Outer Dowsing Offshore Wind

Environmental Statement

Chapter 24 Hydrology and Flood Risk

Volume 3 Appendices

Appendix 24.3 Flood Risk Assessment: Onshore Substation

Date: March 2024

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1.0	March 2024	DCO Application	SLR	GoBe	Shepherd and Wedderburn	Outer Dowsing

Appendix 24.3 Flood Risk Assessment Onshore Substation

Outer Dowsing Offshore Wind Environmental Statement

GoBe Consultants Ltd.

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SLR Project No.: 410.V05356.00013

Client Reference No: 05356

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Revision: V1.0

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Revision Record

Revision	Date	Prepared By	Checked By	Authorised By
V1.0	1 March 2024	SLR Consulting Ltd	GoBe	Outer Dowsing Offshore Wind

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Acronyms and Abbreviations

Acronym	Description
AEP	Annual Exceedance Probability
AIS	Air Insulated Switchgear
AOD	Above Ordnance Datum
BGS	British Geological Survey
CoCP	Code of Construction Practice
DCO	Development Consent Order
DEFRA	Department for Environment, Food & Rural Affairs
DESNZ	Department for Energy Security & Net Zero
DTM	Digital Terrain Model
EA	Environment Agency
FRA	Flood Risk Assessment
GIS	Gas Insulated Switchgear
GW	Gigawatt
IDB	Internal Drainage Board
LiDAR	Light Detection And Ranging
LLFA	Lead Local Flood Authority
LPA	Local Planning Authority
NG	National Grid
NGESO	National Grid Electricity System Operator
NGR	National Grid Reference
NGSS	National Grid Substation
NPPF	National Planning Policy Framework
NPS	National Policy Statement
NSIP	Nationally Significant Infrastructure Project
ODOW	Outer Dowsing Offshore Windfarm
OnSS	Onshore Substation
OSS	Offshore Substation
PPG	Planning Practice Guidance
SFRA	Strategic Flood Risk Assessment
SPZ	Source Protection Zone
TCC	Temporary Construction Compound
UK	United Kingdom

Terminology

Term	Definition
400kV cables	High-voltage cables linking the OnSS to the NGSS.
Baseline	The status of the environment at the time of assessment without the development in place.
Development Consent Order (DCO)	An order made under the Planning Act 2008 granting development consent for a Nationally Significant Infrastructure Project (NSIP).
Effect	Term used to express the consequence of an impact. The significance of an effect is determined by correlating the magnitude of the impact with the sensitivity of the receptor, in accordance with defined significance criteria.
Export cables	High voltage cables which transmit power from the Offshore Substations (OSS) to the Onshore Substation (OnSS) via an Offshore Reactive Compensation Platform (ORCP) if required, which may include one or more auxiliary cables (normally fibre optic cables).
Impact	An impact to the receiving environment is defined as any change to its baseline condition, either adverse or beneficial.
Landfall	The location at the land-sea interface where the offshore export cables and fibre optic cables will come ashore.
Mitigation	Mitigation measures are commitments made by the Project to reduce and/or eliminate the potential for significant effects to arise as a result of the Project. Mitigation measures can be embedded (part of the project design) or secondarily added to reduce impacts in the case of potentially significant effects.
National Grid Onshore Substation (NGSS)	The National Grid substation and associated enabling works to be developed by the National Grid Electricity Transmission (NGET) into which the Project's 400kV Cables would connect.
National Policy Statement (NPS)	A document setting out national policy against which proposals for Nationally Significant Infrastructure Projects (NSIPs) will be assessed and decided upon.
Offshore Export Cable Corridor (ECC)	The Offshore Export Cable Corridor (Offshore ECC) is the area within the Order Limits within which the export cables running from the array to landfall will be situated.
Offshore Reactive Compensation Platform (ORCP)	A structure attached to the seabed by means of a foundation, with one or more decks and a helicopter platform (including bird deterrents) housing electrical reactors and switchgear for the purpose of the efficient transfer of power in the course of HVAC transmission by providing reactive compensation.
Offshore Substation (OSS)	A structure attached to the seabed by means of a foundation, with one or more decks and a helicopter platform (including bird deterrents), containing— (a) electrical equipment required to switch, transform, convert electricity generated at the wind turbine generators to a higher voltage and provide reactive power compensation; and (b) housing accommodation, storage, workshop auxiliary equipment, radar and facilities for operating, maintaining and controlling the substation or wind turbine generators.
Onshore Export Cable Corridor (ECC)	The Onshore Export Cable Corridor (Onshore ECC) is the area within which, the export cables running from the landfall to the onshore substation will be situated.

Onshore substation (OnSS)	The Project's onshore HVAC substation, containing electrical equipment, control buildings, lightning protection masts, communications masts, access, fencing and other associated equipment, structures or buildings; to enable connection to the National Grid.
Outer Dowsing Offshore Wind (ODOW)	The Project.
Order Limits	The area subject to the application for development consent, The limits shown on the works plans within which the Project may be carried out.
Receptor	A distinct part of the environment on which effects could occur and can be the subject of specific assessments. Examples of receptors include species (or groups) of animals or plants, people (often categorised further such as 'residential' or those using areas for amenity or recreation), watercourses etc.
The Project	Outer Dowsing Offshore Wind, an offshore wind generating station together with associated onshore and offshore infrastructure.

Reference Documentation

Document Number	Title
6.1.3	Project Description
6.1.4	Site Selection and Consideration of Alternatives
8.1	Outline Code of Construction Practice
8.1.5	Outline Surface Water and Drainage Strategy
8.12	Outline Operational Drainage Management Plan
8.18	Design Approach Document
8.19	Design Principles Statement

24.0 Introduction

24.1 Overview

1. A Flood Risk Assessment (FRA) has been prepared for the proposed works to be undertaken during the construction and operation of the onshore substation (OnSS) for Outer Dowsing Offshore Wind (ODOW) (the "Project").

2. A full description of the works is provided in Volume 1, Chapter 3: Project Description (document reference 6.1.3).

3. The proposed OnSS is located on land to the east of the A16 at Surfleet Marsh, Lincolnshire (the "Site").

4. The OnSS will contain the electrical components for controlling and transforming the power exported through the onshore cables from 220kV or 275kV to 400kV, and to adjust the power quality factors, as required, to meet the GB National Grid Electricity System Operator (NGESO) Grid Code for supply to the National Grid (NG).

5. Grading, earthworks, and drainage will be undertaken initially within the footprint of the OnSS. Foundations will then be installed which will either be ground-bearing or piled based on the prevailing ground conditions. The substation will either utilise Gas Insulated Switchgear (GIS) or Air Insulated Switchgear (AIS) technology. GIS houses the primary switchgear inside one or more buildings, resulting in a smaller overall footprint, compared with AIS, which has fewer buildings but a larger operations area for external equipment. The flood modelling that has been carried out has assessed the option with the largest footprint.

6. The proposed building substructures will be predominantly composed of steel and cladding materials, although brick/block-built structures are sometimes used. The structural steelwork is likely to be fabricated and prepared off-site and delivered to site and erected into place. The building envelope will consist of cladding panels that are fixed to the steelwork. In addition to buildings, there will be external equipment, such as switchgear, protective devices, grid transformers, shunt reactors, dynamic reactive compensation equipment, harmonic filters, water tanks etc.

7. The onshore electrical infrastructure facilities will be required throughout the lifetime of the Project. The detailed design of the OnSS will take place post-consent, but further)

information regarding the project design are detailed in the Design Approach Document (Document reference 8.18) and the Onshore Design Principles Document (document reference (8.19).

24.2 Context and Site Location

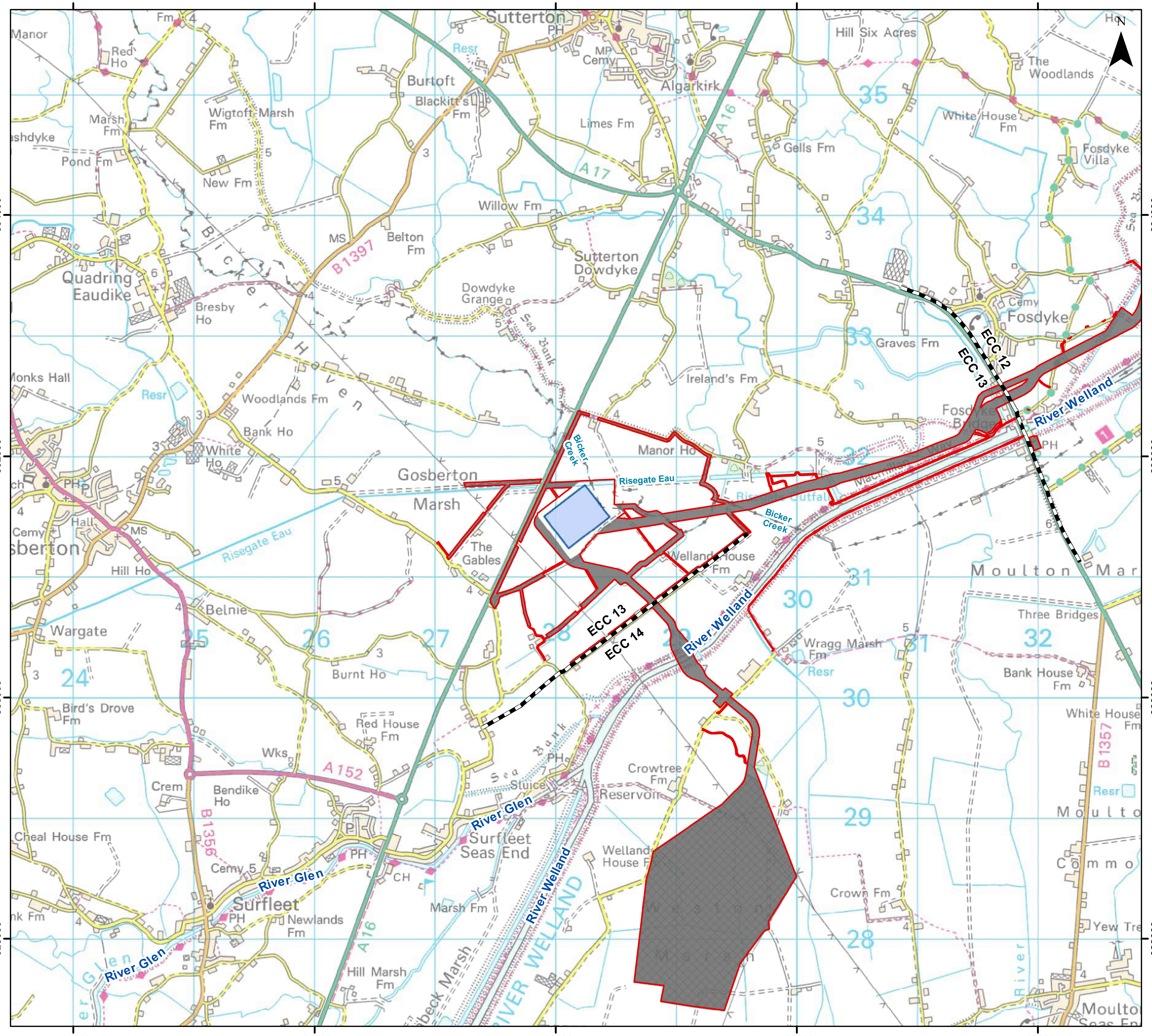
8. The Project is a proposed offshore windfarm located approximately 54km off the Lincolnshire Coast. It is anticipated to generate renewable electricity equivalent to the annual electricity consumption of over 1.6 million households.

9. Cables will connect the turbines to the offshore substation platforms, and then export the power generated to shore by export cables. The offshore Export Cable Corridor (ECC) will make landfall at Wolla Bank, to the south of Anderby Creek. From landfall, the onshore ECC is proposed to run to the OnSS at Surfleet Marsh, with 400kV cables then connecting to the National Grid connection point at Weston Marsh.

10. The proposed OnSS is located within the South Holland District of Lincolnshire, approximately 6.2km to the northeast of Spalding and 3.4km east of Gosberton, approximately centred on NG Grid Reference TF 28175 31504. The Site itself would occupy a permanent area of up to 14.4Ha within the OnSS security fence, with a total area of approximately 20.9ha when including for landscaping, drainage, and access requirements. The OnSS site is comprised entirely of greenfield land currently used for arable agriculture.

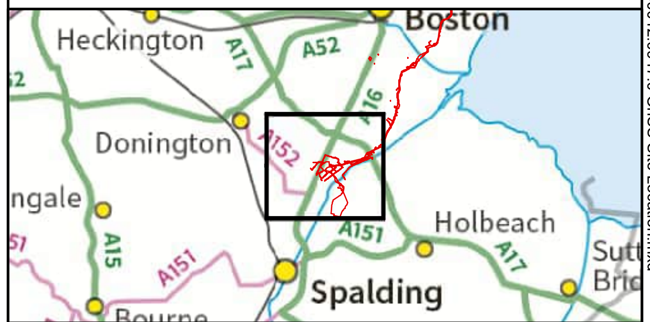
11. The Site is bounded by arable greenfield land on all sides, with the A16 highway at circa 70m to the west and Risegate Eau (watercourse) immediately to the north. There are a large number of watercourses in the wider local area, primarily comprising open field drains and ditches. Most notably, in addition to Risegate Eau Bicker Creek is located approximately 55m to the north, on the opposite side of Risegate Eau and again immediately to the east of the Site. The River Welland, the primary source of flood risk to the area, is located approximately 1.3km to the southeast of the Site.

12. The Site location, along with the location of the River Welland, Risegate Eau and Bicker Creek, are shown below in Figure 24.3.1.These watercourses are discussed further in Section 24.5.2.



Legend

- Order Limits
- Onshore Segment Break
- Onshore Substation (OnSS) Footprint
- Connection Area
- Area not Included in Onshore Substation Flood Risk Assessment



Coordinate System: British National Grid

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Environmental Statement

Site Location Plan

Figure 24.3.1

OUTER DOWSING OFFSHORE WIND

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Document Path: P:\05356 - GoBe Consultants Ltd\00012 GTR4 Outer Dowsing\Tech\GIS\Dwgs\Wking\2023 09 Environmental Statement\Hydrology\FRA\05356.00012.0947.0 OnSS Site Location.mxd

24.3 Background and Aims

13. The aim of this FRA is to assess potential flood risk from all sources and outline the potential for the OnSS to be impacted by flooding, the impacts of the works associated with establishing and operating the OnSS on flooding, and the proposed measures which could be incorporated to mitigate any identified risk. The report has been produced in accordance with National Policy Statement EN-1 section 5.8 (DESNZ, 2023), along with the National Planning Policy Framework (NPPF) (Ministry of Housing, Communities & Local Government, 2023) and the Planning Practice Guidance (PPG) for Flood Risk and Coastal Change (Ministry of Housing, Communities and Local Government, 2022). Current best practice documents relating to assessment of flood risk published by the British Standards Institution BS8533 (BSI, 2017) has also been taken into account.

24.3.1 Data Sources Considered

14. In assessing the flood risk to the OnSS, the following data sources have been reviewed:

- Mapping published on the Environment Agency website:
  - Risk of Flooding from Rivers and Sea:
    - Flood Map for Planning (EA, 2023a); and
    - Long Term Flood Risk Information (EA, 2023b).
  - Risk of Flooding from Reservoirs:
    - EA Long Term Flood Risk Information (EA, 2023b).
  - Risk of Flooding from Surface Water:
    - EA Long Term Flood Risk Information (EA, 2023b).
  - Light Detection and Ranging (LiDAR) data.
- British Geological Survey (BGS, accessed October 2023) mapping for details of superficial and bedrock geology http://mapapps.bgs.ac.uk/geologyofbritain/home.html;
- Cranfield Soil and Agrifood Institute (Cranfield University, accessed October 2023) Soilscapes map viewer for soil information;
- East Coast and Wash - 2018 Coastal Flood Boundary (CFB) Dataset (Environment Agency, 2021)
- East Lindsey Strategic Flood Risk Assessment, March 2017 (East Lindsey District Council, 2017);
- South East Lincolnshire Strategic Flood Risk Assessment, March 2017 (South East Lincolnshire Joint Strategic Planning Committee, 2017); and
- Department of Food and Rural Affairs (DEFRA)'s 'MAGIC' website (DEFRA, 2023).

24.3.2 Modelling

15. In order to assess the level of flood risk to the existing Site, and to determine any potential impacts to flood risk following ground raising on the Site, a dynamically linked 1D-2D hydraulic model has been developed by SLR Consulting using the ESTRY-TUFLOW package. Full details of the modelling work undertaken are provided in Annex 1 of this document: River Welland Breach Modelling Report. Modelled results relating to the Site are discussed in Section 24.8.

24.4 Climate Change

16. NPS EN-1 requires that flood risk is considered over the lifetime of the OnSS and, therefore, consideration must be given to the potential impacts of climate change.

17. In February 2016 the Environment Agency published updated guidance on the impacts of climate change on flood risk in the UK. This was most recently updated in May 2022 (EA, 2022) and advice sets out that peak rainfall intensity, sea level, peak river flow, offshore wind speed and extreme wave heights are all expected to increase in the future as a result of climate change. Consideration of the changes to these parameters should use the allowances outlined in Table 24.1, Table 24.2, and Table 24.3 based on the anticipated lifetime of the OnSS (35-years).

18. The guidance regarding climate change acknowledges that there is considerable uncertainty regarding the absolute level of change that is likely to occur. Therefore, the guidance provides estimates of the expected changes based upon different emissions scenarios over a number of different epochs.

19. Allowances in relation to offshore wind speed and extreme wave height are relevant to sites situated on the open coast. The Environment Agency coastal model data includes results from scenarios which include allowances for climate change. The hydraulic modelling undertaken to inform this Project includes consideration of coastal flood defences (overtopping) and scenarios where coastal flood defences are breached.

20. A detailed assessment of the impact of climate change on the OnSS has been undertaken as part of this FRA, and is included in Section 24.7.

24.4.1 Anticipated Lifetime of Development

21. The Planning Practice Guidance classifies land uses into five categories. Utilities

infrastructure such as the OnSS, is classified as 'Essential Infrastructure'. The OnSS is to be designed for a 35-year design life. It is anticipated that the development will be operational by 2030, therefore it is anticipated the development will be operational up to 2065. This falls within the 2050s epoch (2040 to 2069), when considering climate change allowances for river flow and sea level rise, and the 2070s epoch (2061 to 2125) for peak rainfall intensity. Design of the OnSS will need to consider assessment of the 1 in 1,000 (0.1%) Annual Exceedance Probability (AEP) event.

24.4.2 Peak River Flow

22. Climate change allowances guidance (EA, 2022) states that, for 'Essential Infrastructure' located within Flood Zone 2 or 3a and 3b, the 'Higher Central' allowance for climate change should be considered. The Site falls within the Welland Management Catchment and as shown below in Table 24.1, the Higher Central allowance for the 2050s epoch (based on 35-year design life) equates to 10%.

Table 24.1: Peak River Flow Climate Change Allowances

Management Catchment	Allowance Category	2020s (2015 to 2039)	2050s (2040 to 2069)	2080s (2070 to 2125)
Welland Management Catchment	Central	5%	4%	17%
	Higher Central	10%	10%	28%
	Upper End	22%	26%	53%

24.4.3 Peak Rainfall Intensity

23. For peak rainfall intensity the PPG guidance states that flood risk assessments for 'Essential Infrastructure' developments with a 35-year design life, the Central Allowance for the 2070's epoch (2061 to 2125) for both the 3.3% AEP storm event and 1% AEP storm event should be used. As shown in Table 24.2, for the Welland Management Catchment, this equates to a 25% uplift for both the 3.3% AEP and 1% AEP events.

Table 24.2 Peak Rainfall Intensity Climate Change Allowances

Management Catchment	Annual Exceedance Probability (%)	Allowance Category	2050s (2022 to 2060)	2070s (2061 to 2125)
Welland Management Catchment	3.3	Upper End	35%	35%
		Central	20%	25%
	1	Upper End	40%	40%
		Central	20%	25%

24.4.4 Sea Level Rise

24. Climate change allowances guidance (EA, 2022) states that the predicted cumulative sea level rise for both the Higher Central and Upper End allowance should be assessed, calculated based upon the expected lifetime of the development. Table 24.3 below details the predicted sea level rise in mm per year for the Anglian region, with the cumulative amount for each respective epoch in brackets.

Table 24.3 Sea Level Allowances for the Anglian River Basin District per year (Epoch Total in Brackets)

River Basin District	Allowance	2000 to 2035 (mm)	2036 to 2065 (mm)	2066 to 2095 (mm)	2096 to 2125 (mm)	Cumulative Rise 2000 to 2125 (m)
Anglian	Higher Central	5.8 (203)	8.7 (261)	11.6 (348)	13 (390)	1.20
	Upper End	7 (245)	11.3 (339)	15.8 (474)	18.1 (543)	1.60

25. Using a baseline year of 2018, and based upon a development lifetime of up to 2065 the predicted total cumulative sea level rise using Table 24.3 for the Higher Central scenario is 359.6mm and for the Upper End scenario is 458mm.

Upper End scenario Calculation
2018 – 2035 = 17yrs
17 x 7mm = 119mm.
2036 – 2065 = 30yrs
30 x11.3mm = 339mm.
119mm +339m= **458mm**

24.4.5 H++ Sea Level Allowances

26. Climate change allowances guidance (EA, 2022) states that for a Nationally Significant Infrastructure Project (NSIP), the H++ climate change allowances should also be used as the credible maximum climate change scenario. It is advised that the H++ climate change allowances should be applied as a sensitivity test to help assess how sensitive the proposed development is to changes in the climate for different future scenarios to ensure that the development can be adapted to large-scale climate change over its lifetime.

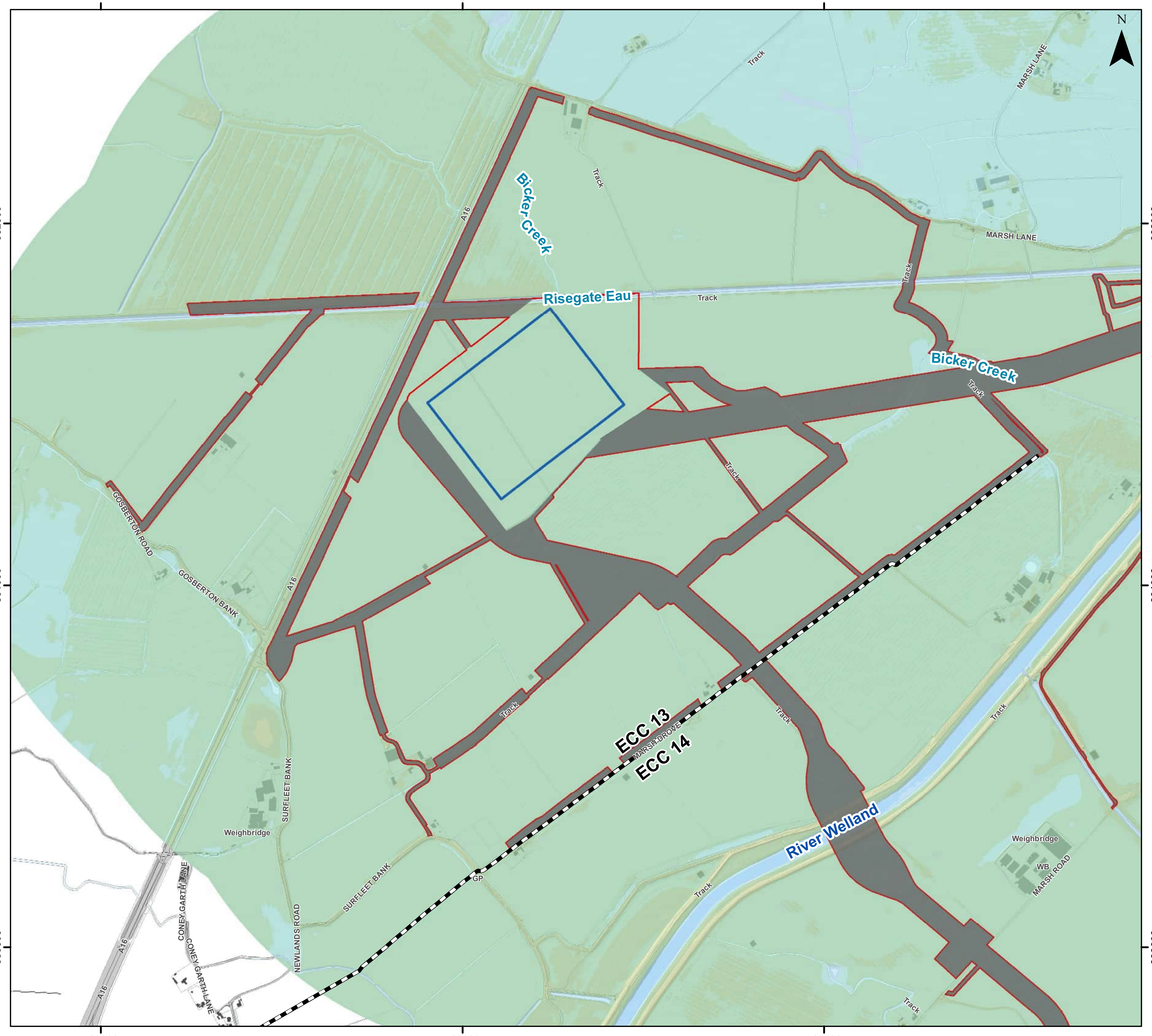
27. The Upper End scenario for sea level rise has been used to assess the design level of the substation, however a sensitivity test using the H++ climate change allowance has been included as part of the assessment. The H++ sea level rise allowance is 1.9m for the total sea level rise to 2100.

28. An additional 2mm for each year on top of sea level rise allowances will also be considered for storm surge as a sensitivity test, which over the 47-years between 2018 to 2065, equates to an additional 94mm.

24.5 Baseline Context

24.5.1 Topography

29. The topography of the Site and surrounding local area have been assessed using a high resolution Digital Terrain Model (DTM) derived from photogrammetry using high resolution digital aerial photography with a 2.5cm ground sample distance (GSD), commissioned by The Project. This data is shown below in Figure 24.3.2, which shows the Site and local area to be essentially flat, with only minor variations due to infrastructure such as raised flood defences along the River Welland and the raised A16 highway. Depressions are present along the alignment of local field boundary watercourses and Risegate Eau. Ground levels are indicated to be around 3.65m AOD.



Legend

- Order Limits
- Onshore Segment Break
- Onshore Substation (OnSS) Footprint
- Area not Included in Onshore Substation Flood Risk Assessment

Elevation (m AOD)

- -1 - 0
- 0 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 5
- 5 - 6
- 6 - 7
- 7 - 8
- 8 - 9
- 9 - 10
- 10 -11
- 11- 12
- 12 - 13
- 13-14
- 14 - 15

Note:
Onshore Substation (OnSS) Footprint symbology adjusted for the purpose of OnSS Flood Risk Assessment

Sources:
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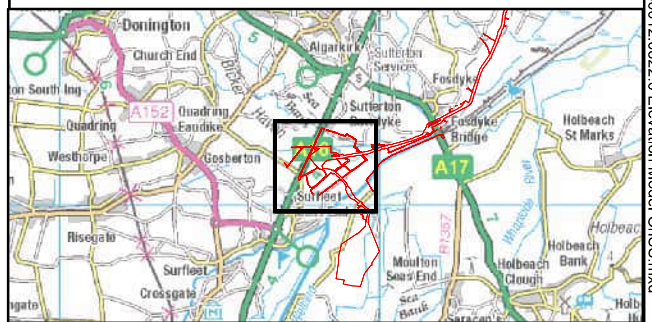

Coordinate System: British National Grid

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Scale: 1:10,000

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Environmental Statement

Topography

Figure 24.3.2

OUTER DOWSING OFFSHORE WIND

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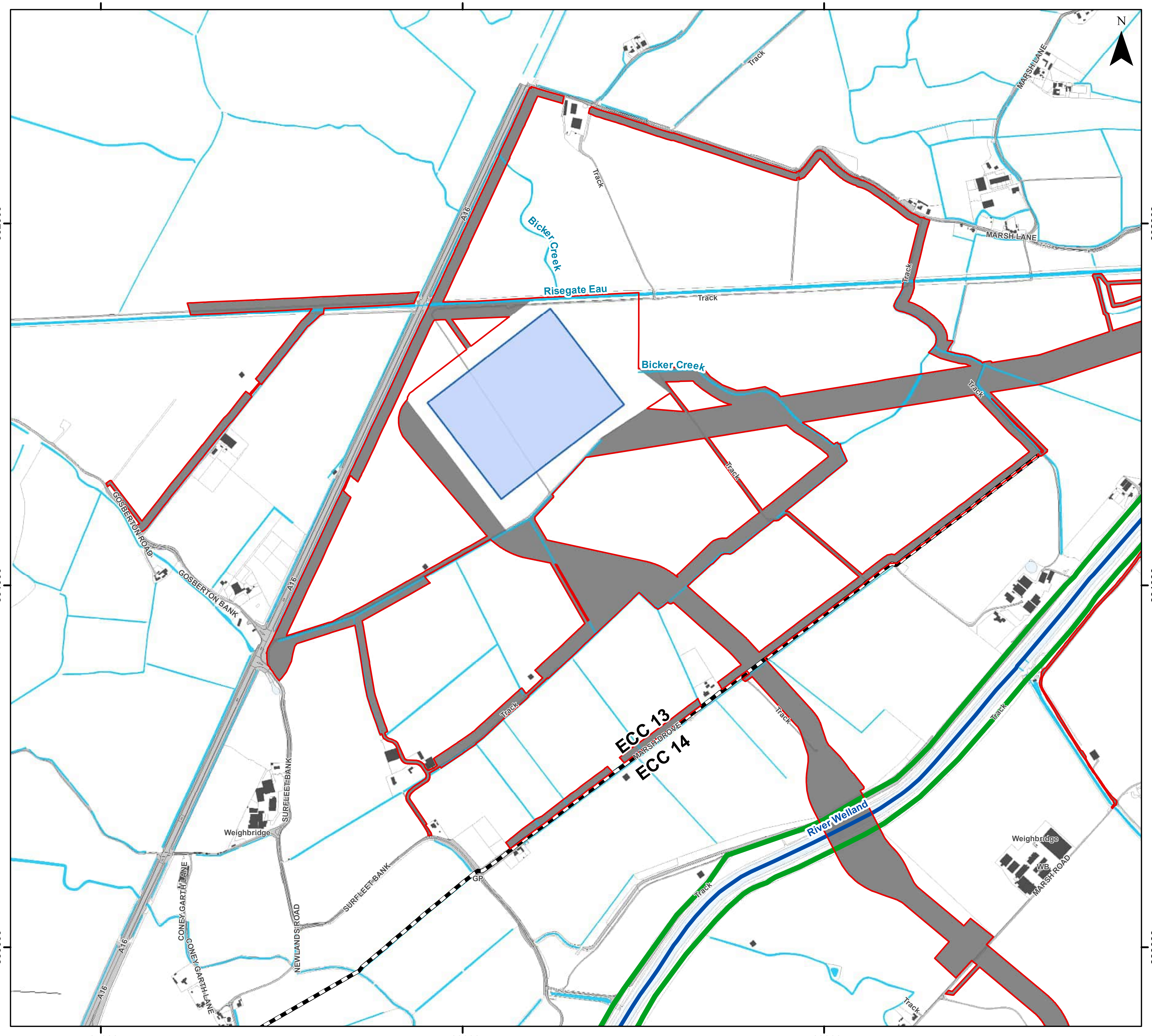
24.5.2 Local Hydrology

30. The Site is located within the Lower Welland Operational Catchment, which forms part of the wider Welland Management Catchment.

31. The Lower Welland Operational Catchment starts below Stamford, collecting urban run-off from Peterborough before becoming the embanked River Welland across the Fens to Spalding, where the watercourse becomes tidal. The River Welland then discharges into the Wash. The watercourse is an important source of water for agricultural use and is the primary drainage feature in the catchment, connected to Internal Drainage Board (IDB) drains, which both provide drainage and a supply of water to the agricultural and horticultural industries.

32. Figure 24.3.3 shows the local hydrological features surrounding the Site.



Legend

- Order Limits
- Onshore Segment Break
- Onshore Substation (OnSS) Footprint
- Area not Included in Onshore Substation Flood Risk Assessment
- Environment Agency Rivers and Sea Flood Defence
- Statutory Main River
- Minor Watercourse
- Waterbody

Sources:
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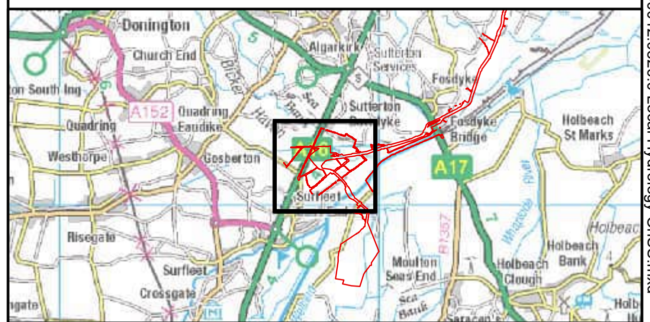

Coordinate System: British National Grid

0 200 400 Metres

Scale: 1:10,000

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Environmental Statement

Local Hydrology

Figure 24.3.3

OUTER DOWSING OFFSHORE WIND

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24.5.2.1 River Welland

33. The River Welland is an Environment Agency Main River which flows from southwest to northeast approximately 1.25km to the southeast of the Site. The river discharges into The Wash and subsequently the North Sea approximately 14.3km to the northeast of the Site and is tidally influenced for an approximate 22km reach from the tidal limits imposed by Fulney Lock and the Coronation Channel sluice at Spalding.

24.5.2.2 Risegate Eau

34. Risegate Eau is an open drain which is classed as an ordinary watercourse and falls under the responsibility of Welland and Deepings Internal Drainage Board. The drain, which lies approximately 25m to the north of the Site at its closest point, runs from west to east, connecting the South Forty Foot Drain and several other IDB drains to the River Welland via Risegate Eau pumping station. The primary purpose of the drain and those connecting to it is to serve as a surface water drainage receptor from surrounding agricultural land.

24.5.2.3 Bicker Creek

35. Bicker Creek is an Ordinary Watercourse which runs generally from northwest to southeast and, before the construction of Risegate Eau, flowed immediately adjacent to the Site’s north-eastern order limits. Since the construction of Risegate Eau, Bicker Creek ends approximately 55m north of the site and no longer flows continually as a single watercourse and primarily acts as a surface water drainage ditch. The watercourse commences again immediately to the east of the Site before combining with Surfleet Marsh Drain and discharging to Risegate Eau.

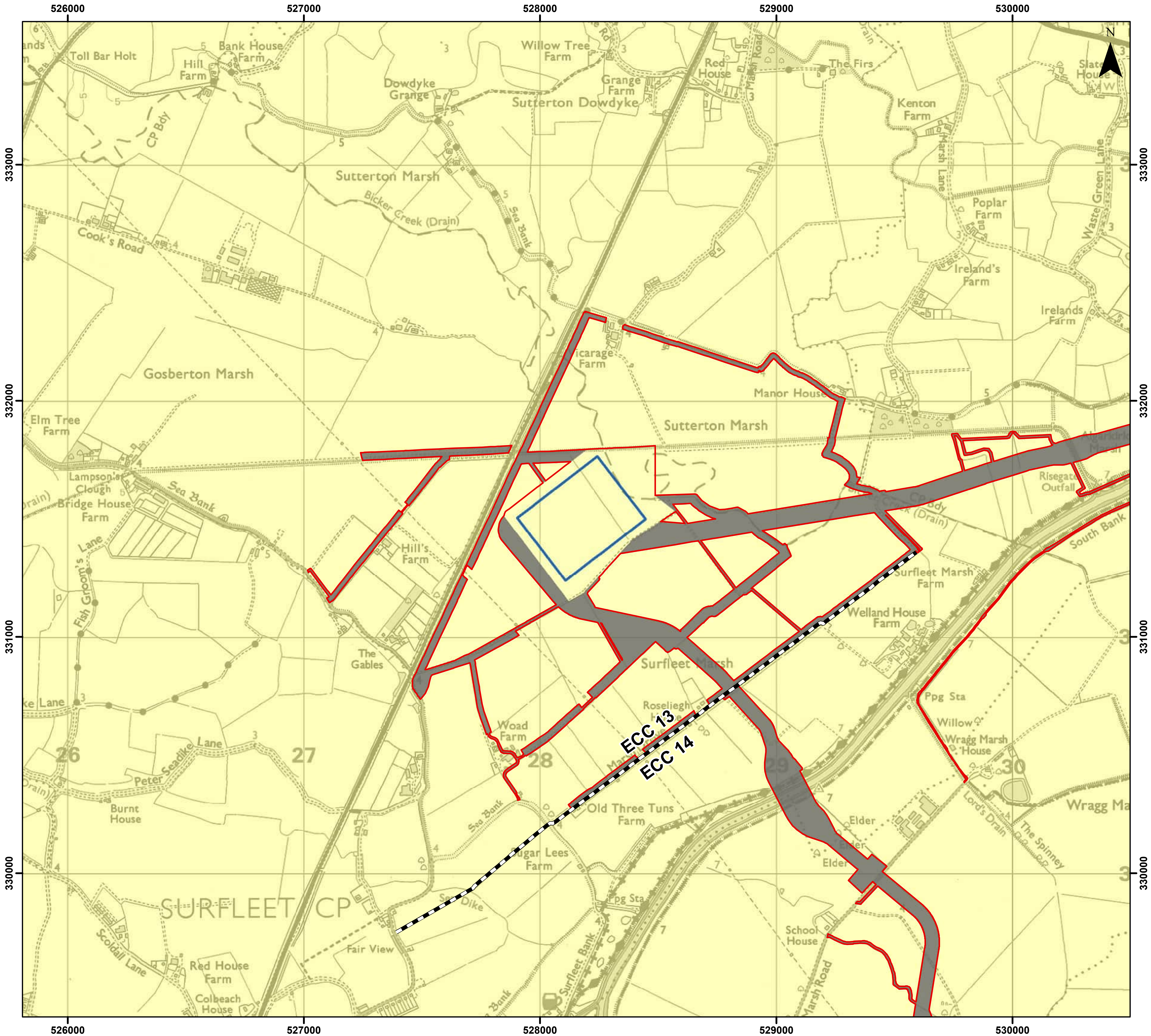
24.5.2.4 Surfleet Marsh Drain

36. Surfleet Marsh Drain is an open drainage ditch which is classed as an ordinary watercourse falling under the responsibility of Welland and Deepings IDB. The ditch originates at Surfleet Bank to the southwest of the Site and runs in a north-easterly direction, passing the Site approximately 500m to the southeast before combining with the former course of Bicker Creek to the east of the Site. The watercourse then subsequently discharges to Risegate Eau.

