoI. A draft technical note (North Portal Stage 1 Numerical Model), covering estimates of groundwater inflows, drawdowns and results of

Aim	Surveys and Investigations
	advective transport simulations (from East Tilbury landfill site), under different engineering mitigation scenarios, has been submitted to the Environment Agency on the 16 September 2019.

Table 2. Summary of proposed groundwater laboratory testing suites.

Laboratory Testing Suite – Groundwater regional water quality assessment	
Electrical Conductivity.	Potassium
Calcium	Sulphate
Iron	Chloride
Magnesium	Alkalinity as CaCO3
Manganese	Hardness as CaCO3
Sodium	Nitrate, NO3-N
Laboratory Testing Suite – Groundwater saline intrusion assessment	
pH	Hardness as $CaCO_3$
Electrical Conductivity	Total dissolved solids (TDS)
Calcium	Strontium
Iron	Boron
Manganese	Bromide
Magnesium	Iodide
Sodium	Fluoride
Potassium	Alkalinity as CaCO3
Sulphate	Chloride

We note and will action your comments on Section 3.1 of the scoping note, which sets out construction phase activities and associated potential risks to WFD waterbodies.

Biodiversity

You have requested the assessment includes commentary on protected areas, their links with WFD waterbodies and compliance of the Scheme with the Habitat Regulations. Some further information is provided below regards the biodiversity monitoring that has been undertaken to date.

NVC (botanical) surveys have been undertaken within the Filborough Marshes part of the Thames Estuary and Marshes Ramsar/SSSI to identify aquatic macrophytes along the route of the proposed tunnel.

Aquatic invertebrate surveys have been carried out in the Filborough Marshes part of the Thames Estuary and Marshes Ramsar/SSSI. Watercourses local to the northern portal and the River Mardyke have also been surveyed. Field determinands of water quality (temperature, pH, dissolved oxygen, conductivity and salinity) were recorded at each survey location.

The results of the above surveys will be used, together with other available information, to understand the baseline eco-hydrological functioning of the Thames Estuary and Marshes Ramsar. If required, the surveys can be repeated post construction to monitor any changes in water quality.

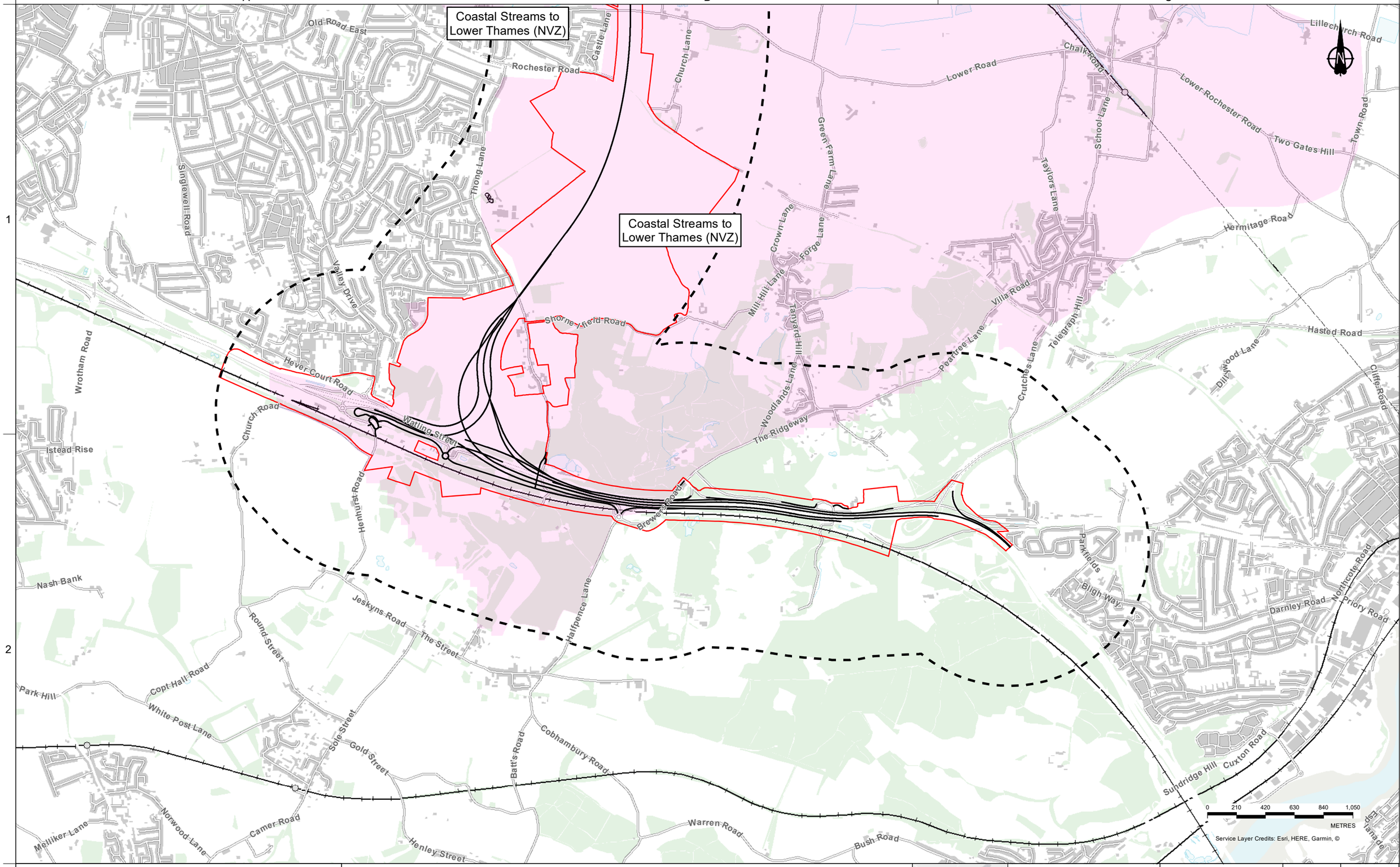
We would be grateful for confirmation that the information enclosed suitably addresses your comments. We will be starting on Stage 2 of the assessment, collating baseline data on the screened-in waterbodies, their current WFD status, their specific objectives and any mitigation measures undertaken to date, in the new year. I look forward to further discussions on Stage 2 in due course.

Yours sincerely

Lisa Driscoll
Water Environment Lead

Appendix 3

Figure 1 - Water Framework Directive Waterbodies within the Proposed Zone of Influence: Surface Water.



Legend:

- LTC Route Alignment
- DR2.8 Statutory Consultation Development Boundary
- Surface Water Zone of Influence (1km)
- Nitrate Vulnerable Zone

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P01	S2	18/09/2019	For Information	RM	LD	CSS

Client: highways england

Project: LOWER THAMES CROSSING

5TH FLOOR BEAUFORT HOUSE
15 ST BOTOLPH STREET
LONDON EC3A 7DT

Status: For Information

Original Size: A3

Revision: P01

Scale: 1:25,000

Drawing title: Water Framework Directive Assessment - Surface Water Proposed Zones of Influence

Drawing number: HE540039-CJV-EWE-SZP_EGNE00000000-DR-LE-30036

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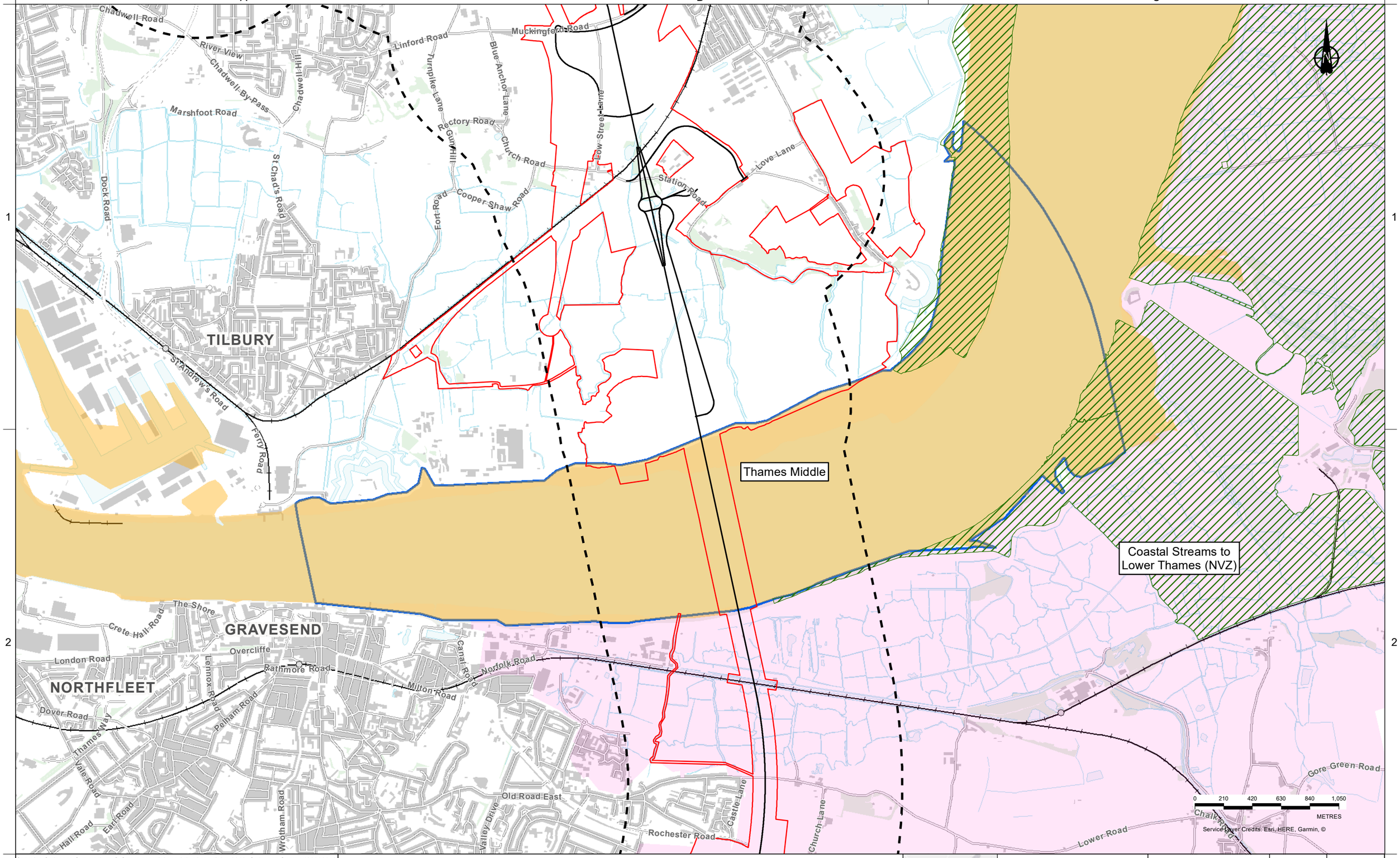

Legend:

- LTC Route Alignment
- DR2.8 Statutory Consultation Development Boundary
- Surface Water Zone of Influence (1km)
- Thames Estuary and Marshes (SPA)
- Moderate
- Estuarine Zone of Influence
- Nitrate Vulnerable Zone

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
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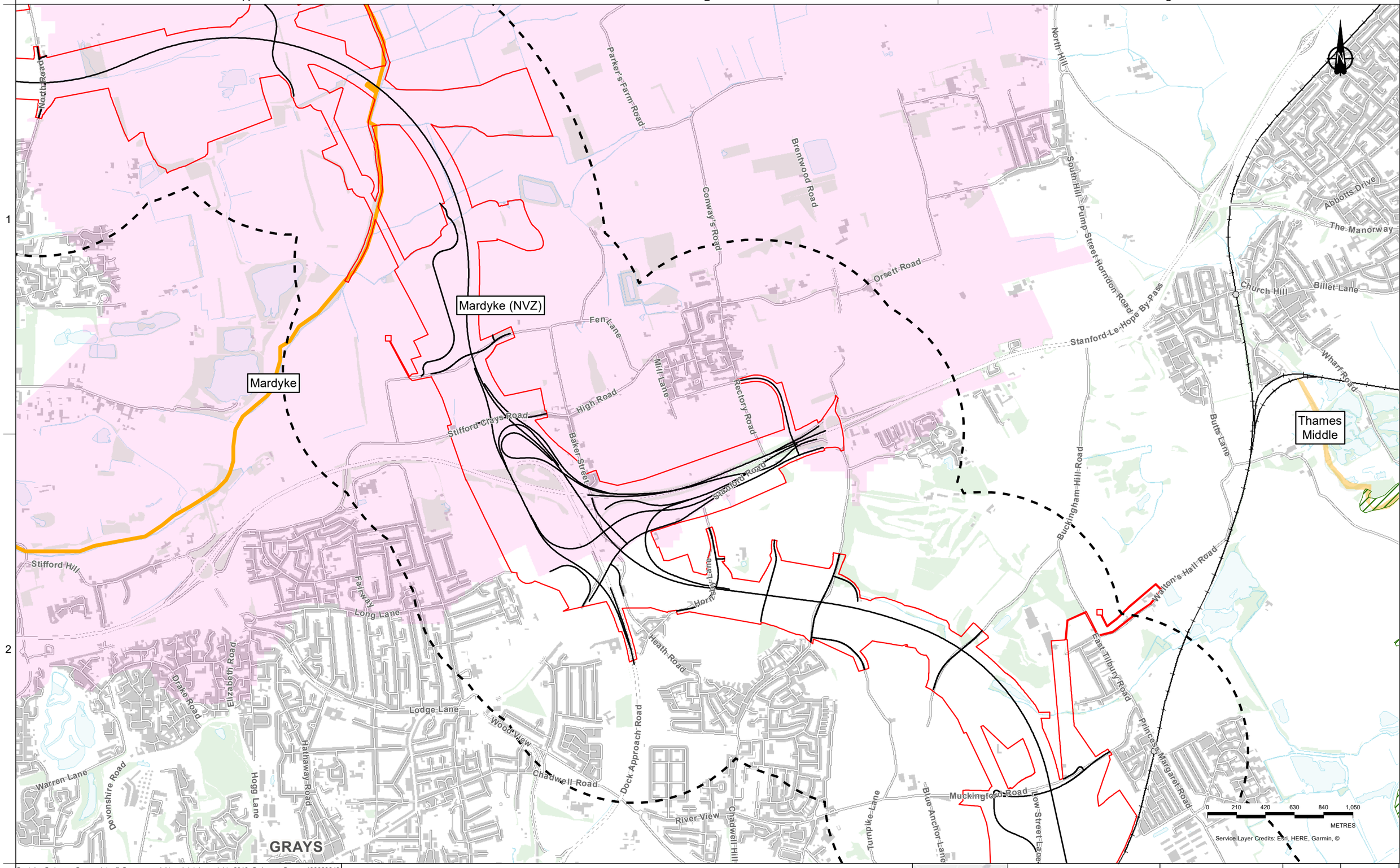

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- Thames Estuary and Marshes (SPA)