24.5.3 Geology

37. British Geological Survey (BGS) mapping (BGS, 2023), as shown on Figure 24.3.4 and Figure 24.3.5 below, indicates the Site to be situated upon bedrock geology comprising

Oxford Clay Formation – Mudstone, overlain by superficial deposits comprising Tidal Flat Deposits – Clay and Silt.



Legend

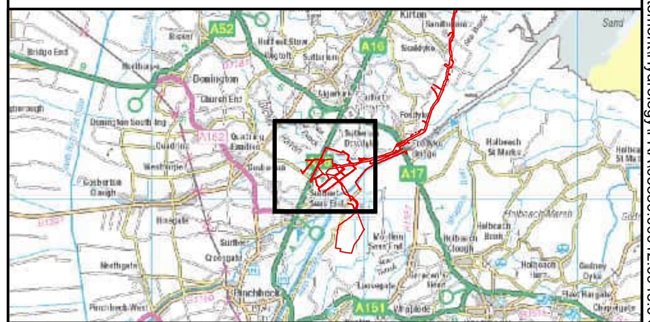
- Order Limits
- Onshore Segment Break
- Onshore Substation (OnSS) Footprint
- Area not Included in Onshore Substation Flood Risk Assessment

Superficial Geology

- Tidal Flat Deposits - Clay And Silt

Note:
Onshore Substation (OnSS) Footprint symbology adjusted for the purpose of OnSS Flood Risk Assessment

Sources:
Superficial Geology data obtained via BGS WMS. British Geological Survey © NERC. All Rights Reserved.



Coordinate System: British National Grid

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Scale: 1:15,000

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Environmental Statement

Superficial Geology

Figure 24.3.4

OUTER DOWSING OFFSHORE WIND

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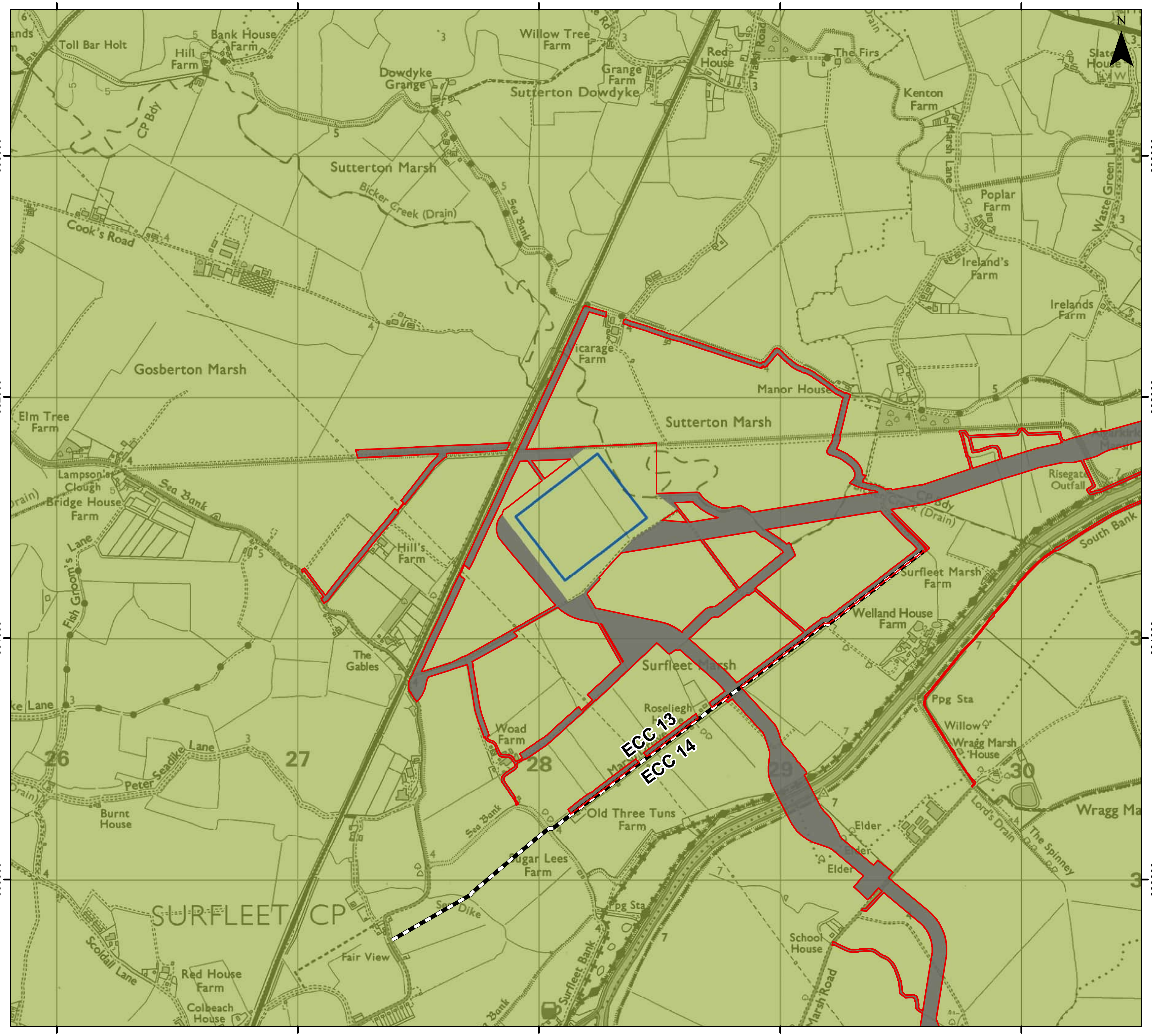


Legend

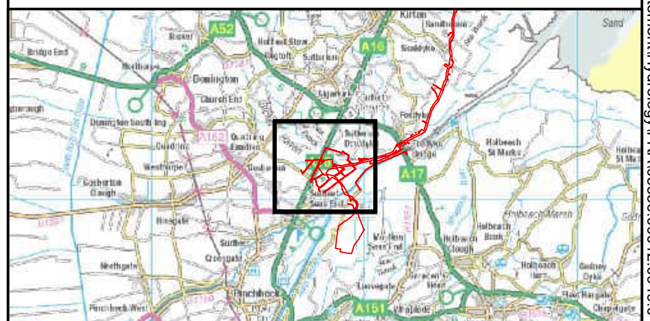
- Order Limits
- Onshore Segment Break
- Onshore Substation (OnSS) Footprint
- Area not Included in Onshore Substation Flood Risk Assessment

Sedimentary Bedrock

- Oxford Clay Formation – Mudstone (Jurassic)

Note:
Onshore Substation (OnSS) Footprint symbology adjusted for the purpose of OnSS Flood Risk Assessment

Sources:
Bedrock Geology data obtained via BGS WMS. British Geological Survey © NERC. All Rights Reserved.



Coordinate System: British National Grid

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Scale: 1:15,000

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Environmental Statement

Bedrock Geology

Figure 24.3.5

OUTER DOWSING OFFSHORE WIND

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38. The National Soils Resources Institute Soilscapes (Cranfield University, date unknown), indicates that the soils at the Site location are categorised as *'Loamy and clayey soils of coastal flats with naturally high groundwater'.* Drainage is classified as being *'naturally wet'* and drains to local groundwater.

24.5.4 Hydrogeology

39. The Aquifer Designation Map (DEFRA, accessed October 2023) identifies both the bedrock and superficial geology at the Site as an *'Unproductive Aquifer: these are geological strata with low permeability that have negligible significance for water supply or river base flow*.' The mapping also identifies the overlying superficial deposits as being classed as *'Unproductive Aquifer'*.

40. Given that the soils at the Site location comprise loamy and clayey soils with a naturally high water table, it is likely that the soils will retain water and remain wet or damp, particularly during the wetter winter months. Furthermore, due to the Site's proximity to a number of watercourses within a low-lying, flat area, groundwater levels are likely to be heavily influenced by water levels within those respective watercourses and especially those within the Risegate Eau and the tidal River Welland.

41. Upon reviewing the Groundwater Source Protection Zone mapping (DEFRA, accessed October 2023), the Site is not located within a Source Protection Zone (SPZ). The closest SPZ to the Site is located approximately 10km to the west.

24.5.5 Existing Site Drainage

42. Given the greenfield nature of the Site, there is no formal drainage infrastructure controlling runoff, apart from the presence of agricultural land drains beneath the Site and local IDB maintained watercourses.

43. It is therefore assumed that during a rainfall event, surface water will infiltrate into the ground, or, if the soil is saturated, flow over the surface, ponding in topographic low points or following the topographic slope into local open field drains, ditches and watercourses.

24.6 Planning Policy & Guidance

44. The proposed development of the OnSS, as part of the wider ODOW Project, will be subject to a Development Consent Order (DCO).

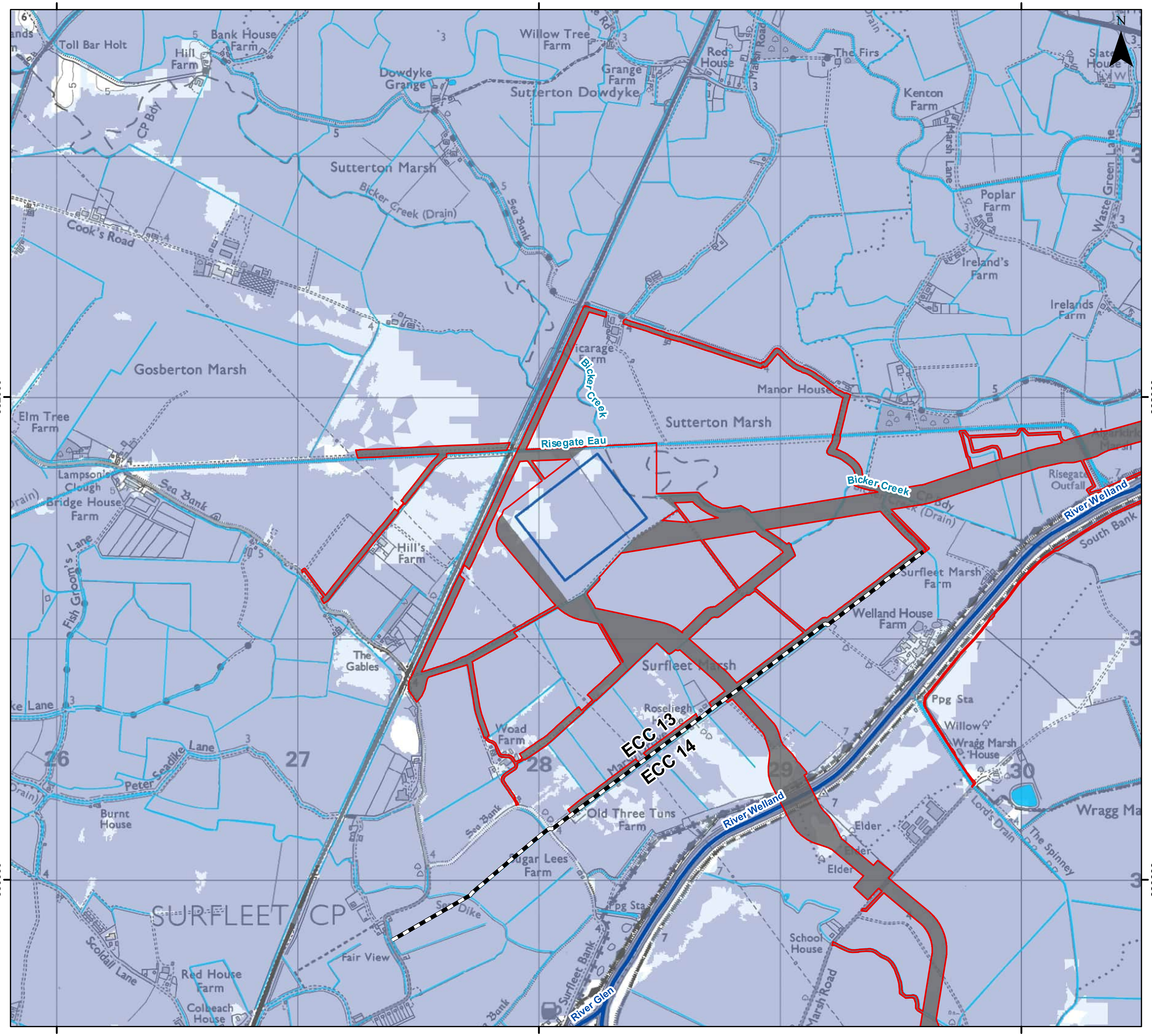
24.6.1 Flood Zone Classification

45. The definition of Environment Agency flood zones is provided in PPG Table 1: Flood Zones:

- Zone 1 – Low Probability (Flood Zone 1) is defined as land which could be at risk of flooding from fluvial or tidal flood events with less than 0.1% annual probability of occurrence (1 in 1,000-year) i.e., considered to be at 'low probability' of flooding.
- Zone 2 – Medium Probability (Flood Zone 2) is defined as land which could be at risk of flooding with an annual probability of occurrence between 1% (1:100-year) and 0.1% (1:1,000-year) from fluvial sources and between 0.5% (1:200-year) and 0.1% (1:1,000-year) from tidal sources i.e., considered to be at 'medium probability' of flooding.
- Zone 3a – High Probability (Flood Zone 3a) is defined as land which could be at risk of flooding with an annual probability of occurrence greater than 1% (1:100-year) from fluvial sources and greater than 0.5% (1:200-year) from tidal sources i.e., considered to be at 'high probability' of flooding.
- Zone 3b – Functional Floodplain (Flood Zone 3b) This zone comprises land where water from rivers or the sea has to flow or be stored in times of flood. The identification of functional floodplain should take account of local circumstances and not be defined solely on rigid probability parameters. Functional floodplain will normally comprise:
  - Land having a 3.3% or greater annual probability of flooding, with any existing flood risk management infrastructure operating effectively; or
  - Land that is designed to flood (such as a flood attenuation scheme), even if it would only flood in more extreme events (such as 0.1% annual probability of flooding).

46. In assessing the boundary between Flood Zones 1, 2 and 3, the protection afforded by any flood defence structures, and other local circumstances, is not considered by the Environment Agency.

47. The Environment Agency's Flood Map for Planning (EA, 2023a) is included as Figure 24.3.6. This mapping indicates that the majority of the Site lies within Flood Zone 3a, with small portions of the Site to the north and west located within Flood Zone 2. However, it is noted that the Site is afforded the protection offered by formal Environment Agency flood defences along the River Welland and Lincolnshire coastline.

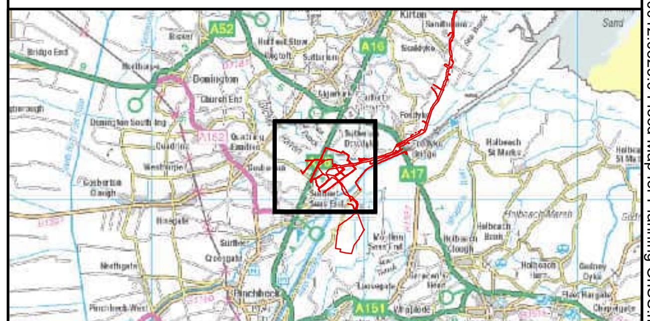


Legend

- Onshore Segment Break
- Onshore Substation (OnSS) Footprint
- Area not Included in Onshore Substation Flood Risk Assessment
- Statutory Main River
- Minor Watercourse
- Waterbody
- Order Limits
- Environment Agency Flood Zone 2
- Environment Agency Flood Zone 3

Note:
Onshore Substation (OnSS) Footprint symbology adjusted for the purpose of OnSS Flood Risk Assessment

Sources:



Coordinate System: British National Grid

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Scale: 1:15,000

Environmental Statement

Flood Map for Planning

Figure 24.3.6

OUTER DOWSING OFFSHORE WIND

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Document Path: P:\05356 - GoBe Consultants Ltd\00012 GTR4 Outer Dowsing\Tech\GIS\Dwgs\Wking\2023 09 Environmental Statement\Hydrology\FRA\05356.00012.0823.0 Flood Map for Planning OnSS.mxd

24.6.2 National Planning Policy

48. The report has been produced in accordance with NPS EN-1, section 5.8 (DESNZ, 2023), the NPPF (Ministry of Housing, Communities & Local Government, 2023) and the PPG for Flood Risk and Coastal Change (Ministry of Housing, Communities and Local Government, 2022). Current best practice documents relating to assessment of flood risk published by the British Standards Institution BS8533 (BSI, 2017) has also been taken into account.

24.6.2.1 Sequential Test

49. In accordance with NPS EN-1, the Sequential Test is a requirement for all development proposed to be located within Flood Zones 2 and 3 and for development which is at risk of other sources of flooding such as pluvial flooding. EN-1 para 5.8.21 provides that:

"*The Sequential Test ensures that a sequential, risk-based approach is followed to steer new development to areas with the lowest risk of flooding, taking all sources of flood risk and climate change into account. Where it is not possible to locate development in low-risk areas, the Sequential Test should go on to compare reasonably available sites with medium risk areas and then, only where there are no reasonably available sites in low and medium risk areas, within high-risk areas*."

50. As the proposed development is located in Flood Zone 3a, the Sequential Test will be required. In consideration of the Sequential Test, other sources of flooding have been considered and found to be insignificant, as detailed in Section 24.7.

51. The Sequential Test is considered further in Section 24.9.

24.6.2.2 Exception Test

52. The Exception Test, as set out in EN-1 para. 5.8.11, requires two criteria to be satisfied:

a. the project would provide wider sustainability benefits to the community that outweigh flood risk; and
b. the project will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible will reduce flood risk overall.

53. The PPG (para. 7-079) details which development types, based upon their vulnerability category, are appropriate within each respective flood zone and whether the Exception Test is required, as shown by Table 24.4.

54. Due to the development passing the Sequential Test, the Onshore OnSS meets that criterion of needing to be located in a flood risk area, for operational reasons. As the Project falls under the ‘Essential Infrastructure’ category in terms of vulnerability, the Exception Test is therefore required.

Table 24.4 Flood Risk Vulnerability and Flood Zone ‘Incompatibility’

Flood Risk Vulnerability Classification		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	Zone 1	✓	✓	✓	✓	✓
	Zone 2	✓	✓	Exception Test Required	✓	✓
	Zone 3a†	Exception Test Required	✓	✗	Exception Test Required	✓
	Zone 3b Functional Floodplain*	Exception Test Required	✓	✗	✗	✗

†In Flood Zone 3a essential infrastructure should be designed and constructed to remain operational and safe in times of flood

- *In Flood Zone 3b (functional floodplain) essential infrastructure that has passed the Exception Test, and water-compatible uses, should be designed and constructed to remain operational and safe for users in times of flood;
- result in no net loss of floodplain storage;
- not impede water flows and not increase flood risk elsewhere.

55. This report will demonstrate that the proposed development satisfies the requirements of the Exception Test, which is considered further in Section 24.9.

24.7 Potential Sources of Flooding

56. A screening study has been completed to identify whether there are any potential sources of flooding at the Site which may warrant further consideration. If required, any potential significant flooding issues identified in the screening study are then considered in subsequent sections of this assessment.

57. There are a number of potential sources of flooding, and these include:

- Flooding from rivers or fluvial flooding;

- Flooding from the sea or tidal flooding;
- Flooding from surface water or overland flow;
- Flooding from groundwater;
- Flooding from sewers;
- Flooding from reservoirs, canals, and other artificial sources; and
- Flooding from the failure of flood defence infrastructure.
-

58. The flood risk from each of these potential sources is discussed below.

24.7.1 Historic Flooding

59. The Environment Agency's Historic Flood Map indicates that they do not hold any records of the Site flooding previously. This dataset displays the maximum extent of all individual recorded flood events that have occurred since 1946 as a result of flooding from rivers, the sea, and groundwater sources, but excludes surface water flooding unless this was indistinguishable to other types of flooding occurring at the same time. This dataset is not definitive as it may fail to include all flooding incidents or precise extents. However, this dataset does provide a useful overview of the risk of flooding to a particular area, as well as indicate how patterns of flooding to an area may have changed over time.

24.7.2 Flooding from Rivers or Fluvial Flooding

60. An extract of the Environment Agency Flood Map for Planning (EA, 2023a) is provided in Figure 24.3.6. This shows that the Site is located within Flood Zones 2 and 3. This risk is associated primarily with the River Welland located approximately 1.25km to the southeast of the Site.

61. It is considered that downstream of Spalding the River Welland is tidally dominated. To the northern edge of Spalding, Fulney Lock and the Coronation Channel sluice act as the tidal limit for the river while also regulating fluvial flows downstream.

62. As such, the risk of fluvial flooding to the Site is considered negligible, due to the River Welland being tidally dominated at the Site and is not considered further. Flood risk from tidal sources is discussed in Section 24.7.3 below.

24.7.3 Flooding from the Sea or Tidal Flooding

63. An extract of the Environment Agency Flood Map for Planning (Environment Agency, 2023a) is provided in Figure 24.3.6. This shows that the Site is located within Flood Zones 2 and 3.

64. This mapping is based upon an undefended scenario and does not account for flood defences or other flood prevention infrastructure and is therefore indicative of the full natural extent of the floodplain. The Site benefits from the protection of flood defences along the Lincolnshire coastline and the banks of the River Welland. In particular, a raised earth embankment defence runs along the left bank of the river, starting at Fulney Lock in Spalding and extending to the mouth of the river at the Wash. It is therefore considered reasonable to determine that flooding from tidal sources will not impact the OnSS unless there is an extreme event resulting in the overtopping of flood defences or if the flood defences were to fail.

65. Breaching or failure of the flood defences is therefore considered to be a residual risk to the OnSS resulting from failure of the flood defence infrastructure and is considered further in Section 24.7.8.

24.7.4 Flooding from Surface Water or Overland Flow

66. As discussed in Section 24.5.1, the topography of the Site and wider local area is essentially flat and level with surface water runoff likely to discharge to a network of field ditches and surface water drains, such as Risegate Eau to the north of the Site.

67. Surface water modelling has been undertaken by the Environment Agency in order to predict the likely extents, depths and velocities of surface water flooding at a given location across three rainfall events (3.33% AEP, 1% AEP and 0.1% AEP). An Extract of the resulting surface water flood map is reproduced in Figure 24.3.7 below.

68. The Environment Agency defines surface water flood risk categories as follows:

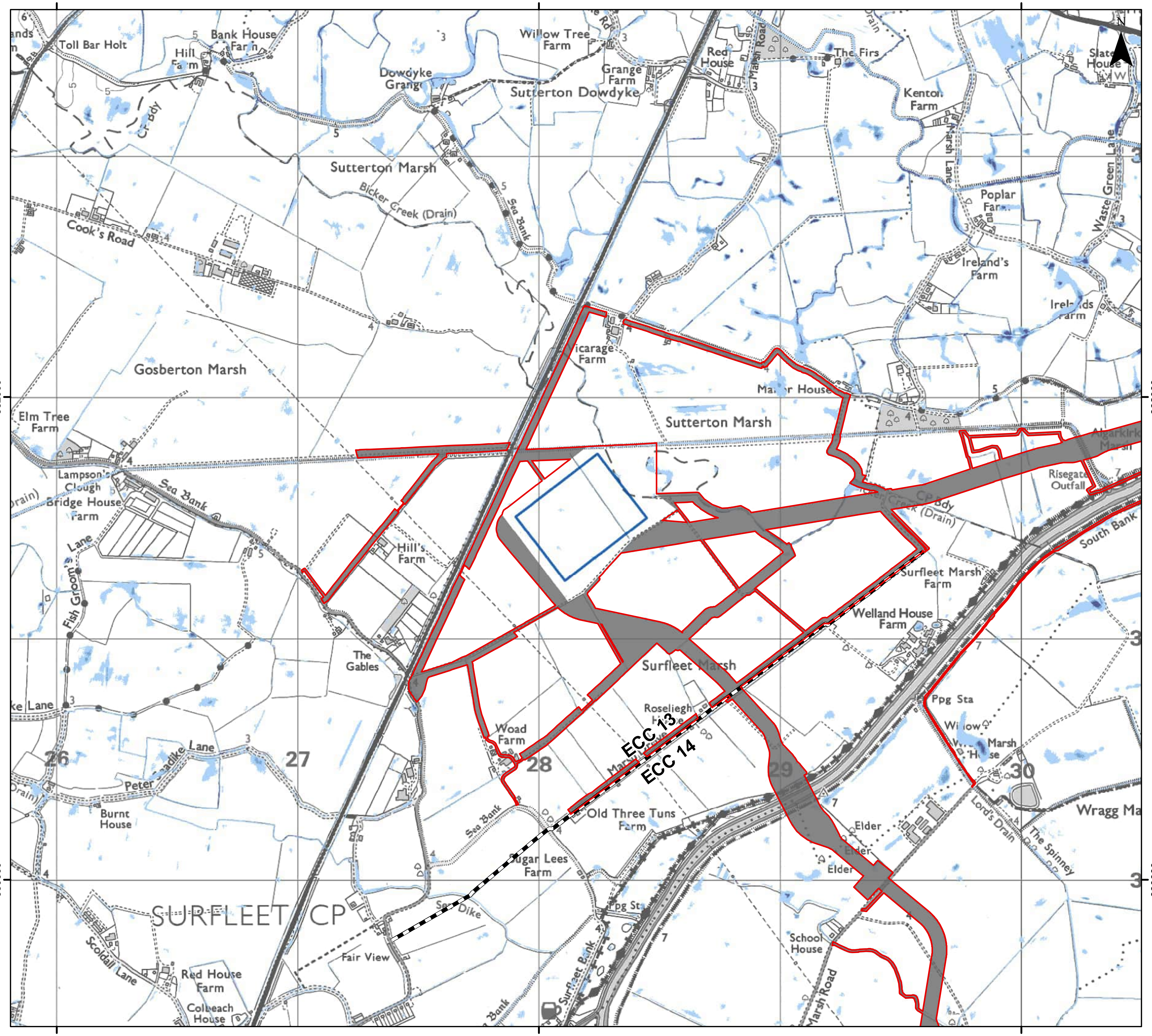
- Very Low: less than 1 in 1,000 annual probability of flooding in any given year;
- Low: less than 1 in 100 annual probability but greater than or equal to 1 in 1,000 annual probability of flooding in any given year;
- Medium: between 1 in 100 annual probability and 1 in 30 annual probability of flooding in any given year; and
- High: greater than 1 in 30 annual probability of flooding in any given year.

-

69. It should be noted that this information does not take into consideration, or include in modelling, any land drainage or formal surface water drainage infrastructure installed beneath the ground surface.

70. Figure 24.3.7 shows the majority of the Site to be at very low (less than 0.1% AEP) risk of surface water flooding. Two small, isolated areas of low (0.1% AEP) risk and a further straight line cutting across the north-eastern end of the Site suggests localised depressions and a potential trench or field drainage ditch, though neither are notable in the current LiDAR data considered in Figure 24.3.2.

71. Based upon the above, the Site is considered to be at very low risk of flooding from surface water and this is not considered further.



Legend

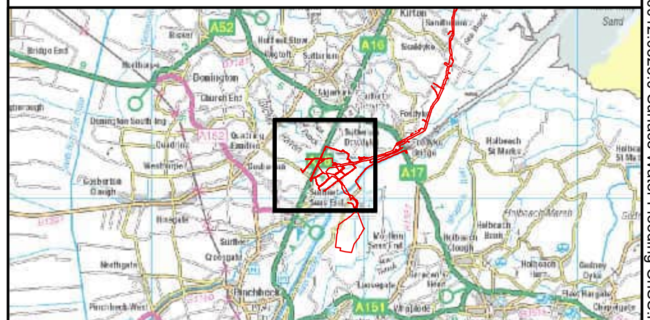
- Order Limits
- Onshore Segment Break
- Onshore Substation (OnSS) Footprint
- Area not Included in Onshore Substation Flood Risk Assessment

Risk of Flooding from Surface Water Flooding Extent

- High Probability (3.3% aep)
- Medium Probability (1% aep)
- Low Probability (0.1% aep

Note:
Onshore Substation (OnSS) Footprint symbology adjusted for the purpose of OnSS Flood Risk Assessment

Sources:
© Environment Agency copyright and/or database right.
Contains OS data © Crown copyright and database right (2022)



Coordinate System: British National Grid

0 0.5 1 km

Scale: 1:15,000

Environmental Statement

Surface Water Flood Map

Figure 24.3.7

OUTER DOWSING OFFSHORE WIND

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24.7.5 Flooding from Groundwater

72. As detailed in Section 24.5.3 and 24.5.4, the Site is underlain by mudstone bedrock deposits that are considered to have low permeability and a low level or storage and water transmission. The superficial deposits of Tidal Flat Deposits are also considered to have low permeability.

73. The BGS Groundwater Flooding Susceptibility mapping, accessed via data from Envirocheck, shows that the Site lies within an area not susceptible to groundwater flooding.

74. The local area is likely to comprise a high water table, managed by land drainage installed below the Site. The water table is likely to remain relatively stationary, with any fluctuations influenced by the local watercourses and the River Welland. Where groundwater flooding is likely to occur, this will likely be due to rising flood levels within the local watercourses.

75. The risk of flooding from this source is therefore considered to be low and is not considered further.

24.7.6 Flooding from Sewers and Water Mains

76. As outlined in Section 24.5.5, the Site is agricultural land and is therefore unlikely to have significant formal sewerage infrastructure.

77. Utilities data acquired from Anglian Water indicates that there is no formal sewer or mains networks within the Site.

78. The risk of flooding from sewers and water mains is therefore considered to be negligible and is not considered further.

24.7.7 Flooding from Reservoirs, Canals and Other Artificial Sources

79. Environment Agency mapping (EA, 2023) indicates that the Site does not lie within an area at risk of flooding from reservoirs. The Site is not within close proximity of any canals and, as such, is not at risk of flooding in the event of a canal breach.

80. The Site is, however, within close proximity to Risegate Eau, a manmade surface water drain. This watercourse is operated and maintained by Welland and Deepings IDB

and serves as a regulated receptor for surface water runoff, with surface water pumped into the River Welland when a sufficient water level is reached. As such, this watercourse alone does not present a direct risk of flooding to the Site, though the watercourse is likely to act as a conveyance route for floodwater in the event of a breach of the River Welland defences and therefore could be considered an indirect source of flooding of residual risk.

81. Flooding from infrastructure failure (breach and overtopping) is considered within Section 24.7.8. Flooding from reservoirs and canals is considered to be negligible and is not considered further.

24.7.8 Flood Risk from Infrastructure Failure

24.7.8.1 Flood Defences

82. Coastal flood defences are located along the Lincolnshire coastline and banks of the River Welland. These defences are regularly inspected and maintained by the Environment Agency, however there is a residual risk of failure or overtopping.

83. A detailed assessment of the risk of flooding from breach and overtopping is considered in Section 24.8.

24.7.8.2 Pumping Stations

84. The IDBs maintain a number of pumping stations that serve the land within and around the Site. Failure of a pumping station would have the potential to increase flood risk locally, effectively creating an increase in fluvial flood risk. The IDBs undertake regular inspections and carry our regular maintenance and servicing of all assets under their care, including pumping stations. The likelihood of failure is considered to be low, and any failure would be immediately notified to the relevant IDB for inspection and repair.

85. The chance of flooding from failure of a pumping station is therefore considered to be low and is not considered further.

24.8 Detailed Assessment of Flood Risk

24.8.1 Flooding from Breach and Overtopping

86. This section presents a summary of the results of the hydraulic modelling conducted to assess the risk of flooding in the event of defence overtopping and in the event of a

defence breach. Full details and results of the modelling are available within Annex 1: River Welland Breach Modelling Report, which should be referred to in conjunction to this Flood Risk Assessment.

87. The hydraulic model has been used to simulate a range of extreme flood events up to and including the 0.1% AEP tidal event with an allowance for climate change, as detailed in Section 24.4.4. During the 0.1% AEP + climate change event the model has demonstrated that overtopping of the left (north) bank flood defences is expected but that the Site and surrounding local area are predicted to remain free from flooding. Therefore, the Site is not considered to be at risk of flooding in the event that the existing flood defences are overtopped.

88. Two breach scenarios have been modelled (Breach 1 and Breach 2). Breach 1 was selected because flood flow will more easily reach the OnSS site area through Bicker Creek. Breach 2 was chosen because the area near it has the lowest floodplain elevation along the flood defences, and it is closer to the OnSS site. In the event of a breach of the left (north) bank defence, significant flooding is expected to occur throughout the wider area. Under baseline conditions, peak flood levels are expected to range from 3.94m AOD during the 0.5% AEP and 4.093m AOD during the 0.1% AEP plus climate change scenario for Breach 2. Table 24.5 and below extracted from the hydraulic modelling technical report, summarises the predicted peak flood levels for the Site during each modelled breach flood event respectively.

Table 24.5 Modelled Peak Breach Scenario Flood Levels on Site

Modelled Flood Event	Breach 1 Peak Flood Level (m AOD)	Breach 2 Peak Flood Level (m AOD)
0.5% AEP	3.972	3.940
0.5% AEP + CC	3.999	3.991
0.1% AEP	4.019	4.024
0.1% AEP + CC	4.082	4.093

24.8.2 H++ Sensitivity Analysis

89. As discussed in Section 24.4.5, the H++ Climate Change allowance is a scenario in which sea levels are predicted to rise significantly as a result of climate change and should be used as the credible maximum climate change scenario for NSIP developments.

90. As part of the hydraulic modelling completed for the OnSS, simulations have been completed to account for the H++ scenario which, based on guidance from the EA[1], included a cumulative in sea level increase of 1.9m up to the year 2100. This was applied in the model by increasing the tidal model inflow for the 0.5% AEP and 0.1% AEP events and tested for both overtopping and breach scenarios.

91. The results of the model simulations, which are presented in the River Welland Breach Modelling Report, included in Annex 1, show that in both the 0.5% AEP and 0.1% AEP events flooding is predicted to be more severe in the event of a defence breach as opposed to defence overtopping with H++ applied. In the event of the defence overtopping, peak flood depths of up to approximately 0.25m are predicted during the 0.5% AEP event, with peak depths of greater than 0.25m and less than 0.5m during the 0.1% AEP event. In the event of a defence breach, peak depths of 0.25m to 0.5m are predicted during the 0.5% AEP event, with peak depths of 0.25m to 0.5m during the 0.1% AEP event but to a slightly greater extent.

24.9 Sequential and Exception Test

24.9.1 Sequential Test

92. The Sequential Test gives preference to locating new development in areas at lowest risk of flooding. The Environment Agency Flood Map for Planning and Strategic Flood Risk Assessments (SFRAs) provide the basis for applying this test.

93. The Sequential Test provides that:

" Where it is not possible to locate development in low-risk areas, the Sequential Test should go on to compare reasonably available sites with medium risk areas and then, only where there are no reasonably available sites in low and medium risk areas, within high-risk areas."

94. Details of the sequential test and site selection are addressed in Volume 1, Chapter 6.1.4: Site Selection and Consideration of Alternatives (document reference: 6.1.4). The flood risk sequential test assessment there set out concludes that the sequential test is passed in respect of the OnSS site.

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1 Flood risk assessments: climate change allowances https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances#H-plus-plus

24.9.2 Exception Test

24.9.2.1 Part One

95. The first part of the Exception Test requires that the development must demonstrate wider sustainability benefits to the community that outweigh flood risk.

96. The Project is a NSIP, which is a 1.5GW offshore windfarm off the Lincolnshire Coast. Once completed it will be one of the UK's largest offshore windfarms. It is anticipated to generate renewable electricity equivalent to the annual electricity consumption of over 1.6 million households and will play a critical role in achieving the UK Government's ambition to deliver 50GW of offshore wind by 2030 and to achieve net zero by 2050. The Project will displace the equivalent of nearly 2 million tonnes CO2 emissions per year of operation through the generation of renewable electricity.

97. Based on the above, it is therefore considered that the first part of the Exception Test is passed.

24.9.2.2 Part Two

98. To satisfy the second part of the Exception Test, it must be demonstrated that the development will be safe for its lifetime, taking into account the vulnerability of its users and that it will not increase flood risk elsewhere, and, where possible, will reduce flood risk overall.

99. As part of the results analysis for the hydraulic modelling, and following discussions with the Environment Agency to determine their assessment requirements, a comparison of the flood hazard rating between the baseline existing conditions and post-development scenario has been made. This has been completed by calculating the flood hazard rating for the 0.1% AEP plus climate change breach event, with the results provided as the difference between that of the post-development scenario and the baseline. The results, provided in Figure 41 and Figure 61 of the Modelling Report in Annex 1, demonstrate an increase in hazard rating across a number of small areas within the vicinity of the OnSS.

100. A review of these areas where flood hazard has been carried out indicating that there is potentially an increase in flood hazard rating for 11 properties within the area. Inspection of each of the properties has found that the increases are the result of increases in peak flood depths of less than 10mm to eight of the of the properties, of less than 20mm to two of the of the properties, and an increase in peak flood depth of 94mm

to the remaining property. In each instance of an increase in peak depth affecting properties, all were isolated from one another and represented as single cell increases within the model. Given how remote these increases are from the development, these are considered more likely to represent acceptable anomalies within the hydraulic modelling, rather than actual changes that would occur in the event of a breach scenario.

101. Even if the above increases were considered as actual effects of the development, and not anomalies in the model, it is important to note that this risk would still be residual. The assessment has been based on the more onerous 0.1% AEP plus climate change flood event in conjunction with a breach of the flood defences occurring. Given that the flood defences are inspected and maintained, the eventuality of this scenario occurring is minor.

102. There is no increase in flood risk elsewhere following development of the OnSS other than in the event of a failure of flood defences on the River Welland.

103. It is proposed to raise sensitive equipment at the Site to the peak predicted 0.1% AEP plus climate change flood level plus 300mm freeboard, through a combination of measures, including raising the site level, mounting equipment on plinths and the setting of floor levels. In doing so, it will ensure that the OnSS Site will remain free from flooding throughout its operational lifetime. Given that the Site is only considered to be at risk of flooding in the event of a breach of the defences from a tidally influenced watercourse, the raising of ground levels will have a negligible impact on flood levels elsewhere and, as such, floodplain compensation is not required.

104. Based on the outcomes of the modelling undertaken, and the findings of this FRA, including the mitigation measures outlined below, it can be concluded that the Project would be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and where possible will reduce flood risk overall, thus meeting the requirements of the Exception Test.

24.10 Mitigation Measures

24.10.1 Design of OnSS

105. To ensure that the OnSS remains free from flooding in all eventualities, the design level for sensitive equipment at the Site is to be raised 300mm above the peak modelled flood level, through a combination of ground level raising, the use of equipment plinths

and by raising finished floor levels. The detailed design of the OnSS will be carried out post consent and will form part of the details to be approved by the Local Planning Authority, in accordance with the relevant DCO requirement and in consultation with the Environment Agency and the Lead Local Flood Authority (LLFA). As part of the modelling, proposed scenario simulations of the Site with a raised ground level have been modelled to simulate the presence of the development platform, with the results confirming that the Site would remain free from flooding for all events up to and including the 0.1% AEP plus climate change.

24.10.2 Flood Response

24.10.2.1Flood Warnings and Alerts

106. The main risk of flooding to the OnSS is derived from the residual risk existing from tidal flood defence breach or overtopping. Flood response is the improving of awareness of personnel working on the Site for an incoming tidal event and will be beneficial for the Site.

107. The Site is located within ‘Flood Warning’ and ‘Flood Alert’ areas. As a result, in the event of increasing water levels and a heightened risk of flooding, the Environment Agency will issue a flood warning to allow site occupants the chance to prepare for a Site to be inundated, including evacuation.

108. It is therefore recommended that the Principal Contractor responsible for construction of the OnSS and subsequent operational phase site management sign up for the Environment Agency’s ‘Floodline’ flood warning service for general awareness of potential flood events and to receive automated flood alerts and flood warnings when these are issued.

109. This process should also form part of a wider Operational Emergency Flood Response Plan for the Site, and should include details of actions to be carried out should a warning or alert be received. The Operational Emergency Flood Response Plan should be implemented ahead of the Site becoming operational. Where conditions change in the future, it is recommended that the plan is kept up to date as required.

24.10.2.2 Evacuation

110. Due to the nature of the onshore substation, the Site will not be occupied by maintenance staff on a permanent or long-term basis. It is recommended that an

Operational Emergency Flood Response Plan which includes details regarding the evacuation procedure and removal or securing of sensitive plant or equipment is implemented before the Site becomes operational, with any site visitors being briefed on the plan before they attend the Site.

24.10.2.3 Access & Egress

111. While unlikely, in the event of a significant tidal flood event coinciding with a breach or overtopping of the defences it is unlikely that safe and dry access and egress to the Site will be available. As such, it is recommended that preparations are made for evacuation when a flood warning is issued, ahead of a potential flood event. It is also recommended that site visitors do not return to the Site until flood waters have subsided and when the area is deemed to be safe.

24.10.3 Surface Water Drainage

112. Without mitigation the OnSS could lead to an increase in the rate and volume of surface water runoff generated due to the increase in impermeable coverage. An Outline Surface Water and Drainage Strategy (document reference 8.1.5) has therefore been provided as part of the DCO Application within the Outline Code of Construction Practice (document reference 8.1) to manage drainage during the construction of the OnSS. Additionally, an Outline Operational Drainage Management Plan (document reference 8.12) has been produced for DCO Application which details the proposed measures to manage the quantity, rate and quality of surface water runoff discharge off-site during its operational lifetime.

24.10.4 Construction Activities

113. Construction activities at the OnSS will be managed through a plan submitted as part of a CoCP (document reference 8.1).

114. Spills of bulk materials such as concrete or entrainment of stockpiled material from excavations during OnSS construction could result in watercourses or drainage ditches becoming restricted or blocked. This could impact flow regimes and could result in an increase in localised fluvial flood risk. Implementation of mitigation measures to be proposed within the CoCP, would reduce the likelihood of construction activities resulting in spillage incidents occurring and will ensure that there is very limited chance of stockpiled material becoming entrained to potentially enter watercourses.

115. Large stockpiles of excavated/construction materials could block overland flow of surface water during heavy rainfall events and result in changes to existing surface water hydrology and an increase in surface water flood risk.

116. The laying of temporary surfacing material for access roads, OnSS development platform, Temporary Construction Compounds (TCC) areas or any designated stockpile areas could result in a reduction in the permeability of the ground and therefore an increase in surface water flood risk. These effects would be mitigated through the appropriate siting of stockpiles, provision of gaps to allow passage of surface water and development of a final Surface Water Drainage Strategy for the construction phase.. Therefore, the effects of construction on surface water flood risk would be largely mitigated through the measures proposed within the CoCP.

117. The proposed OnSS is within an area that is at a high risk of fluvial and tidal flooding. However, given that the Site benefits from the protection of formal Environment Agency flood defences, this risk is considered residual. Therefore, it is considered the activities carried out during the construction phase would not impede floodplain flows arising from a tidal or fluvial flood event.

118. The hydraulic modelling completed to assess flood risk at the Site demonstrates that the Site is only at risk of flooding in the event of a breach of the flood defences, with no risk of flooding in the event of defences being overtopped. It is therefore recommended that construction personnel register for flood warnings from the Environment Agency and, in the event that a warning is issued, evacuate the site at the earliest opportunity. Following any such flood warning being issued, Site construction personnel should not return to the Site until the Environment Agency have deemed it safe to do so.

24.11 Conclusions

119. Based upon the information available, the Site has been determined to be at risk of flooding from the tidally influenced River Welland. Due to the presence of flood defences, the risk of flooding is considered residual, with the Site only likely to be affected in the event of a breach or overtopping of the defences.

120. Hydraulic modelling completed to assess the risk of flooding to the Site under baseline conditions has demonstrated that the Site is not predicted to flood as a result of

defence overtopping for all events up to and including the 0.1% AEP plus climate change. In the event of a breach of the flood defences the Site is predicted to be at risk of flooding, with peak water levels expected to range from 3.972m AOD (0.5% AEP event) to 4.093m AOD (0.1% AEP + CC).

121. Flood risk from all other potential sources is not considered to be significant and will be managed through appropriate construction and design measures.

122. Due to the risk of flooding in the event of a breach of the flood defences, sensitive equipment and finished floor levels at the OnSS will be raised to a design level of a freeboard of 300mm above the peak modelled flood level at the Site of 4.093m AOD. This will, through a combination of ground level raising and the use of equipment plinths and setting floor levels, ensure that the Site will be free and safe from flooding for all events up to and including the modelled 0.1% AEP + climate change event throughout its lifetime.

123. It is recommended that the Principal Contractor responsible for construction of the OnSS and subsequent operational phase site management sign up for the Environment Agency's 'Floodline' flood warning service, for general awareness of potential flood events and to receive automated flood alerts and flood warnings when these are issued.

124. It is recommended that an Operational Emergency Flood Response Plan which includes details regarding the evacuation procedure is implemented before the Site becomes operational, with any visitors being briefed on the plan before they attend the Site.

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Appendix A Hydraulic Modelling Report

Appendix 24.3 Flood Risk Assessment Onshore Substation

Outer Dowsing Offshore Wind Environmental Statement

GoBe Consultants Ltd.

SLR Project No.: 410.V05356.00013

1 March 2024

Chapter 24 Appendix 3 Annex 1 River Welland Breach Modelling

Outer Dowsing Offshore Wind Environmental Statement

GoBe Consultants Ltd

Prepared by:

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Floor 3, 86 Princess Street, Manchester, M1 6NG

SLR Project No.: 410.V05356.00013

Client Reference No: 05356

26 February 2024

Revision: V1.0

Revision Record

Revision	Date	Prepared By	Checked By	Authorised By
V1.0	26 February 2024	SLR Consulting Ltd	GoBe	Outer Dowsing Offshore Wind

Basis of Report

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1.0 Introduction

1.1 Context

1. SLR Consulting Limited has been appointed by GoBe Consultants Ltd to prepare a Hydraulic Modelling Technical Report in support of a Flood Risk Assessment (FRA) for the proposed Outer Dowsing Offshore Wind (ODOW) Onshore Substation (OnSS), to be located at Surfleet Marsh, south of Boston, Lincolnshire. The modelling was commissioned prior to the final selection of the OnSS site and therefore covered two site search areas that were under consideration for the Preliminary Environmental Impact Assessment (PEIR). Subsequently, following a site selection and evaluation process, the site at Surfleet Marsh, to the north of the River Welland was selected.
2. The development is part of a Nationally Significant Infrastructure Project (NSIP) that must be designed to remain operational under a 1 in 1,000-year flood event (including climate change). The objective of the modelling is to determine the maximum flood depth under these conditions in order to establish the appropriate design level to provide the necessary protection.
3. This technical report has been prepared under the direction of a Technical Director for Hydrology at SLR who specialises in flood risk and associated planning matters. The report summarises the construction of a 2-Dimensional (2D) hydraulic model for the River Welland and its associated floodplain. The model is newly developed using freely available datasets. The aim of this model is to evaluate the flood risk to the ODOW OnSS site at Surfleet Marsh in the event of a tidal surge and subsequent breach of defences along the River Welland.
4. The outputs of the hydraulic model are considered to provide the best currently available information on the tidal flood risk to the site.

1.1.1 Consultation

5. A technical note explaining the methodology was submitted to the Environment Agency prior commencement of the modelling. This was reviewed by external consultants and the methodology was amended to address the comments received. Addressed comments and responses are summarised in Table 1-1:. The remaining comments were already incorporated into the methodology.

Table 1-1: Technical note review comments/responses matrix

EA Comment	SLR Response
The methodology doesn't detail how land use will be considered within the 2D Domain i.e., Manning's roughness. The consultant should delineate areas of land use and apply appropriate roughness values.	For land use, the Land Cover Map 2021 (LCM2021) provided by the UK Centre for Ecology & Hydrology (UKCEH) has been utilized, along with the standard roughness values. Specifically, in accordance with EA guidance, we have increased the roughness value within the model to 0.1 for the building footprints.
A 10m 2D grid resolution is proposed based on 1m DTM composite LIDAR data. This is considered appropriate based on the Site topography and nature of the assessment. A check should be undertaken to ensure the river channel is of an appropriate size to convey flow along the channel to the breach.	The modelling was carried out using the 2D TUFLOW software, employing a base grid size of 10m for the floodplain with sub-grid sampling (SGS). A cell size sensitivity check will be carried out.

EA Comment	SLR Response
Two breach locations have been proposed; a northern and southern location, which are located on the northern and southern River Welland defence embankments. The Site area shown in Figure 1.1 is large and as such, it is unclear where the substation will be located within the Site boundary. As such, it is not possible to determine whether the breach locations represent the worst case to the proposed development. The methodology states 'Proposed southern and northern breach locations along the River Welland have been located at critical locations along the primary flood defences, which will allow for worst case flood events to the proposed substation site option search areas. As such, it is assumed that the substation locations will be determined from the results of the modelling assessment. If this is the case, then multiple and alternative breach locations should be considered in order to determine the most flood risk resilient substation location. By not having a defined substation location, it cannot be determined if the proposed breach locations represent worst case scenarios.	When the initially submission of the methodology, the site location has not been finalized. Now that it is, determined the proposed location, simulations will be undertaken with alternative breach locations to identify the worst-case scenario.
The Environment Agency have stated that model runs need to consider overtopping and breach with defences at their current levels and if they were to be increased in line with sea level rise. However, the breach methodology proposed will only increase the defence crest to an elevation that does not overtop in the 1000yr + CC peak. This approach only assesses a breach scenario when defence crests are raised in line with climate change. The consideration that defences are not raised should not be limited to overtopping runs but should also be undertaken in breach runs whereby defence crests remain as per the present day.	The defence crests have been kept as per the present day.
The methodology states that all runs will be modelled with a base date of 2006 for the present day. It is unclear what is meant by this as supplied HT tidal curves have been developed using a 2018 base date.	The climate change allowances are defined with a base date of 2000 for the present day. However, the climate change allowance has been calculated based on a 2018 base date." Climate change allowances 2018 – 2035 – 17yrs x 7mm = 119mm 2036 – 2065 – 339mm Total sea level rise (2018-2065) = 458mm
The consultant has stated that only the 1000yr + CC tidal level exceeds the existing defence crest levels. We have not been provided with the defence crest levels so can't confirm if this statement is correct or whether there is significant variation in defence crest heights.	0.1% AEP is the first overtopping event and the model has already been run for the 0.1% AEP tidal level as well.

EA Comment	SLR Response
We accept the overtopping methodology, however, in light of not knowing the defence crest height, the consultant should undertake an overtopping run for all return period events where the tidal peak level is greater than the lowest defence crest elevation.	
The methodology states that a sensitivity test for the H++ climate change allowances will be undertaken. This should occur for both overtopping and breach runs. Excel spreadsheet 'HT_BC.xlsx' does not include proposed H++ tidal curves. Environment Agency guidance 2 states that tidal H++ runs should apply an increase of 1.9m for total sea level rise to the year 2100.	Sensitivity analysis for the H++ has been completed (Appendix B).
As discussed above, a 70-hour simulation duration is proposed. However, the consultant should consider a 36-hr simulation, in line with guidance, with the breach occurring on the first tidal peak, and maximum tidal peak occurring as the middle curve.	Since the peak flood level occurs within the first 36 hours of the run time, it will be reduced to 36 hours. Model breaches at the first and highest tidal cycle, which is what is recommended in the EA guidance[1], so it will not conform with the "max tidal peak occurring as the middle curve" as mentioned above. The original guidance from the EA will be followed.

6. A draft River Welland Breach Modelling report was submitted to the Environment Agency on 21st December 2024, and following this a meeting was held with the Environment Agency on 10th January 2024 to discuss the contents of the draft report.
7. Following this meeting, two further actions were taken with regard to amendments to the modelling and presentation of results:
   - The access road to the substation was amended to provide a more accurate portrayal of the proposed levels and grading on site; and
   - Hazard class change figures have been provided in order to identify any potential properties which result in hazard classification changes as a result of the proposed development.

1.2 Model Selection

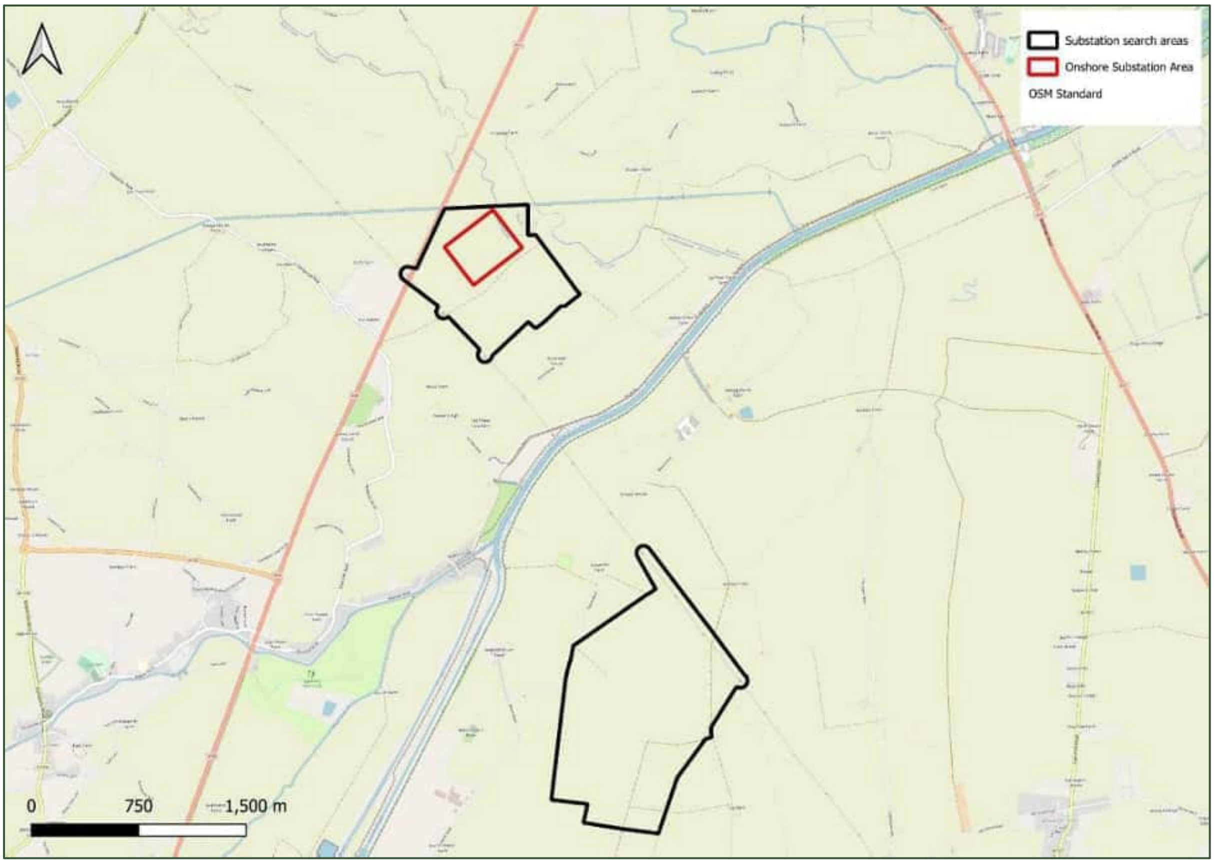
8. The River Welland breach model has been constructed using the TUFLOW hydraulic modelling package (Build: 2023-03-AB-iSP-w64).
9. The TUFLOW HPC module was selected as the numerical solver for the development of the coastal 2D hydraulic model. The High-Performance Compute (HPC) module solves the full 2D shallow water equations, including inertia and turbulence, and is suited to floodplain, open channel, and pipe hydraulics. The HPC solver also enables adaptive time-stepping in conjunction with smaller grid resolutions for greater granularity of results and topographic features where this is required. This package, which is distributed by BMT is widely used in the UK and has been benchmarked by the Environment Agency.

[1]Environment Agency, Anglian Region, Northern Area Requirements for Hazard Mapping. January 2014

1.3 Site Location

10. The proposed site is situated in an area of Lincolnshire known as 'The Fens'. This is a low-lying coastal area surrounding the River Welland and is drained by a series of artificial ditches with embankments to prevent flooding from seawater. The proposed OnSS site is located approximately 1.3km to the northeast of the River Welland. The River Welland is tidally influenced until it meets Spalding Lock and Coronation Channel Dam at the town of Spalding, 6km south (upstream) of the proposed site. The northern corner of the site is adjacent to the Risegate Eau drain and the Bicker Creek drains the eastern area of the site. The A16 highway is situated 100m to the west of the site. The proposed site location is indicated in Figure 1-1 below.

Figure 1-1 Site Location Plan



2.0 Methodology

11. This section of the report summarises the construction of the 2-Dimensional (2D) hydraulic model of the River Welland in Lincolnshire.

12. The construction of 2D hydraulic models requires a number of data sets and parameters, of which the key items are summarised below:

- Model extent;
- Floodplain topography in the form of a digital terrain model (DTM);
- Cell size;
- Topography edits;
- Hydraulic structures;
- Hydraulic boundaries; and
- Roughness (Manning's n).

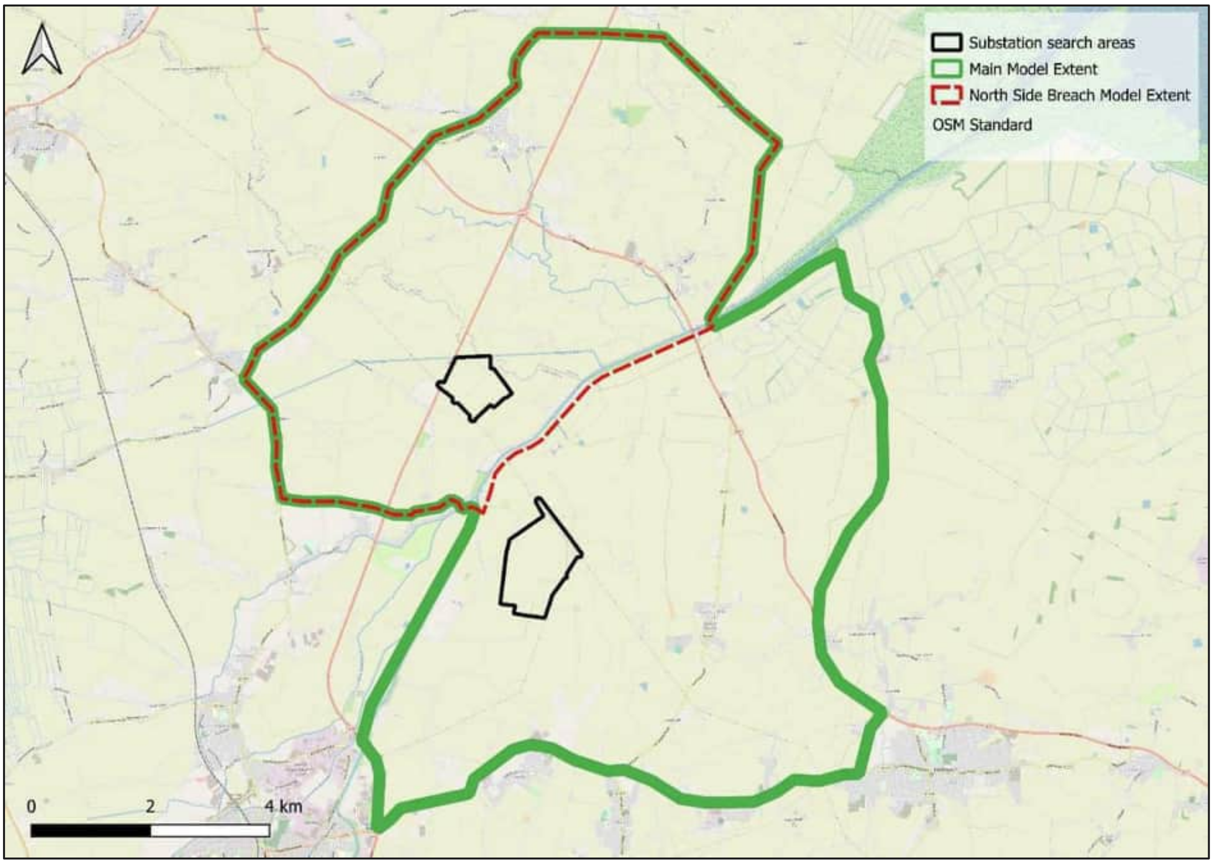
2.1 Model Extent

13. The main hydraulic model domain extends from A151 High Road located between Holbeach and Spalding of the south side of the River Welland, and to the north side of the River Welland covering up to of the B1397 Spalding Road.

14. Two model domains, one for the north of the river and one for the north and south as shown in Figure 2-1 below, were used to facilitate breach and overtopping scenarios to be tested independently while also optimizing model runtimes.

15. The main model extent is used for all overtopping runs and the 'North Side' domain is used to simulate the breach scenarios.

Figure 2-1 Hydraulic Model Extents



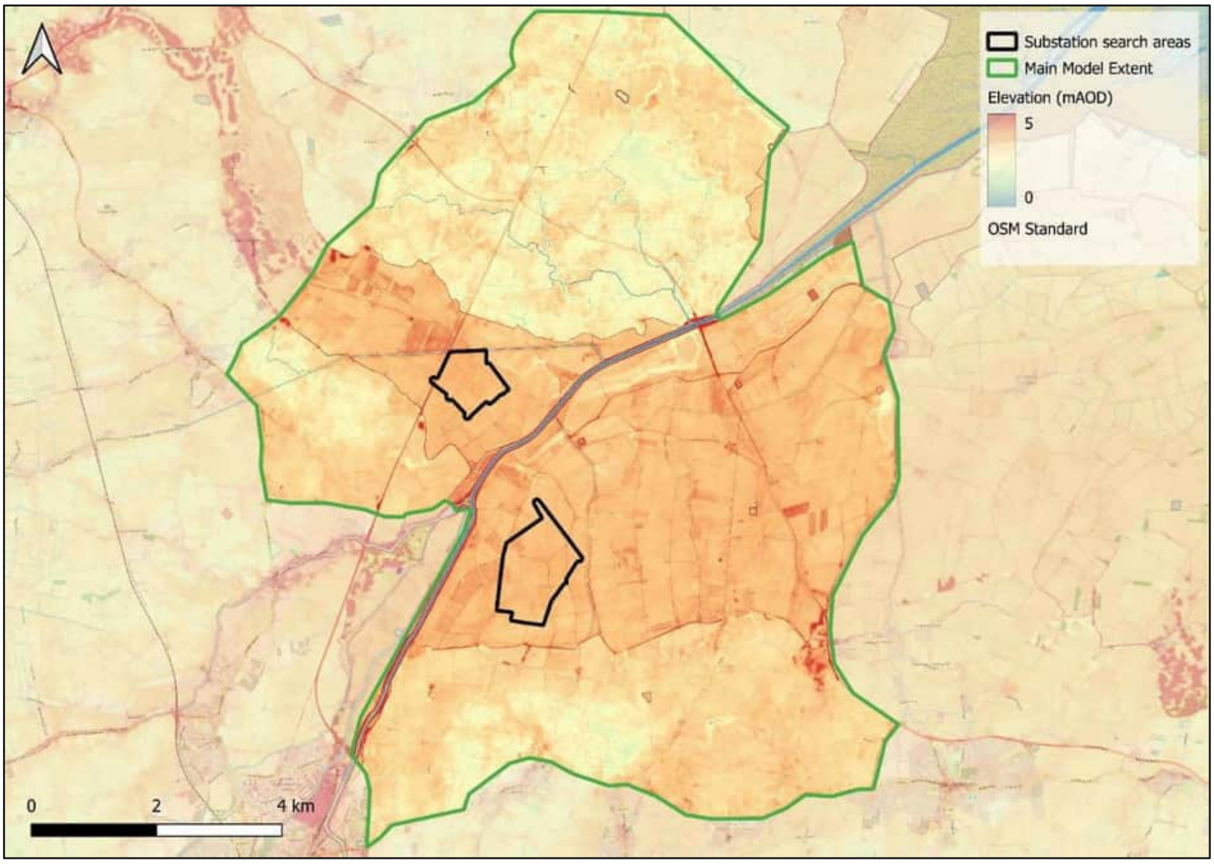
16. For the overtopping scenario modelling, the full model extent was used to allow an assessment of spill on either bank of the River Welland.

2.2 Topography (DTM)

17. The underlying base topography for the hydraulic model of the study area has been generated from the filtered aerial photogrammetry (LiDAR) data obtained from the Defra website[2] *'TF11ne_DTM_1m.* This 2022 LiDAR dataset adequately represents the floodplain topography, allowing for accurate flood routing for out of bank 2D flow, while also providing coverage of the full model extents as shown in Figure 2-2 below.

[2] Defra Data Services Platform, June 2023. https://environment.data.gov.uk/DefraDataDownload/?Mode=survey

Figure 2-2 Regional Topography



2.3 Topography Edits

18. The following key components were also added to the baseline LiDAR DTM to add more detail to the 2D domain of the flood model:

- In accordance with EA guidance[3], building footprints within the model extent have been raised by 0.3 meters. OS Open Map – Local (OML)[4] was used to represent the building footprints in the hydraulic model using a 2D_zsh layer.
- In accordance with EA guidance, pumping stations along the river have been assumed to be inoperative during a tidal event and subsequently disregarded. Therefore, the openings of these pumping stations in the LiDAR data were patched using 2D_zsh layers.
- The heights of riverbank defences in the River Welland study area are defined by a series of Z lines in TUFLOW. The elevations used for the defences were obtained from a combination of AIMS Spatial Flood Defences[5] data and LIDAR data.
- For the proposed development model scenario, the footprint of the site (OnSS) has been raised using a 2D zsh so that the final development platform is above the peak water level for the maximum assessed scenario (a design level of 4.2 mAOD defined by the Project has been adopted for modelling purposes).

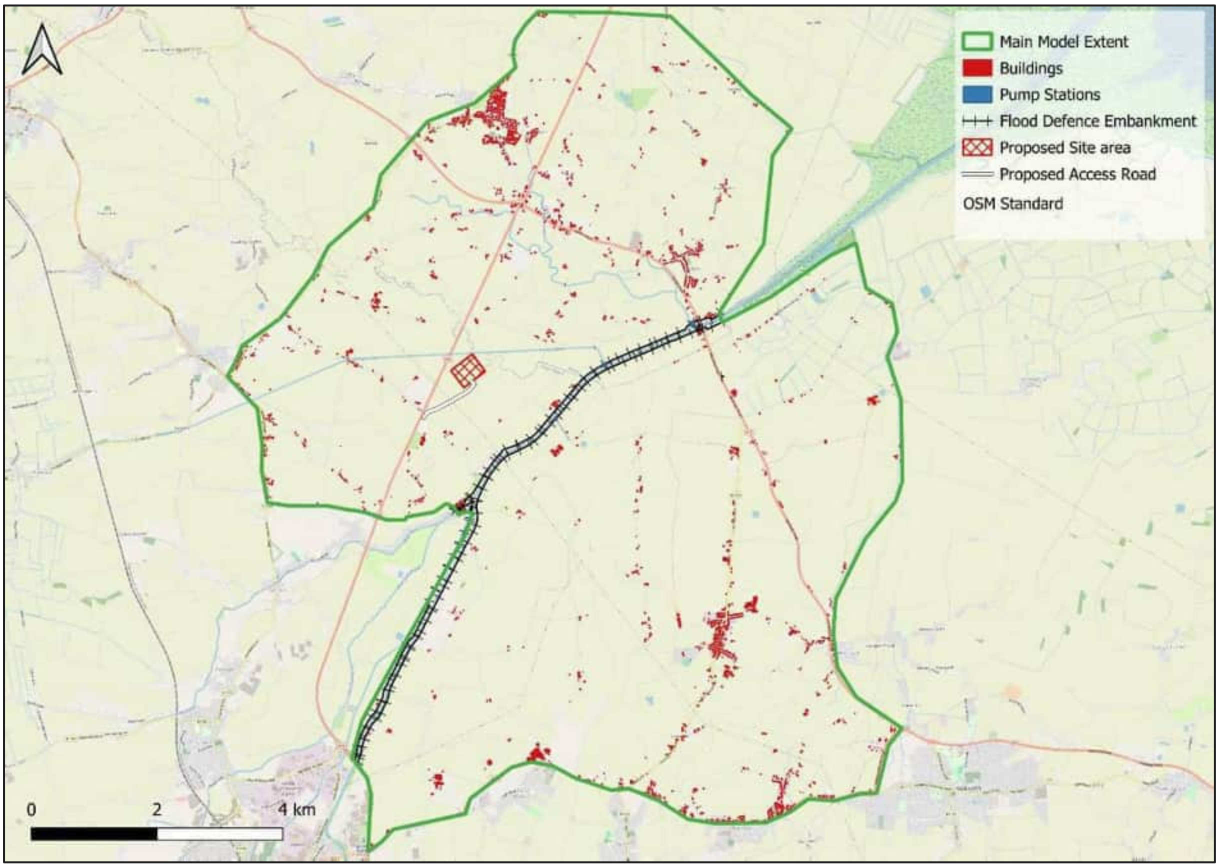
19. The above key topographical edits are also indicated in Figure 2-3 below.

[3] Environment Agency, Anglian Region, Northern Area Requirements for Hazard Mapping. January 2014

[4] Ordnance Survey Platform, Aug 2023, https://www.ordnancesurvey.co.uk/products/os-open-map-local

[5] AIMS Spatial Flood Defences (inc. standardised attributes), Sep 2023, https://www.data.gov.uk/dataset/cc76738e-fc17-49f9-a216-977c61858dda/aims-spatial-flood-defences-inc-standardised-attributes

Figure 2-3 Key Topographic Edits



2.4 Cell Size

20. A 10m model grid cell size was utilized taking into account the floodplain's expansive area and likely flow paths, relatively minimal variation in regional topography and largely rural nature. This cell size has also been determined to be sufficient for incorporating crucial details such as channel width, breach length, flood embankment width, and the width of main roads surrounding the study area. These factors were carefully considered to provide an accurate evaluation of the flood risk model grid cell size, ensuring a thorough and robust assessment of potential vulnerabilities and hazards.

2.5 Breach Locations

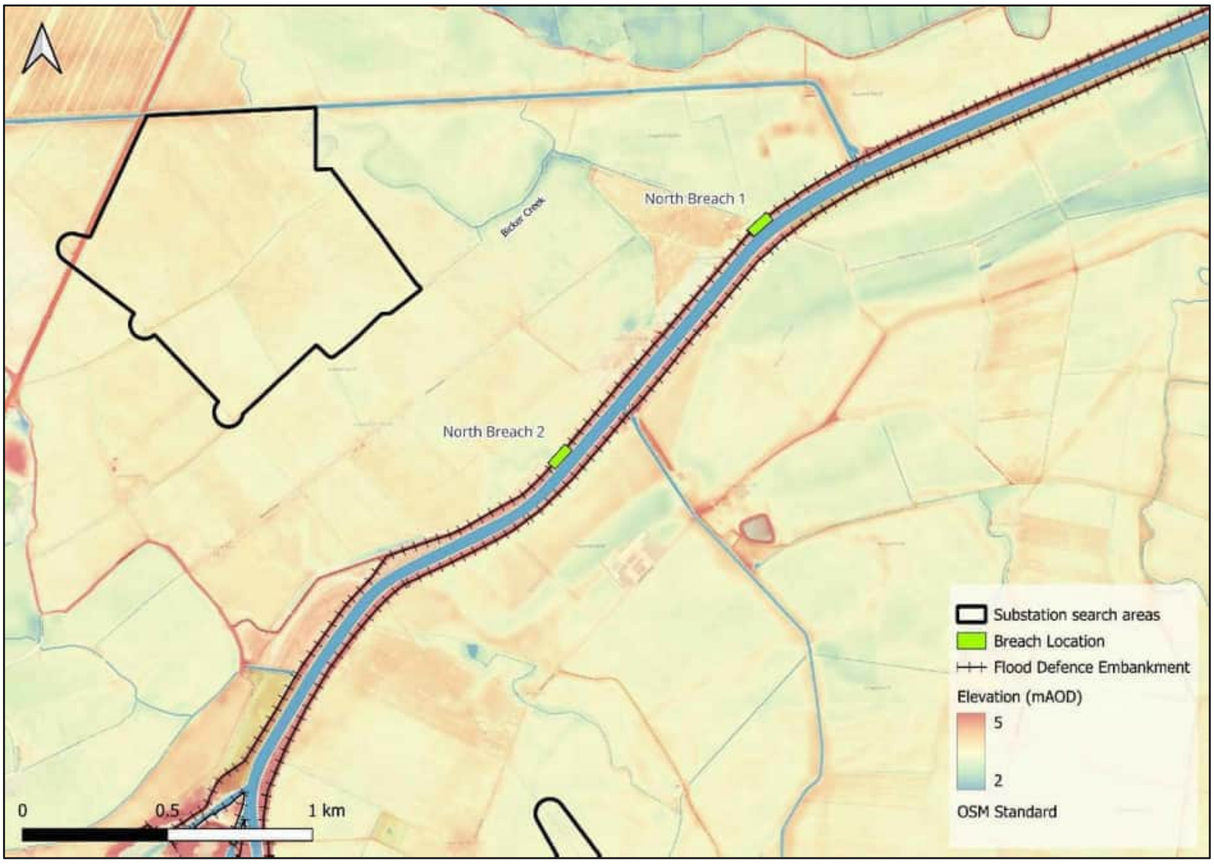
21. Two primary breaches were considered:

- North Breach 1; and,
- North Breach 2.

22. These breach locations were selected considering the distance to the proposed site location, watercourses surrounding the study area and regional topography. Breach 1 was selected because flood flow will more easily reach the OnSS site area through Bicker Creek. Breach 2 was chosen because the area near it has the lowest floodplain elevation along the flood defences, and it is closer to the OnSS site. Each breach was triggered to occur one hour before the peak water level time, as per Environment Agency

Guidance[6] and were represented in TUFLOW using variable (2d_vzsh) shape files. The location of the breaches is shown in Figure 2-4.

Figure 2-4 River Welland Breach Locations



2.6 Hydraulic Boundaries

23. The boundary condition applied to the TUFLOW model was a Head-Time (HT) boundary placed across the river at the Fosdyke Bridge. This boundary is used to assign the tidal curves for the 1 in 200 annual chance (0.5% Annual Exceedance Probability (AEP), 1 in 1,000 annual chance (0.1% AEP), 1 in 200 annual chances plus an allowance for climate change and 1 in 1,000 annual chance plus an allowance for climate change events.

24. Previous studies commissioned by the Environment Agency show coastal flooding to be the critical flood mechanism for this area of The Fens. This is considered mutually exclusive from fluvial flooding, as the same conditions that generate peak coastal flooding levels on this section of coastline are not thought to be linked with storm conditions which will generate large fluvial floods. Therefore, this study focuses solely on coastal / tidal flooding mechanisms.

25. The shape of the astronomical tidal curves used in the modelling were taken from the 2011 Hyder River Welland Hydraulic modelling report[7]. These tidal curves have then

[6] Environment Agency, Anglian Region, Northern Area Requirements for Hazard Mapping. January 2014

[7] April 2011, Hyder/Environment Agency: Strategic Flood Risk Management Framework Tidal Nene and Tidal Welland Hazard Mapping Hydraulic Modelling Report

been scaled to fit the extreme water levels estimated at Fosdyke Bridge[8] (*CFB conditions for the UK 2018 for 'Location: ESTURY_RiverWELLAND Chainage: _3992_5*).

26. Climate change allowances for sea level rise have been calculated from a base year of 2018 using the current Guidance from the EA for the Anglian Region for the Upper End Scenario (Flood risk assessments climate change allowances).