Ecological Status of Surface Water

- Moderate
- Moderate
- Nitrate Vulnerable Zone

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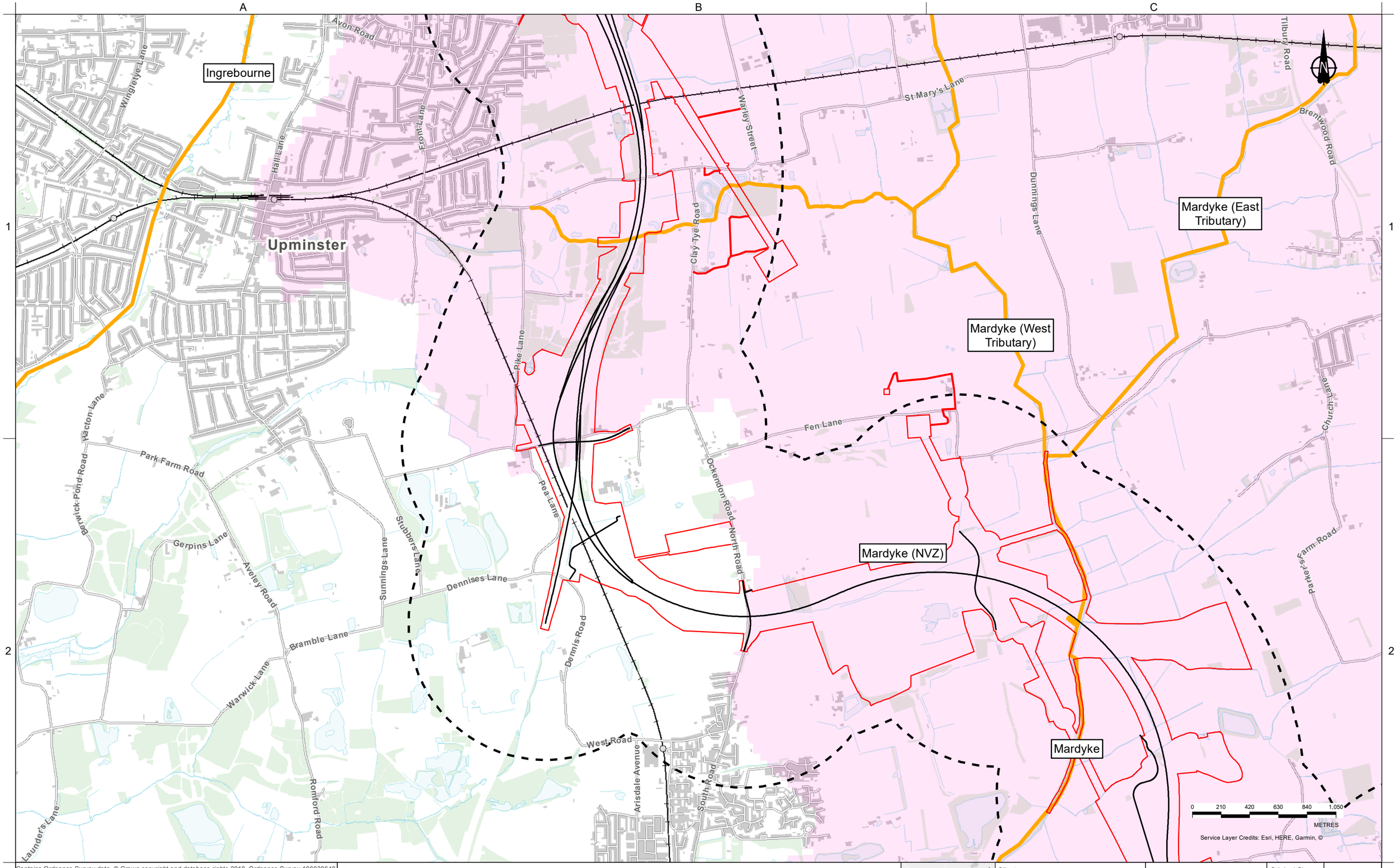

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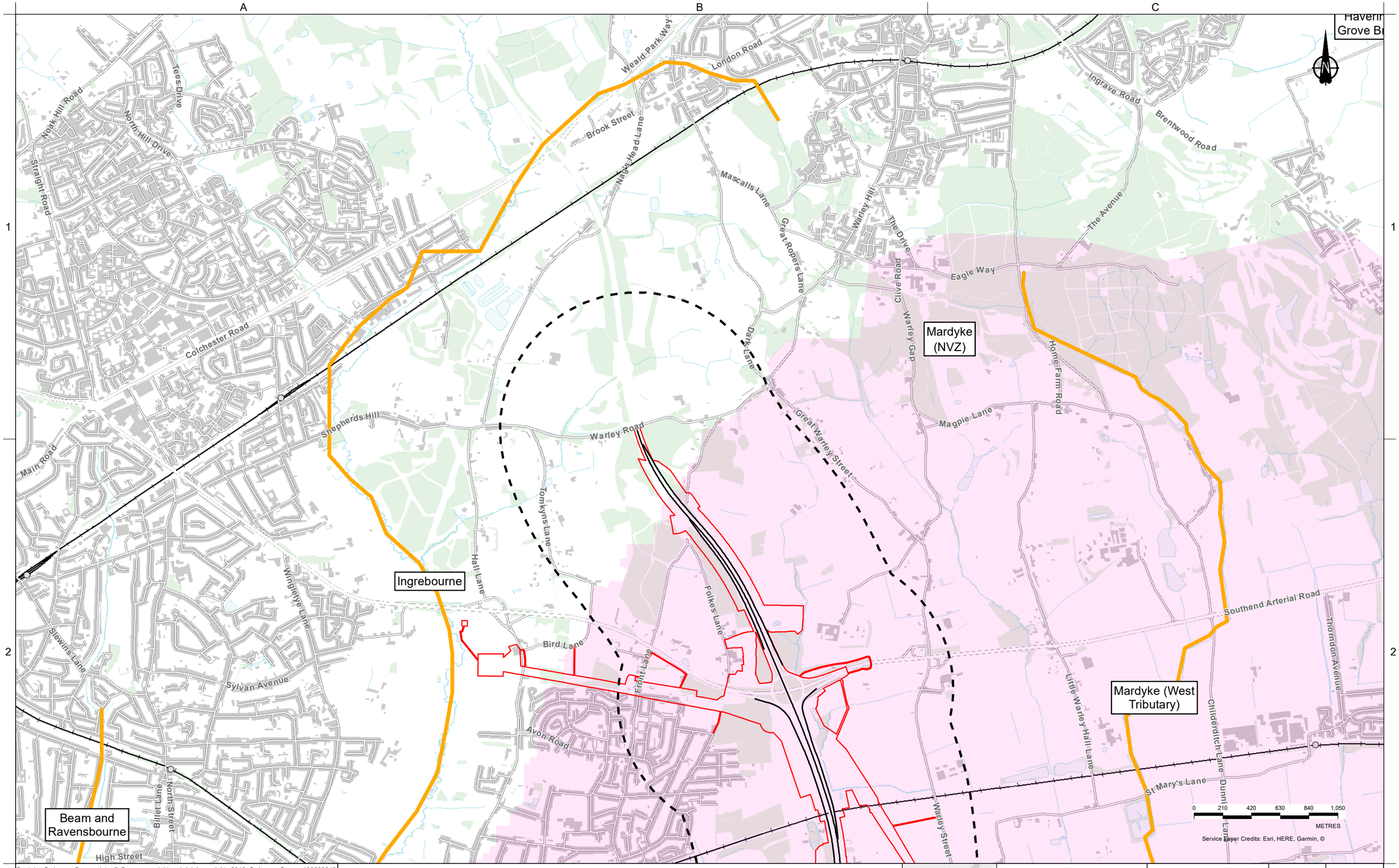

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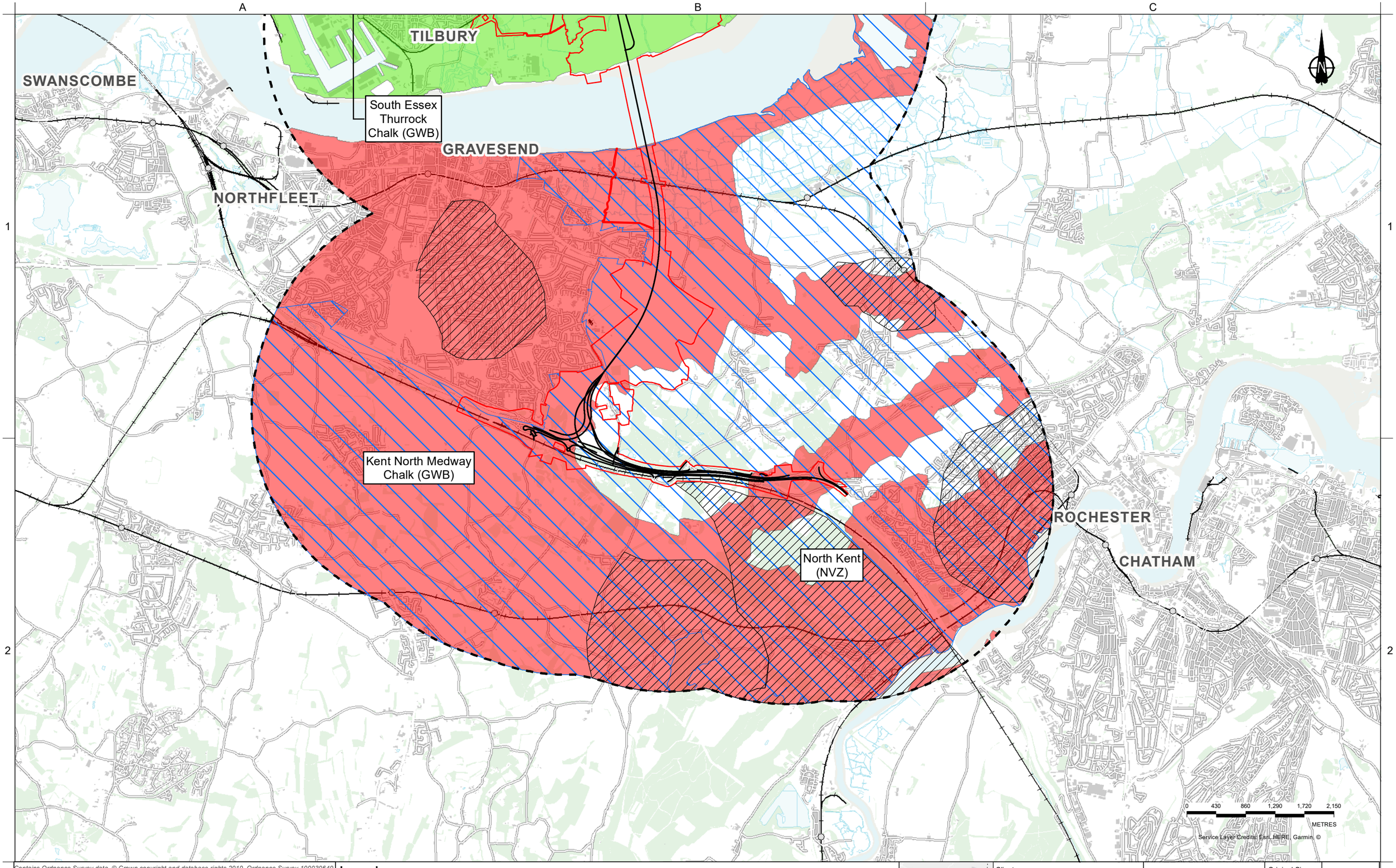
Figure 2 - Water Framework Directive Waterbodies within the Proposed Zone of Influence: Groundwater.



Legend:

- LTC Route Alignment
- Groundater Zone of Influence (3km)
- DR2.8 Statutory Consultation Development Boundary
- Drinking Water Protected Areas Safeguard Zones
- Groundwater Nitrate Vulnerable Zones (NVZ)

Overall Groundwater Body Status

- Good Status
- Poor Status

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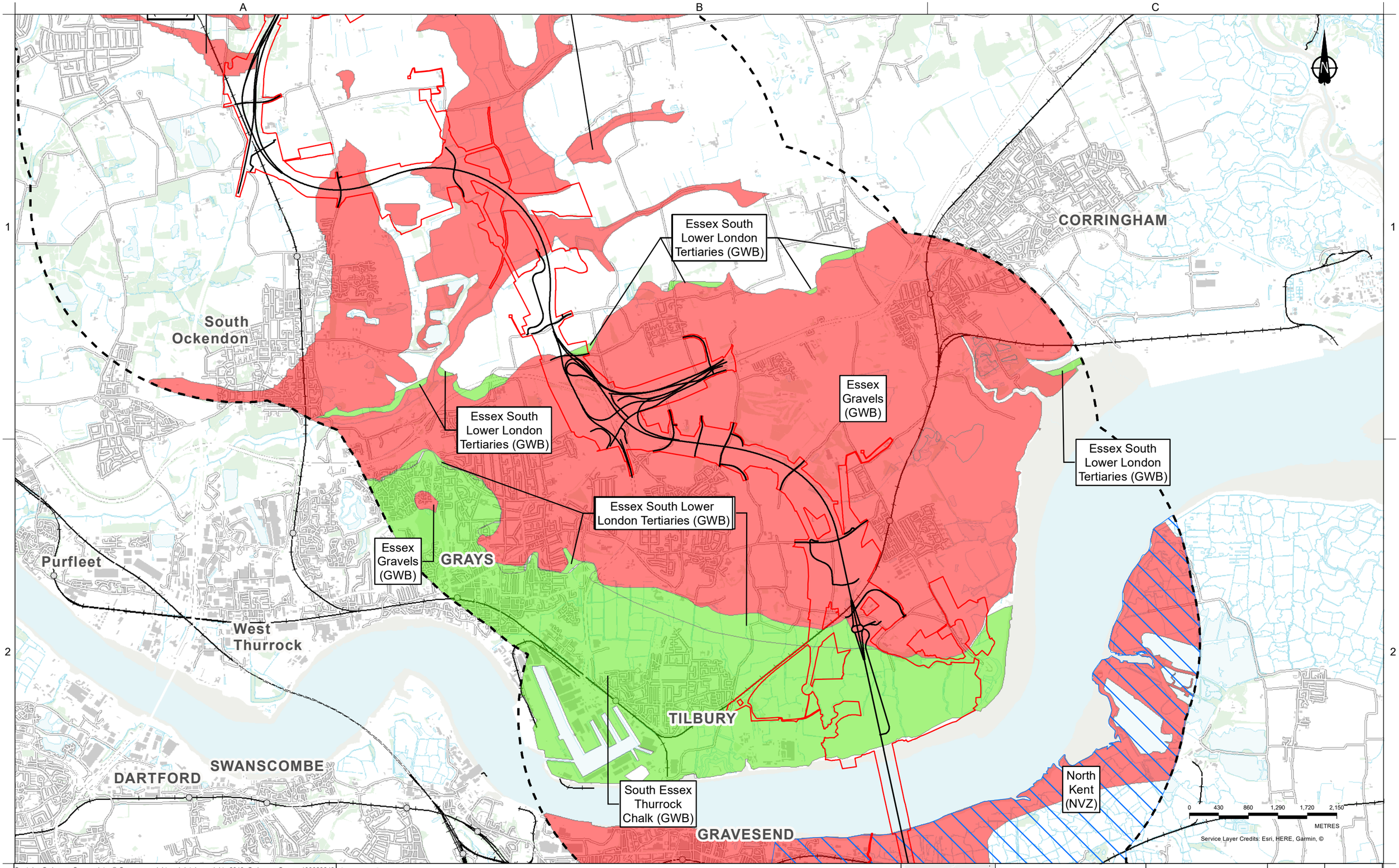