27. Resultant Peak Tidal Levels at Fosdyke Bridge are summarised below in Table 2-1.

Table 2-1: Summary of Peak Tidal Levels at Fosdyke Bridge

AEP%	EA Report[9] (m)	CFB (m)	CFB (97.5% confidence levels)
1:200 (0.5% AEP)	5.99	5.98	6.38
1:200 (0.5% AEP) + CC	7.13	6.44	6.84
1:1000 (0.1% AEP)	6.69	6.29	6.97
1:1000 (0.1% AEP) + CC	7.83	6.75	7.43

Climate change allowances:

2018 – 2035 – 17yrs x 7mm = 119mm

2036 – 2065 – 339mm

Total cumulative sea level rise (2018-2065) = 458mm

2.7 Manning's n

28. The definition of the extent of each of the roughness values in the 2D domain was determined using the Land Cover Map 2021 (LCM2021) provided by the UK Centre for Ecology & Hydrology (UKCEH). This was correlated with aerial photography to delineate different land use areas based on ground surface characteristics (Table 2-2-). Each land use type was assigned a corresponding Manning's n value in the TUFLOW Materials File as shown below in Table 2-2, with a set default Manning's value of 0.04 (99).

29. On review of the LCM2021 several amendments were made to the land use classifications. Adjustments were made to the in-channel and flood defences roughness, along with the standard roughness values. Specifically, in accordance with EA guidance, the roughness value within the model for building footprints has been increased to 0.1.

30. The material roughness across the model domain has been read into the hydraulic model using a TUFLOW standard Material.csv with Manning's n values derived from Chow[10].

[8] 2018, Environment Agency: Coastal Flood Boundary Extreme Sea Levels

[9] April 2011, Hyder/Environment Agency: Strategic Flood Risk Management Framework Tidal Nene and Tidal Welland Hazard Mapping Hydraulic Modelling Report

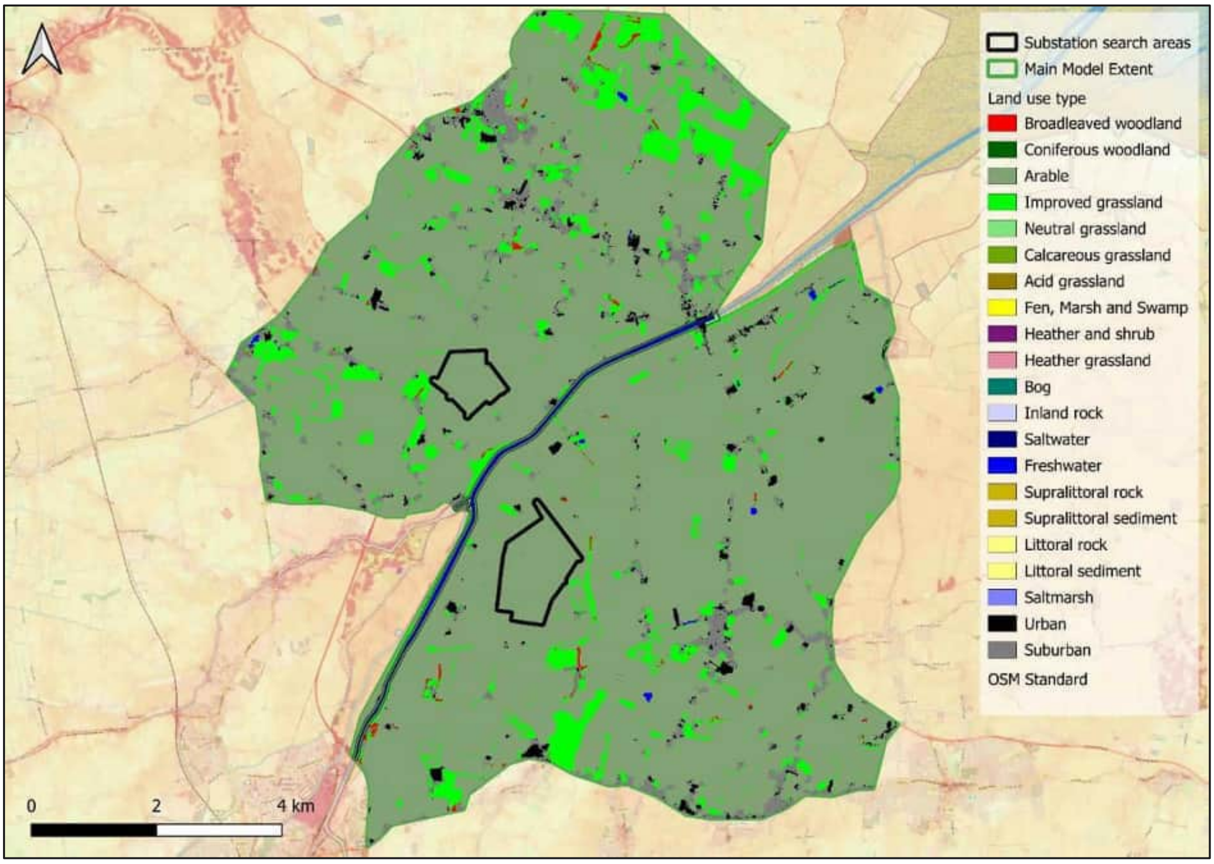
[10] Chow, V.T., (1959). Open-channel hydraulics, McGraw-Hill, New York

Table 2-2: Modelled material Properties

Material ID as referenced in GIS layer	Manning's n value	Land use type
1	0.100	Deciduous woodland
2	0.060	Coniferous woodland
3	0.035	Arable
4	0.030	Improve grassland
5	0.035	Neutral grassland
6	0.035	Calcareous grassland
7	0.030	Acid grassland
8	0.035	Fen
9	0.050	Heather
10	0.050	Heather grassland
11	0.035	Bog
12	0.040	Inland rock
13	0.025	Saltwater
14	0.025	Freshwater
15	0.040	Supralittoral rock
16	0.040	Supralittoral sediment
17	0.050	Littoral rock
18	0.040	Littoral sediment
19	0.035	Saltmarsh
20	0.100	Urban
21	0.060	Suburban
22	0.100	Buildings
99	0.040	Default value

31. Figure 2-5 below shows the applied Manning’s n roughness values applied to varying land uses within the model.

Figure 2-5 Hydraulic Model Material Roughness



2.8 Software Version

32. In line with best practice, the TUFLOW model was constructed using the latest commercially available software version at project outset: TUFLOW HPC 2023-03-AB (single precision).

2.9 Modelling Parameters

33. The underlying 2D digital terrain model (DTM) was generated using the base 1m LiDAR grid described in Section 2.2. Sub-grid sampling (SGS) testing was undertaken during the initial model build. It was decided to continue using HPC with SGS functionality in 10m grid cell size.

34. All modelled scenarios have been simulated for 36 hours to allow for the inflow boundaries to peak across the model domain. The computational timesteps used by HPC are adaptive over the course of the simulation, with 2D time-varying outputs generated every 15 minutes.

2.10 Model Operation

35. The hydraulic model was simulated using the HPC Solver for TUFLOW build 2023-03-AB single precision (iSP). Initialisation of the TUFLOW model utilised a standard Windows Batch file linking the TUFLOW executable, TUFLOW control file (.tcf) and relevant event and scenario logic, as defined in Table 2-3 below.

Table 2-3: Model Scenario Definitions

Run Reference:	ODO_~e1~_~s1~_~s2~_~s3~_021.tcf	
Scenario Description (-s1)	10m (10m cell size)	
Scenario Description (-s2)	OVP - Overtopping NB1 - North Side Breach 1 NB2 - North Side Breach 2	
Scenario Description (-s3)	EXG (Existing/baseline) PRO (Proposed)	
Return Periods (-e1)	0200R 0200R_CC 1000R 1000R_CC	0.5% AEP 0.5% AEP + Climate Change 0.1% AEP 0.1% AEP + Climate Change

36. All simulations were executed using a Windows batch file (.bat). Batch files are text files which contain a series of commands and allow for a large degree of flexibility in starting TUFLOW simulations. Due to the number of variables being modelled, event and scenario management wildcards (e.g., ~s1~, ~e1~) were utilised within the batch file to easily run simulations in series or concurrently.

37. An example batch file configuration for the Baseline runs is given below:

```
set TUFLOWEXEiSP="H:\TUFLOW\Releases\2023-XX\2023-03-AB\TUFLOW_iSP_w64.exe"
set RUN=start "TUFLOW" /wait "%TUFLOWEXEiSP%" -b

set "EValues=0200R 0200R_CC 1000R 1000R_CC"
set "SValues=OVP NB1 NB2 STH"
set "MValues=EXG PRO"

for %%m in (%MValues%) do (
    for %%s in (%SValues%) do (
        for %%e in (%EValues%) do (
            echo Running command with S3=%%m S2=%%s E=%%e
            %RUN% -e1 %%e -s1 10m -s2 %%s -s3 %%m ODO_~e1~_~s1~_~s2~_~s3~_020.tcf
            Powershell.exe Move-Item -Force -Path %Output% -Destination %Destination%
        )
    )
)
```

3.0 Model Results

38. Maximum flood extents and depths, maximum velocities, and hazard rating results for the areas on and surrounding the site are presented in Figure 3-1 through to Figure 3-9 below. Appendix A also contains depth difference outputs of the proposed and baseline model scenarios for better representation of flood extents and changes after construction of the OnSS.

3.1 Scenarios and Events

39. The peak flood extents of the overtopping model do not reach the OnSS site, even during the most extreme event (0.1% AEP + Climate change).

40. The peak flood extents for both breach flood events under baseline conditions show significant flooding in the site area, which is summarized in Tables 3.1 and 3.2 below. The A16 road plays a significant role in controlling flood depths around the Project site area, acting as an obstruction to flow, holding water between the river and the road. The peak flood extents for baseline conditions under all scenarios for the largest event (0.1% AEP + Climate change) are shown in Figure 3-1 to Figure 3-3.

41. Under the proposed conditions, the OnSS remains free from flooding for both breach 1 and 2 in any event. The peak flood extents for the proposed condition for the 0.1% AEP + climate change event for breach 1 & 2, the flood depth difference between baseline and proposed conditions and hazard class changes, are presented in Figure 3-4- to Figure 3-9, with peak flood levels and depths on-site provided in Table 3-1 and Table 3-2 below.

Table 3-1: Peak Water Levels across the Site

Maximum Flood Levels (m AOD)	Overtopping	Breach 1	Breach 2
1:200 (0.5% AEP)	-	3.972	3.940
1:200 (0.5% AEP) + CC	-	3.999	3.991
1:1000 (0.1% AEP)	-	4.019	4.024
1:1000 (0.1% AEP) + CC	-	4.082	4.093

Table 3-2: Peak Water Depths across the Site

Maximum Flood Depths (m)	Overtopping	Breach 1	Breach 2
1:200 (0.5% AEP)	-	0.572	0.547
1:200 (0.5% AEP) + CC	-	0.601	0.591
1:1000 (0.1% AEP)	-	0.621	0.623
1:1000 (0.1% AEP) + CC	-	0.688	0.690

Figure 3-1 Maximum Flood Depths Baseline Overtopping 0.1% AEP+CC

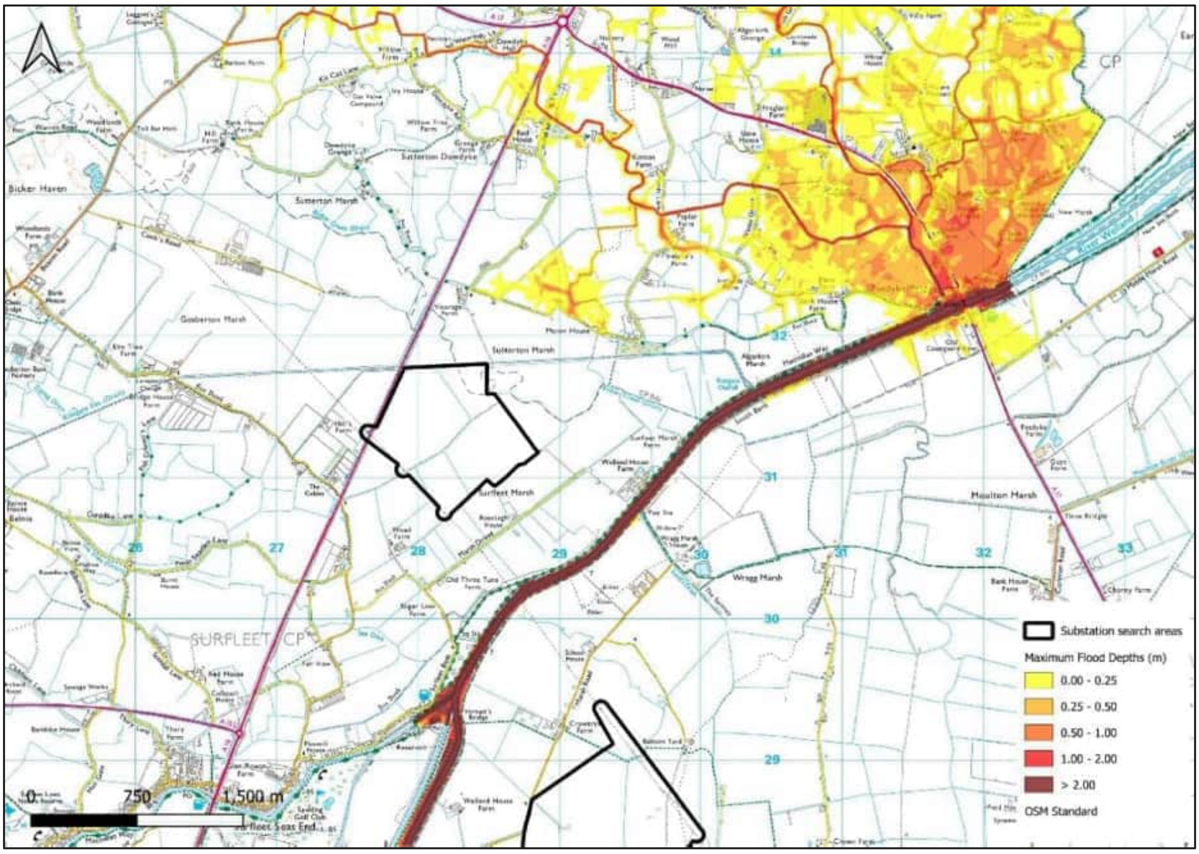


Figure 3-2 Maximum Flood Depths Baseline Breach 1 - 0.1% AEP+CC

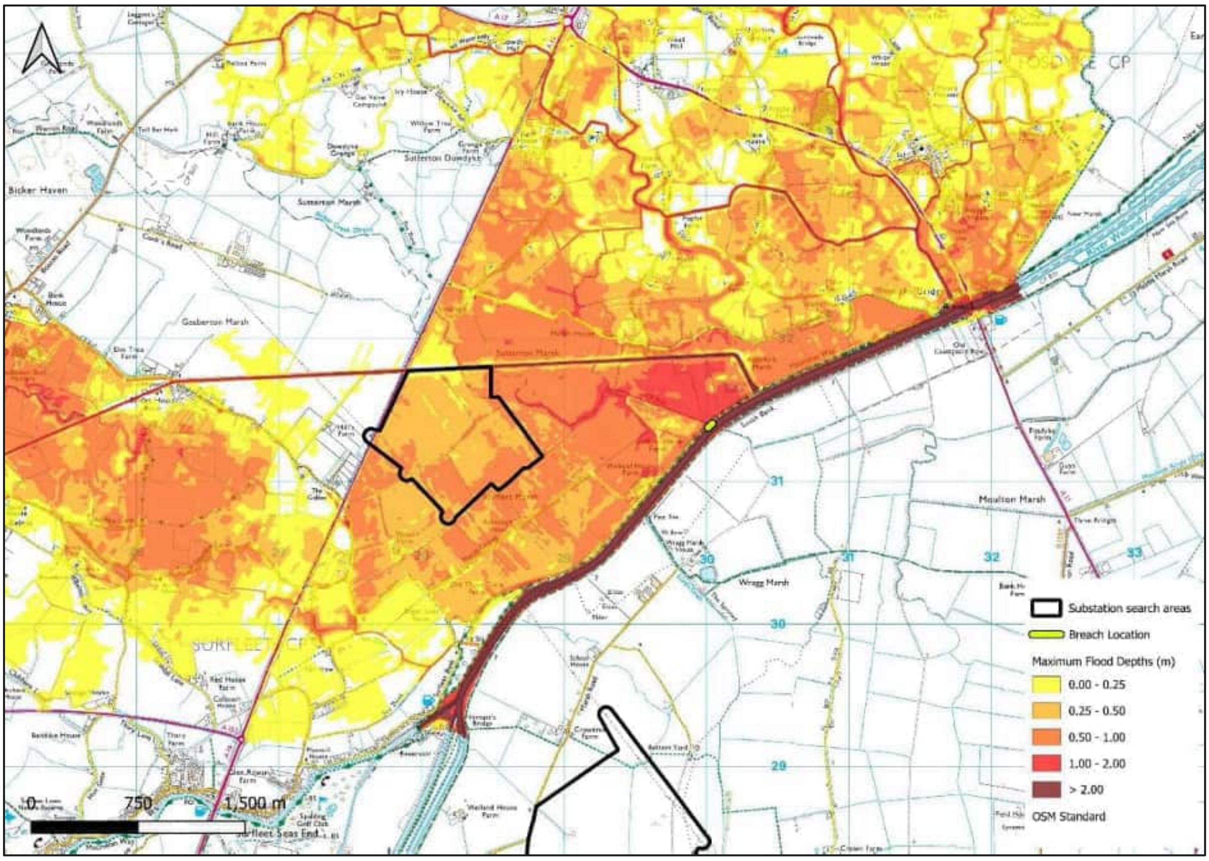


Figure 3-3 Maximum Flood Depths Baseline Breach 2 - 0.1% AEP+CC

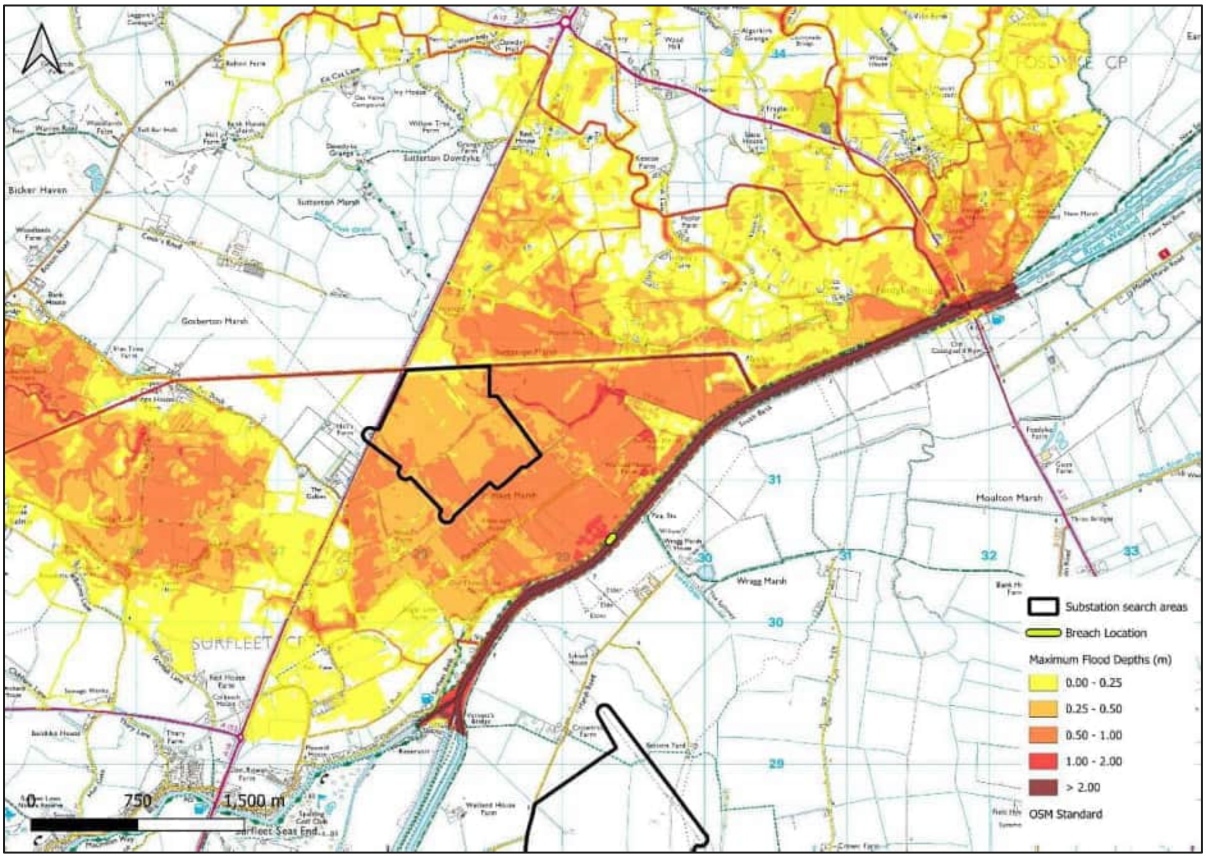


Figure 3-4 Maximum Flood Depths Proposed Breach 1 - 0.1% AEP+CC

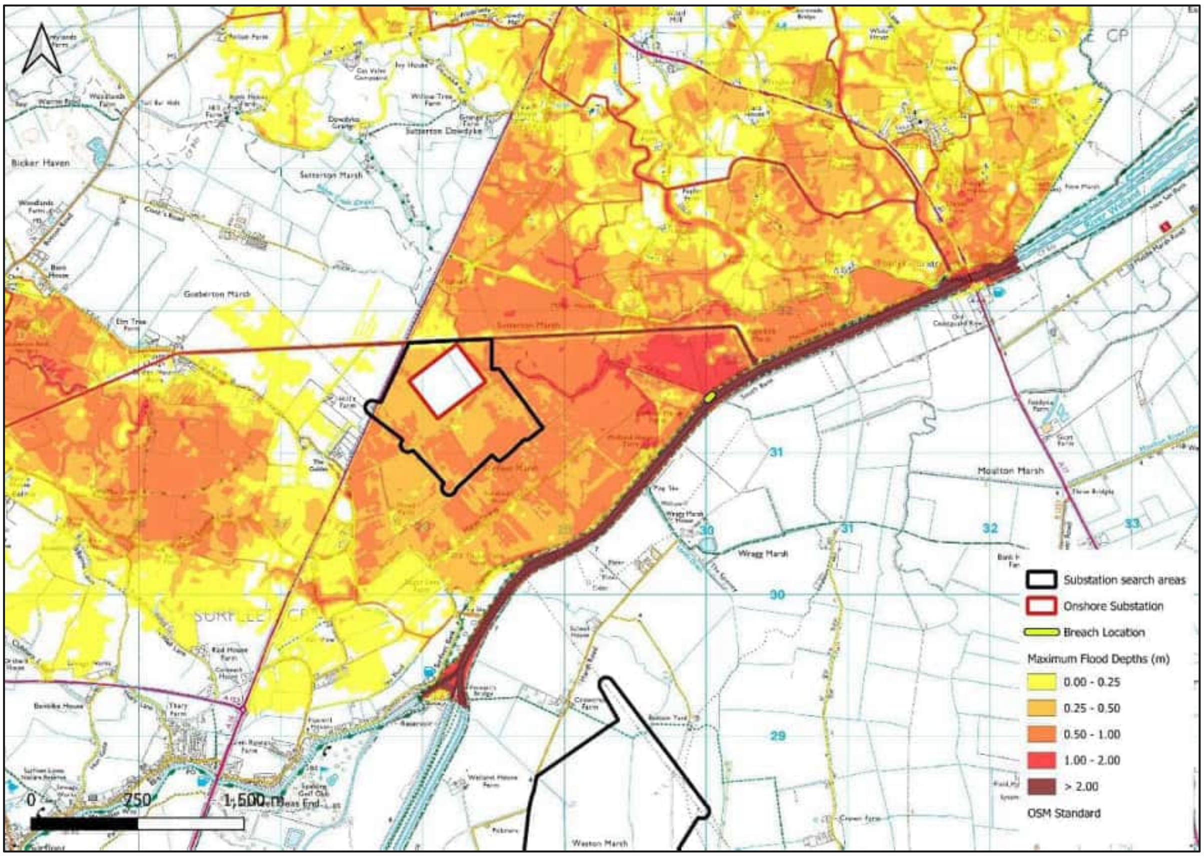


Figure 3-5 Flood Depth Difference Breach 1 - 0.1% AEP+CC

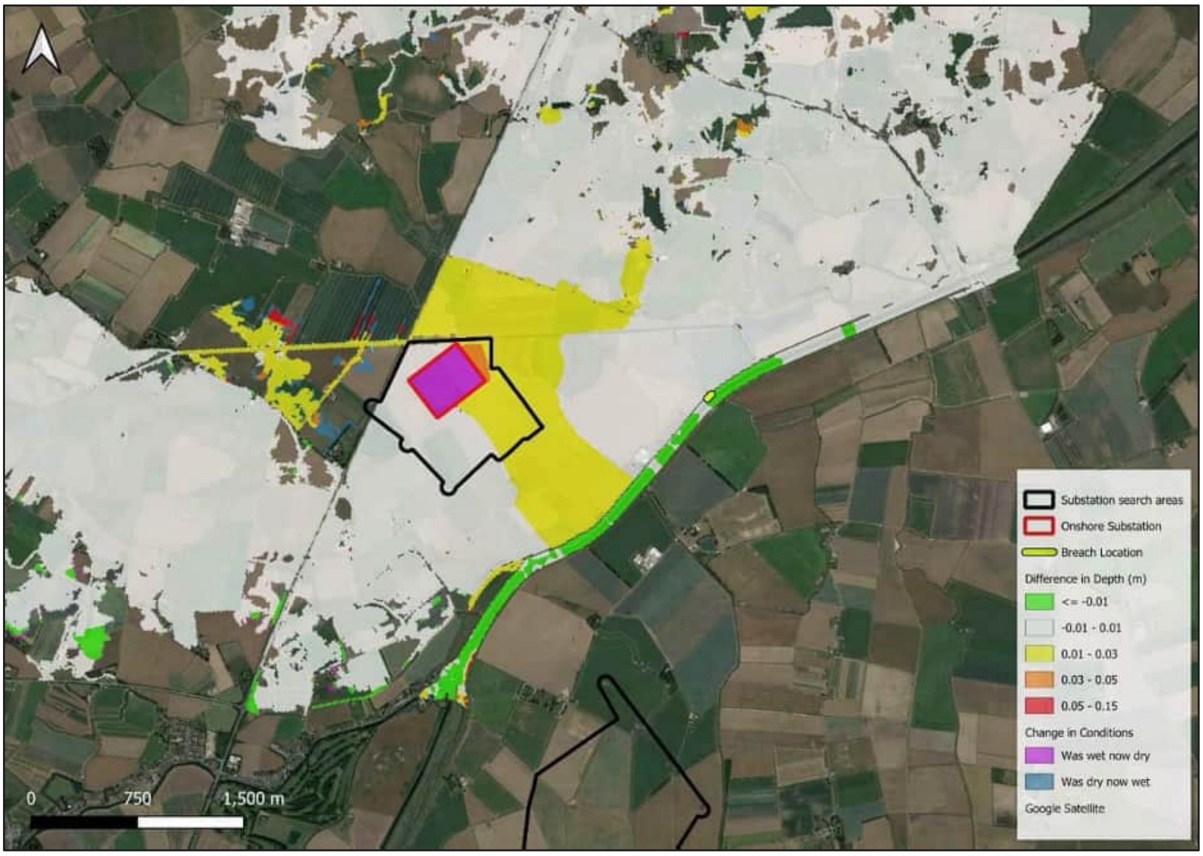


Figure 3-6 Hazard Class Changes Breach 1 - 0.1% AEP+CC

Figure 3-7 Maximum Flood Depths Proposed Breach 2 - 0.1% AEP+CC

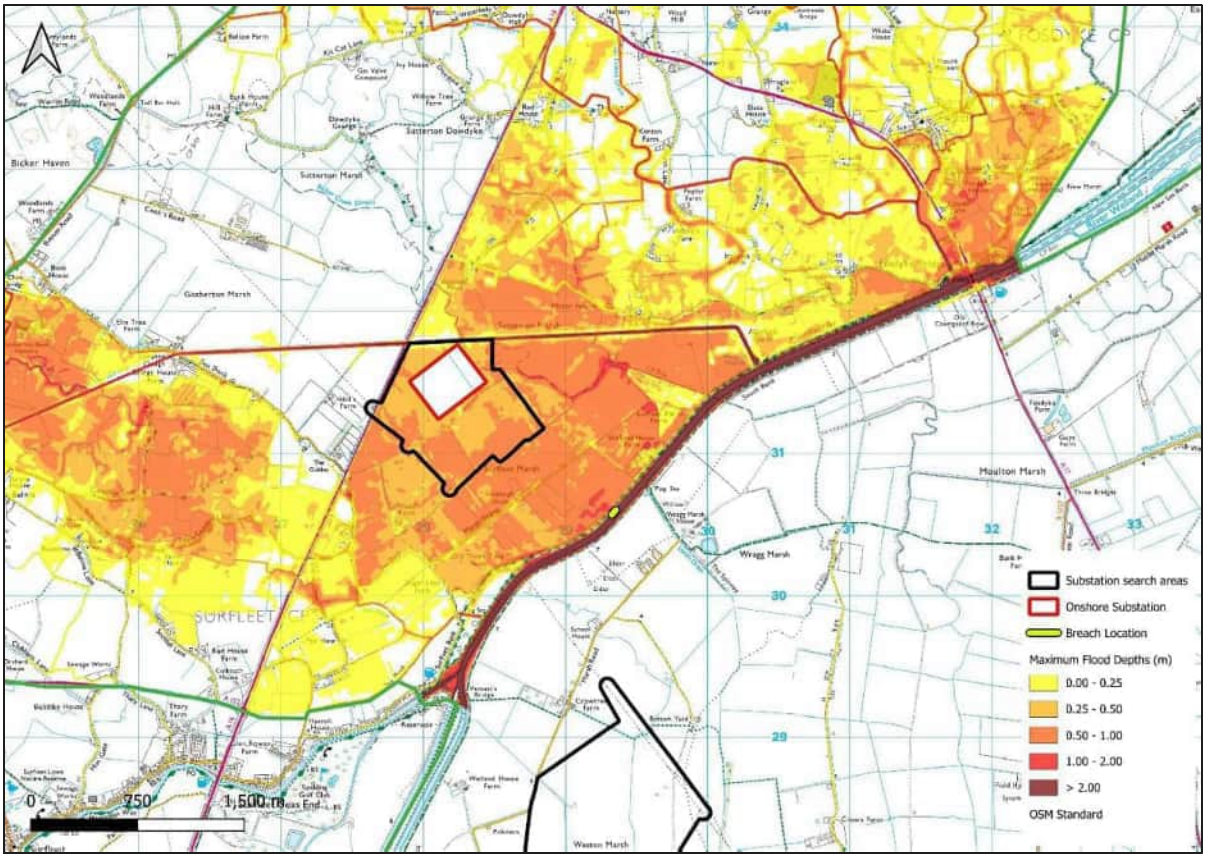


Figure 3-8 Flood Depth Difference Breach 2 - 0.1% AEP+CC

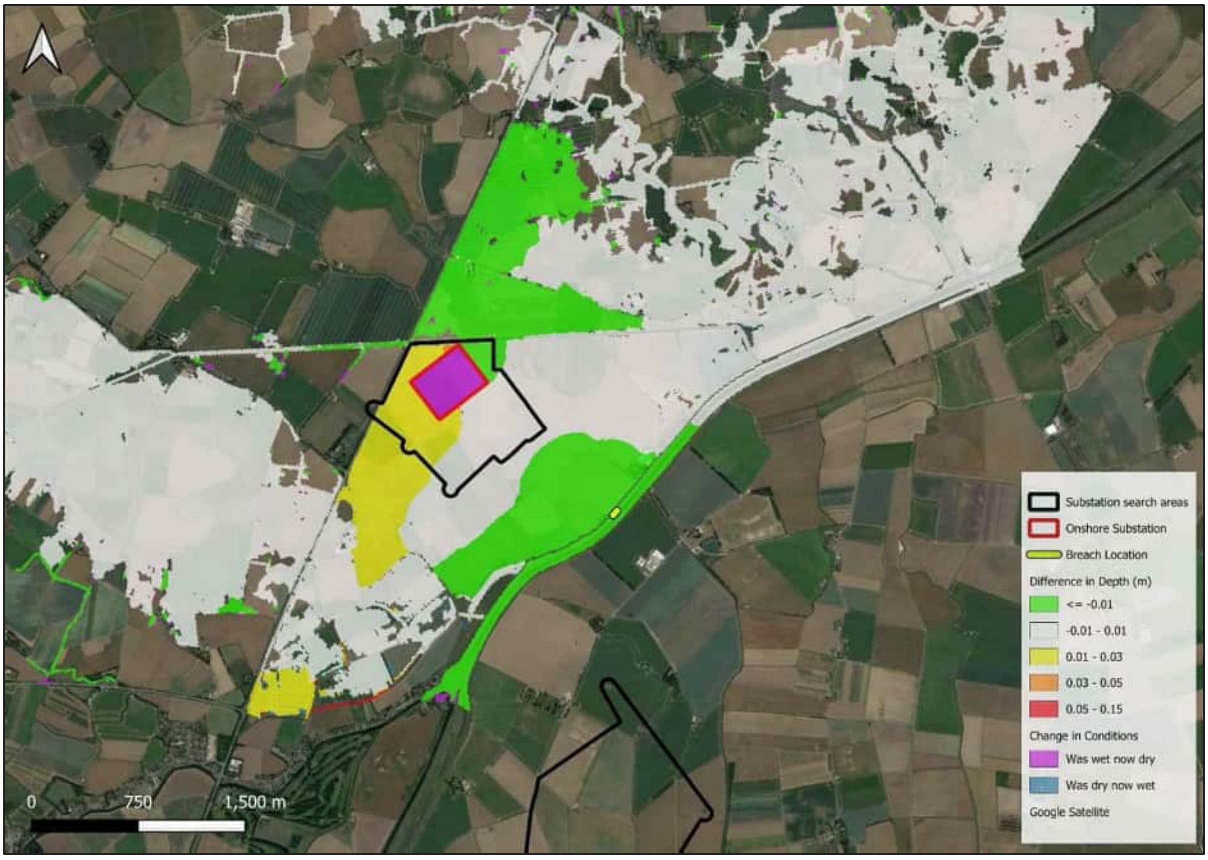


Figure 3-9 Hazard Class Changes Breach 2 - 0.1% AEP+CC

3.2 Quality Assurance

42. This section outlines the Quality Assurance (QA) measures undertaken in developing the River Welland hydraulic model.

43. Part of the general model QA process involves reviewing the TUFLOW messages generated during the model compilation stage and resolving any issues. Warnings produced by TUFLOW during the run are also investigated. Locations causing recurring warnings were identified and a solution implemented to reduce or remove the source of the issue. Model logs have also been utilised to record the key decisions made when developing the model, allowing for traceability and aid in the transfer of the models between different users. The main components of the River Welland model build, configuration and application were recorded and have been reviewed and signed-off by a senior hydraulic modeller.

44. Further QA over the course of the model build was undertaken, including:

- Material roughness was checked by importing and thematically mapping the grd_check file to ensure surface resistance was applied correctly with respect to aerial images.
- The extent of the 2D domain was reviewed to ensure it was not limiting flood extents in the larger flood events within the area of interest.
- Minimum dT values across the 2D domain were reviewed to highlight any troublesome areas that were slowing down overall run time; and
- Flow rates within the river channel were reviewed to check for high velocities and potential instabilities.

3.3 Model Stability

45. The model has been reviewed and found to be generally stable and appropriate for its intended use. TUFLOW HPC is inherently stable by nature of the adaptive time-stepping, with low time-steps (dT) typically occurring along or near the 2D HT boundary where high velocities are passing through 2D cells. Many check messages (CHECK 3505 - SGS TIN outside model domain) occur in breach scenario runs due to buildings' footprints being raised by using a single layer for both overtopping and breach scenarios. This discrepancy arises from the use of different model domains for overtopping and breach scenarios.

3.4 Model Limitations

46. This model has been developed to take advantage of the most accurate available data to help inform flood risk at the site. There are however several limitations to the hydraulic model worth noting:

- The downstream tidal hydrograph that is based on the original coastal model produced by Mott MacDonald[11] only has a relatively small number of data points per tide cycle, resulting in a sparsely defined curve. This may mean that the full complexity of the tidal hydrograph may not be reproduced in the model.
- The breach base levels were determined solely on ground profiles on a hypothetical basis, which is likely to provide conservative results; no consideration was given to the structural integrity and probability of failure of the defences and embankments.
- The fluvial inflows have not been considered in this study.

[11] April 2011, Hyder/Environment Agency: Strategic Flood Risk Management Framework Tidal Nene and Tidal Welland Hazard Mapping Hydraulic Modelling Report

4.0 Sensitivity Analysis

47. Sensitivity analysis is the study of how the variation in the output of the model (depth) can be apportioned, qualitatively or quantitatively, to difference changes in the model inputs (model variables, boundary conditions and parameters). Appendix B contains plans of select sensitivity results.

48. Sensitivity analysis is used to identify:

- The factors that potentially have the most influence on the model outputs.
- The factors that need further investigation to improve confidence in the model; and
- Regions in space where the variation in the model output is greatest.

49. In line with good practice, the following parameters, and variables for the hydraulic model have been varied in accordance with the % uplift / parameter change specified below:

Table 4-1: Sensitivity Analysis Variables

Parameter	Value change
Model Cell Size	14m and 6m
Channel and floodplain roughness	± 20 %
Model Inflows	H++ CC on the 0.1% and 0.5% AEP

4.1 Model Cell Size

50. The initial run was conducted with a 10m cell size. Subsequent sensitivity tests were carried out with 14m and 6m cell sizes. Interestingly, the 6m run exhibited striking similarities to the 10m model, suggesting a robust representation of the floodplain. However, the 14m run showed more significant flooding, presumably the 14m resolution have resulted in a more simplified DTM which ignores smaller changes in topography. As an example, it did not accurately capture the flood defences and the A16 road as well as the 6m or 10m grids. These findings indicate that the 10m cell size strikes a balance, effectively capturing important features in the floodplain while reducing the model run time without compromising result quality. Peak depth results for 14m and 6m can be seen in Appendix B.

4.2 Channel and Floodplain Roughness

51. A universal separate increase and decrease of 20% to the Manning's roughness values was applied across the entirety of the model domain. Generally, the model results demonstrated little difference in the extents of the flooding resulting from these changes. This is due to the generally even nature of the topography.