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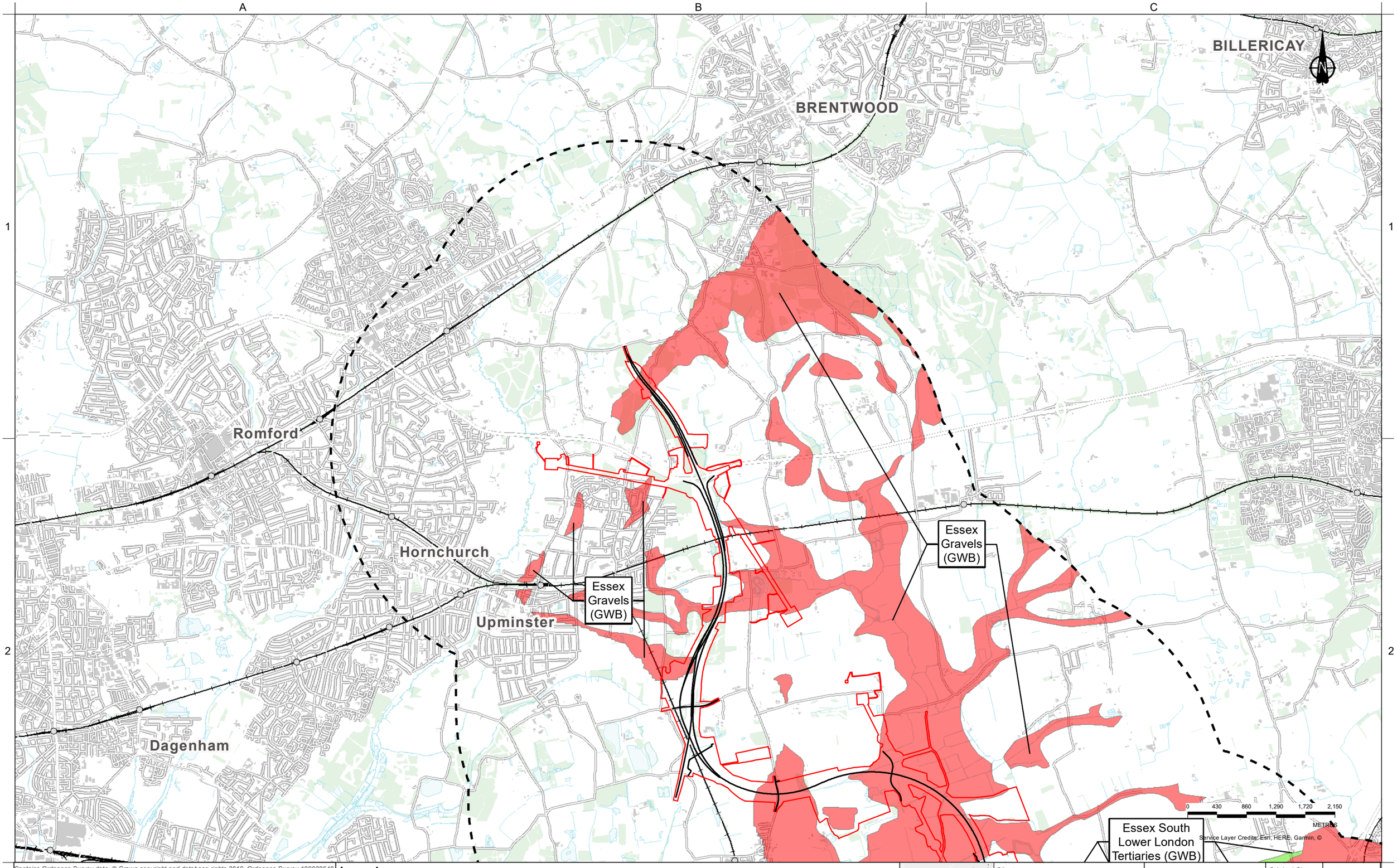

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- Poor Status

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Lower Thames Crossing

Water Framework Directive Assessment
Stage 3

Document Number: HE540039-CJV-GEN-GEN-ASM-ENV-00002

December 2019

Revision	Production Date	Prepared by	Checked by	Approved for release by
1.0	04.12.19	L. Driscoll	M. Wilson	B. Forrest
2.0	11.12.19	L. Driscoll	M. Wilson	B. Forrest

Contents

Appendices

1 Introduction

1.1.1 This document presents Stage 3 of a Water Framework Directive (WFD) Assessment that is being progressed in connection with the Lower Thames Crossing (LTC) project.

1.1.2 It has been prepared following completion of a Stage 1 scoping note and collation of baseline data on waterbody status, specific objectives and interventions, referred to as Stage 2. The scoping note and baseline information have been reviewed by the Environment Agency, who have noted their approval of these early stages of the assessment.

1.1.3 Stage 3 of the assessment methodology comprises:

- Defining the relationship between the Proposed Development components and the screened in waterbodies;
- Screening out elements of the Proposed Development that are not considered to be relevant in terms of having the potential to impact on WFD waterbodies and associated protected areas; and
- Taking forward to Stage 4 of the assessment any other components.

1.1.4 The purpose of this document is to present the Stage 3 data for discussion with the Environment Agency.

2 Proposed Development Description

2.1 Overview

2.1.1 The Proposed Development is shown on Figure 1 in Appendix 1.

2.1.2 The Proposed Development would connect the A2 in Kent, east of Gravesend, to the M25 south of junction 29, crossing under the River Thames by means of two bored tunnels. The Proposed Development would include changes to the M2/A2, A13 and M25, described below. The total length of new roads, including M2/A2 and M25 improvements, would be approximately 31km, including approximately 4.25 km in tunnel.

2.2 South of the River Thames

2.2.1 Table 1 provides a summary of the main elements of the Proposed Development to the south of the River Thames crossing.

Table 1. Summary of Proposed Development Components South of the River Thames Crossing

Location	Works Description
A2 / M2 corridor	Realignment and widening of the existing A2 corridor between Henhurst Road and Valley Drive through to the junction 1 of the M2. Construction of replacement bridges for Brewers Road and Thong Lane. Construction of new connector roads to provide local access south of the existing A2. Construction of the Gravesend East junction upgrade. Drainage works in the form of large open infiltration basins with a series of shallow soakaway trenches across their base. Demolition of an existing petrol station.
A2 / LTC Junction	Construction of new junction to connect the LTC to the A2 to the east of Gravesend. Junction works will include construction of east and west bound connections with associated structures, including a new viaduct and underpasses to cross the existing A2. A new green bridge will be constructed over the LTC alignment on Thong Lane where the LTC route continues into cutting.
Main Crossing and south portal	Deep cuttings between the south portal and the A2 / LTC junction. Construction of the south portal and Tunnel Boring Machine (TBM) reception shaft, with associated earthworks. The south portal is located approximately 500m south of the A226. Construction of an additional bored tunnel to facilitate the ground treatment (grouting) of River Terrace Deposits at planned intervals prior to the main tunnel construction. This will include the construction of a launch shaft to the south of Lower Higham Road and a reception shaft

Location	Works Description
	approximately 700m north, within the Metropolitan Police Service Specialist Training Centre. The ground treatment will provide stability to allow for TBM interventions during construction of the main bored tunnels.

2.2.2 To the south of the River Thames five construction compounds would be established during the enabling works phase, three are classified as main compounds where materials and aggregates would be stored and there would be provision for parking, plant storage and refuelling, welfare and office facilities. The largest of these, compound CA03, will be located around and to the south of the south portal. The compound will facilitate the construction of the portal and reception of the TBMs. Two would be satellite compounds, more transient in nature, providing local office and welfare space, as well as wheel wash and refuelling facilities. Compounds would be suitably fenced, topsoil would be stripped and stored, and a granular hardcore material laid. Hardstand would be provided where required, for example, for parking areas.

2.2.3 Access and haul roads would be created, having a maximum width of 15m.

2.3 Thames Crossing

2.1.1 The bored tunnel crossing would be located between a point approximately 500m south of the A226, to the south-east of the village of Chalk and a point 500m to the north of the River Thames, west of East Tilbury. The tunnel would pass under the Thames and Medway Canal, North Kent Railway Line, the Thames Estuary and Marshes Ramsar site, South Thames Estuary and Marshes SSSI and the Metropolitan Police Service Specialist Training Centre. At the centre of the river the tunnel would be around 30m below the riverbed and around 50m below the mean highwater spring level.

2.3.1 The tunnel would be a twin-bore structure, and each bored section would have a diameter of approximately 16m. A series of cross passages, at intervals of 150m and internal diameter of 3.45m, would connect the two tunnel bores.

2.4 North of River Thames

2.4.1 The tunnel would rise to the north of the River Thames. The twin-bored tunnel would end at a headwall at a depth of approximately -12m AOD. The highway would continue through a short section of cut and cover up to 200m in length before entering open cutting at a depth of approximately -5 mAOD. The proposed north portal would be about 500m north of the river bank and 1.5km south of the Tilbury Loop Railway Line. The route would reach existing ground level about 530m north of the tunnel portal.

2.4.2 Table 2 provides a summary of the main elements of the Proposed Development to the north of the River Thames crossing, which are illustrated in Figure 1 in Appendix 1.

Table 2. Summary of Proposed Development Components North of the River Thames Crossing

Location	Works Description
Thames North Shore	Retain use of, or construct a like for like replacement of an existing jetty at Ingrebourne Valley, to facilitate construction phase movements of materials by river.
North Portal	Ground treatment (grouting) for stability local to the TBM launch site and tunnel headwall Construction of TBM launch box using diaphragm walling to create a perimeter and excavation and casting of a concrete box structure underlain by a grout plug to limit groundwater ingress Groundwater control (including dewatering) of the TBM launch box construction, treatment and discharge of dewatering effluents to the River Thames Construction of a slurry wall between the north portal and approach ramps and the East Tilbury landfill site TBM slurry treatment Pre-casing of concrete tunnel sections, culverts etc
Tilbury Loop	Culverting of a main river and several ordinary watercourses Re-provision of an irrigation water supply reservoir Viaduct construction Drainage installations comprising open balancing ponds with integral wetland discharging to a watercourse.
A13	Excavations for structures to cross beneath the existing A13 Realignment of the A1013 and construction of structures to link roads south of the A13 and east of the A1089 Realignment of Baker Street Construction of a new north bound link between the A1089 and LTC mainline Demolition and reconstruction of Rectory Road Overbridges and structures to facilitate A1089 north bound links Drainage installations including deep trunk pipeline, outfalling to a watercourse via open balancing ponds with integral wetland.
Ockendon Link	Construction of the highway between the junction with the A13 and the M25 Construction of the Mardyke viaducts Culverting and diversion of several Ordinary Watercourses Drainage installations including a deep drainage network outfalling to a balancing pond with integral wetland discharging to a watercourse.
M25	Construction of an underbridge beneath the M25 by box jacking Major earth works activities to create a deep cutting

Location	Works Description
	New bridges at North Road, Ockendon Road and Folkes Lane and a bridge for the M25 offslip to cross over the LTC north bound link Widening and tie in works along the existing M25 corridor Extension of an existing culverted watercourse and diversion/culverting of several Ordinary Watercourses Drainage installations comprising upgrade of existing drainage networks and new drainage infrastructure.

2.4.3 To the north of the River Thames 13 construction compounds would be established during the enabling works phase. The largest main works compound, CA05, would be set up local to the north portal. From this compound tunnelling operations would be managed and there would be additional facilities for concrete batching/pre-casting. Slurry and wastewater treatment facilities and a segment factory would also be provided at this compound.

2.4.4 A network of access and haul roads would also be created, having a maximum width of 15m.

2.5 Components with Potential to Effect WFD Surface Waterbodies

2.5.1 Under the WFD, surface water body status is classified based on chemical and ecological status (or potential). Chemical status is defined by compliance with environmental standards for chemicals that are priority substances and/or priority hazardous substances. Ecological status or potential is defined by the overall health or condition of the watercourse based on four classification elements or 'tests:

- Biological - indicated by a biological quality element such as the abundance of fish, invertebrates or algae and by the presence of invasive species;
- Physico-chemical - compliance with environmental standards for supporting physico-chemical conditions, such as dissolved oxygen, phosphorus and ammonia;
- Specific pollutants - compliance with environmental standards for concentrations of specific pollutants, such as zinc, cypermethrin or arsenic; and
- Hydromorphology - a combination of the structural (morphological) characteristics of a watercourse and its water flow and level regime (hydrological characteristics). Changes to these characteristics are often a required for flood protection, or to support water supply, irrigation or navigation. Where this is poor there can be adverse ecological effects, affecting the biological quality element.

2.5.2 Table 3 presents a summary of those components that are considered to have potential to effect one or more of these classification elements of the WFD surface waterbodies within the Zone of Influence (ZoI) of the Project.

Table 3: Potential Impacts of Proposed Development components on WFD Surface Waterbodies and Protected Areas

Component	WFD Waterbody / Protected Area	WFD Element Affected
Watercourse culverting, realignment (new and extension) and drainage outfall installation.	Mardyke (and tributaries draining to the Mardyke) Tilbury Main* Mardyke (West Tributary)	Potential to disturb channel bed/bank forms, alter lateral connectivity with floodplains, change flow dynamics/hydraulics and sediment transport processes (erosion and accretion). Create a barrier to fish and mammal passage and cause habitat loss. **Biological Quality Elements** **Hydromorphology**
Significant excavations e.g. for the north portal TBM launch box and the M25 cutting	Tilbury Main* Mucking Flats and Marshes SSSI Mardyke (West Tributary)	Mobilisation of ground contaminants from their source (e.g. historical or active landfills), their transport and delivery to aquatic systems **Physico-chemical** **Specific Pollutants** **Biological Quality Elements**
New road construction, road widening, and general construction activity including stockpiling of materials and spoil	Mardyke Mardyke (West Tributary) Mardyke (East Tributary)	Increase in paved (impermeable) land cover, changing rainfall runoff patterns and the rates and volumes of runoff received by watercourses in affected catchments. Risks of generation of silted runoff from work sites, spills of oils, hydrocarbons and other construction wastes causing pollution. **Biological Quality Elements** **Physico-chemical** **Hydromorphology**
Structures spanning watercourses e.g. viaducts	Mardyke (and tributaries draining to the Mardyke) Mardyke (East Tributary)	Shading of watercourses leading to loss of habitats/sensitive vegetation. **Biological Quality Elements**

Component	WFD Waterbody / Protected Area	WFD Element Affected
Operational road drainage	Mardyke Mardyke (West Tributary)	Risks of chronic and acute pollution of watercourses receiving drainage discharges **Physico-chemical** **Specific Pollutants** **Biological Quality Elements**
Ground treatment for stability and to allow TBM interventions	Thames Estuary and Marshes Ramsar site	Reduced water levels in the ditch network due to induced groundwater draw down, as well as risks to surface water quality. **Biological Quality Elements** **Physico-chemical** **Specific Pollutants** **Hydromorphology**
Set up and operation of construction compound CA05	Tilbury Main*	Pollution risks linked to slurry treatment, plant refuelling and concrete pre casting. **Physico-chemical** **Specific Pollutants** **Biological Quality Elements**
Construction and use of haul roads	Mardyke Mardyke (West Tributary)	Risks of generation of silted or otherwise polluted runoff. Routes cut off surface water flow paths and cross watercourses, inducing physical or hydrological change. **Biological Quality Elements** **Physico-chemical** **Hydromorphology**

***Tilbury Main is not a classified WFD waterbody, but is a main river that drains to the Thames Middle waterbody**

2.6 Components with Potential to Effect Estuarine WFD Waterbodies

2.6.1 The Proposed Development design is such that there are relatively few direct or indirect impacts on the Thames Middle waterbody, as the bored tunnels would be constructed at depth below the bed of the river.

2.6.2 Table 4 provides a summary of those elements of the Proposed Development that have been screened in.

Table 4 Potential Impacts of Proposed Development components on WFD Estuarine Waterbodies

Component	WFD Waterbody	WFD Element Affected
Jetty	Thames Middle	Piling linked to construction of a replacement jetty, resulting in localised water quality and hydrodynamic effects and noise/vibration disturbing marine species. **Biological Quality Elements** **Physico-chemical** **Specific Pollutants** **Hydromorphology**
Receipt of treated discharges of dewatering effluents from the north portal excavation		Adding built development spanning the intertidal zone (pipeline and outfall), and potential water quality and hydrodynamic effects **Biological Quality Elements** **Physico-chemical** **Specific Pollutants** **Hydromorphology**
Receipt of discharges of operational discharges from tunnel drainage		Adding built development spanning the intertidal zone (pipeline and outfall), and potential water quality and hydrodynamic effects **Biological Quality Elements** **Physico-chemical** **Specific Pollutants** **Hydromorphology**
Noise and vibration during tunnel construction and operation		Disturbance of marine benthic invertebrates, mammals and fish **Biological Quality Elements**

2.7 Components with Potential to Effect WFD Groundwater Bodies

2.7.1 Groundwater body status is classified based on quantitative and chemical status.

2.7.2 Quantitative status is defined by the quantity of groundwater available as base flow to watercourses and water-dependent ecosystems, and as

'resource' available for use as drinking water and other consumptive purposes. There are four classification elements or 'tests:

- Saline or other intrusions - intrusion of poor quality water, such as saline water or water of different chemical composition, as a result of groundwater abstraction;
- Surface water - test designed to identify groundwater bodies where groundwater abstraction is leading to a significant decrease of the ecological status of associated surface water bodies;
- Groundwater dependent terrestrial ecosystems - test designed to identify groundwater bodies where groundwater abstraction is leading to "significant damage" to associated Groundwater dependent terrestrial ecosystems (GWDTEs) (with respect to water quantity); and
- Water balance – identifies groundwater bodies where groundwater abstraction exceeds the available groundwater resource.

2.7.3 Chemical status is defined by the concentrations of a range of key pollutants, by the quality of groundwater feeding into watercourses and water-dependent ecosystems, and by the quality of groundwater available for drinking water purposes.

2.7.4 Table 5 presents a summary of those components that are considered to have potential to effect one or more of these classification elements of the WFD groundwater bodies with the ZoI.

Table 5 Potential Impacts of Proposed Development components on WFD Groundwater Bodies

Component	WFD Waterbody / Protected Area	WFD Element Affected
New road construction, road widening, and general construction activity including stockpiling of materials and spoil	North Kent Medway Chalk Essex Gravels South Essex Thurrock Chalk Essex South Lower London Tertiaries	Increase in paved (impermeable) land cover, changing rainfall runoff and groundwater recharge patterns and quantities. **Quantitative status** **Chemical status**
Temporary dewatering or permanent groundwater control	North Kent Medway Chalk Essex Gravels South Essex Thurrock Chalk Essex South Lower London Tertiaries	Lowering of groundwater levels and reduction in groundwater contributions to surface water bodies, GWDTEs or groundwater abstractions. Saline intrusion. **Quantitative status** **Chemical status**
Earthworks – creation of embankments,	North Kent Medway Chalk	Disturbing or mobilising

Component	WFD Waterbody / Protected Area	WFD Element Affected
cuttings and other excavations such as at the north and south tunnel portals	Essex Gravels South Essex Thurrock Chalk Essex South Lower London Tertiaries	existing poor quality groundwater or ground contaminants from their soil source, for example, historical landfills at Goshems Farm, East Tilbury, Baker Street and Low Street, creating new pathways along which existing poor quality groundwater can migrate. **Chemical Status**
Foundations – piling, diaphragm walling and other below ground construction, including tunnelling	North Kent Medway Chalk Essex Gravels South Essex Thurrock Chalk Essex South Lower London Tertiaries	"Damming" or diversion of groundwater flows, in places reducing groundwater contributions to surface water bodies, GWDTEs and groundwater abstractions or causing groundwater levels to rise increasing flood risk. Also potentially opens pathways for pollution. **Quantitative status** **Chemical status**
Ground treatment for ground stability, e.g. where embankments are built on soft ground and to allow TBM interventions, including a grout tunnel south of the River Thames	North Kent Medway Chalk Thames Estuary and Marshes Ramsar Site Essex Gravels South Essex Thurrock Chalk	Impacts on groundwater levels and flows, reducing groundwater contributions to surface water bodies, GWDTEs, as well as risks to water quality. **Quantitative status** **Chemical status**
Operational drainage via infiltration to ground (soakaways)	North Kent Medway Chalk Thames Estuary and Marshes Ramsar Site Essex Gravels Essex South Lower London Tertiaries South Essex Thurrock Chalk	Risks of chronic and acute (spillage induced) pollution and changes to recharge patterns **Quantitative status** **Chemical status**

Component	WFD Waterbody / Protected Area	WFD Element Affected
Set up and operation of construction compound CA05, CA03 and other smaller compounds	North Kent Medway Chalk Essex Gravels South Essex Thurrock Chalk	Pollution risks linked to slurry treatment, plant refuelling, concrete pre casting etc, building foundations opening pollution pathways to groundwater. **Chemical status**

2.8 Screened Out Components

2.8.1 Any activities which cause a short term change, that is, that impacts a waterbody for a short period of time and the waterbody recovers within a short period of time without the need for restoration measures, are not considered to cause deterioration as defined in the WFD. For the purpose of this assessment, short term has been assumed as 3 years or less, which is in line with other large infrastructure projects.

The following short term activities have therefore been screened out:

- Temporary traffic management;
- Utility diversions meeting the criteria above regarding timescales of ground disturbance and waterbody recovery; and
- Landscaping (excluding formation of large landscaping bunds) and habitat creation.

2.8.2 Longer terms effects on the Thames Middle waterbody linked to the operational phase of the proposed jetty have also been scoped out. This is because the jetty would replace, on a like for like basis, an existing jetty structure, the presence of which is accounted for in the current WFD status of this waterbody.

3 Design & Embedded Mitigation Measures

3.1.1 Impacts and changes to the water environment due to activities associated with the Proposed Development would be prevented or reduced as an outcome of a process of iterative design, whereby measures have been embedded to reduce environmental effects.

3.1.2 Key examples relevant to protecting the status of WFD waterbodies are:

- Design of the crossing of the Mardyke, its first order tributaries and floodplain, with clear spanning viaducts that are orientated to prevent disruption to key floodplain flow paths and minimise any effects on floodwater afflux, as well as hydromorphology, and reducing the risk of impacts on water quality;
- Design of watercourse crossings to minimise impacts on existing hydromorphology, e.g. by maintaining existing channel gradients, aligning entry/exits with existing watercourse channels and limiting culvert lengths to a practical minimum. Also culvert inverts would be depressed to allow formation of natural bed and culverts would be sized to accommodate ledges for passage of otters and other mammals;
- Use of tunnel boring techniques and inclusion of structures at major cuttings and excavations to limit groundwater ingress and the associated need for dewatering, hence limiting groundwater drawdown magnitude and extent; and
- In high risk areas, inclusion of features to minimise the mobilization of leachates and existing contamination from historical landfill sites e.g. slurry walls, to protect groundwater and surface water quality.

3.1.3 During the operational phase of the Proposed Development, the drainage design would provide for attenuation and treatment of road runoff prior to discharge to the receiving water environment. Infiltration drainage solutions would be adopted only where studies indicate suitable ground conditions exist and outside of any groundwater Source Protection Zone 1. Where new outfalls to surface watercourses are needed, these would be constructed to minimise impacts on flow regimes and to limit risks of scour or erosion.

3.1.4 Using the results of a detailed Flood Risk Assessment, the Proposed Development has also been designed with in-built flood protection, inclusive of resilience for future climate change, and includes for mitigation measures to ensure any increase in baseline flood risk due to construction is managed.

3.1.5 Good practice construction techniques would also safeguard WFD waterbody status. These include mitigation measures imposed, for example, as a result of legislative requirements and/or standard sectoral practices, and some of which may be secured through the marine licensing route. These mitigation measures would be detailed in a Code of Construction Practice (CoCP). Examples include provision of storage

lagoons and treatment/settlement facilities, on site availability of oil spill clean-up equipment, use of drip trays for mobile plant, testing of made ground/reworked soils to identify contamination and sediment-trapping matting/bunds installed downstream of any construction activities adjacent to or over watercourses.

3.1.6 Further information on the mitigation measures that would be adopted will be provided in the Stage 4 WFD assessment report and will also be presented in Chapter 14 (Road Drainage and Water Environment) of the Environmental Statement. Suitably worded commitments about providing the necessary measures to prevent WFD noncompliance will also be included in the Register of Environmental Actions and Commitments submitted as part of the Development Consent Order application.

4 Summary and Next Stages

4.1.1 The next stage of the WFD Assessment (Stage 4) will appraise the potential for those screened in components of the Proposed Development to cause detriment to the status or objectives and measures set for the WFD waterbodies in the defined ZoI of the Proposed Development.

4.1.2 Stage 4 will be informed by the results of several numerical modelling studies and other assessments including:

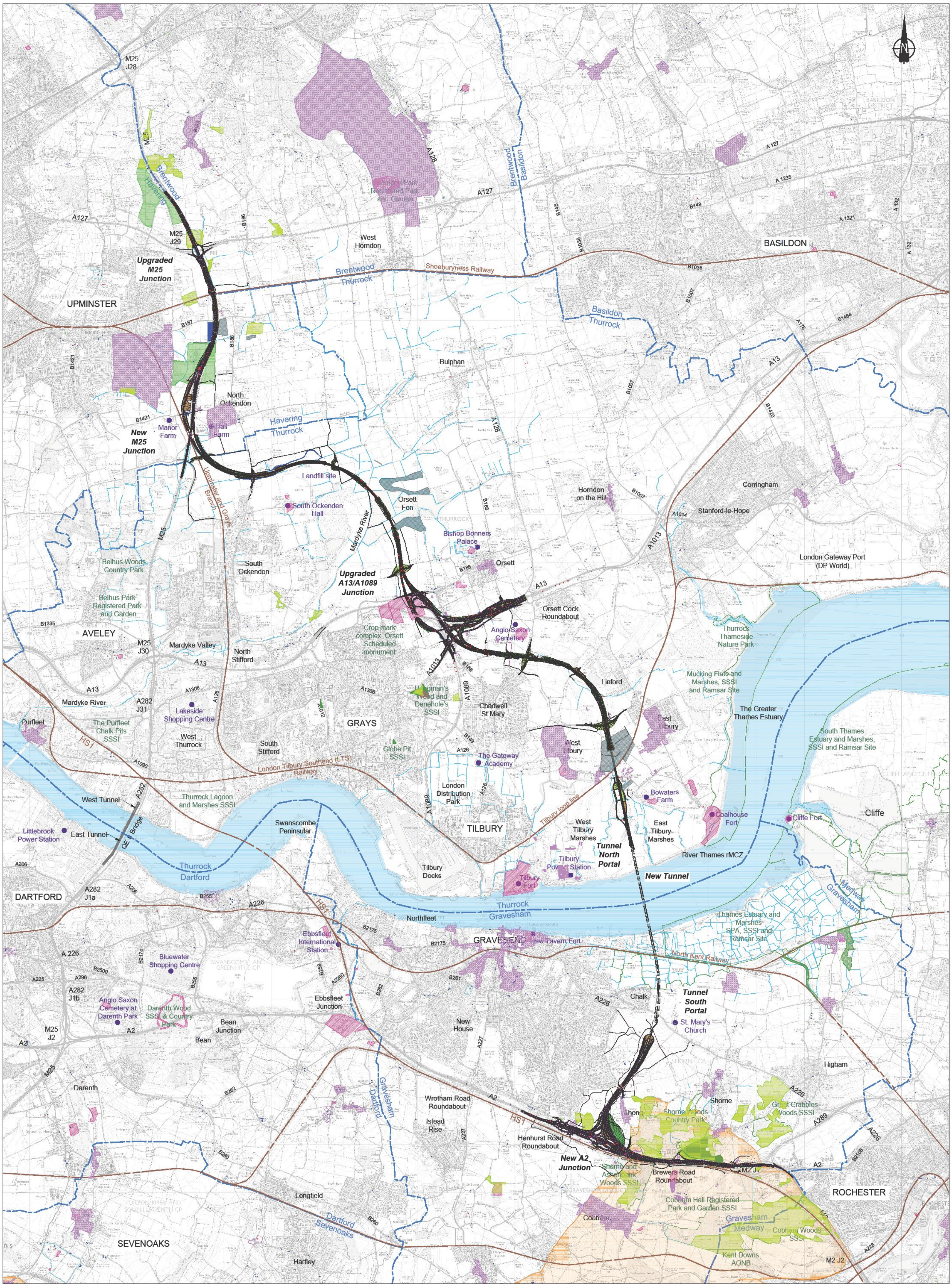
- Hydraulic modelling of the flooding regime of the Mardyke river, key tributaries and its floodplain;
- Results of Highways England Water Risk Assessment Tool (HEWRAT) and UKTAG Metals Bioavailability Assessment Tool (M-BAT) calculations defining the risk of pollution of surface and groundwater bodies associated with receipt of operational drainage discharges and due to accidental spills;
- Groundwater modelling studies local to the north portal, to quantify dewatering impacts on groundwater levels and flows, saline intrusion, as well as particle tracking modelling to assess the risks of mobilising contamination from the East Tilbury landfill;
- Groundwater modelling studies to assess the risks of ground treatment beneath the Thames Marshes and Estuary Ramsar site impacting on groundwater levels and flows and saline intrusion; and
- Groundwater modelling studies to assess the pollution risks to the Thames Marshes and Estuary Ramsar site from upgradient infiltration based operational drainage solutions.

4.1.3 The Stage 4 assessment will also draw on conceptual site models that have been developed and the findings of a Hydrogeological Risk Assessment.

Appendix 1

Figure 1

Working on behalf of



LEGEND

- AONB (Area of Outstanding Natural Beauty)
- Ancient Woodland
- SSSI (Site of Special Scientific Interest) and Ramsar
- SPA Special Protection Area

highways england

LOWER THAMES CROSSING SUPPLEMENTARY CONSULTATION

PROPOSALS FOR CONSULTATION

GENERAL ARRANGEMENT WHOLE SCHEME

Annex B Summary of Environment Agency comments and Project responses

WFD stage	Environment Agency comment	Project response
Stage 1 (December 2017)	The applicant has satisfactorily scoped the risks and further assessment work required from a marine water quality perspective.	Noted.
1	It is critical that the next stage of investigations and reporting on groundwater quality and flow is comprehensive to understand the potential impacts on groundwater, in particular the effects of dewatering.	A detailed assessment, including numerical modelling is presented in Appendix 14.5: Hydrogeological Risk Assessment (Application Document 6.3). This includes detailed studies to understand the Project's effects on groundwater levels and flows. These assessments will continue to be verified and advanced as further ground investigation data is received.
1	We are pleased to note that all WFD groundwater bodies within a 3km zone will be included and find this suitable. The Essex Gravels groundwater body should be included.	The Essex Gravels groundwater body has been included.
1	It would be useful to make it explicit that the Thames Estuary SPA, includes the Mucking Flats and Marshes SSSI.	This is clarified in Section 7 of this report.
1	Additional data may be needed to characterise the biodiversity of protected areas.	National Vegetation Classification surveys within Filborough and Shorne Marshes have been completed to identify aquatic macrophytes. Aquatic invertebrate surveys have been carried out in the Filborough Marshes part of the Thames Estuary and Marshes Ramsar site/South Thames Estuary and Marshes SSSI. Watercourses local to the North Portal and the River Mardyke have also been surveyed.
Stage 3 (December 2019)	The assessment will need to include detail on the methods, materials and timescales of different elements of the Project.	Additional details have been provided in Section 3 of this report, in addition to sections 3.2, 4.2, 5.2 and 6.2 of the Stage 4 Preliminary report.
3	The impact of airborne particulates should be considered for watercourses and also factored into the assessment of the Ramsar/SSSI/SPA.	This has been considered as part of the assessment.