52. Within key areas inside the site boundary, peak differences in the order of ±0.01m between each roughness scenario can be observed. As such the hydraulic model is not seen as particularly sensitive to changes in Manning's roughness.

4.3 Model Inflows

53. The H++ Climate Change Allowance is a scenario in which sea levels are projected to rise significantly due to climate change. The "H++" terminology is often used in climate change assessments to represent a high-end or extreme sea-level rise scenario. This

means that a substantial increase in sea levels, which may be driven by factors such as the melting of terrestrial ice masses and thermal expansion of seawater due to global warming, is given consideration.

54. Environment Agency guidance[12] states that tidal H++ runs should apply an increase of 1.9m for total sea level rise to the year 2100. In this case, the sensitivity check is aimed at understanding how the tidal model responds to changes in sea level driven by the H++ climate change allowance. Results for the overtopping and the two north breach scenarios, for the 0.1% and 0.5% with H++ climate change allowance events, can be seen in Appendix B.

[12] Flood risk assessments: climate change allowances https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances#H-plus-plus

5.0 Conclusion and Recommendations

55. SLR Consulting Limited was appointed by GoBe Consultants to prepare a hydraulic model to quantify the flood risk to the site using the latest available information. The detailed hydraulic modelling has confirmed that there is no risk of overtopping conditions. Still, there is a reasonable estimate of flood risk in the event of flood defence failures on or around the site.

56. The maximum water level within the proposed substation area reaches up to 4.093 mAOD with the north breach 2 scenario for 0.1% AEP + climate change event. The modelled development platform remains dry for all events up to and including the maximum studied flood event.

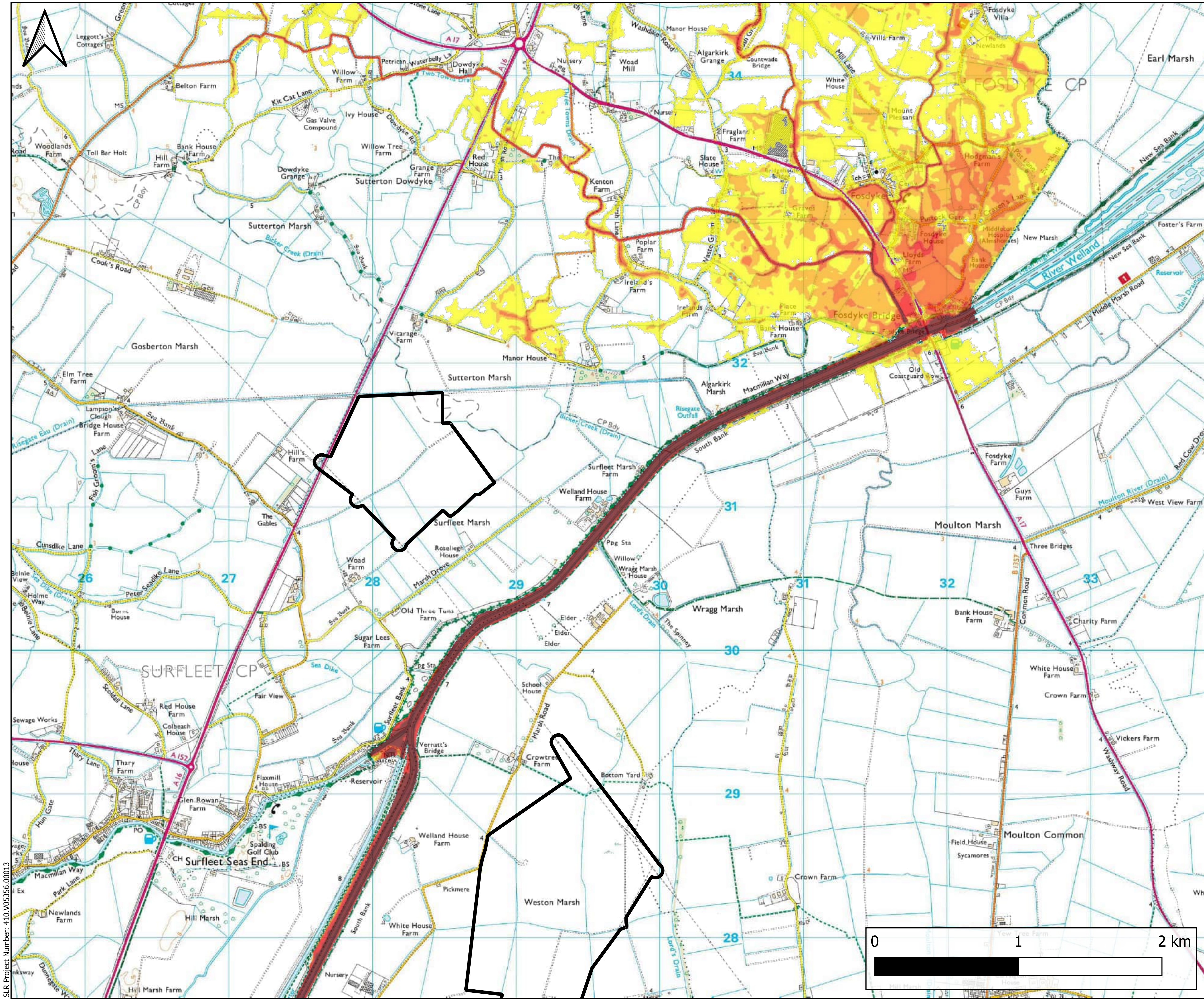
57. A 2-D TUFLOW model has been developed in order to understand the risks of flooding to the site. TUFLOW's HPC module has been used due to its performance and its ability to ensure stable model simulations through the use of adaptive time stepping.

58. Model simulations have been completed for a range of events and scenarios in order to fully assess and understand the risk of flooding to the site and local area.

59. The model has been checked via a QA process, with stability checks and sensitivity tests being completed to ensure that the model is healthy and suitable for use.

60. The model results for the proposed development scenario demonstrate that even in the event of a failure of the flood defences along the River Welland, the site will be safe, and the construction of the site will not result in a material increase to flooding elsewhere.

Appendix A Flood Maps



LEGEND

Substation Search Areas

Breach Location

Maximum Flood Depth (m)

- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 2.00
- > 2.00

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 1

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

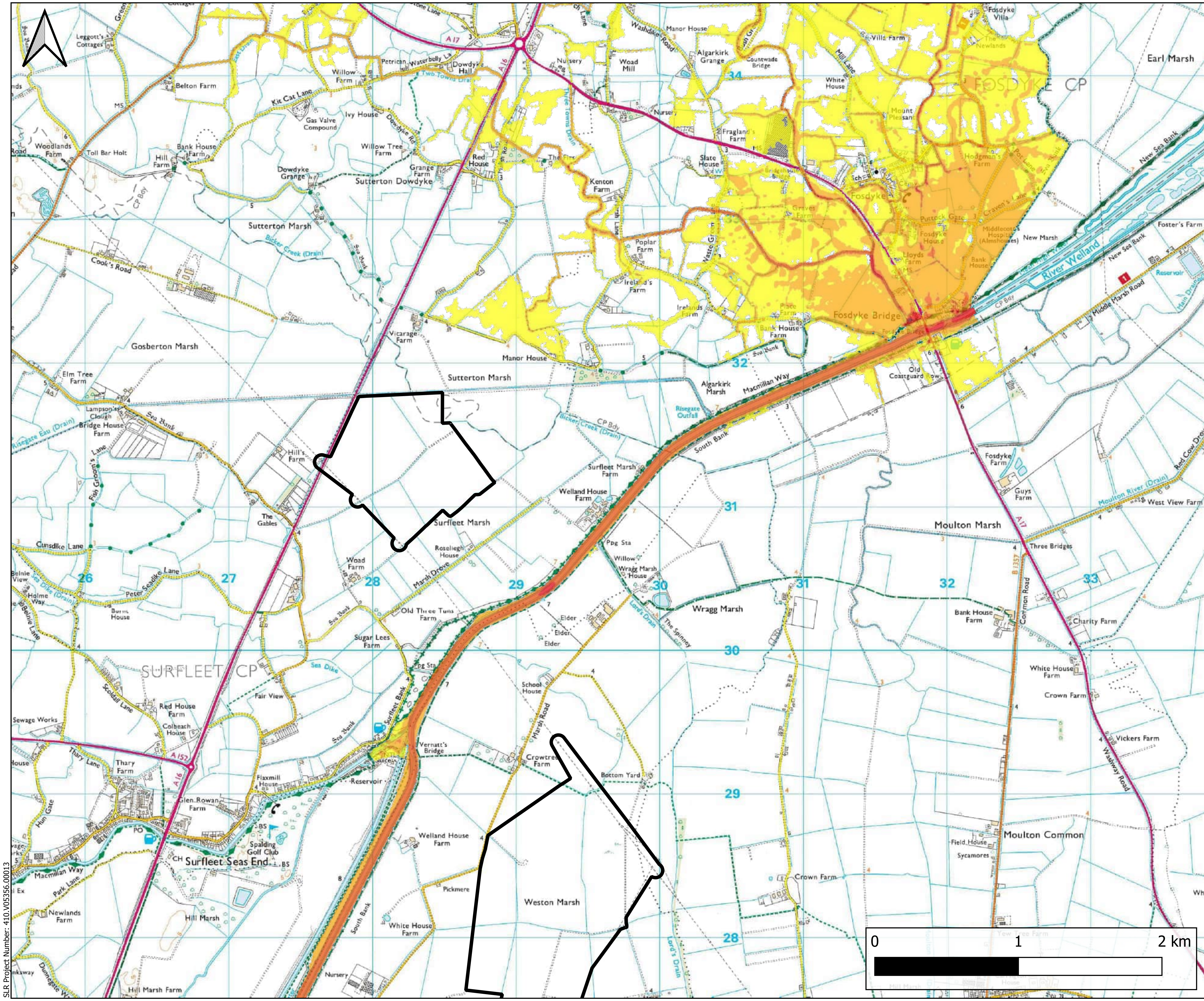
6 PRINCESS STREET
MANCHESTER
M1 6NG

www.slrconsulting.com

Maximum Flood Depths 1:1000yr+CC Overtopping Baseline Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Breach Location

Maximum Flood Velocity (m/s)

- 0.00 - 0.30
- 0.30 - 1.00
- 1.00 - 1.50
- 1.50 - 2.50
- > 2.50

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 2

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

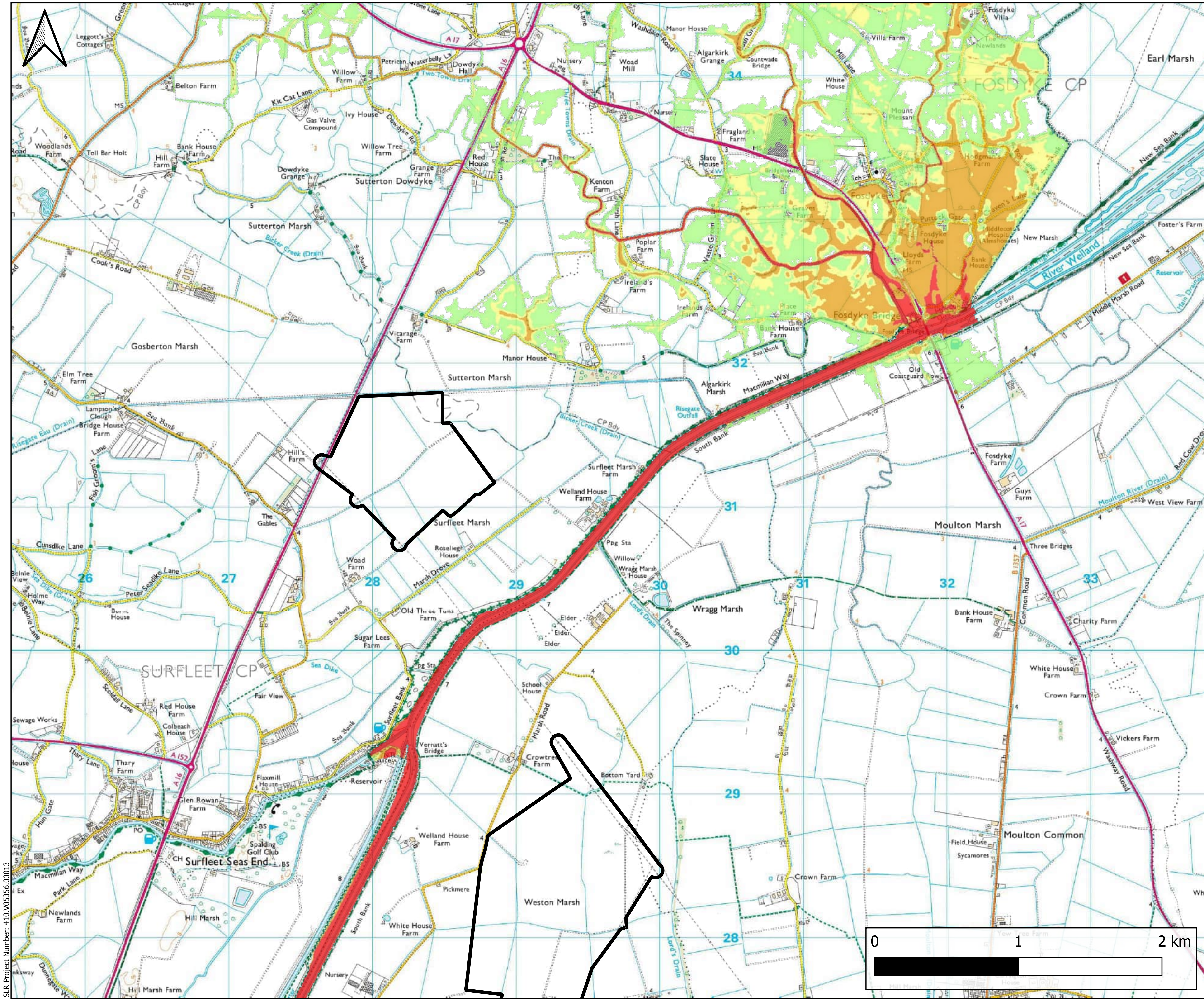
SLR

6 PRINCESS STREET
MANCHESTER
M1 6NG
www.slrconsulting.com

Maximum Flood Velocity 1:1000yr+CC Overtopping Baseline Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Breach Location

Flood Hazard Rating

- <= 0.7500
- 0.7500 - 1.2500
- 1.2500 - 2.0000
- > 2.0000

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 3

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

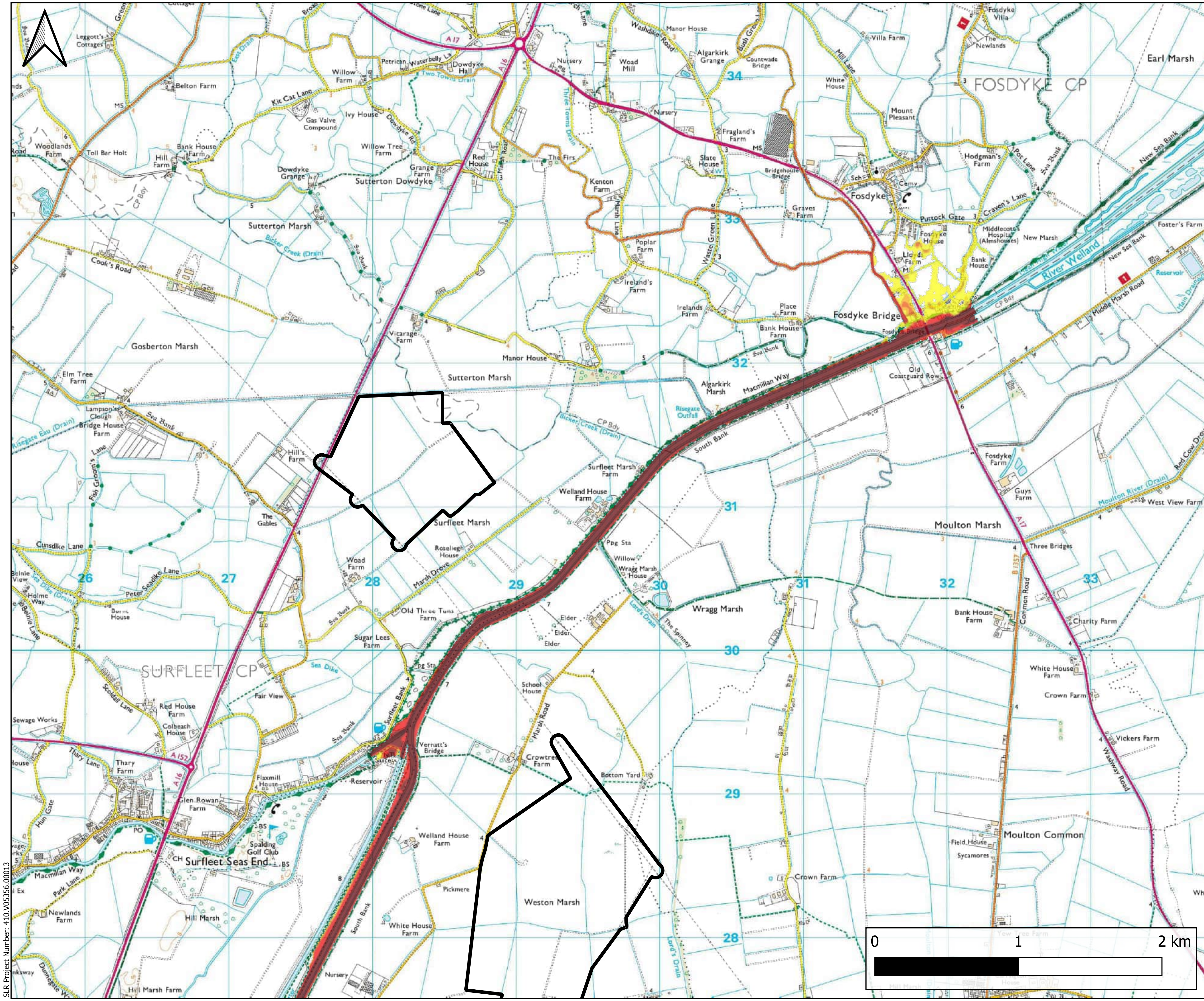
SLR

6 PRINCESS STREET
MANCHESTER
M1 6NG
www.slrconsulting.com

Maximum Flood Hazard 1:1000yr+CC Overtopping Baseline Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Breach Location

Maximum Flood Depth (m)

- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 2.00
- > 2.00

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 4

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

6 PRINCESS STREET
MANCHESTER
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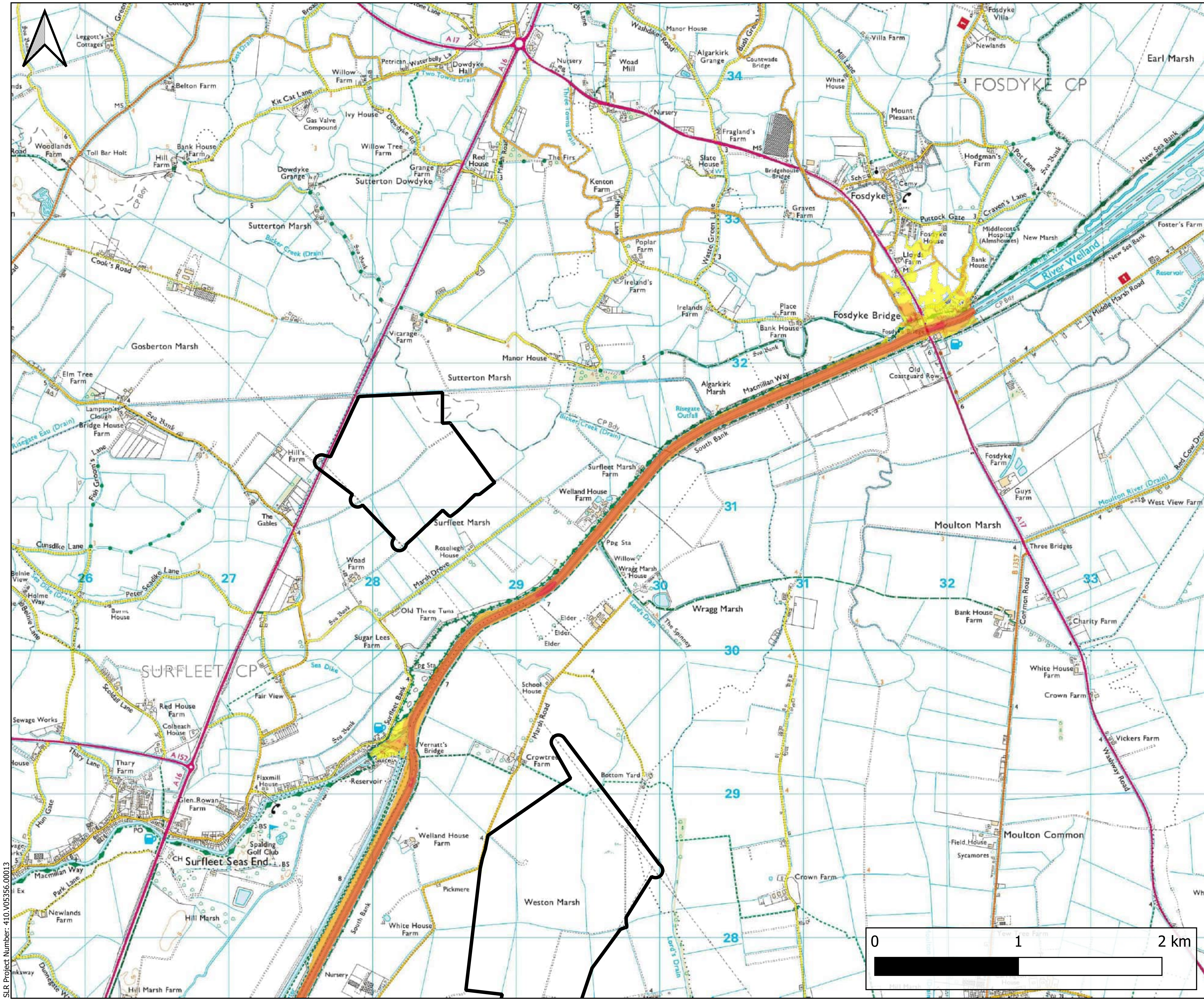
Maximum Flood Depths 1:1000yr Overtopping Baseline Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Breach Location

Maximum Flood Velocity (m/s)

- 0.00 - 0.30
- 0.30 - 1.00
- 1.00 - 1.50
- 1.50 - 2.50
- > 2.50

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 5

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

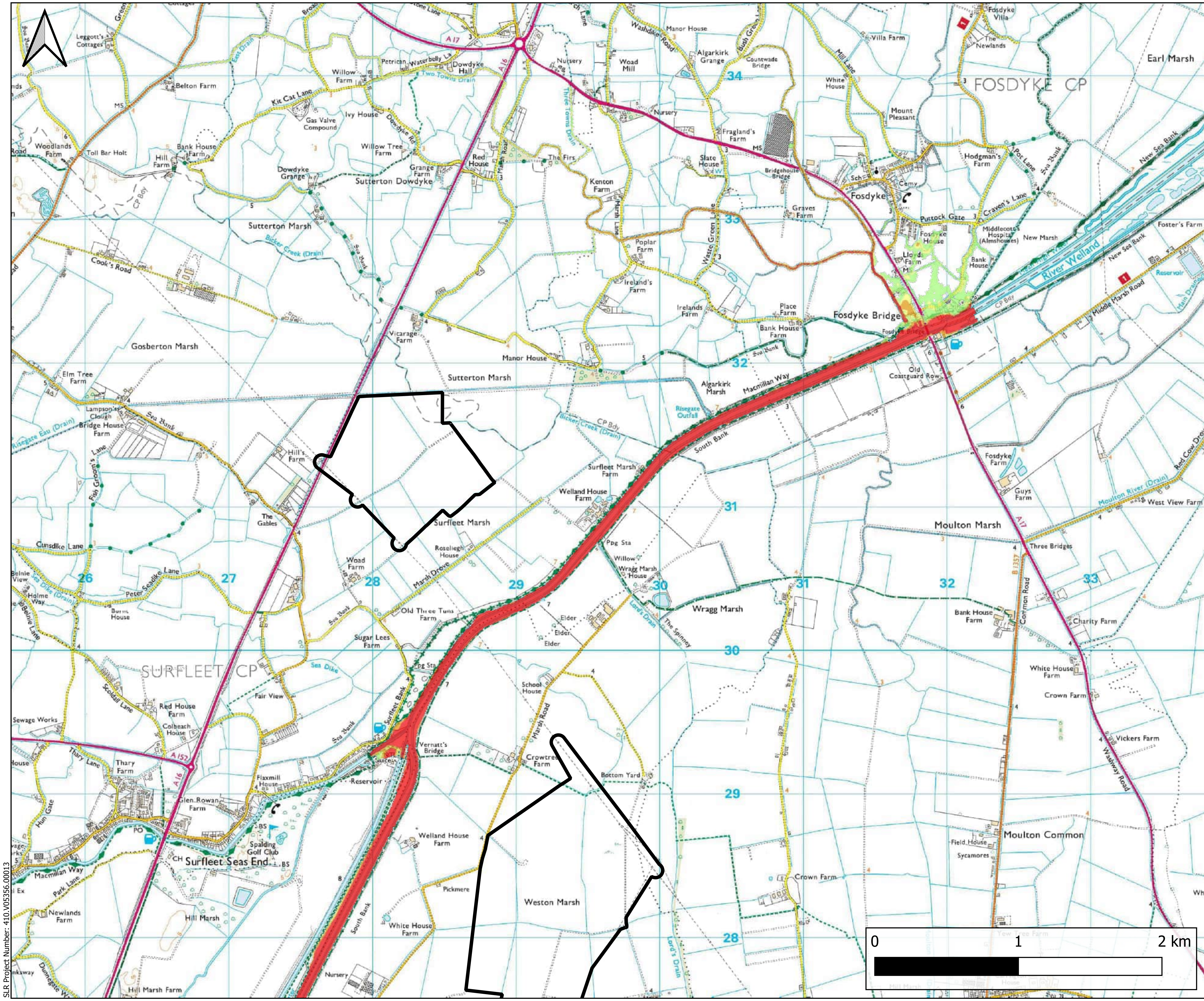
SLR

6 PRINCESS STREET
MANCHESTER
M1 6NG
www.slrconsulting.com

Maximum Flood Velocity 1:1000yr Overtopping Baseline Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Breach Location

Flood Hazard Rating

- <= 0.7500
- 0.7500 - 1.2500
- 1.2500 - 2.0000
- > 2.0000

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 6

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

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M1 6NG
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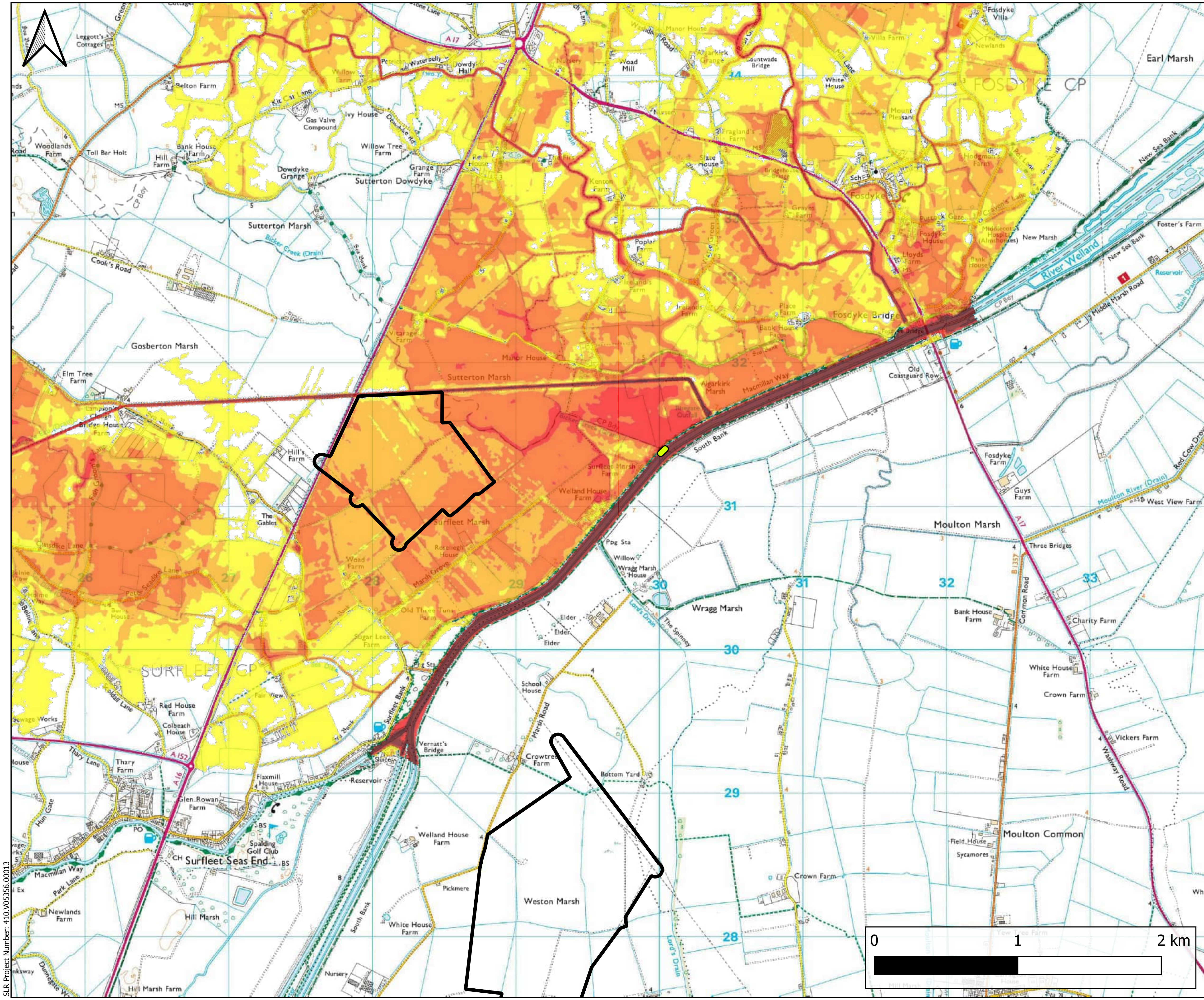
Maximum Flood Hazard 1:1000yr Overtopping Baseline Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Breach Location

Maximum Flood Depth (m)

- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 2.00
- > 2.00

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 7

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

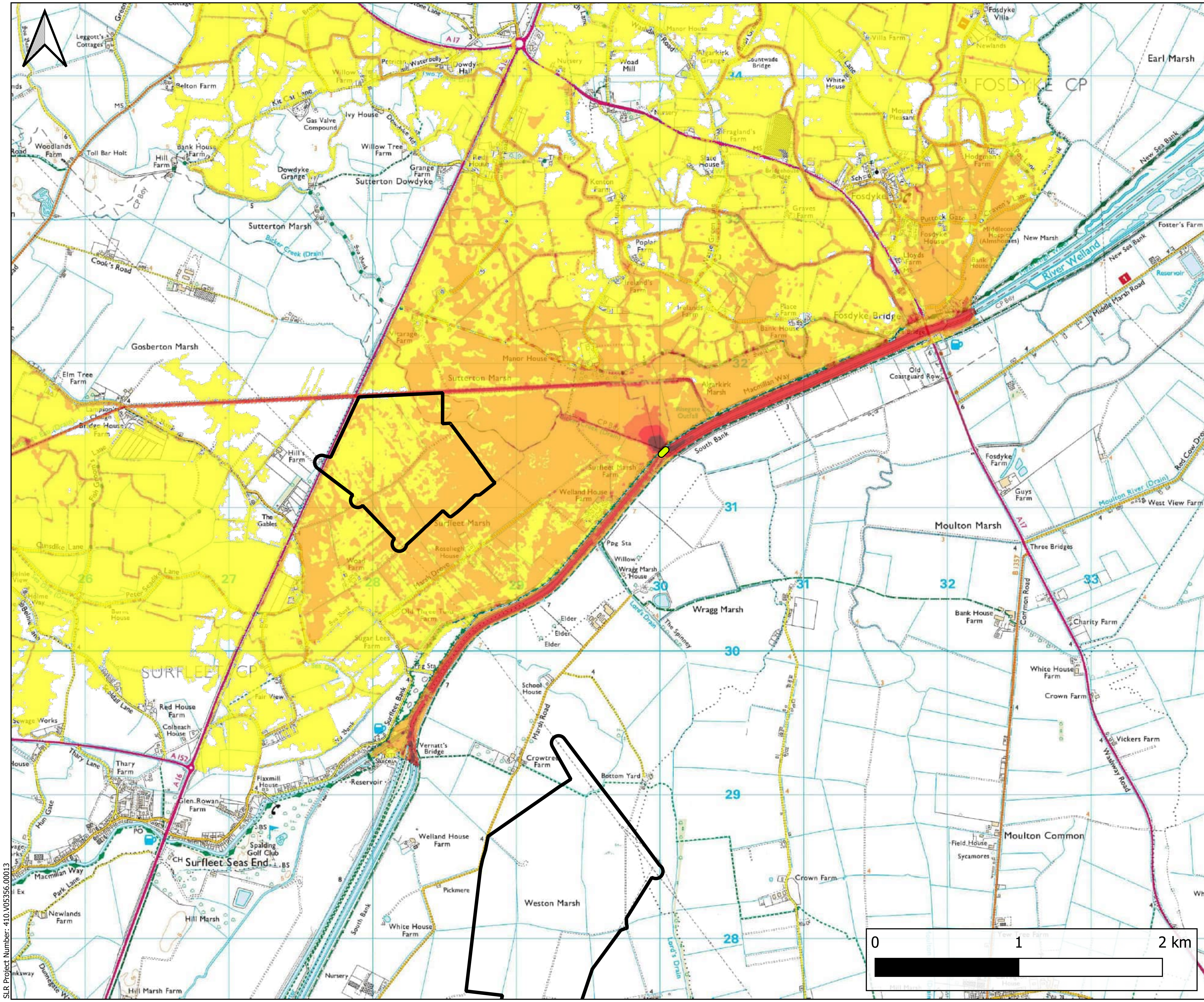
6 PRINCESS STREET
MANCHESTER
M1 6NG

www.slrconsulting.com

Maximum Flood Depths 1:1000yr+CC North Breach 1 Baseline Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Breach Location

Maximum Flood Velocity (m/s)

- 0.00 - 0.30
- 0.30 - 1.00
- 1.00 - 1.50
- 1.50 - 2.50
- > 2.50

Ordnance Survey(OS) 1:25000 Raster Basemap

0 1 2 km

Figure No. 8

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

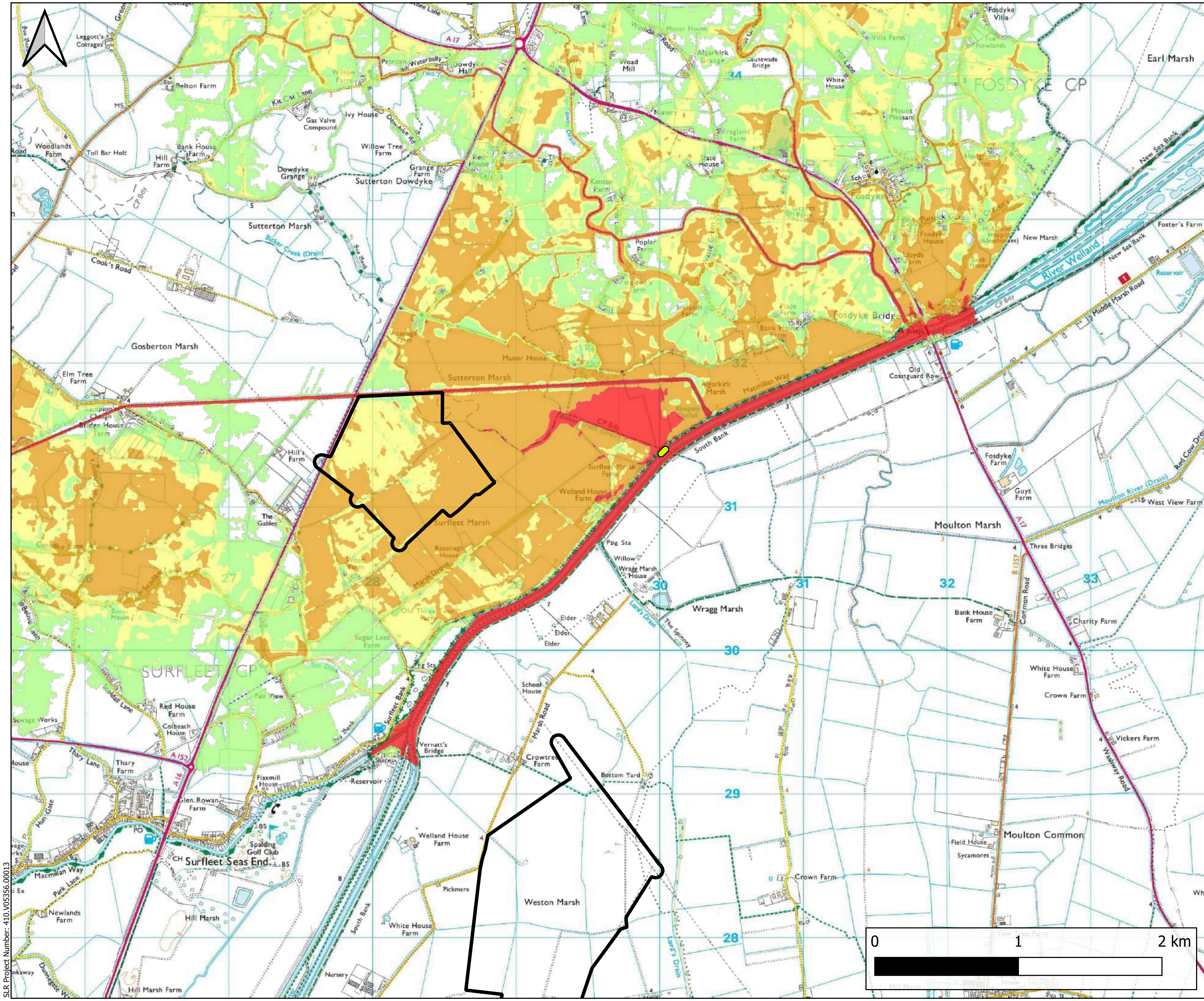
6 PRINCESS STREET
MANCHESTER
M1 6NG
www.slrconsulting.com

Maximum Flood Velocity 1:1000yr+CC North Breach 1 Baseline Scenario

Scale A3

Date November 2023

SLR Project Number: 410.V05356.00013



LEGEND

Substation Search Areas

Breach Location

Flood Hazard Rating

<= 0.7500

0.7500 - 1.2500

1.2500 - 2.0000

> 2.0000

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 9

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

6 PRINCESS STREET
MANCHESTER
M1 6NG

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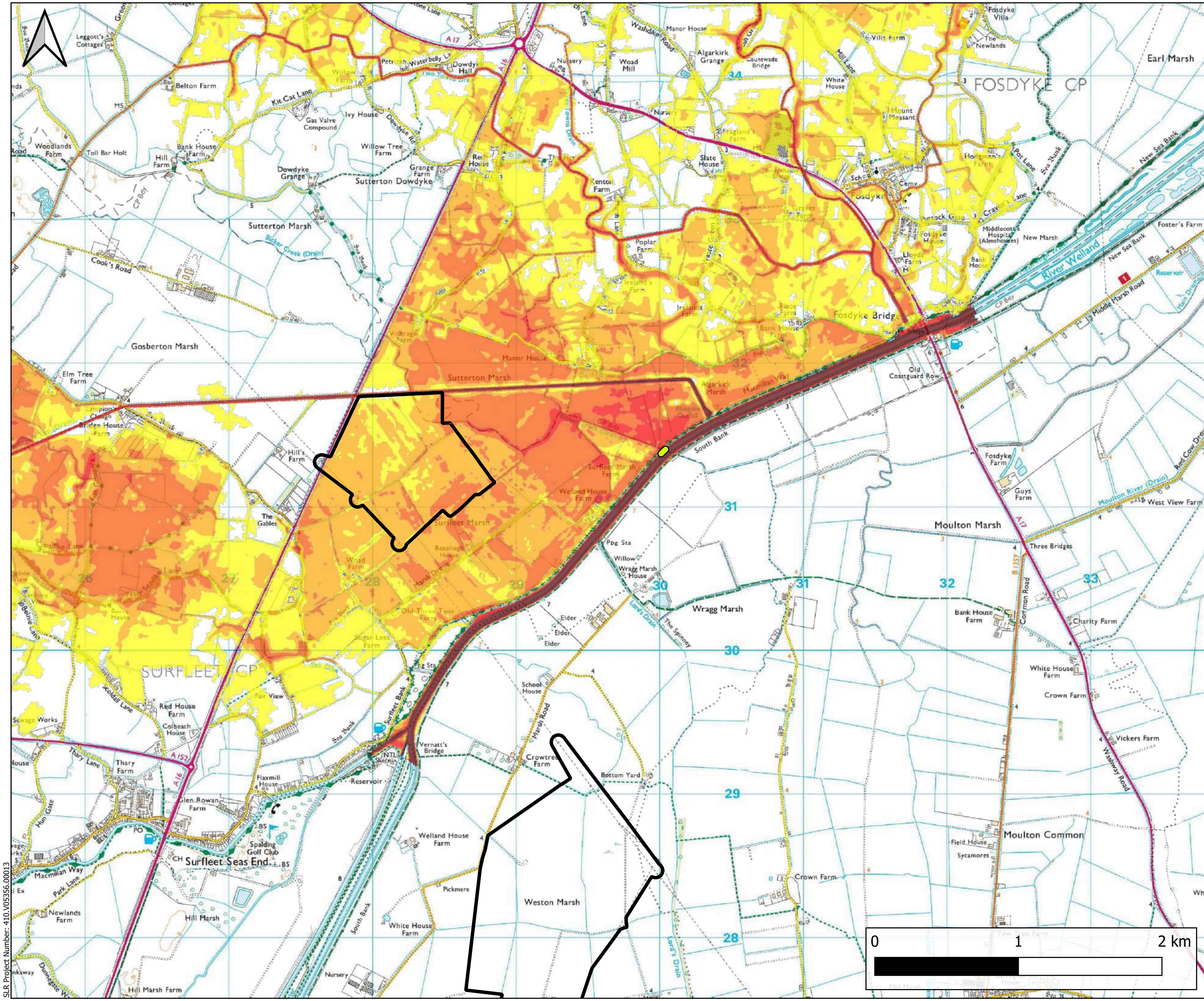
Maximum Flood Hazard 1:1000yr+CC North Breach 1 Baseline Scenario

Scale: A3

Date: November 2023

SLR Project Number: 410.V05356.00013



LEGEND

Substation Search Areas

Breach Location

Maximum Flood Depth (m)

- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 2.00
- > 2.00

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 10

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

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MANCHESTER
M1 6NG

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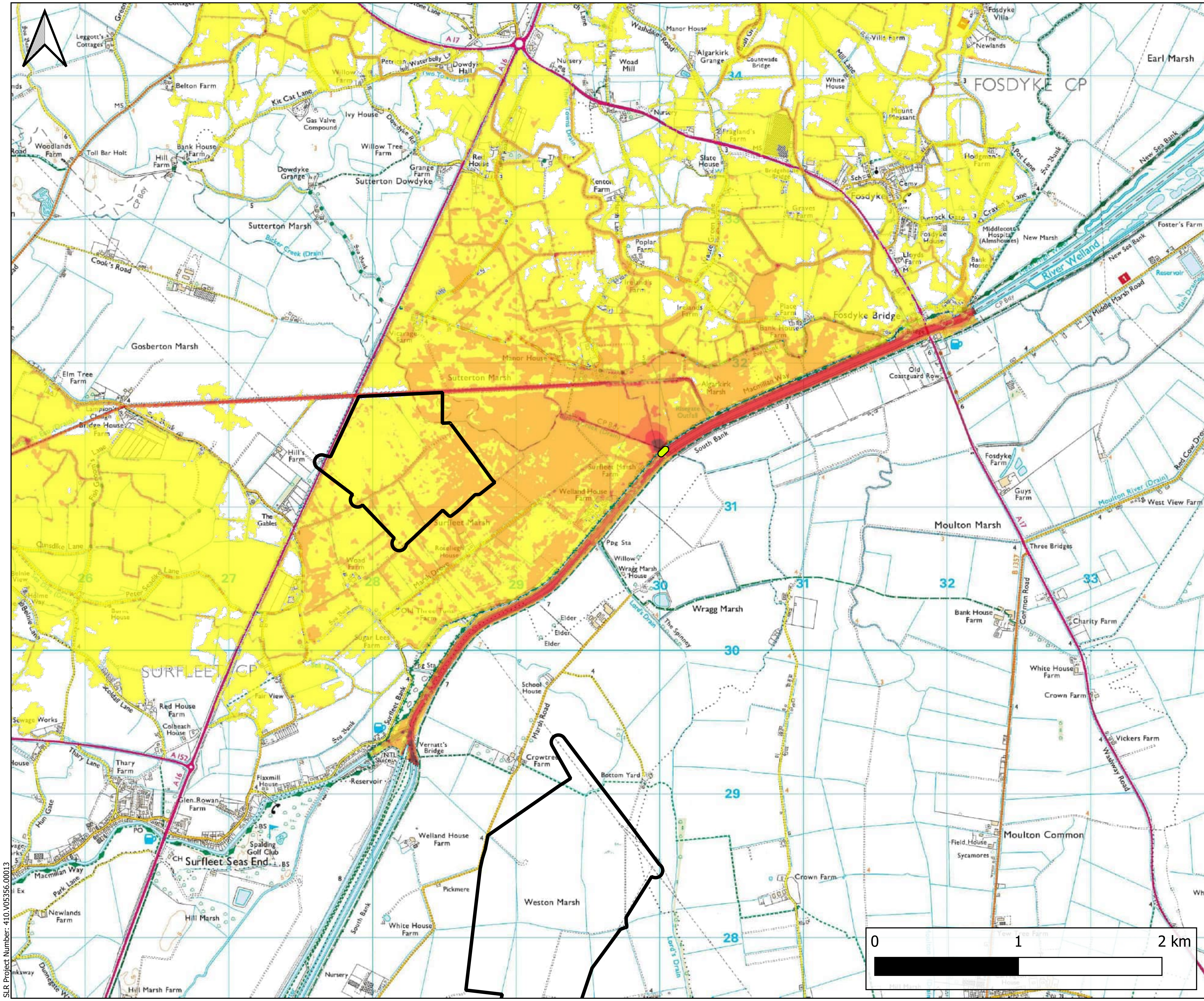
Maximum Flood Depths 1:1000yr North Breach 1 Baseline Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

Substation Search Areas

Breach Location

Maximum Flood Velocity (m/s)

- 0.00 - 0.30
- 0.30 - 1.00
- 1.00 - 1.50
- 1.50 - 2.50
- > 2.50

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 11

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

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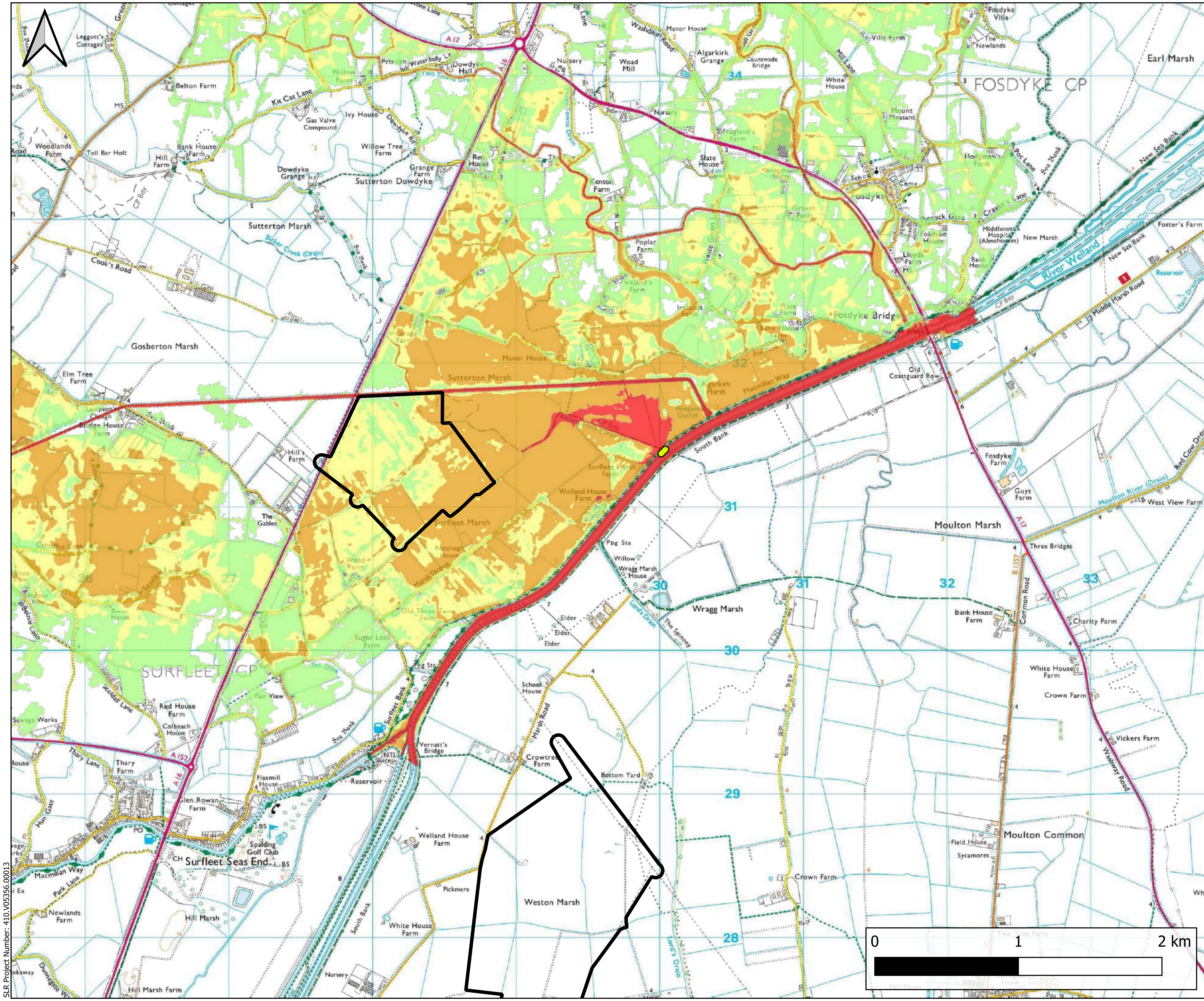
Maximum Flood Velocity 1:1000yr North Breach 1 Baseline Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

Substation Search Areas

Breach Location

Flood Hazard Rating

- <= 0.7500
- 0.7500 - 1.2500
- 1.2500 - 2.0000
- > 2.0000

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 12

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

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MANCHESTER
M1 6NG

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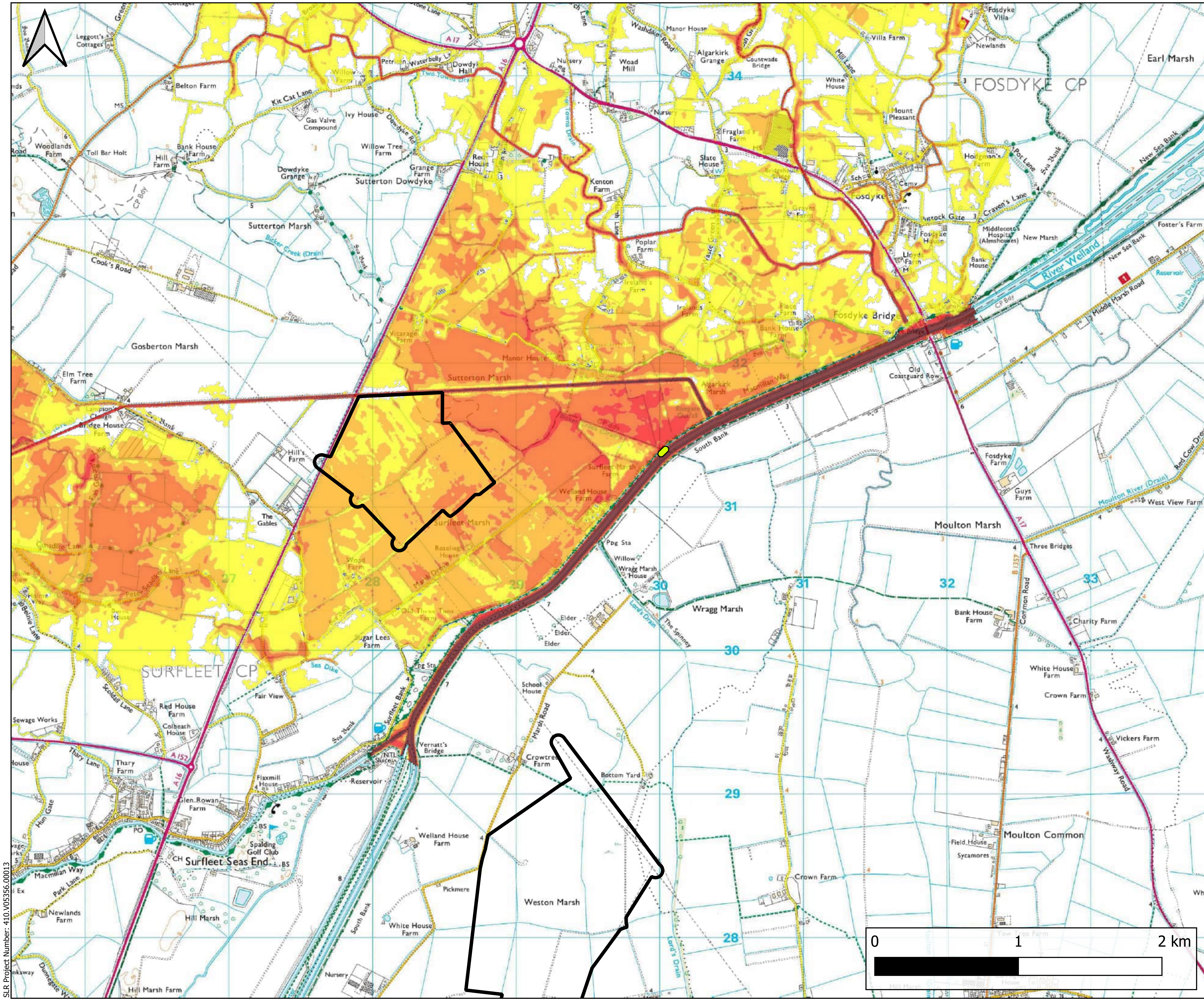
Maximum Flood Hazard 1:1000yr North Breach 1 Baseline Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

Substation Search Areas

Breach Location

Maximum Flood Depth (m)

- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 2.00
- > 2.00

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 13

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

6 PRINCESS STREET
MANCHESTER
M1 6NG
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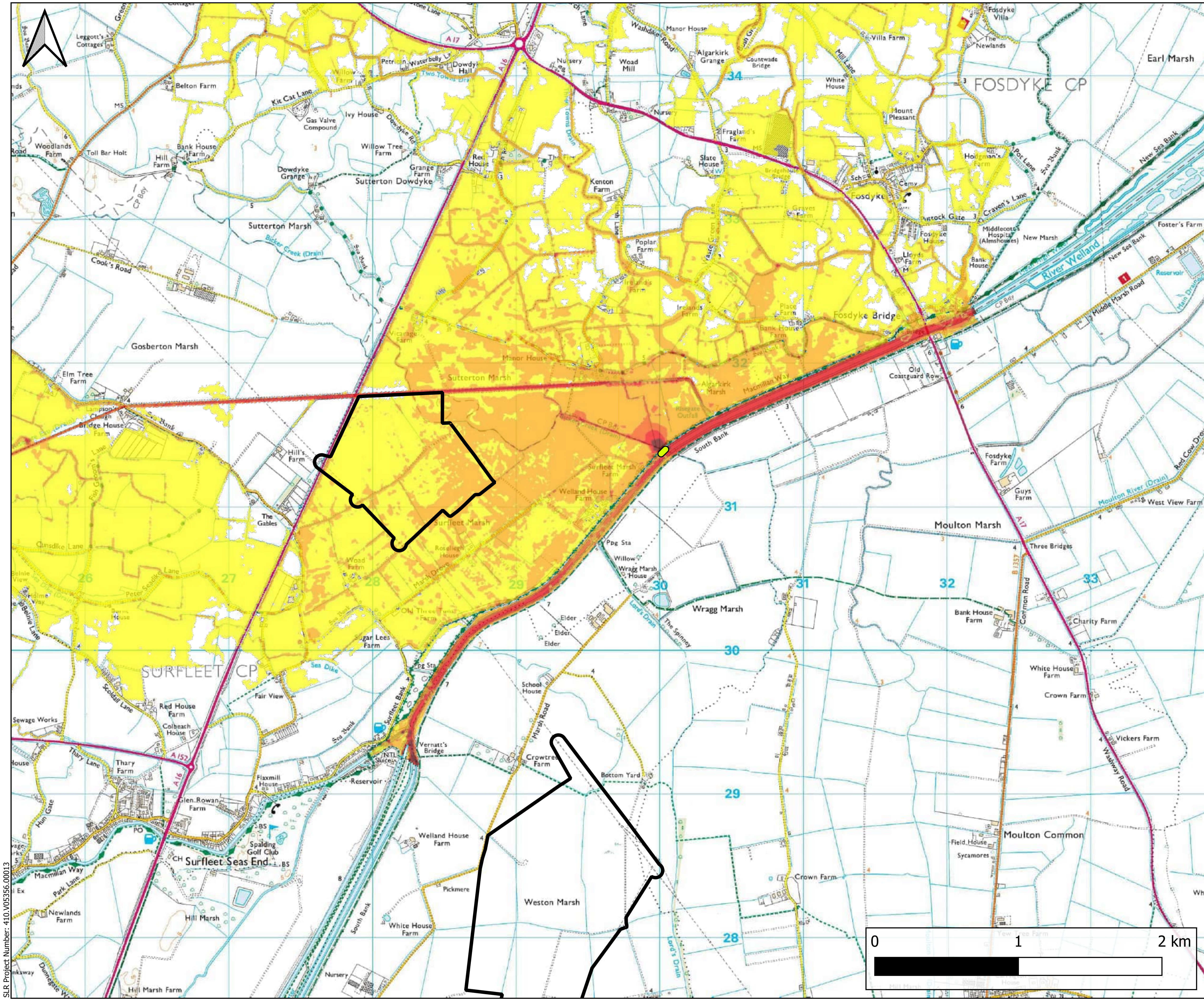
Maximum Flood Depths 1:200yr+CC North Breach 1 Baseline Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

Substation Search Areas

Breach Location

Maximum Flood Velocity (m/s)

- 0.00 - 0.30
- 0.30 - 1.00
- 1.00 - 1.50
- 1.50 - 2.50
- > 2.50

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 14

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

6 PRINCESS STREET
MANCHESTER
M1 6NG

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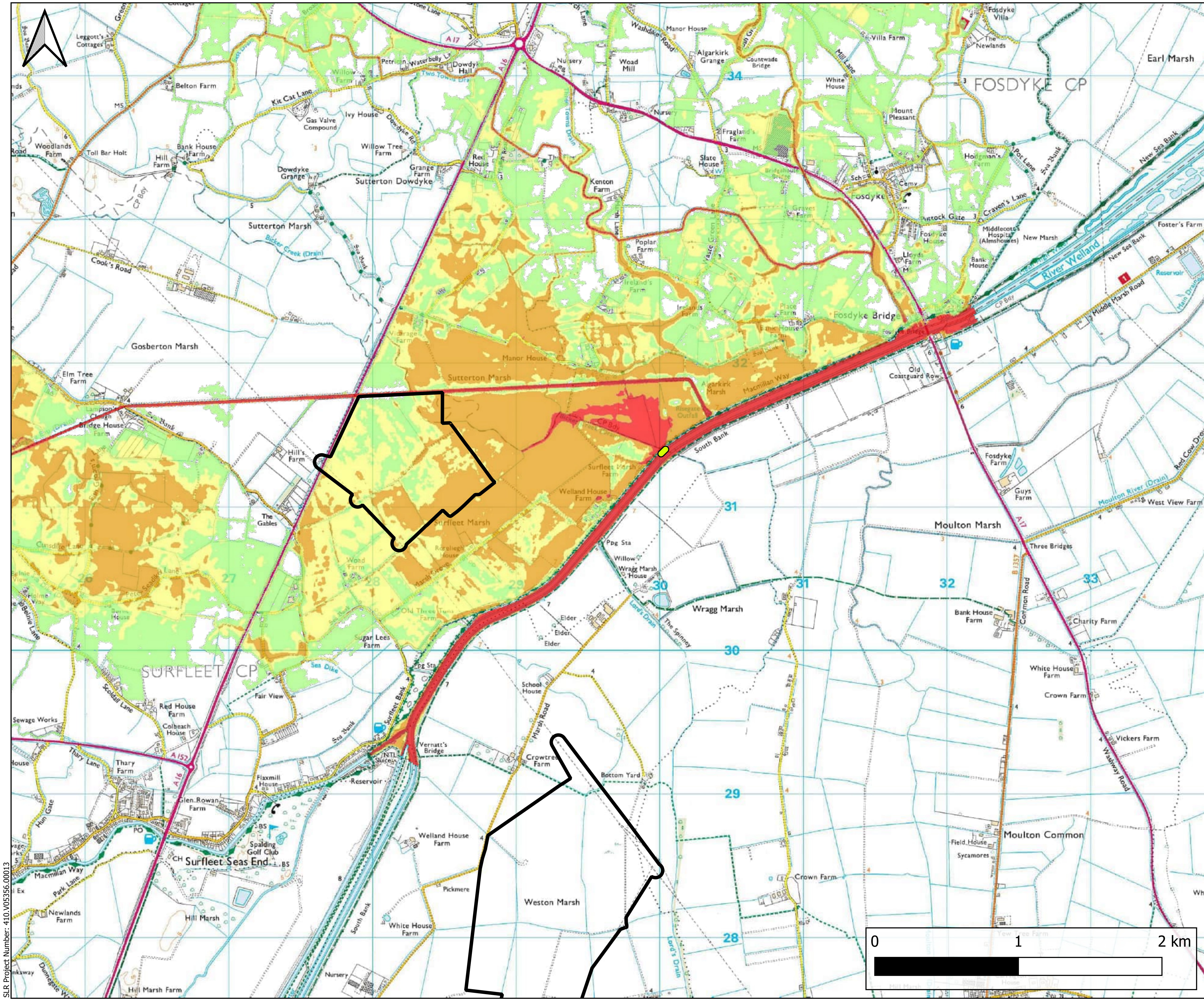
Maximum Flood Velocity 1:200yr+CC North Breach 1 Baseline Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

Substation Search Areas

Breach Location

Flood Hazard Rating

- <= 0.7500
- 0.7500 - 1.2500
- 1.2500 - 2.0000
- > 2.0000

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 15

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

6 PRINCESS STREET
MANCHESTER
M1 6NG
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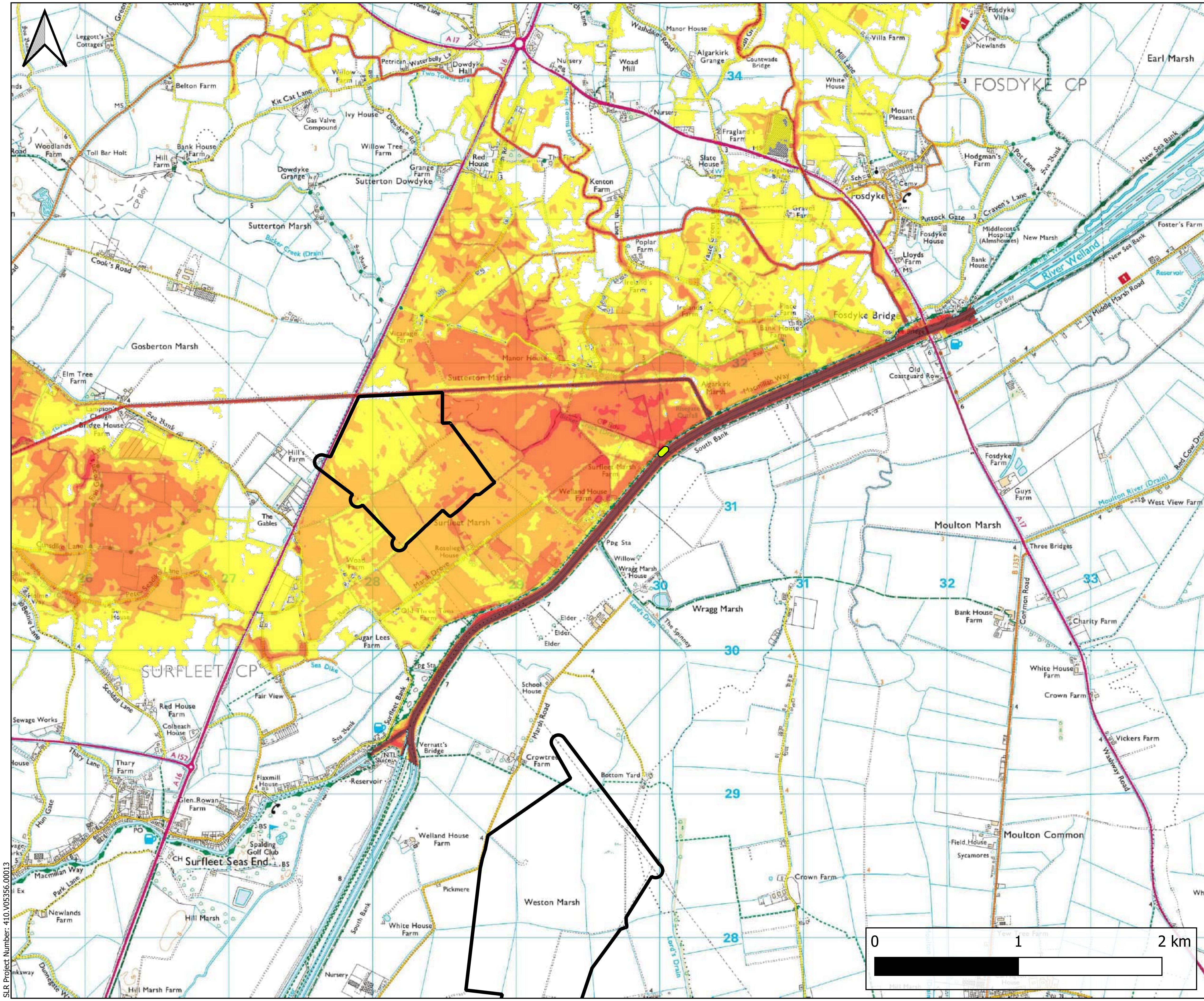
Maximum Flood Hazard 1:200yr+CC North Breach 1 Baseline Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

Substation Search Areas

Breach Location

Maximum Flood Depth (m)

- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 2.00
- > 2.00

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 16

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

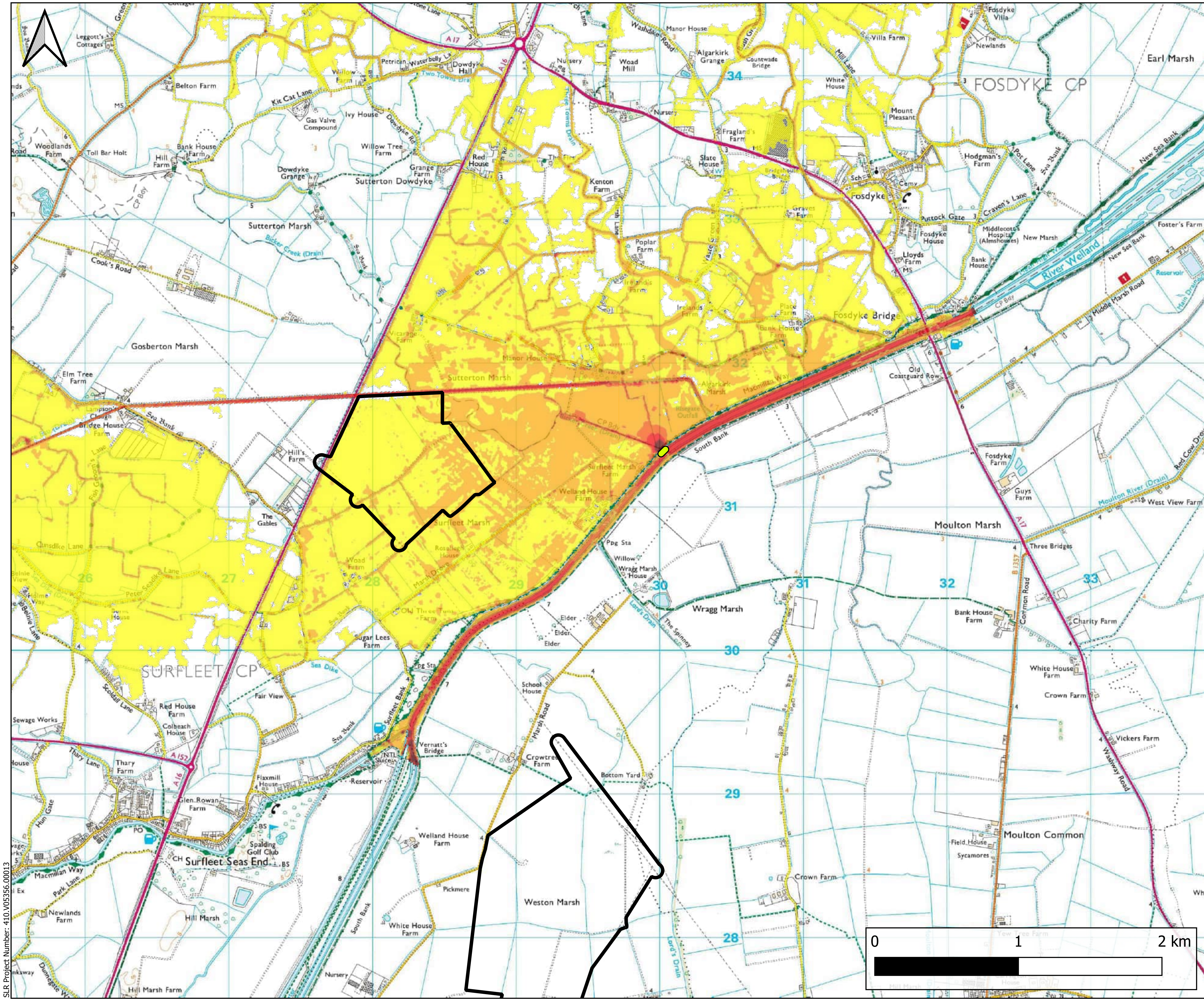
6 PRINCESS STREET
MANCHESTER
M1 6NG
www.slrconsulting.com

Maximum Flood Depths 1:200yr North Breach 1 Baseline Scenario

Scale A3

Date November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Breach Location

Maximum Flood Velocity (m/s)

- 0.00 - 0.30
- 0.30 - 1.00
- 1.00 - 1.50
- 1.50 - 2.50
- > 2.50

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 17

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

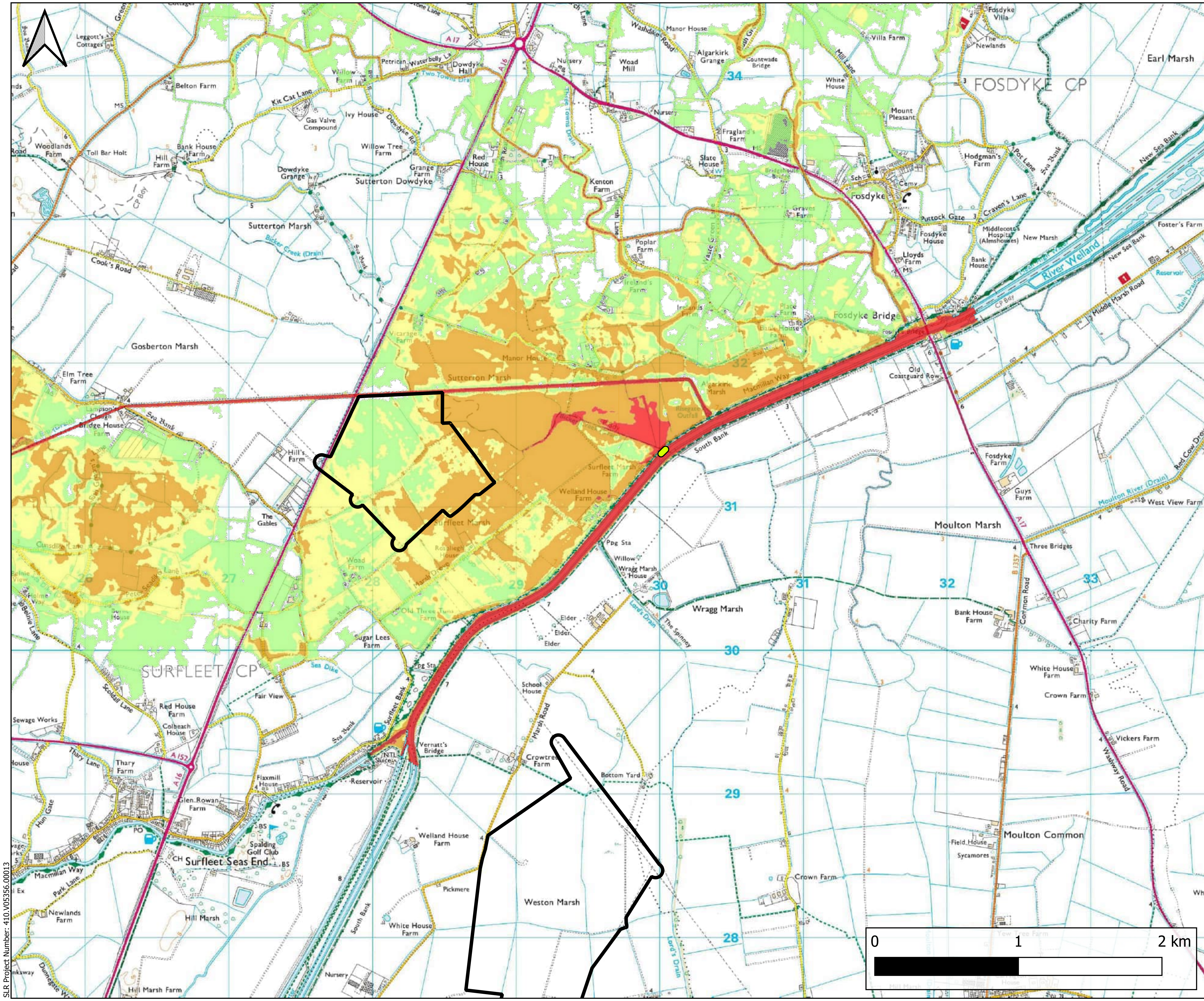
6 PRINCESS STREET
MANCHESTER
M1 6NG

www.slrconsulting.com

Maximum Flood Velocity 1:200yr North Breach 1 Baseline Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Breach Location