WFD stage	Environment Agency comment	Project response
3	Information from ecological and water quality surveys should be included to enable the current ecological status of affected water bodies to be defined.	Survey methods and results are presented in Appendix 8.4: Freshwater Ecology (Application Document 6.3).
3	Impacts from use of the jetty should be included and the long-term effects of the structure should be included unless the proposal specifically includes its removal once the Project is complete.	Neither the construction of a new jetty nor maintenance and use of the existing jetty at Goshem's Farm fall under the current scope of works for the Project; this has therefore been removed from the WFD assessment scope. This is confirmed in Section 1.2 of the WFD (Application Document 6.3, Appendix 14.7).
3	The Stage 3 report identifies short term as 3 years or less, this needs to be reduced. Good practice normally defines short term as 1 year or less.	Noted – the Stage 4 assessment has based 'short term' as Project activities of one year duration or less.
3	Habitat creation near the Ramsar/ SSSI should not be screened out. Creation could cause non-native species to be introduced or spread.	Noted. Habitat creation has been included in this assessment.
3	The design should aim to be positive and any positive impacts should be taken into consideration	Section 4.8 herein documents how the design would contribute to improvements in surface water body status.
3	We agree the items for further stage 4 assessment listed must be supported by good evidence from ground assessments and further modelling	Evidence is provided in the technical notes supplied in Appendix 14.5: Hydrogeological Risk Assessment (Application Document 6.3).
3	Figures need to be included to show protected sites, construction compound locations and defined ZoI.	Please see drawings provided in Annex C.
3	Demolition of existing petrol stations in the south need to be assessed.	Please note that a petrol station at the service station situated alongside the A2 has already been demolished, with suitable remediation having taken place. This activity has therefore been scoped out of this Stage 4 assessment.
Stage 4 (Preliminary Report) (August 2021)	Insufficient detail is provided to fully assess the impact of the construction to the ground protection tunnel. More technical details on methods of construction are required.	Additional information to describe the ground protection tunnel and the proposed techniques to construct it have been added to Section 3 of this report.

WFD stage	Environment Agency comment	Project response
4 (Preliminary Report)	The document does not mention the Local Wildlife Site where the reception shaft of the ground protection tunnel begins. Risks to water bodies in this vicinity also need to be assessed.	The Local Wildlife Site has been described in Section 7.1, and the potential for the Project to affect the site has been assessed.
4 (Preliminary Report)	There is no mention of the proposed outfall on the south bank of the Thames other than its assessment of the Thames Middle water body. The Order Limits goes along the ditches that border or lie within the Ramsar/SSSI and effects on the designated site should be included.	Further details on drainage proposals for the large construction compound to the south of the Thames Middle water body have been added to Section 3 of this report. The effects of this discharge route have also been assessed and are reported in Sections 4, 5 and Section 7.
4 (Preliminary Report)	The document states that an annual spillage risk of 0.5% is considered acceptable. If applied to the Ramsar/SSSI we would need this confirmed as an acceptable risk by Natural England.	Further details regarding annual spillage risk have been added to Section 7. During review of the draft HRA Screening report, Natural England had no comments on the proposal to screen out water quality issues due to the conclusion that there would be no Likely Significant Effects.
4 (Preliminary Report)	Plans show the compound area for the southern portal abutting the SSSI area. How this compound is laid out and used adds an element of risk due to proximity and this should be assessed.	Further details and assessment are provided in Sections 3 and 4 of this report.
4 (Preliminary Report)	The impact of the jetty is not fully included. As it is going to be in place for between 5 and 10 years, we will treat it as a permanent structure, in which case mitigation for the original loss of habitat needs to be factored in.	The construction or maintenance of an existing jetty no longer falls under the scope of works for the Project and has therefore been removed from the WFD assessment scope. This is confirmed in Section 1.2 of this WFD Assessment Report (Application Document 6.3).
4 (Preliminary Report)	The document does not address the issues raised regarding disconnection of the West Tilbury Main water body by constructing a culvert. We recognise that in the grand scheme of things the West Tilbury Main is not the most ecologically diverse or valuable water body, there is no evidence to suggest that organisms can or will travel 65m between the	Further assessment of the West Tilbury Main culvert is provided in Section 4 of this report

WFD stage	Environment Agency comment	Project response
	upstream and downstream sections of the culvert.	
Stage 4 (Draft final report) (July 2022)	There is unlikely to be a permit for run-off. Therefore, some other means of agreeing a run-off standard will be required. This is particularly important for non-solids, that will not be easily removed from the water such as hydrocarbons, oils, or anything that might dissolve. More information on these items should be provided at some stage. This is so we can understand how this system will deal with any chemical or pollution risk substance that will be used on the site, and how the system will work in practice.	We have now agreed with the Environment Agency national permits team that this discharge would be regulated through an environmental permit. Runoff waters from the southern tunnel entrance compound will be separated from the runoff generated by the long-term temporary stockpile, therefore, the main pollutant of concern will be suspended solids. Pre-application discussions are ongoing with the Environment Agency to understand likely permit thresholds that the Project would need to achieve. Parameters to be considered for an environmental permit have been included within REAC item RDWE033.
4 (Draft final report)	Habitat creation land at Coalhouse Point - We would query how this will be dealt with if there is a breach in the current defence along Coalhouse Fort? Please clarify if there is another location that has flood risk protection from tidal ingress as an alternative, more sustainable option?	Due to the uncertainty in relation to the Coalhouse Point flood defences, the freshwater mitigation area has been moved to a parcel of land within the Mardyke catchment. This proposed design has been able to achieve the original requirements of the mitigation at Coalhouse Fort and has also been reviewed as part of the flood risk assessment.
4 (Draft final report)	Section 6.3.1 We would welcome further clarification on this paragraph. There are no pumps associated with the system, although there is an abstraction licence from the Denton New Cut to service the canal (when there is sufficient rainfall to accommodate this). Stop boards retain water in the system at set levels. The water from Filborough Marshes will naturally drain north and into Denton New Cut, it is not reliant on the removal of any stop boards to do this. Whether it flows will be dependent on rainfall and therefore whether there is excess water in the marshes.	This section of the report has been updated to better describe the water management regime of the marshes, reflecting the information provided.
4 (Draft final report)	Table 6.1 - There would be a net increase in flow from the compound area during construction as the marshes do	The principles for the drainage arrangements have progressed. General compound runoff will be dealt with via a separate arrangement encouraging

WFD stage	Environment Agency comment	Project response
	not currently get any water flows from south of the A226. The assessment states that the amount of increase as a proportion would not be significant. We would require these calculations to confirm this.	infiltration to ground. Water discharged to western ditch will be from the stockpile runoff. Provision has been made within the drainage arrangements to attenuate flows to an acceptable limit to avoid significant changes to ditch water flows and levels. Discharge rates and volumes have been calculated and these would be regulated via the discharge permit.
4 (Draft final report)	Please refer to the recent meeting notes for our comments on re-assessing groundwater risks in relation to variable compliance points for the surface water drainage infiltration basin assessments.	These comments have been addressed in Appendix 14.5: Hydrogeological Risk Assessment, of the (Application Document 6.3).
4 (Draft final report)	The assessment makes mention of a ConSim assessment. We would like to review this assessment, including the ConSim files.	Noted, this information has been shared.
4 (Draft final report)	Section 5.2.5 The cut off diaphragm wall will greatly reduce the potential impact from dewatering and activities during the main construction phase. Please can you confirm if there has been any consideration of proposed mitigation measures in the event of failure of the diaphragm wall? Will the diaphragm wall remain in-situ post construction or are there plans to breach it once completed? If so, has any assessment of post construction breach been made with respect to potential changes in groundwater level.	Failure of the diaphragm walls has not been assessed/mitigated for as this situation is not considered to represent a reasonable worst case. The diaphragm walls would remain *in situ* post construction; there are no plans to breach them.
4 (Draft final report)	Section 6.3.5 Cranham Marsh - The comments provided suggest that onsite investigation or surveys have not been undertaken and only a desk-based study has been carried out. Based solely on desk-based studies, the assessment concludes that no significant impact will be made. We would like a more robust assessment to confirm that construction activities	Further groundwater modelling has been undertaken. The modelling has incorporated a significant amount of additional ground investigation which has allowed the Project to refine the conservative parameters used in the model in 2020. The updated model now shows a greatly reduced impact zone with respect to groundwater drawdown and demonstrates that Cranham Marsh falls outside of this zone and will not be adversely impacted from the works at the

WFD stage	Environment Agency comment	Project response
	will not cause damage to the Marsh and its associated sites. An ecological survey of the wetland could provide a much greater understanding of the potential eco-hydrological requirements of the site for those species present. The results would also determine whether construction drawdown needs to be monitored and whether mitigation measures need to be proposed should impacts be greater than expected.	M25 cutting in both a mitigated and unmitigated scenario. The model has demonstrated potential adverse effects at Hall Farm Moat SINC, however, mitigation in the form of seepage control has been shown to be effective in eliminating the adverse effects of groundwater drawdown at this location. Updates to the REAC have been made to secure this mitigation.
4 (Draft final report)	The Water Framework Directive quantitative status of the groundwater bodies has been updated ahead of Cycle 3 commencing in 2021. The methodology for calculating the groundwater balance has been revised and results show that the South Essex Thurrock Chalk is now failing the balance test moving to Poor, High Confidence. Based on the quantitative status of the Chalk at this location we would not issue any new consumptive groundwater abstraction and may seek to claw back from existing licences. Please can you confirm if the construction of the Lower Thames Crossing requires new groundwater resource and, if so, has the source of water and volume already been determined/acquired?	Data recently provided by the Environment Agency has been used to update water body status. The Project does not require new groundwater resource, other than a supply for the TBM, which it is intended would be drawn from Linford PWS borehole under its current licence. The effects of this abstraction have been assessed as part of the North Portal groundwater modelling reported on in the Hydrogeological Risk Assessment (Appendix 14.5, Application Document 6.3).
4 (Draft final report update)	Surface water pollution prevention Two temporary discharges from the construction phase are to be regulated via two separate permits under the Environmental Permitting Regulations (EPR). Full WFD assessments are expected to be undertaken when processing applications for these permits and consultations with local EA teams and external organisations are likely to be required. Details regarding	The permit applications will be made by the appointed contractors who would be expected to fully engage with all relevant stakeholders. To assist in setting discharge quality thresholds an initial period of baseline water quality monitoring has been completed for the Western Ditch (proposed to receive treated discharges from the southern tunnel entrance construction compound). The data set, comprising measurements of field determinands and laboratory analysis of water samples collected between

WFD stage	Environment Agency comment	Project response
	volume and quality thresholds will be decided following this process.	November 2021 to May 2022, is presented in Appendix 14.2 Water Features Survey Report. We would also be happy to share the data set separately.
4 (Draft final report update)	The updated WFD assessment does not reference the intention to apply for an environmental permit for the operational phase discharge for tunnel drainage, which has been proposed to discharge to the Thames Estuary at high water towards the northern end of the tunnel. Further details regarding the proposed control mechanisms for containment of contaminated water and the expected quality and composition of the discharge are required. This discharge may require controls by means of an environmental permit. Please include further detail regarding this proposed discharge.	Further detail regarding the tunnel drainage system has been included. Commitment RDWE026 within the REAC provides for the capture and isolation of contaminated waters from the tunnel drainage system, with the aim of safeguarding the quality of the Thames Middle waterbody.
4 (Draft final report update)	Groundwater and Contaminated Land The operational drainage designs have been agreed in outline and do not appear to have fundamentally changed by this latest submission, so we have no detailed comments to make over and above previous responses. We have no objection to the WFD assessment for in relation to groundwater quality for the southern portal and works within the Kent area.	It is confirmed that operational drainage designs have not fundamentally changed. Your satisfaction with regard to groundwater quality is noted, no further updates to this aspect of the assessment have been undertaken.
4 (Draft final report update)	Groundwater and Hydrogeology Monitoring and control measures will be agreed through construction via the CoCP and the REAC. From a groundwater resources perspective, we have no objection to the WFD assessment for the Kent side of works.	Your stance on groundwater resources is noted and no further updates to this aspect of the assessment have been undertaken.
4 (Draft final report update)	There seems to be inaccuracies/omissions present relating to which chemicals are failing.	The summary of waterbody chemical status that is quoted in your comment (from paragraph 4.1.4 of the report) relates to the WFD surface water bodies that are included in the assessment,

WFD stage	Environment Agency comment	Project response
	The report states '*water bodies overall and ecological statuses remain as moderate, whilst each of the water bodies currently fail with regard to their chemical status. The reasons for the failures are common to all the water bodies and are attributed to three priority hazardous substances, namely mercury and its compounds, Polybrominated diphenyl ethers (PBDE) and Perfluorooctane sulfonate (PFOS)*'. We note however that section 5.4.12 indicates awareness of the failures for priority hazardous substances, so perhaps the paragraphs are not consistent.	rather than the Thames Middle waterbody. Baseline status information for the Thames Middle is presented in paragraph 5.4.12. There is no inconsistency in reporting.
4 (Draft final report update)	With regard to the assessments outlined in section 5.2.1 and developed in more detail in the following sub-paragraphs within section 5.3, we note again that in 5.4.4" habitats and water quality (physico-chemical and specific pollutants" priority hazardous substances are again not mentioned. They will be present in sediment that is disturbed by construction, or by scour (if caused) from the discharges.	The information provided in your response has been used to update Section 5 of the report, including update of Tables 5.1 to 5.4 (as appropriate) to include reference to priority hazardous substances. Taking into account of the design and good practice measures proposed for construction of the new outfalls, and the proposals for treatment of the proposed discharges to the Thames Middle waterbody, an assessment of the risk of waterbody deterioration due to disturbance of contaminated sediments has been included.
4 (Draft final report update)	The last classification (2019: using the data collected in 2016-18) identified more failures in THAMES MIDDLE than just these three chemicals mentioned above (*mercury and its compounds, PBDE and PFOS)*. Failures are recorded for the following Priority Hazardous chemicals (though in addition there are other classes of chemicals (e.g. Zinc, as a Specific Pollutant) that also fail) • Benzo(b)fluoranthene, • Tributyl tin compounds, • Benzo(g-h-i) perylene. Also the data available likely significantly underrepresents the	There is no discrepancy in reporting, as clarified in the response above. Paragraph 5.4.12, describing the chemical classification of the Thames Middle waterbody states: *"some of the specific pollutants and priority hazardous substances tested for are at levels exceeding or approaching WFD EQS limits. These include mercury, zinc and cyanide. Various polycyclic aromatic hydrocarbons are also reported at maximum concentrations that exceed the relevant EQSs, including benzo(b)fluoranthene, benzo(g,h)perylene and benzo(k)fluoranthene".* Updates are included to reference to Tributyl tin compounds and to note that

WFD stage	Environment Agency comment	Project response
	benzo(a)pyrene levels in Thames Middle waterbody, which is likely to be failing for this substance.	the waterbody is likely to be failing for benzo(a)pyrene.
4 (Draft final report update)	Any WFD assessment for Thames Middle should consider whether activities could disturb sediments containing Benzo(a) pyrene, or indeed Benzo (g-h-i) perylene. The Deemed Marine License for the construction of the outfalls needs to consider WFD, and we understand the main arguments put forward for no deterioration on water quality grounds rest on the design of the construction. We acknowledge the intention to install the subtidal discharge pipeline at low water in order to avoid greater disturbance of intertidal sediment and mobilisation into the water column. Since the pipe will terminate sub-tidally, some disturbance (of the subtidal sediment during construction), and subsequent remobilisation of bed sediment to the water column is inevitable. The operation of the discharges will be assessed at detailed design and we assume that they will also take into account the potential for any remobilisation of bed sediments into the water column caused by the act of discharging. In our view, deterioration at waterbody scale of physico-chemical attributes seems unlikely, and we accept there will be a high degree of mixing of the freshwater effluent inevitable. The operation of the discharges will be assessed at detailed design stage and we assume that they will also take into account the potential for any remobilisation of bed sediments into the water column caused by the act of discharging. In our view, deterioration at waterbody scale of physico-chemical attributes seems unlikely, and we accept	Noted. In light of your concluding view no further updates to this aspect of the assessment have been made.

WFD stage	Environment Agency comment	Project response
	there will be a high degree of mixing of the freshwater effluent.	
4 (Draft final report update)	The points made about naturally high turbidity are valid, though we must stress that whilst there may be wide variation in suspended solids levels over WFD classification periods, any additions are net increases on the "natural" envelope of variation. The scale of change of the mean suspended solids value (considered here as a proxy for mobilised sediment contaminants) at water body level is likely to be small, given the size (volume)of the waterbody. It will not be zero, so perhaps it would be more accurate to state, instead of: • "Negligible risk –the discharges would not lead to any changes in physico-chemical characteristics''. • "Negligible risk –the discharges would not lead to any detectable *changes in physico-chemical characteristics''*. The insertion of the word "detectable", or, perhaps more conservatively, "significant" should still provide the explanation for the risk being "Negligible" but avoids overstating the case.	The recommended change to the text has been included in the updated report, 'detectable' has been added.
4 (Draft final report update)	It would be helpful to understand how much (roughly, in cubic metres) sediment might be resuspended by these operations. If volumes below approximately 300 cubic metres we would be happy to accept that dilution will be adequate without seeing any further calculations of sediment contaminant uplifts in the water column, however should the volumes be significantly higher (so on a par with dredging) we would expect a little more detail to support claims	The construction methodology (secured by the Deemed Marine Licence and REAC commitment MB001) would limit sediment mobilisation from the working area. This is because works would only be undertaken at low tide and the pipeline trench (which has a cross sectional area of approximately 4m^2) would be backfilled as the pipeline is laid along its approximately 400m length. It is therefore considered that the volumes of sediment generated would be considerably lower than that generated during dredging and combined with the available dilution, the

WFD stage	Environment Agency comment	Project response
	for insignificant effect, and then it might be appropriate to provide sediment chemistry data to back up no deterioration claims for water quality (particularly for chemicals which are currently failing). Given the size of this major infrastructure project we feel a little more detail in the impact assessment stage (evidence) would be appropriate to convince the public of its WFD compliancy. We do not, however, generally disagree about the level of probable risk, but consideration of likely volumes of sediment can help to provide confidence that the net change in the annual average really would be "negligible".	assessment conclusion of negligible risk of waterbody deterioration is appropriate.
4 (Draft final report update)	Surface water pollution prevention The table on page 30 states 'Residual spillage risk does not exceed acceptable thresholds defined by LA 113 of the DMRB. Please can we ask the applicant to confirm implications for accidental spillage control measures in the drainage design. We want to see containment infrastructure such as penstocks to be included in the design. This will allow pollutants arising from accidental spillages or firefighting run off to be contained in and removed from the drainage system before it reaches the receiving water.	The project includes commitments (RDWE025, RDWE034 and RDWE035) that would ensure protection of the groundwaters and surface watercourses that are proposed to receive operational drainage. These stipulate that drainage infiltration basins and retention ponds would be designed in accordance with the provisions of DMRB CD532 and CD501. CD532 (para 3.6) requires that soakaway design shall incorporate measures necessary to provide spillage and pollution control to protect receiving groundwater and clause 4.4 states that the design of the soakaway and its immediate surroundings shall allow access for emergency personnel and equipment to be able to mitigate the effects of a spillage. CD501 provides for similar safeguards with regards to the design of surface water retention ponds. Further information has been added regarding spillage containment to clarify.
4 (Draft final report update)	Fisheries, Biodiversity and Geomorphology The terrestrial side of things in south Essex seems fine and as agreed. Specifically, since completion of Stage 3, the Order Limits of the Project have been extended to include land to accommodate habitat creation	Your comments are noted and no further updates to this aspect of the assessment are proposed.

WFD stage	Environment Agency comment	Project response
	sites proposed as compensation for the effects of nitrogen deposition, and to accommodate works to supply water from the River Thames to an area of wetland habitat creation at Coalhouse Point. It is good to see the extra 500m specifically mentioned. I think the document covers the means of offsetting the culverting.	
4 (Draft final report update)	Groundwater and Hydrogeology The South Essex Thurrock Chalk has been remodelled into a multi-layer groundwater body which is more reflective of the hydrogeology of the area. It is now in Good status. We recommend you update this report to reflect these updates.	The EA catchment data explorer webpage does not reflect the change, with the waterbody still recorded as having Poor overall status. The projects various environmental assessments have data cut off points/dates beyond which changes cannot be accommodated in our submission documents. It is proposed that the change is noted and that we will review any potential implications post submission, with this approach being documented in the Environment Agency Statement of Common Ground.
4 (Draft final report update)	Section 6.2.13 states: '*For protection of potable groundwater sources, no fuel storage or fuel filling shall be allowed within a published source protection zone 1 (SPZ1) or within the 50m default SPZ radius of a private water supply well or spring [RDWE0XX]*'.The 50m SPZ1 radius is a default for domestic supplies, we would expect a bespoke assessment in each case to determine an appropriate SPZ1 more accurately in this instance. We recommend you reconsider this within your assessment.	Your comment is noted and a commitment to agree more bespoke SPZ1 for private water supply wells or springs with the Environment Agency has been included within REAC commitments GS004 and GS005.
4 (Draft final report update)	Section 6.3.5, describing quantitative status - As noted above, the South Essex Thurrock Chalk has been remodelled into a multi-layer groundwater body which is more reflective of the hydrogeology of the area. It is now in Good status. We	The EA catchment data explorer webpage does not reflect the change, with the waterbody still recorded as having Poor overall status. The projects various environmental assessments have data cut off points/dates beyond which changes cannot be accommodated in our submission documents. It is proposed that

WFD stage	Environment Agency comment	Project response
	recommend you update this report to reflect these updates.	the change is noted and that we will review any potential implications post submission, with this approach being documented in the Environment Agency Statement of Common Ground.

Annex C Drawings

Drawing 1 Construction compound and haul road location plans

Drawing 2 WFD surface water bodies and protected areas, also illustrating the proposed freshwater habitat creation area

Drawing 3 WFD groundwater bodies

Drawing 4 West Tilbury Main Culvert

A226 Gravesend Road Compound

Southern Tunnel Entrance Compound

Construction Section B

Construction Section A

ULH 13

ULH 14

ULH 15

ULH 16

Marling Cross Compound

A2 Compound

0 0.3 0.6 0.9 1.2 KM

Legend

- Route alignment
- Order Limits
- Working area for utilities
- Overhead electricity works
- Multi-utility works
- Public rights of way
- Construction sections
- Utilities Logistics Hub
- Main Works Construction Compound

Utilities Access Route

- Utilities Offline Access
- Utilities Online Access

Main Works Construction Access Route

- Short Term - Online - Main
- Long Term - Online - Main
- Construction Routes - Offline - Main
- Emergency Turning Point
- Crossing
- Secondary
- Land Roads Tracks And Paths

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P02	S8	22/09/2022	DCO Application	SW	LD	BF

Client: national highways

Project: LOWER THAMES CROSSING

Status: DCO APPLICATION

Original Size: A3

Revision: P02

Application Document Number: TR010032/APP/6.3

Scale: 1:25,000

Drawing Title: Compound and Access Route Plan

Page 1 of 5

Drawing Number: HE540039-CJV-EWE-SZP_EGNE00000000-DR-CW-00061

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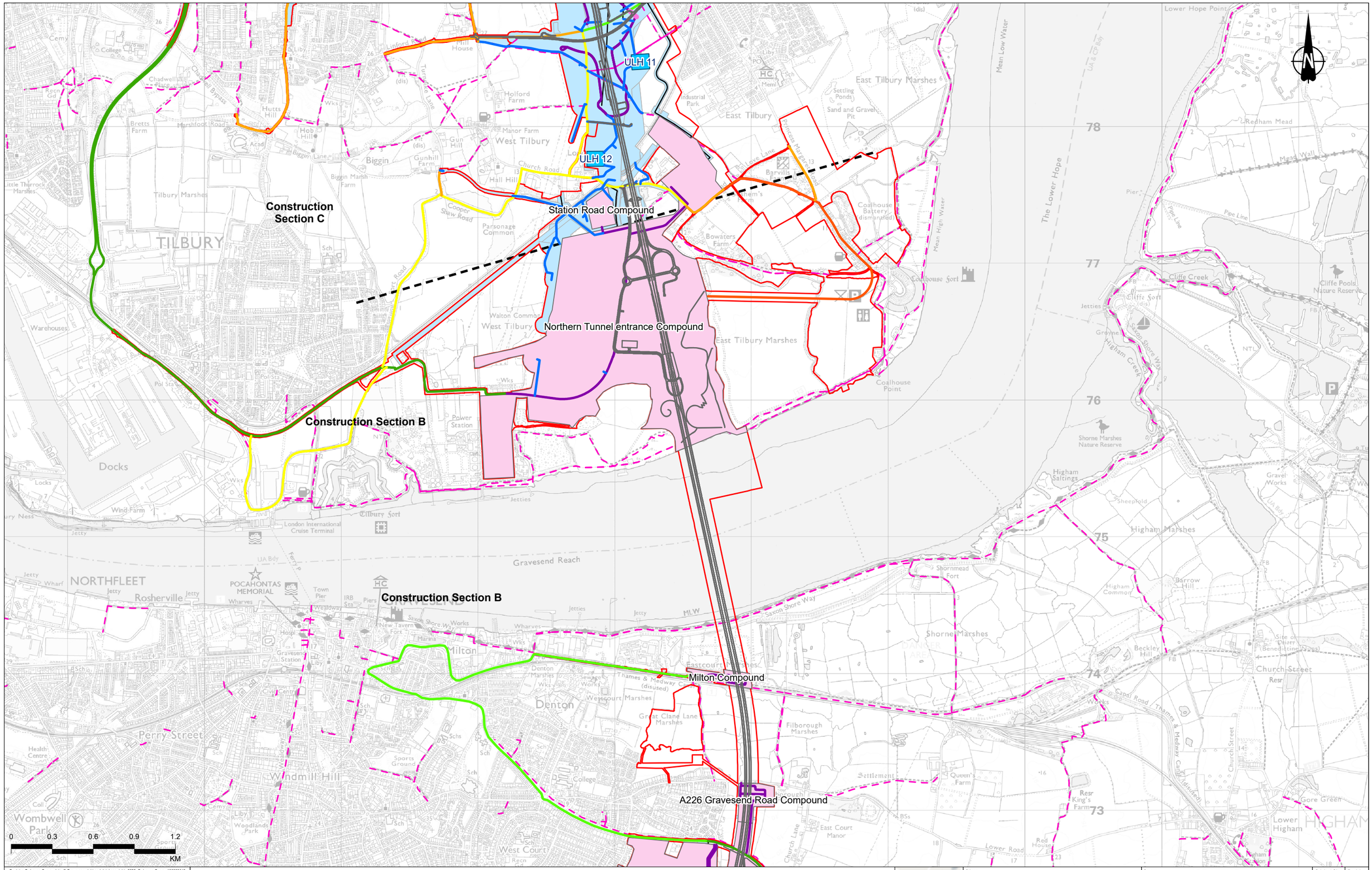

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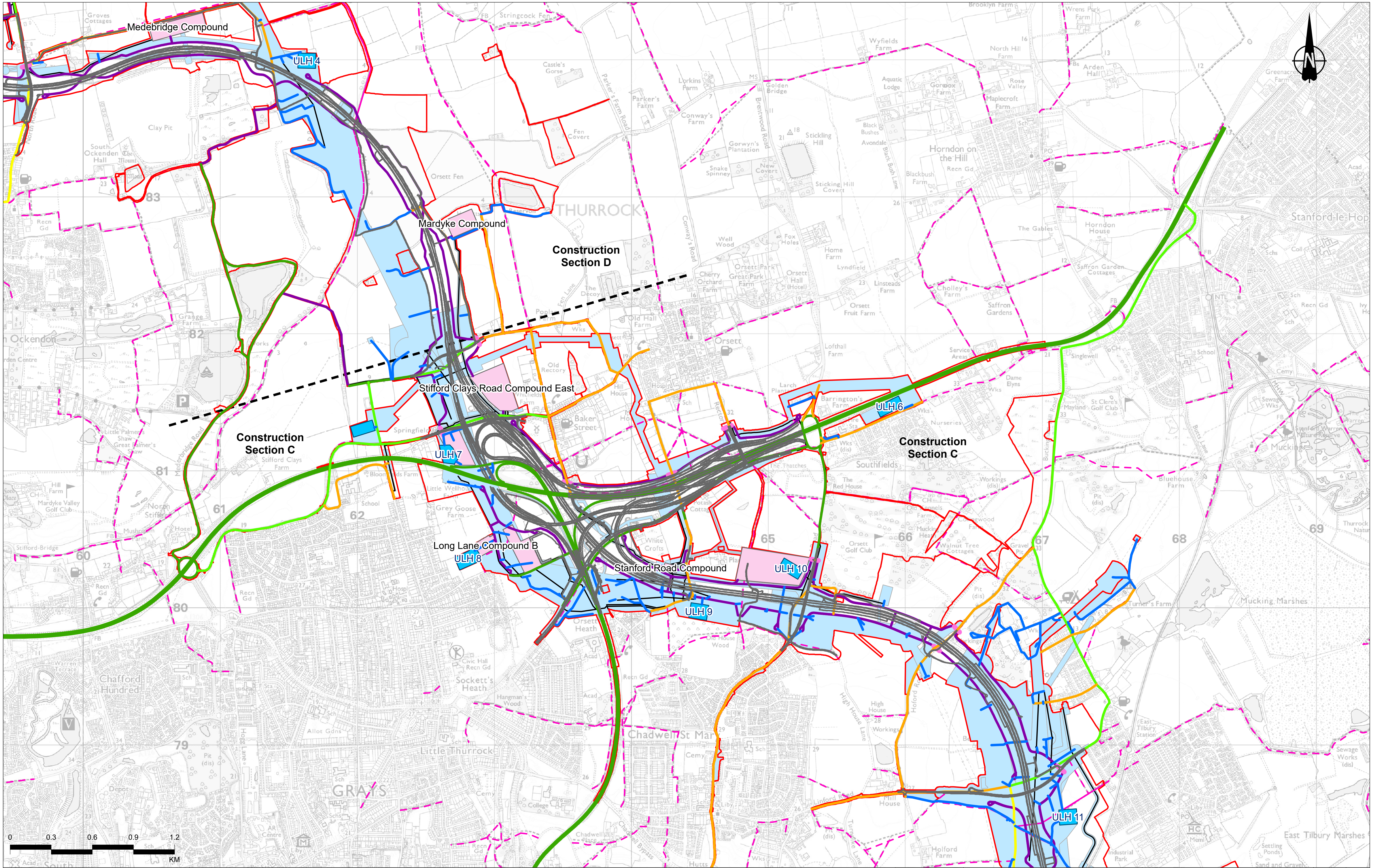