Flood Hazard Rating

- <= 0.7500
- 0.7500 - 1.2500
- 1.2500 - 2.0000
- > 2.0000

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 18

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

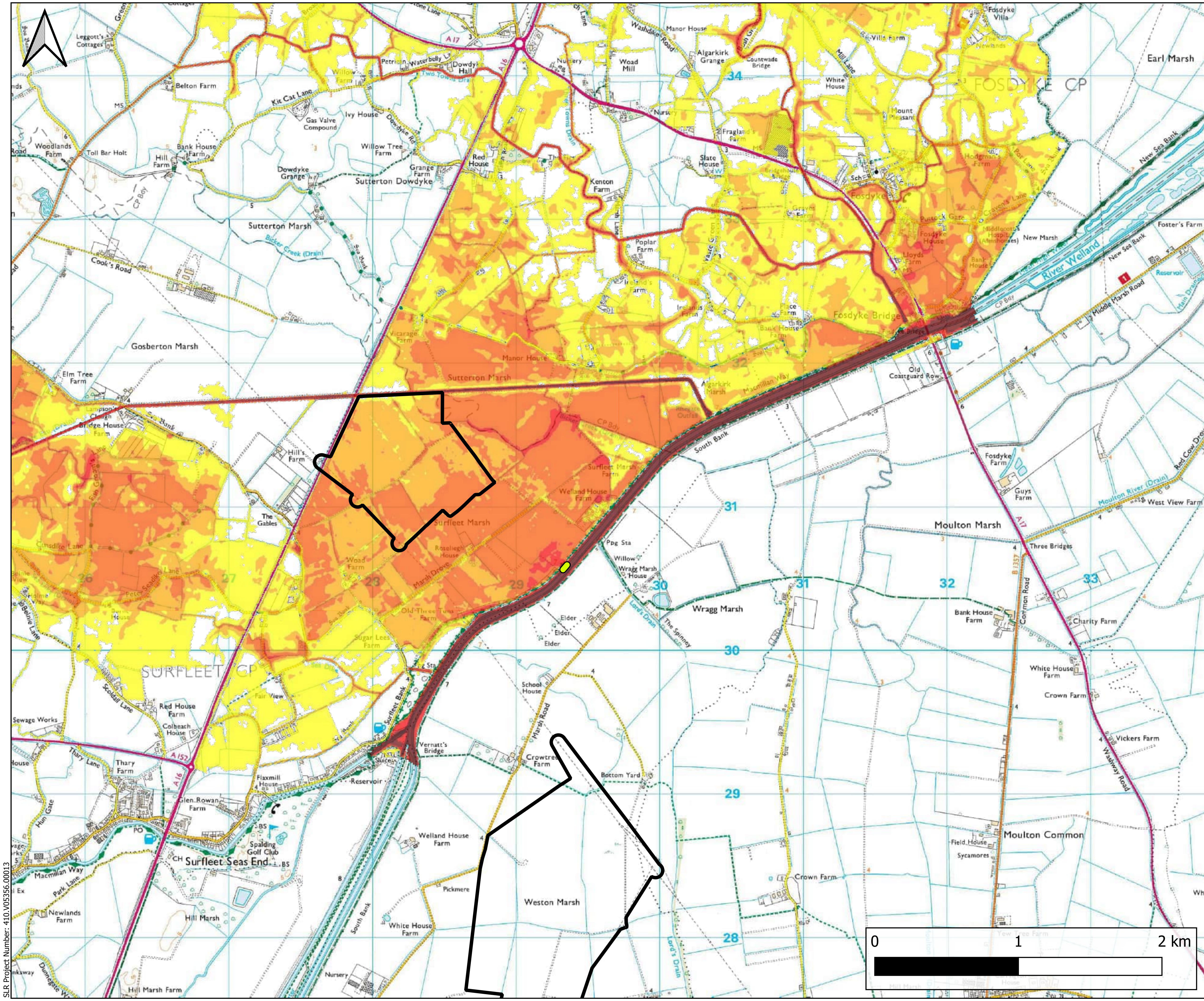
SLR

6 PRINCESS STREET
MANCHESTER
M1 6NG
www.slrconsulting.com

Maximum Flood Hazard 1:200yr North Breach 1 Baseline Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Breach Location

Maximum Flood Depth (m)

- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 2.00
- > 2.00

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 19

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

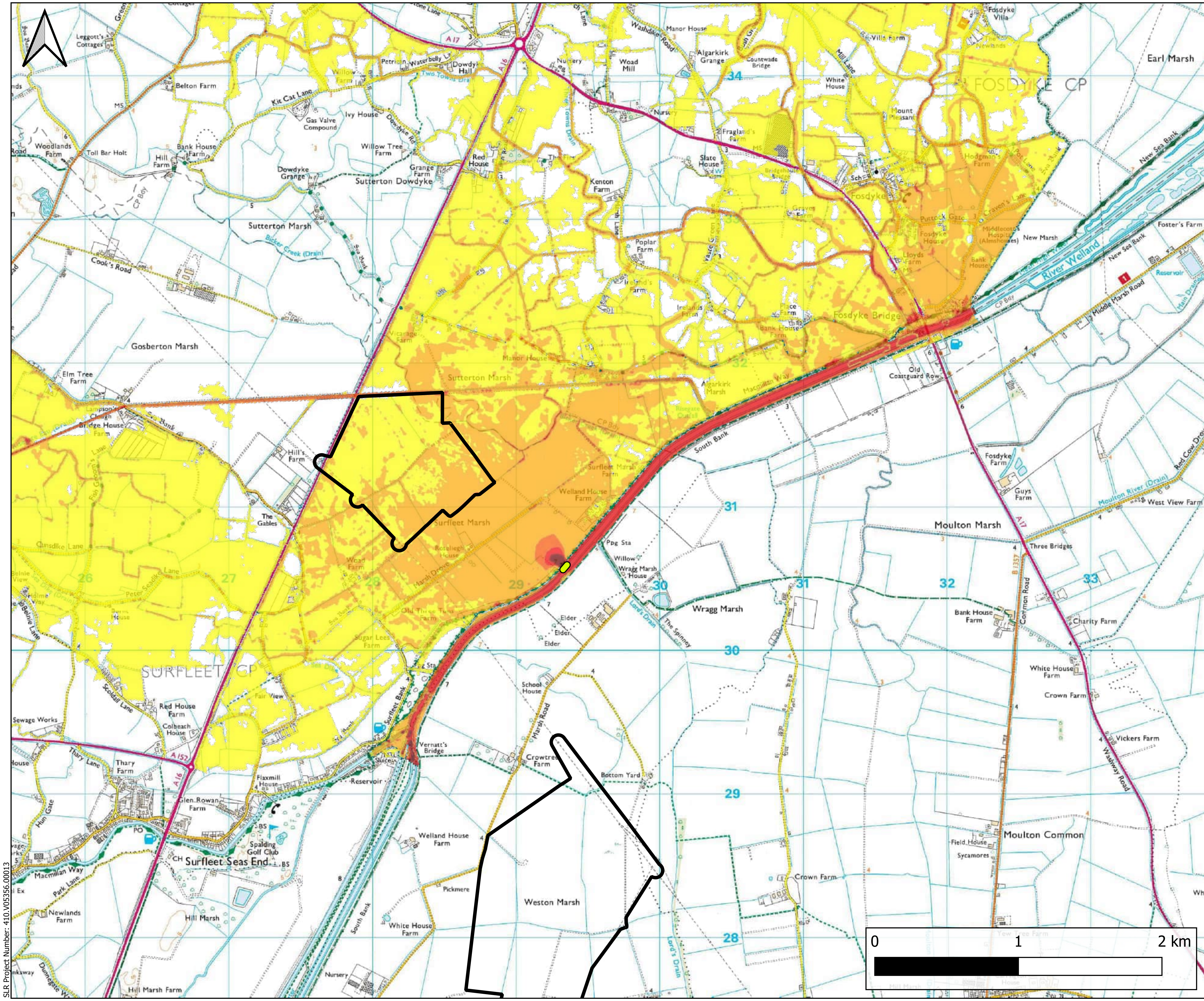
6 PRINCESS STREET
MANCHESTER
M1 6NG

www.slrconsulting.com

Maximum Flood Depths 1:1000yr+CC North Breach 2 Baseline Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Breach Location

Maximum Flood Velocity (m/s)

- 0.00 - 0.30
- 0.30 - 1.00
- 1.00 - 1.50
- 1.50 - 2.50
- > 2.50

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 20

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

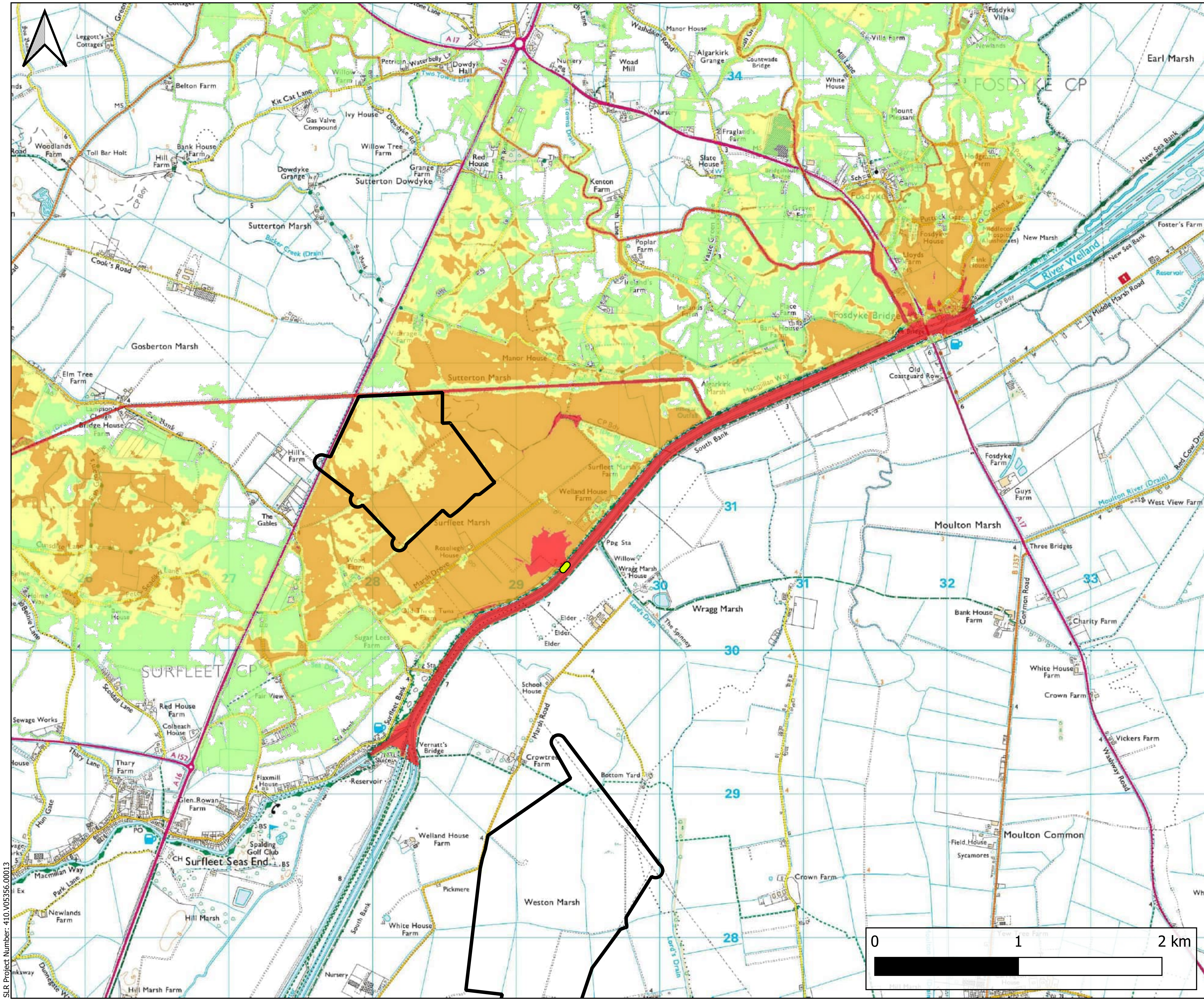
6 PRINCESS STREET
MANCHESTER
M1 6NG

www.slrconsulting.com

Maximum Flood Velocity 1:1000yr+CC North Breach 2 Baseline Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Breach Location

Flood Hazard Rating

- <= 0.7500
- 0.7500 - 1.2500
- 1.2500 - 2.0000
- > 2.0000

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 21

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

6 PRINCESS STREET
MANCHESTER
M1 6NG

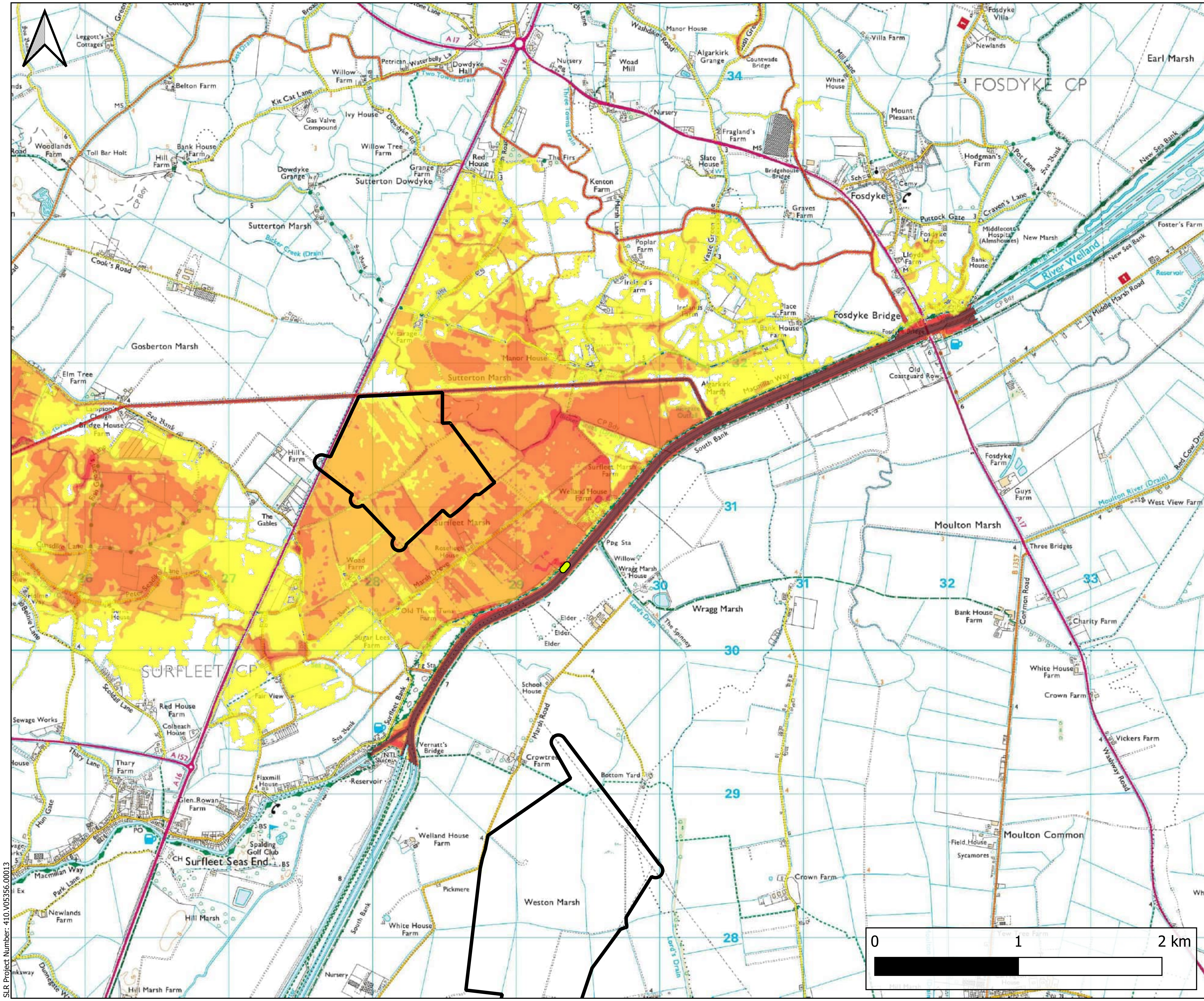
www.slrconsulting.com

Maximum Flood Hazard 1:1000yr+CC North Breach 2 Baseline Scenario

Scale A3

Date November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Breach Location

Maximum Flood Depth (m)

- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 2.00
- > 2.00

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 22

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

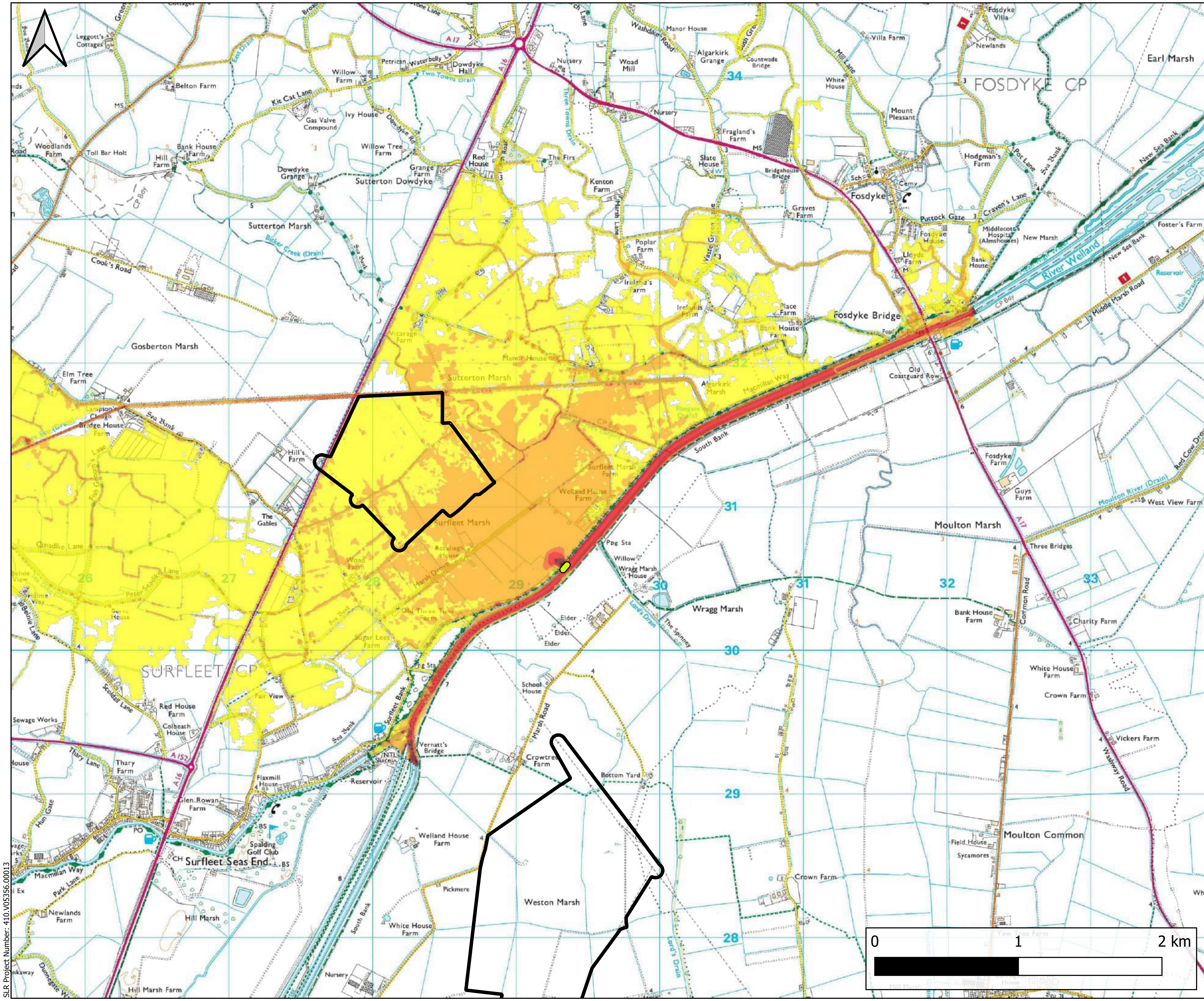
SLR

6 PRINCESS STREET
MANCHESTER
M1 6NG
www.slrconsulting.com

Maximum Flood Depths 1:1000yr North Breach 2 Baseline Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

Substation Search Areas

Breach Location

Maximum Flood Velocity (m/s)

- 0.00 - 0.30
- 0.30 - 1.00
- 1.00 - 1.50
- 1.50 - 2.50
- > 2.50

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 23

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

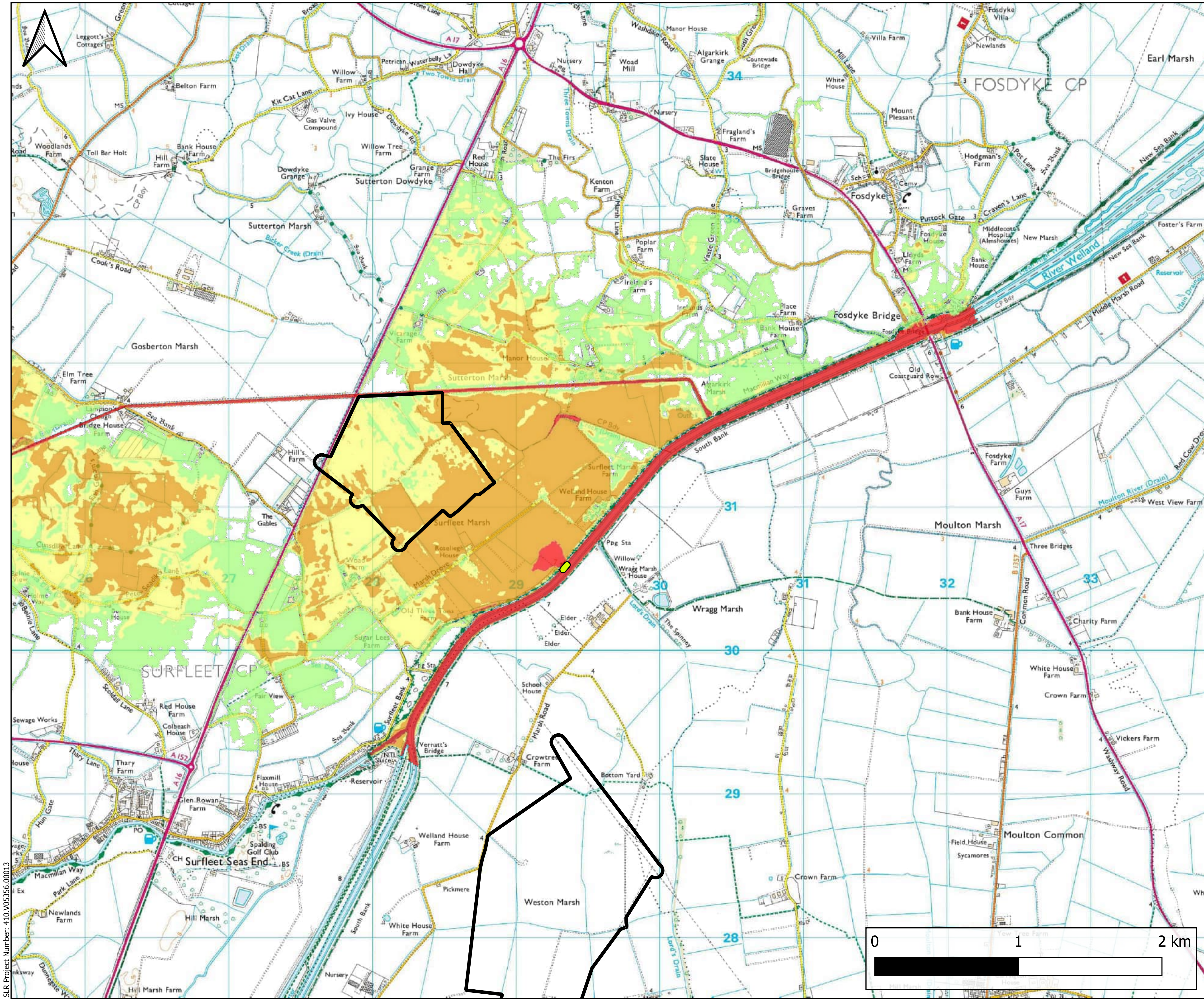
SLR

6 PRINCESS STREET
MANCHESTER
M1 6NG
www.slrconsulting.com

Maximum Flood Velocity 1:1000yr North Breach 2 Baseline Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Breach Location

Flood Hazard Rating

- <= 0.7500
- 0.7500 - 1.2500
- 1.2500 - 2.0000
- > 2.0000

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 24

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

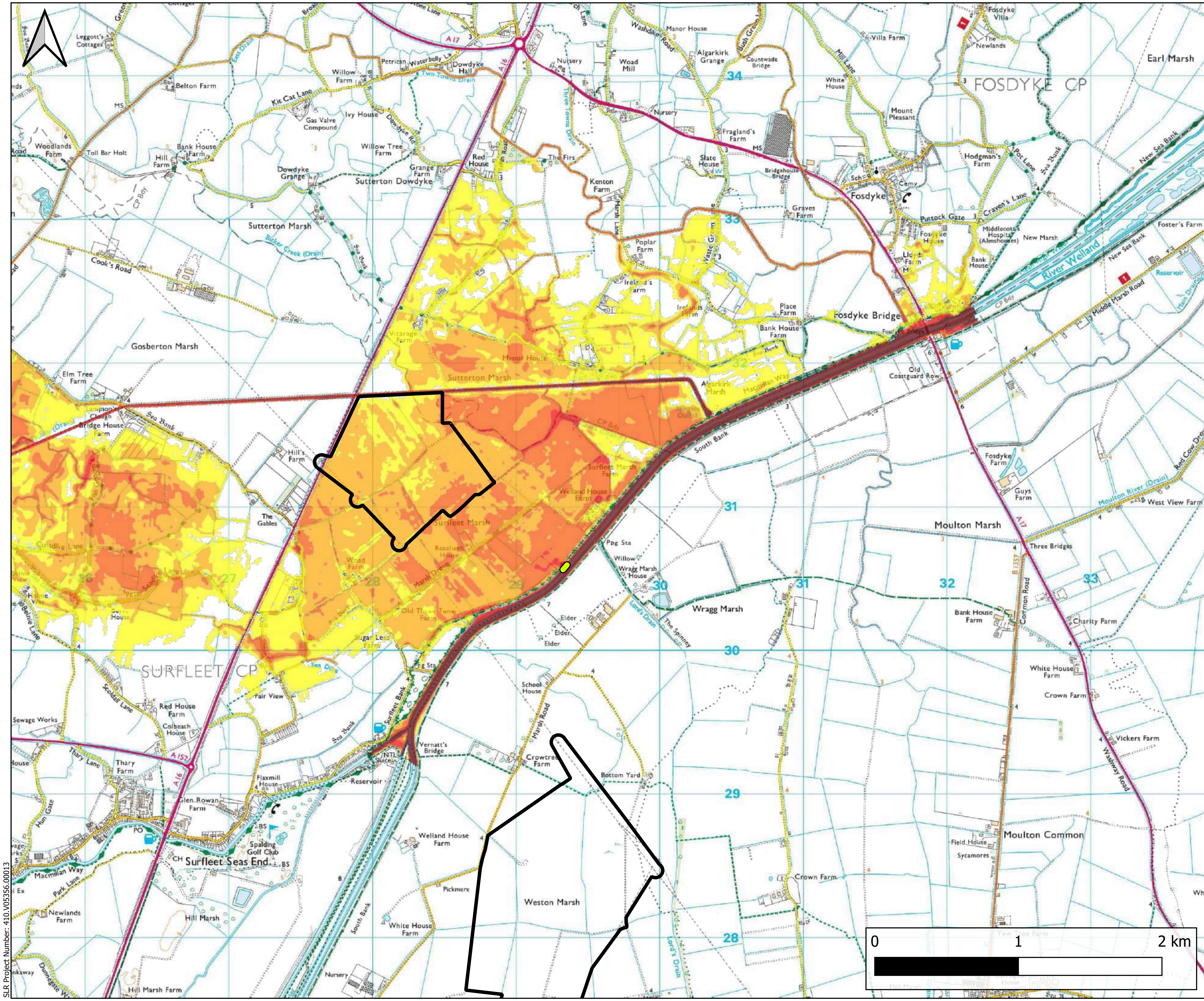
6 PRINCESS STREET
MANCHESTER
M1 6NG

www.slrconsulting.com

Maximum Flood Hazard 1:1000yr North Breach 2 Baseline Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

Substation Search Areas
Breach Location
Maximum Flood Depth (m)
0.00 - 0.25
0.25 - 0.50
0.50 - 1.00
1.00 - 2.00
> 2.00
Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 25

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

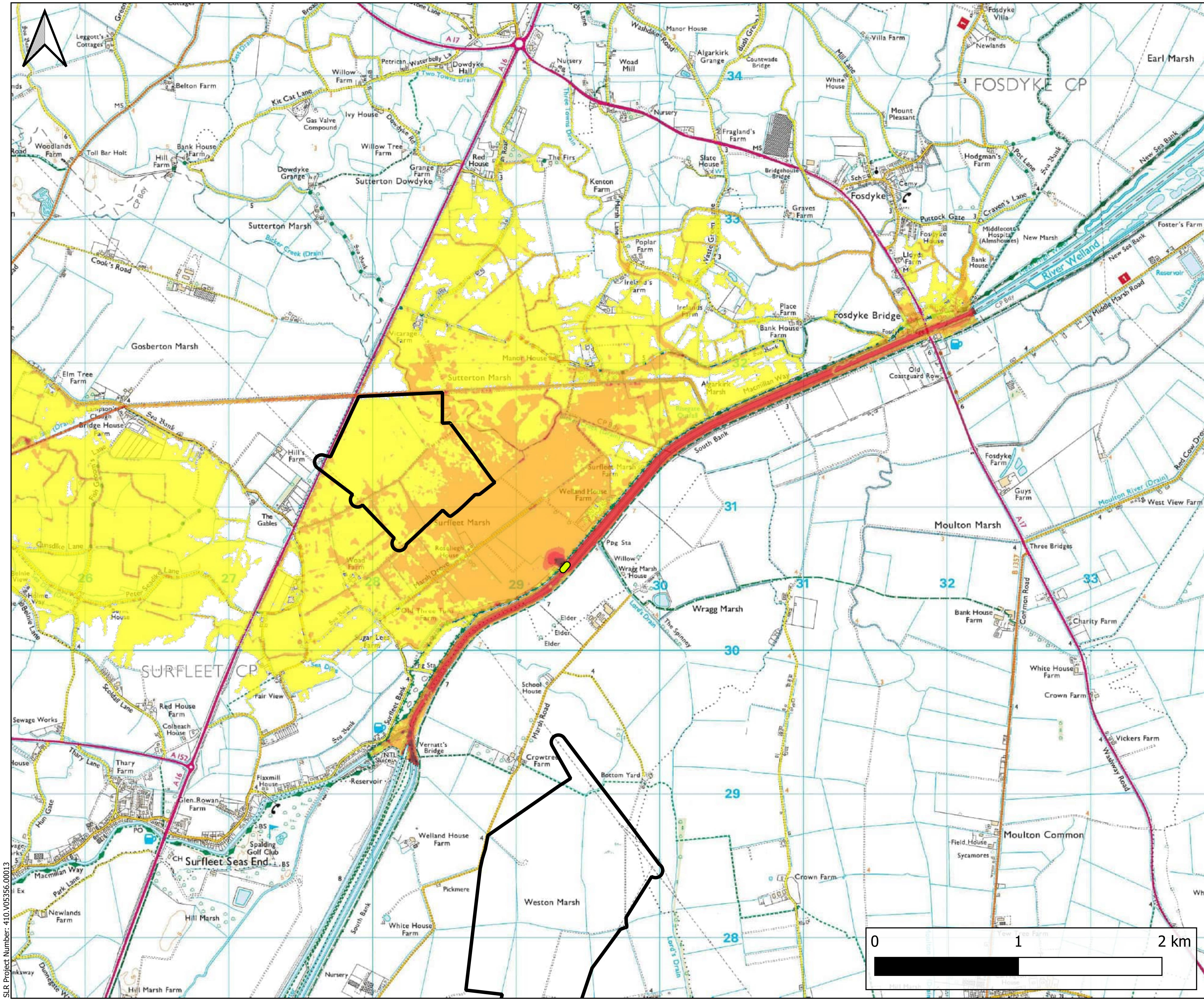
SLR

6 PRINCESS STREET
MANCHESTER
M1 6NG
www.slrconsulting.com

Maximum Flood Depths 1:200yr+CC North Breach 2 Baseline Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

Substation Search Areas

Breach Location

Maximum Flood Velocity (m/s)

- 0.00 - 0.30
- 0.30 - 1.00
- 1.00 - 1.50
- 1.50 - 2.50
- > 2.50

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 26

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

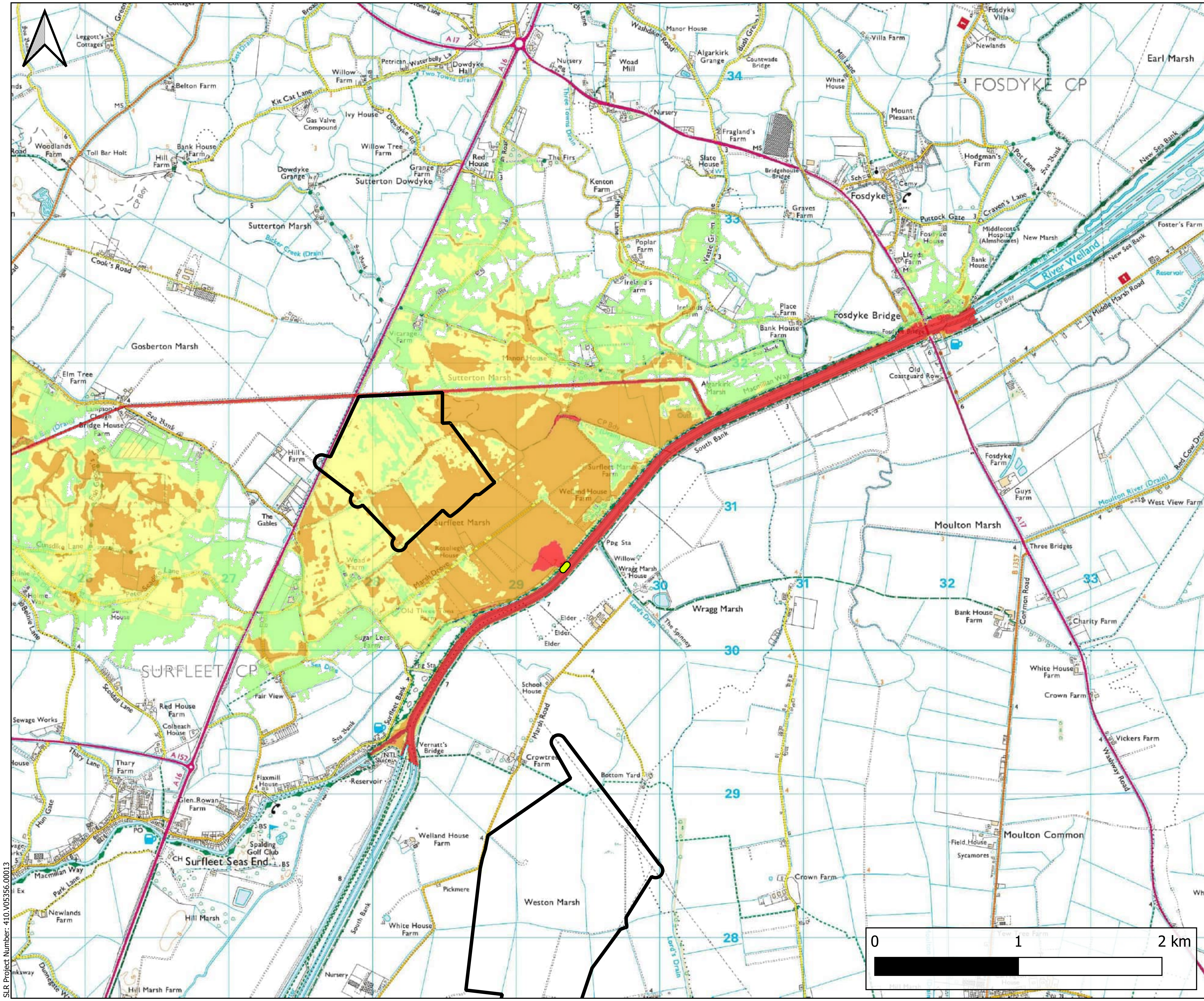
6 PRINCESS STREET
MANCHESTER
M1 6NG

www.slrconsulting.com

Maximum Flood Velocity 1:200yr+CC North Breach 2 Baseline Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

Substation Search Areas

Breach Location

Flood Hazard Rating

<= 0.7500

0.7500 - 1.2500

1.2500 - 2.0000

> 2.0000

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 27

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

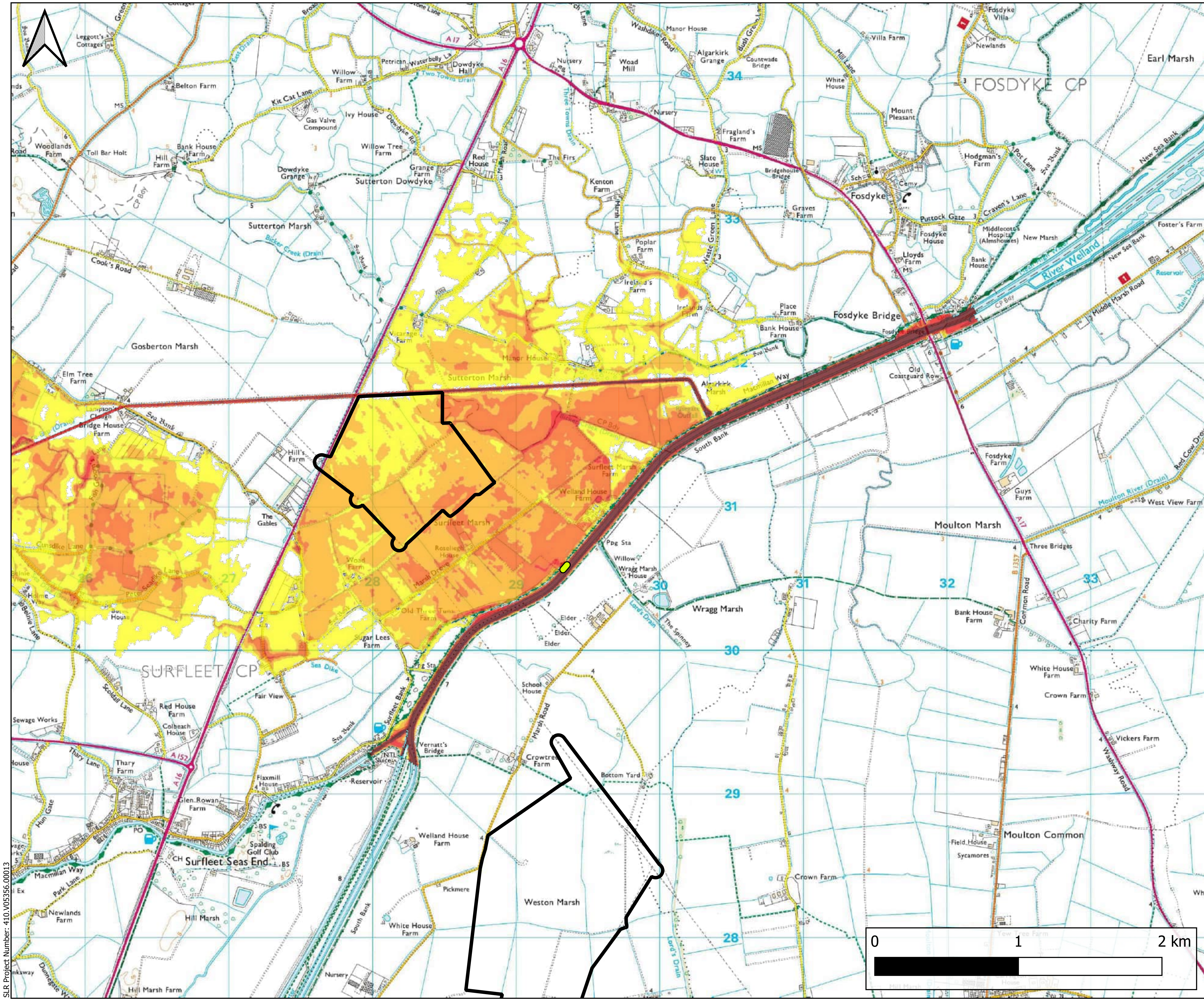
6 PRINCESS STREET
MANCHESTER
M1 6NG

www.slrconsulting.com

Maximum Flood Hazard 1:200yr+CC North Breach 2 Baseline Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Breach Location