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Warley Street Compound

Construction Section D

Ockendon Road Compound

M25 Compound

Medebridge Compound

ULH 4

Construction Section D

Mardyke Compound

Construction Section D

0 0.3 0.6 0.9 1.2 KM

Legend

- Route alignment
- Order Limits
- Working area for utilities
- Overhead electricity works
- Multi-utility works
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Construction Section D

ULH 1

ULH 2

Warley Street Compound

0 0.3 0.6 0.9 1.2 KM

Legend

- Route alignment
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South Thames Estuary and Marshes

South Thames Estuary and Marshes

Shorne and Ashenbank Woods

Shorne and Ashenbank Woods

Great Crabbles Wood

Shorne and Ashenbank Woods

Cobham Woods

Halling to Trottiscliffe Escarpment

0 0.3 0.6 0.9 1.2 KM

Legend

- Route alignment
- Order Limits
- Surface water zone of influence (1km)
- Banks and ditches
- Ramsar site
- Sites of Special Scientific Interest (SSSI)

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P02	S8	28/09/2022	DCO Application	SW	LD	BF

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Status: DCO APPLICATION

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Revision: P02

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Scale: 1:25,000

Drawing Title: Water Framework Directive Assessment - Surface Water Proposed Zones of Influence
Page 1 of 5

Drawing Number: HE540039-CJV-EWE-SZP_EGNE00000000-DR-LE-30036

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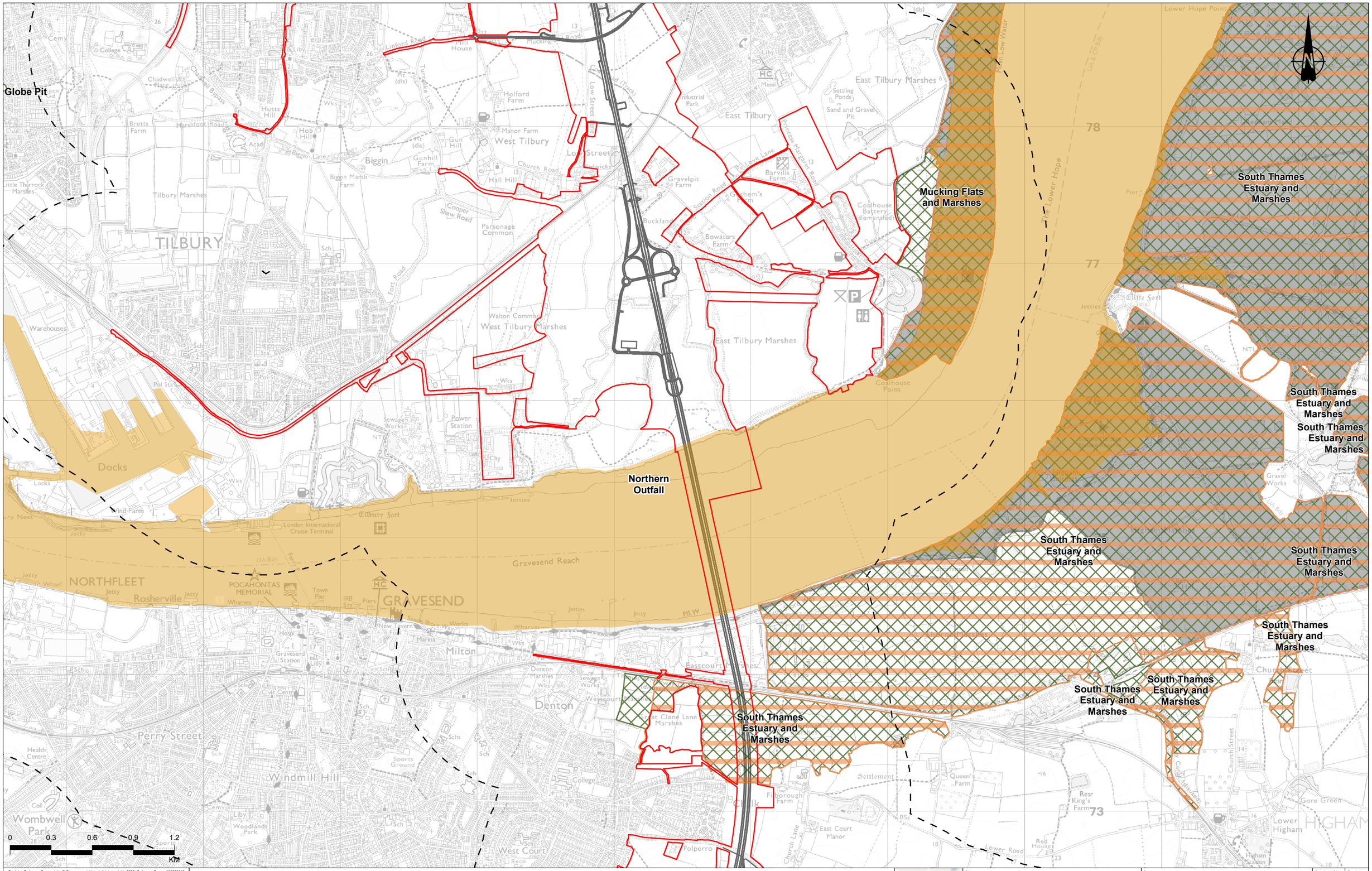

Legend

- Route alignment
- Order Limits
- Surface water zone of influence (1km)
- Transitional waterbodies
- Ramsar site
- Sites of Special Scientific Interest (SSSI)
- Special Protection Area (SPA)

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Mardyke Freshwater Creation Area

Grays Thurrock Chalk Pit

Hangman's Wood & Deneholes

Globe Pit

Mucking Flats and Marshes

0 0.3 0.6 0.9 1.2 KM

Legend

- Route alignment
- Order Limits
- Surface water zone of influence (1km)
- Transitional waterbodies
- **Surface water - ecological status**
- Moderate
- Ramsar site
- Sites of Special Scientific Interest (SSSI)
- Special Protection Area (SPA)

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
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Hornchurch Cutting

Mardyke (East Tributary)

Mardyke Freshwater Creation Area

Ingrebourne Marshes

Ingrebourne Marshes

0 0.3 0.6 0.9 1.2 KM

Legend

- Route alignment
- Order Limits
- Surface water zone of influence (1km)

Surface water - ecological status

- Moderate
- Sites of Special Scientific Interest (SSSI)

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Thorndon Park

Thorndon Park

Thorndon Park

Thorndon Park

Thorndon Park

Thorndon Park

Mardyke (West Tributary)

Hornchurch Cutting

0 0.3 0.6 0.9 1.2 KM

Legend

- Route alignment
- Order Limits
- Surface water zone of influence (1km)

Surface water - ecological status

- Moderate
- Sites of Special Scientific Interest (SSSI)

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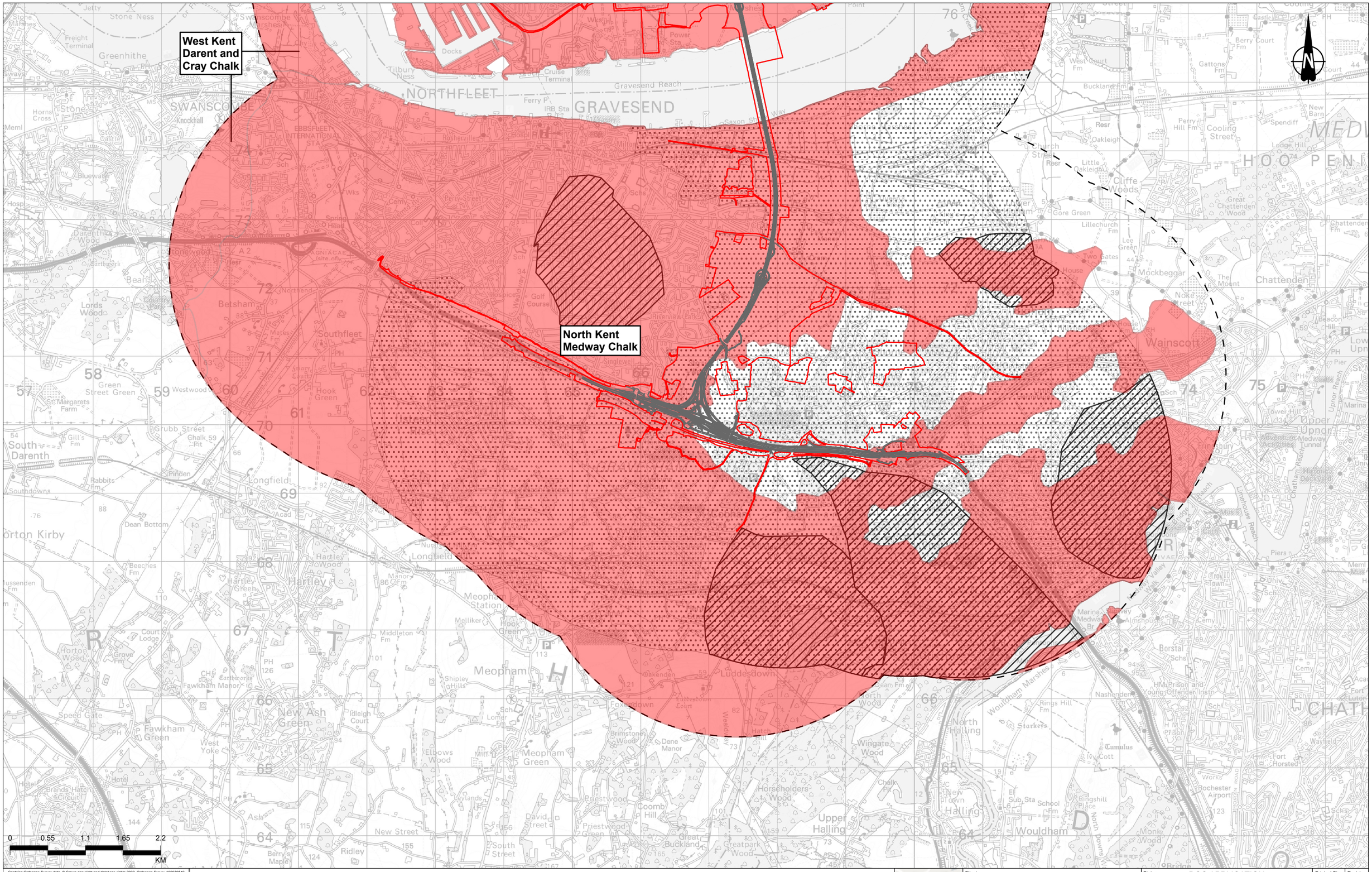

Legend

- Route alignment
- Order Limits
- Ground water zone of influence (3km)
- Groundwater Nitrate Vulnerable Zones (NVZ)

WFD groundwater bodies cycle 2 status

- Poor
- Drinking water protected areas safeguard zones

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P01	S8	18/10/2022	DCO Application	SW	LD	BF

Client: national highways

Project: LOWER THAMES CROSSING

Status	DCO APPLICATION
Original Size	A3
Revision	P01
Application Document Number	TR010032/APP/6.3
Scale	1:50,000

Drawing Title: Water Framework Directive Assessment - Groundwater Proposed Zones of Influence

Drawing Number: HE540039-CJV-EWE-SZP_EGNE00000000-DR-LE-30035

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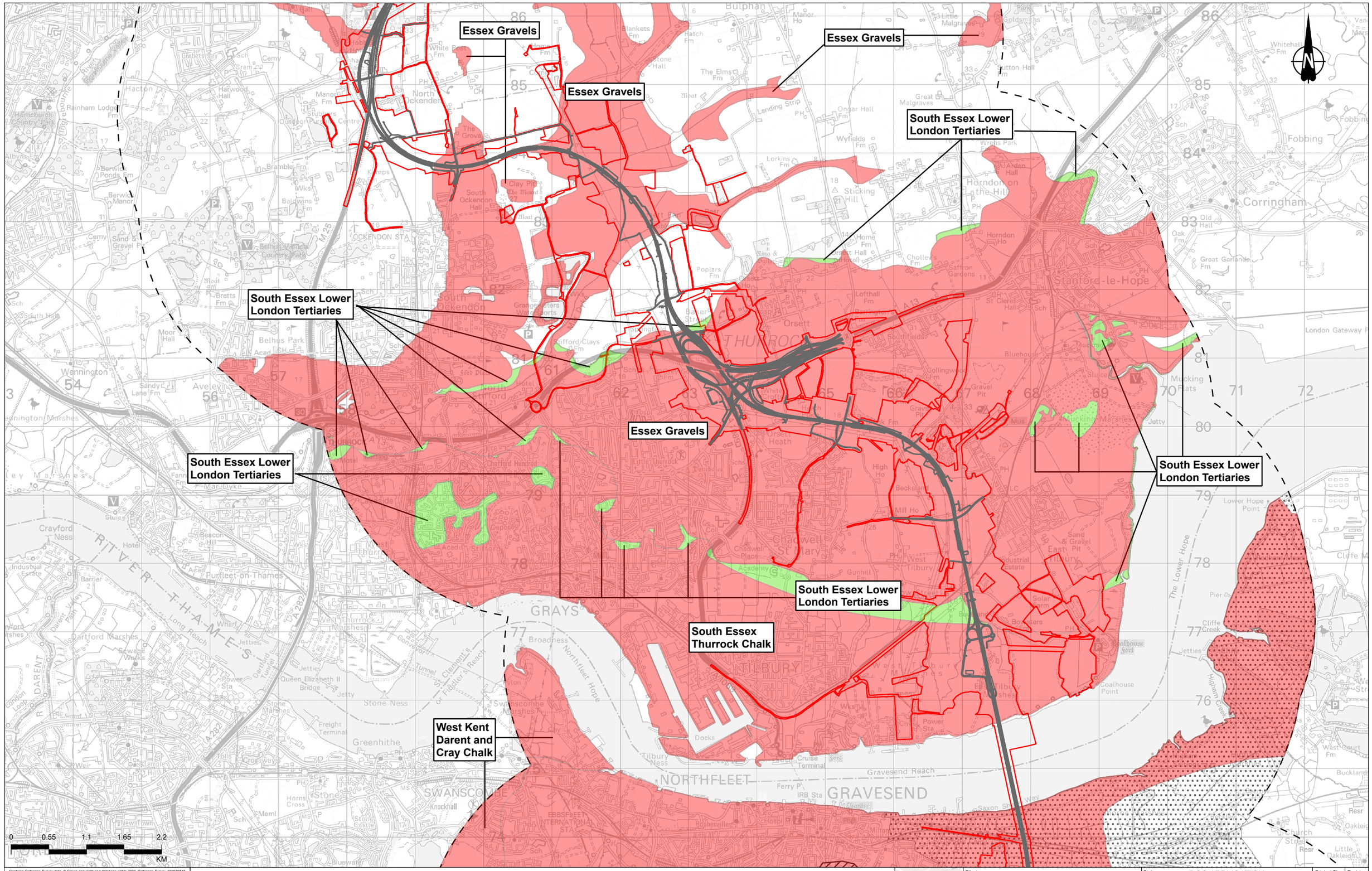


Legend

- Route alignment
- Order Limits
- Ground water zone of influence (3km)
- Groundwater Nitrate Vulnerable Zones (NVZ)

WFD groundwater bodies cycle 2 status

- Good
- Poor
- Drinking water protected areas safeguard zones

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P01	S8	18/10/2022	DCO Application	SW	LD	BF

Client: national highways

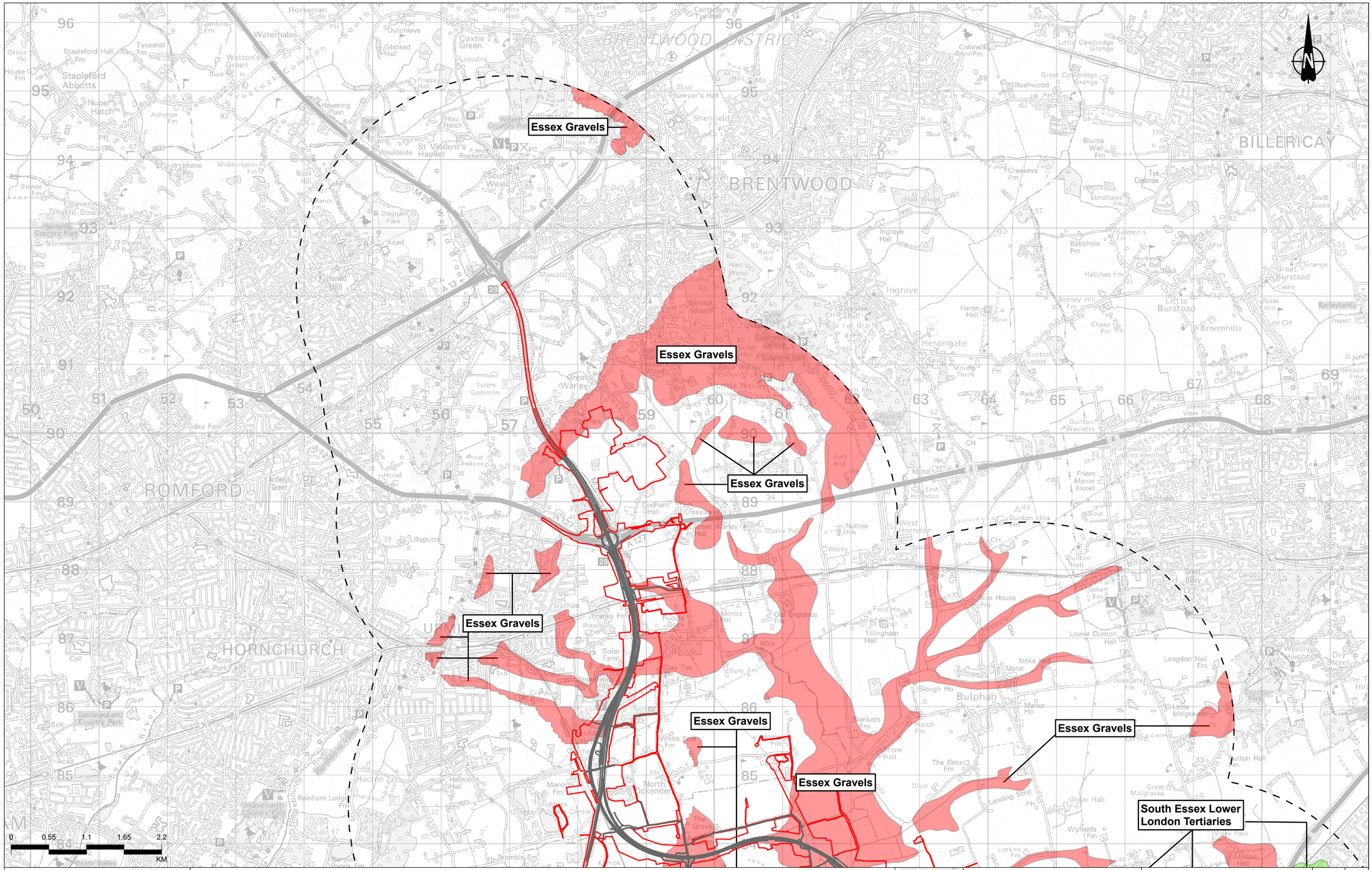
Project: LOWER THAMES CROSSING

Status	DCO APPLICATION
Original Size	A3
Revision	P01
Application Document Number	TR010032/APP/6.3
Scale	1:50,000

Drawing Title: Water Framework Directive Assessment - Groundwater Proposed Zones of Influence

Drawing Number: HE540039-CJV-EWE-SZP_EGNE00000000-DR-LE-30035

Z:\Environment\Volumes\EWE - Water Environment\HE540039-CJV-EWE-SZP_EGNE00000000-DR-LE-30035 - Water Framework Directive Assessment - Groundwater Proposed Zones of Influence [update].aprx



Legend

- Route alignment
- Order Limits
- Ground water zone of influence (3km)

WFD groundwater bodies cycle 2 status

- Good
- Poor

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P01	S8	18/10/2022	DCO Application	SW	LD	BF

Client: national highways

Project: LOWER THAMES CROSSING

Status	DCO APPLICATION
Original Size	A3
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Drawing Title: Water Framework Directive Assessment - Groundwater Proposed Zones of Influence

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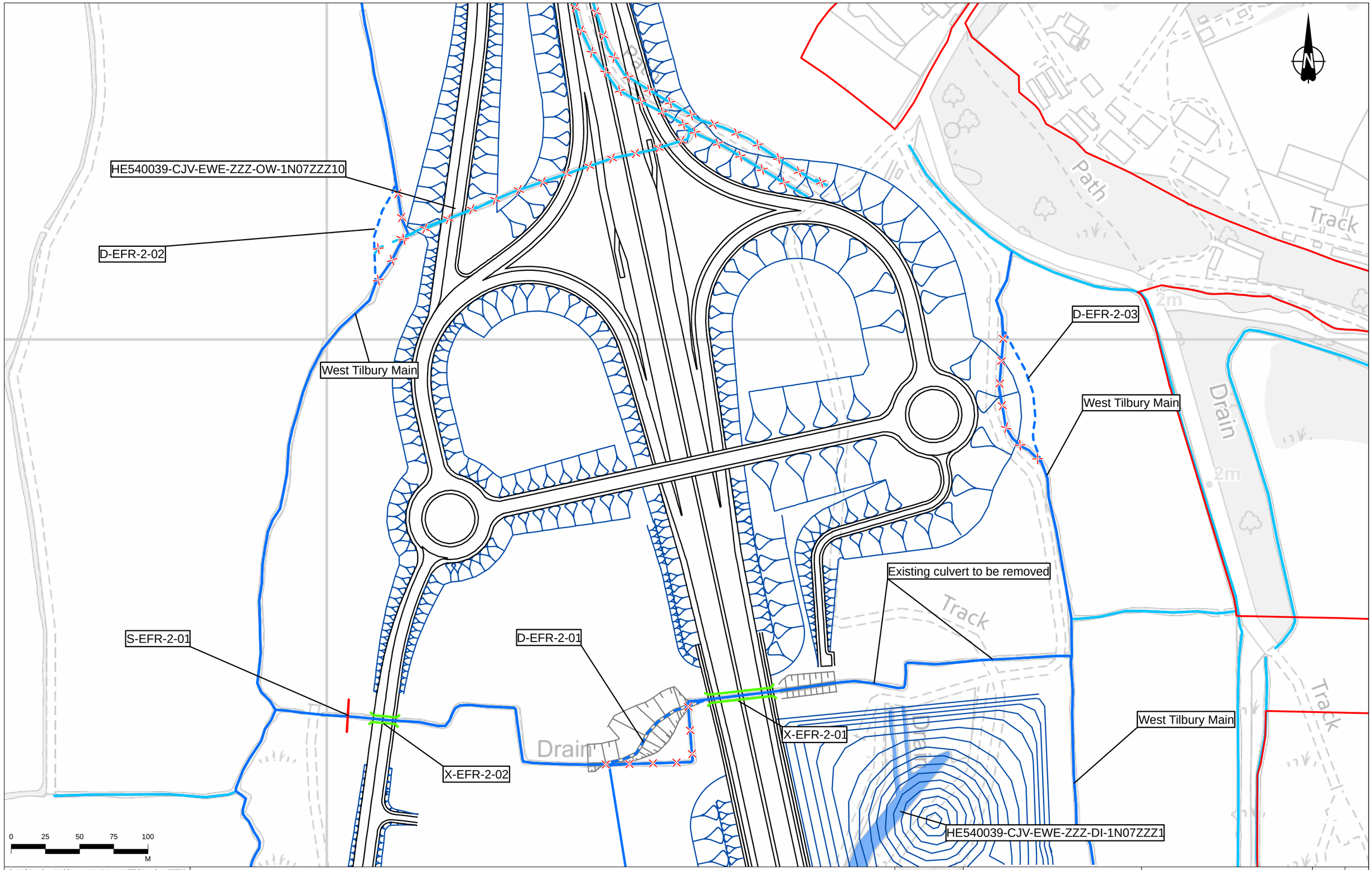
Z:\Environment\Volumes\EWE - Water Environment\HE540039-CJV-EWE-SZP_EGNE00000000-DR-LE-30035 - Water Framework Directive Assessment - Groundwater Proposed Zones of Influence [update].aprx



Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P01	S8	07/10/2022	DCO Application	SW	IF	MW

Legend

- Order Limits
- Route alignment
- Earthworks
- Main river (existing)
- Main river diversion
- Main river abandoned
- Ordinary watercourse/ditch (existing)
- Ordinary watercourse/ditch diversion
- Ordinary watercourse/ditch abandoned
- X-EFR-5-XX Watercourse crossing
- D-EFR-5-XX Watercourse diversion
- Existing culvert
- Proposed headwall
- Proposed culvert
- Ordinary watercourse diversion in piped culvert
- Culvert manhole
- Proposed flood control device
- Viaducts
- Ponds

Notes:
1.Culverted watercourses shall be straight. Minor diversions to the watercourse alignment may be required through the culvert and at either end in order to maintain the linearity of the culvert.
2. Water feature reference numbers have been taken from Water Feature Survey Factual Report included in Appendix 14.2 of the Environmental Statement.
3. This drawing should be read in conjunction with HE540039-CJV-EFR-SZP_GNZZZZZZZZ-DR-LF-00212.

Client: national highways

Project: LOWER THAMES CROSSING

Status	DCO APPLICATION
Original Size	A3
Revision	P01
Application Document Number	TR010032/APP/6.3
Scale	1:2,500

Drawing Title: 00211- Watercourse Crossings and Diversions - Tilbury
Page 1 of 2

Drawing Number: HE540039-CJV-EFR-SZP_GNZZZZZZZZ-DR-LF-00211

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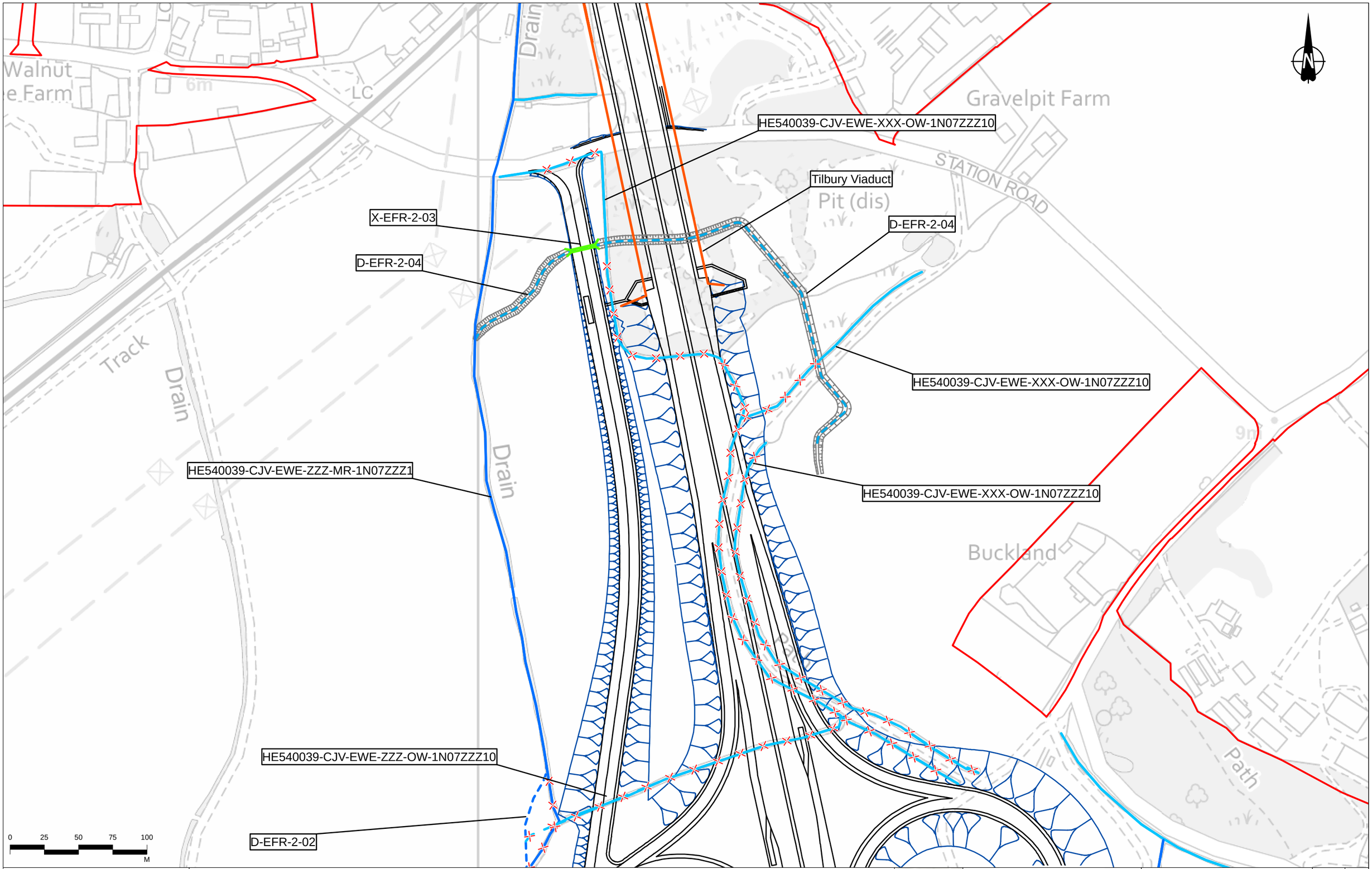

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P01	S8	07/10/2022	DCO Application	SW	IF	MW

Legend

- Order Limits
- Route alignment
- Earthworks
- Main river (existing)
- Main river diversion
- Main river abandoned
- Ordinary watercourse/ditch (existing)
- Ordinary watercourse/ditch diversion
- Ordinary watercourse/ditch abandoned
- X-EFR-5-XX Watercourse crossing
- D-EFR-5-XX Watercourse diversion
- Existing culvert
- Proposed headwall
- Proposed culvert
- Ordinary watercourse diversion in piped culvert
- Culvert manhole
- Proposed flood control device
- Viaducts
- Ponds

Notes:
1.Culverted watercourses shall be straight. Minor diversions to the watercourse alignment may be required through the culvert and at either end in order to maintain the linearity of the culvert.
2. Water feature reference numbers have been taken from Water Feature Survey Factual Report included in Appendix 14.2 of the Environmental Statement.
3. This drawing should be read in conjunction with HE540039-CJV-EFR-SZP_GNZZZZZZZZZ-DR-LF-00211.

Client: national highways

Project: LOWER THAMES CROSSING

Status: DCO APPLICATION
Original Size: A3
Revision: P01
Application Document Number: TR010032/APP/6.3
Scale: 1:2,500

Drawing Title: 00212- Watercourse Crossings and Diversions - Tilbury
Page 2 of 2

Drawing Number: HE540039-CJV-EFR-SZP_GNZZZZZZZZZ-DR-LF-00212

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