Maximum Flood Depth (m)

- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 2.00
- > 2.00

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 28

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

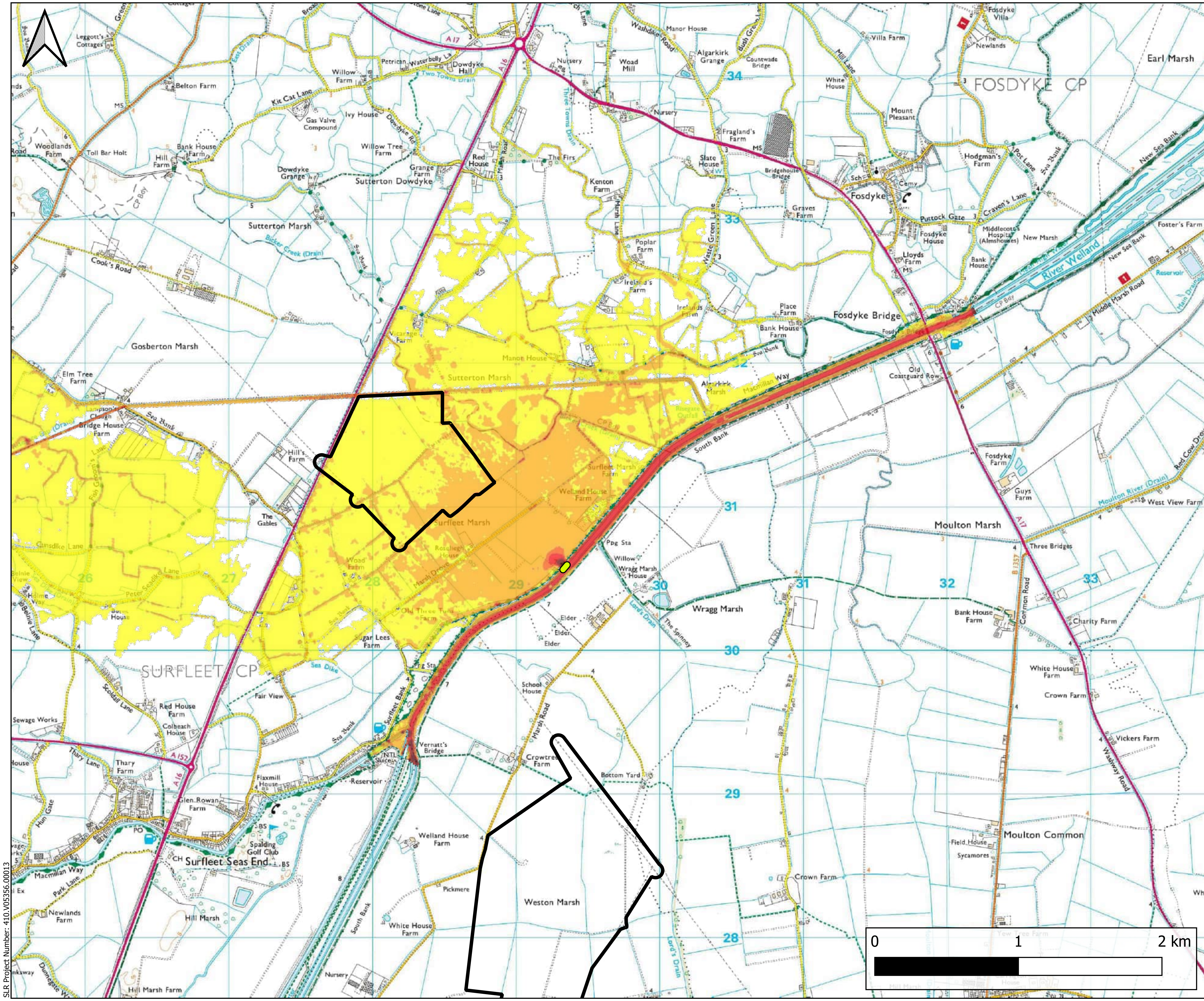
SLR

6 PRINCESS STREET
MANCHESTER
M1 6NG
www.slrconsulting.com

Maximum Flood Depths 1:200yr North Breach 2 Baseline Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

Substation Search Areas

Breach Location

Maximum Flood Velocity (m/s)

- 0.00 - 0.30
- 0.30 - 1.00
- 1.00 - 1.50
- 1.50 - 2.50
- > 2.50

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 29

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

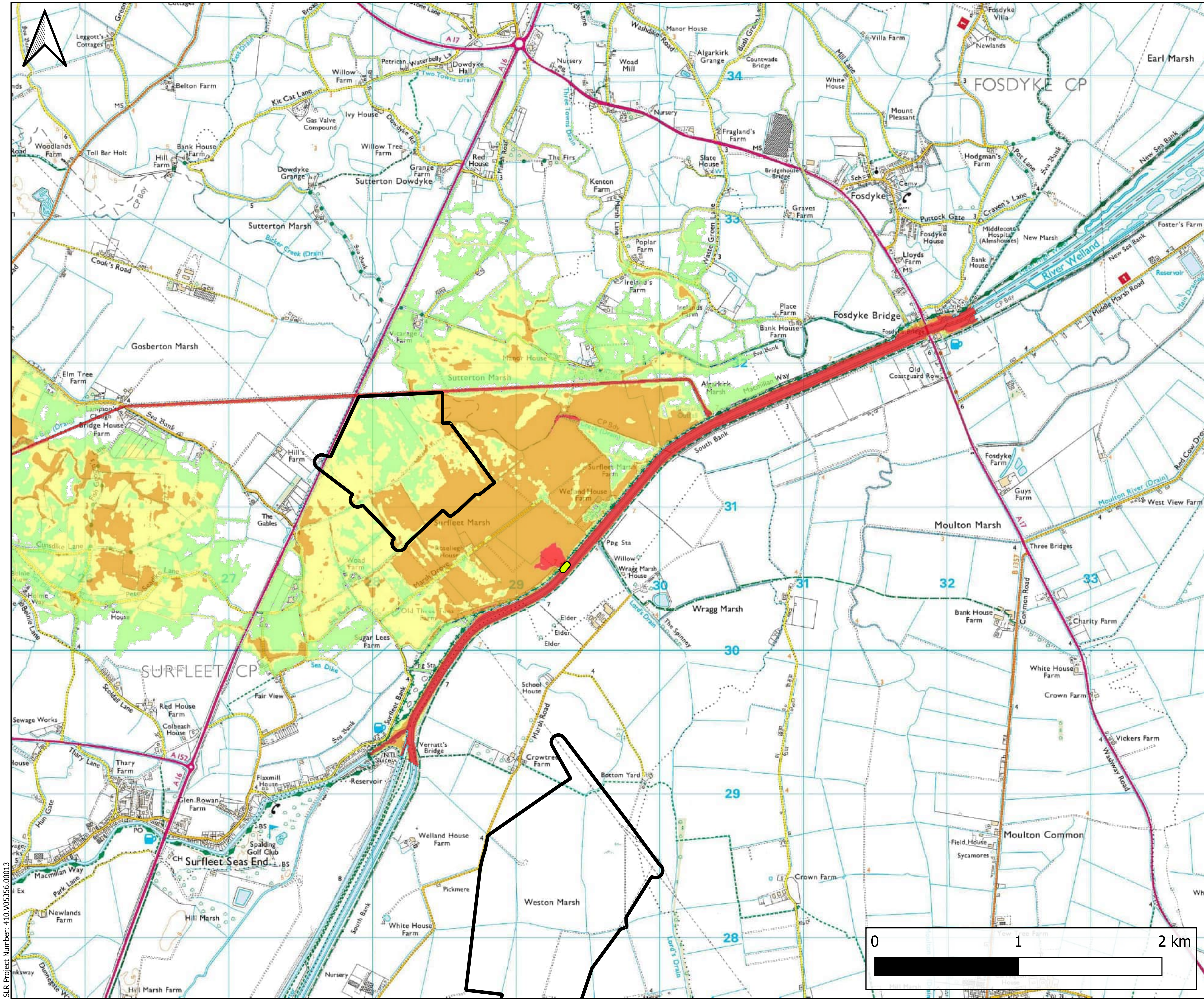
6 PRINCESS STREET
MANCHESTER
M1 6NG

www.slrconsulting.com

Maximum Flood Velocity 1:200yr North Breach 2 Baseline Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Breach Location

Flood Hazard Rating

- <= 0.7500
- 0.7500 - 1.2500
- 1.2500 - 2.0000
- > 2.0000

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 30

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

6 PRINCESS STREET
MANCHESTER
M1 6NG

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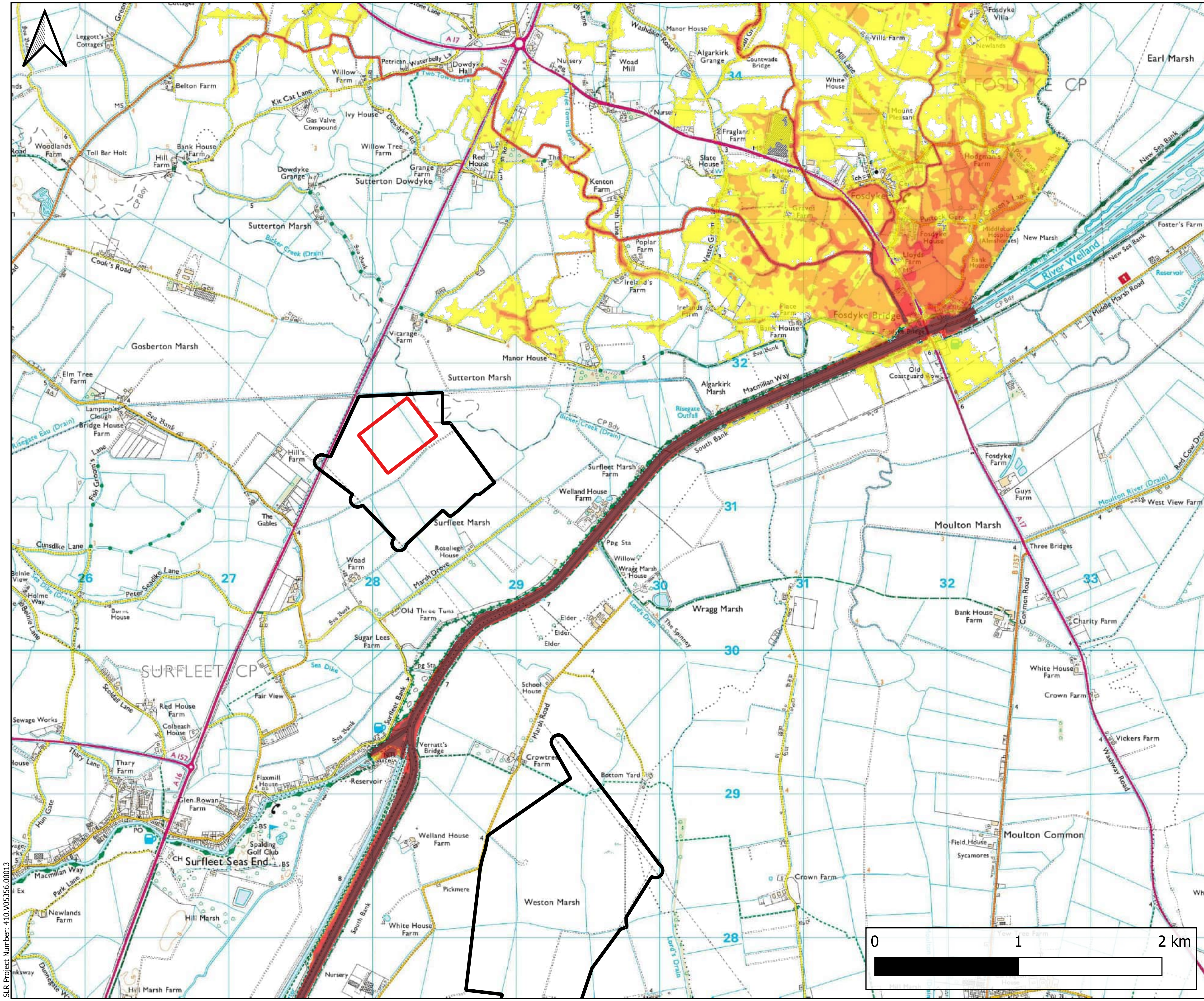
Maximum Flood Hazard 1:200yr North Breach 2 Baseline Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Onshore Substation Area
- Breach Location

Maximum Flood Depth (m)

- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 2.00
- > 2.00

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 31

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

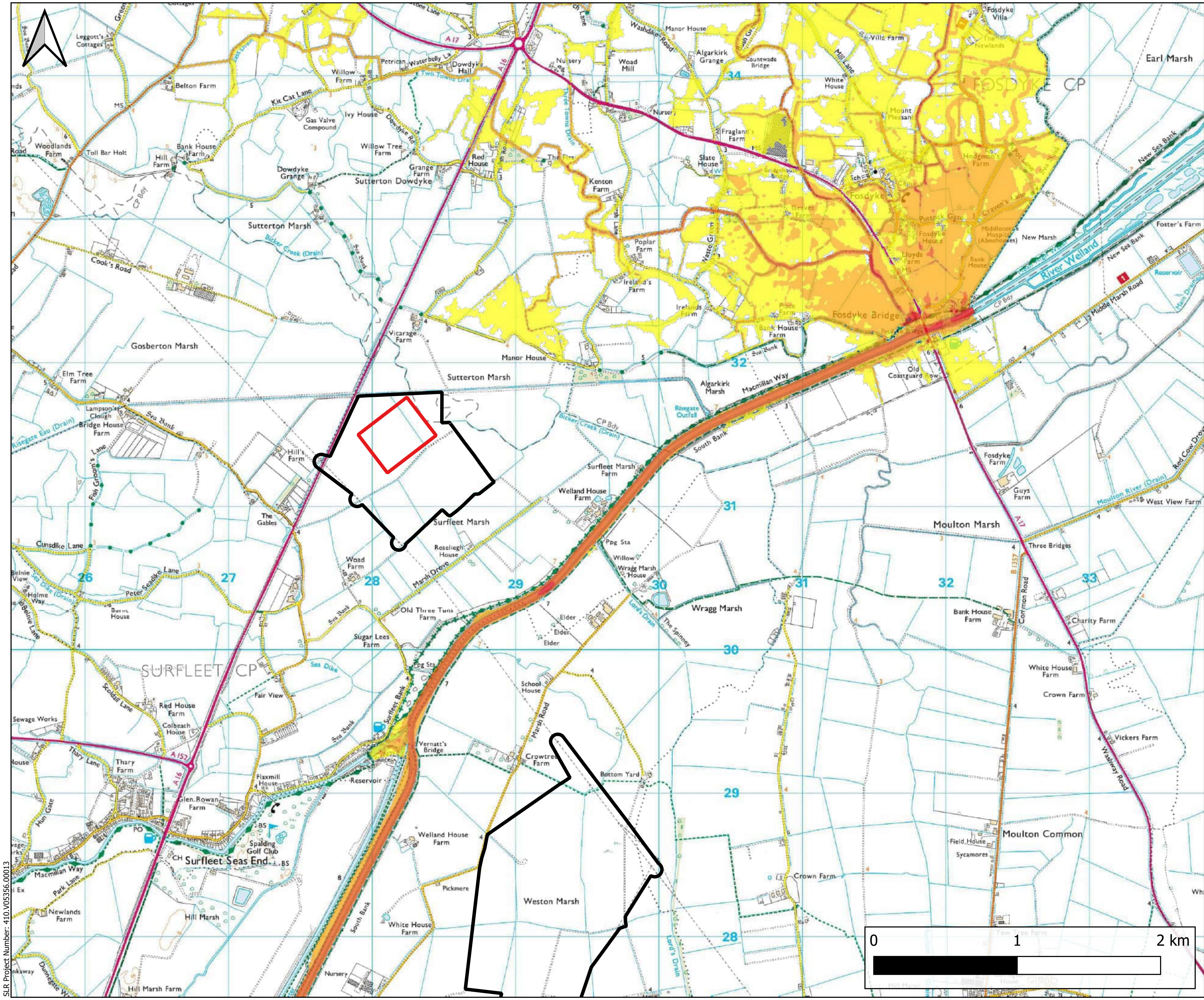
SLR

6 PRINCESS STREET
MANCHESTER
M1 6NG
www.slrconsulting.com

Maximum Flood Depths 1:1000yr+CC Overtopping Proposed Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Onshore Substation Area
- Breach Location

Maximum Flood Velocity (m/s)

- 0.00 - 0.30
- 0.30 - 1.00
- 1.00 - 1.50
- 1.50 - 2.50
- > 2.50

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 32

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

6 PRINCESS STREET
MANCHESTER
M1 6NG
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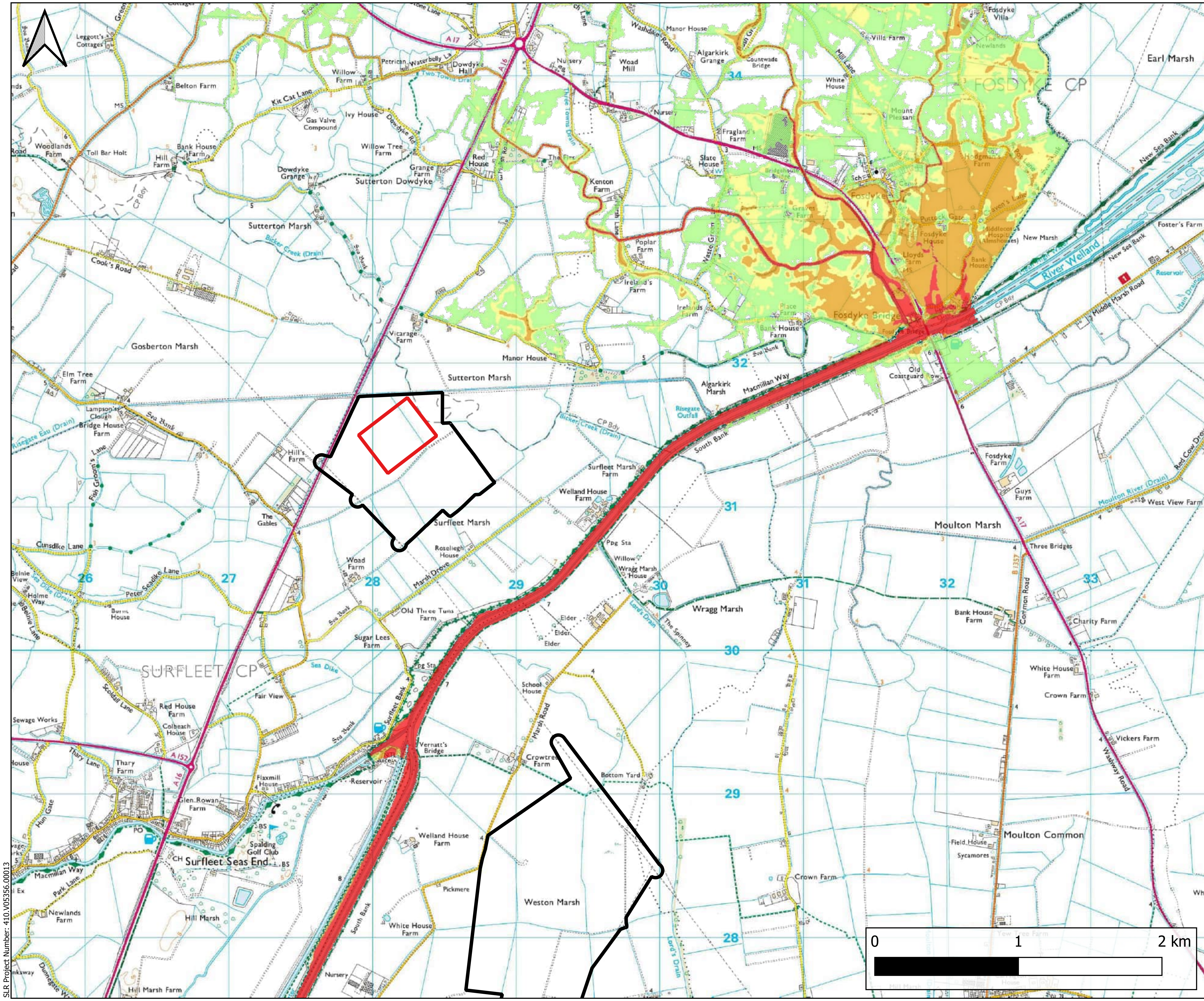
Maximum Flood Velocity 1:1000yr+CC Overtopping Proposed Scenario

Scale: A3

Date: November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Onshore Substation Area
- Breach Location

Flood Hazard Rating

- <= 0.7500
- 0.7500 - 1.2500
- 1.2500 - 2.0000
- > 2.0000

Ordnance Survey(OS) 1:25000 Raster Basemap

0 1 2 km

Figure No. 33

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

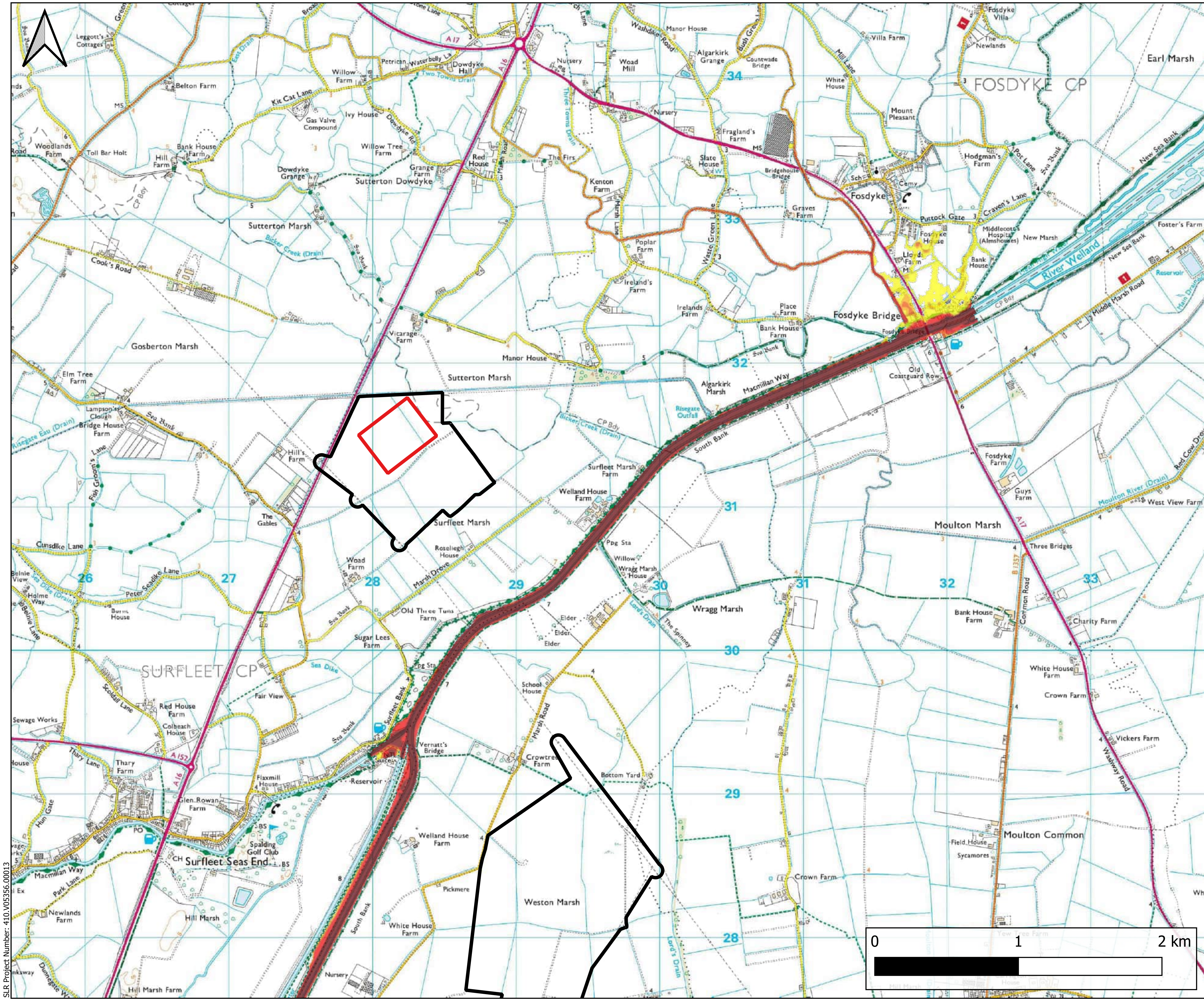
SLR

6 PRINCESS STREET
MANCHESTER
M1 6NG
www.slrconsulting.com

Maximum Flood Hazard 1:1000yr+CC Overtopping Proposed Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Onshore Substation Area
- Breach Location

Maximum Flood Depth (m)

- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 2.00
- > 2.00

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 34

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

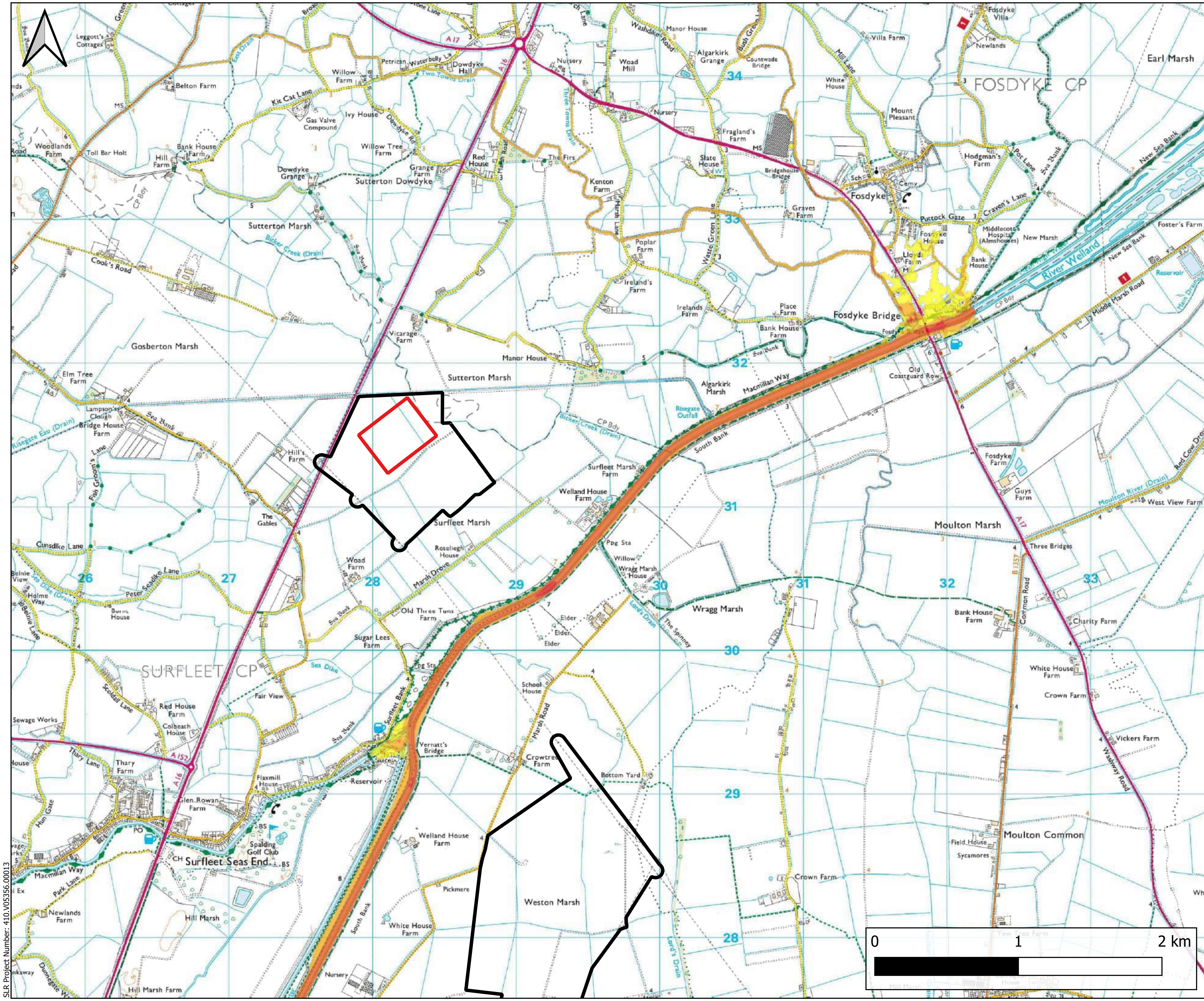
6 PRINCESS STREET
MANCHESTER
M1 6NG
www.slrconsulting.com

Maximum Flood Depths 1:1000yr Overtopping Proposed Scenario

Scale: A3

Date: November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Onshore Substation Area
- Breach Location

Maximum Flood Velocity (m/s)

- 0.00 - 0.30
- 0.30 - 1.00
- 1.00 - 1.50
- 1.50 - 2.50
- > 2.50

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 35

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

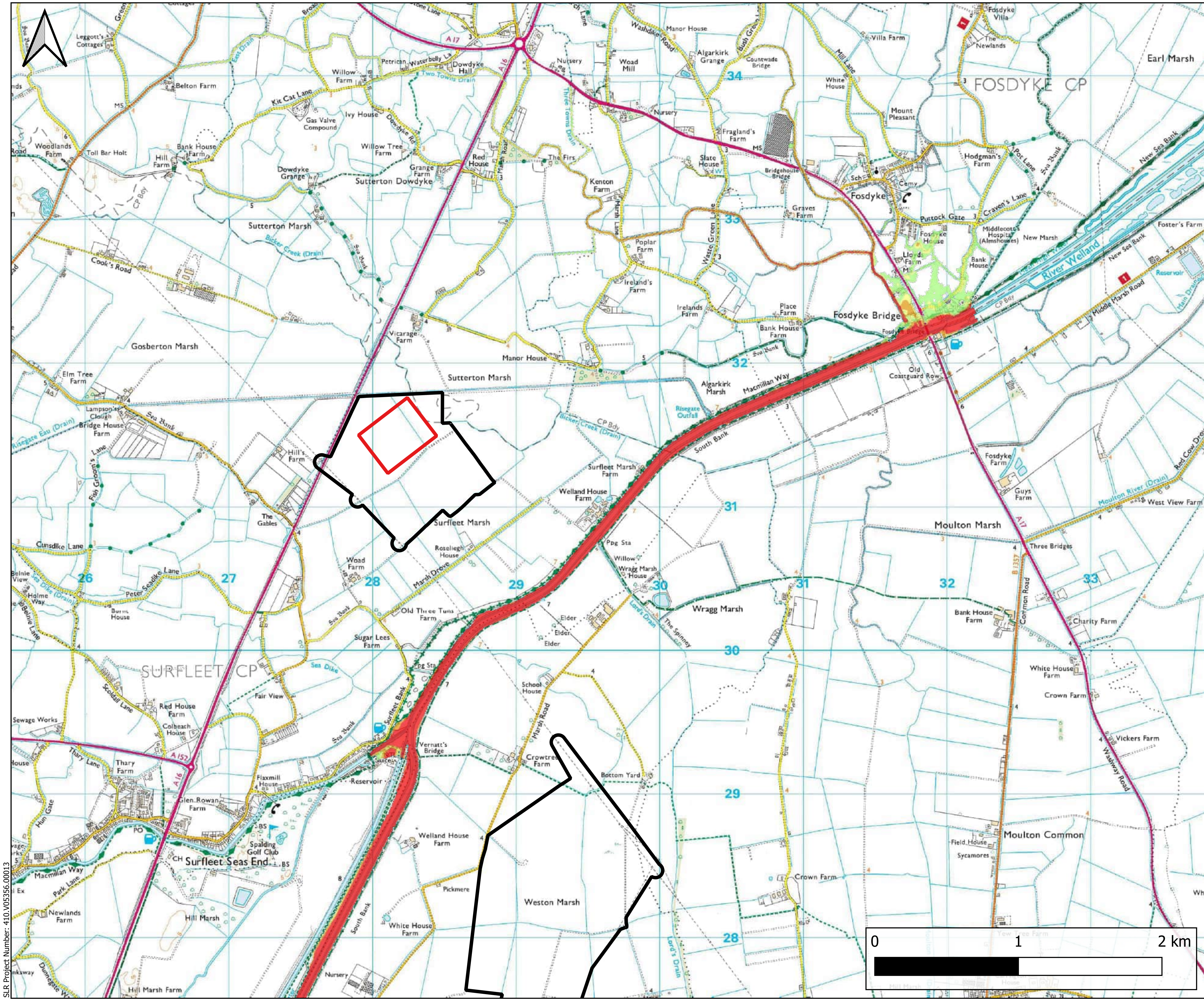
Outer Dowsing Offshore Wind

6 PRINCESS STREET
MANCHESTER
M1 6NG
www.slrconsulting.com

Maximum Flood Velocity 1:1000yr Overtopping Proposed Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Onshore Substation Area
- Breach Location

Flood Hazard Rating

- <= 0.7500
- 0.7500 - 1.2500
- 1.2500 - 2.0000
- > 2.0000

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 36

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

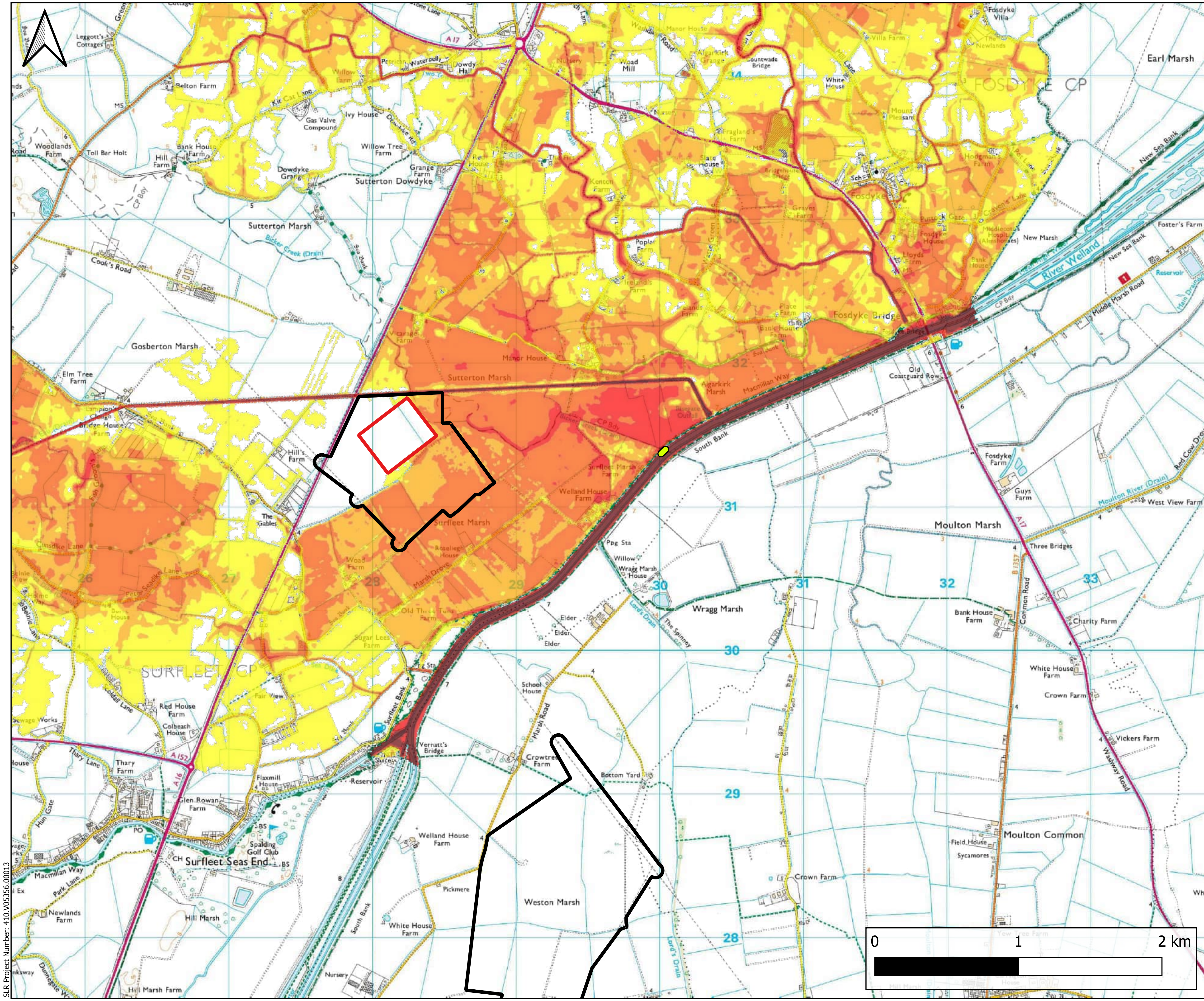
6 PRINCESS STREET
MANCHESTER
M1 6NG

www.slrconsulting.com

Maximum Flood Hazard 1:1000yr Overtopping Proposed Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Onshore Substation Area
- Breach Location

Maximum Flood Depth (m)

- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 2.00
- > 2.00

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 37

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

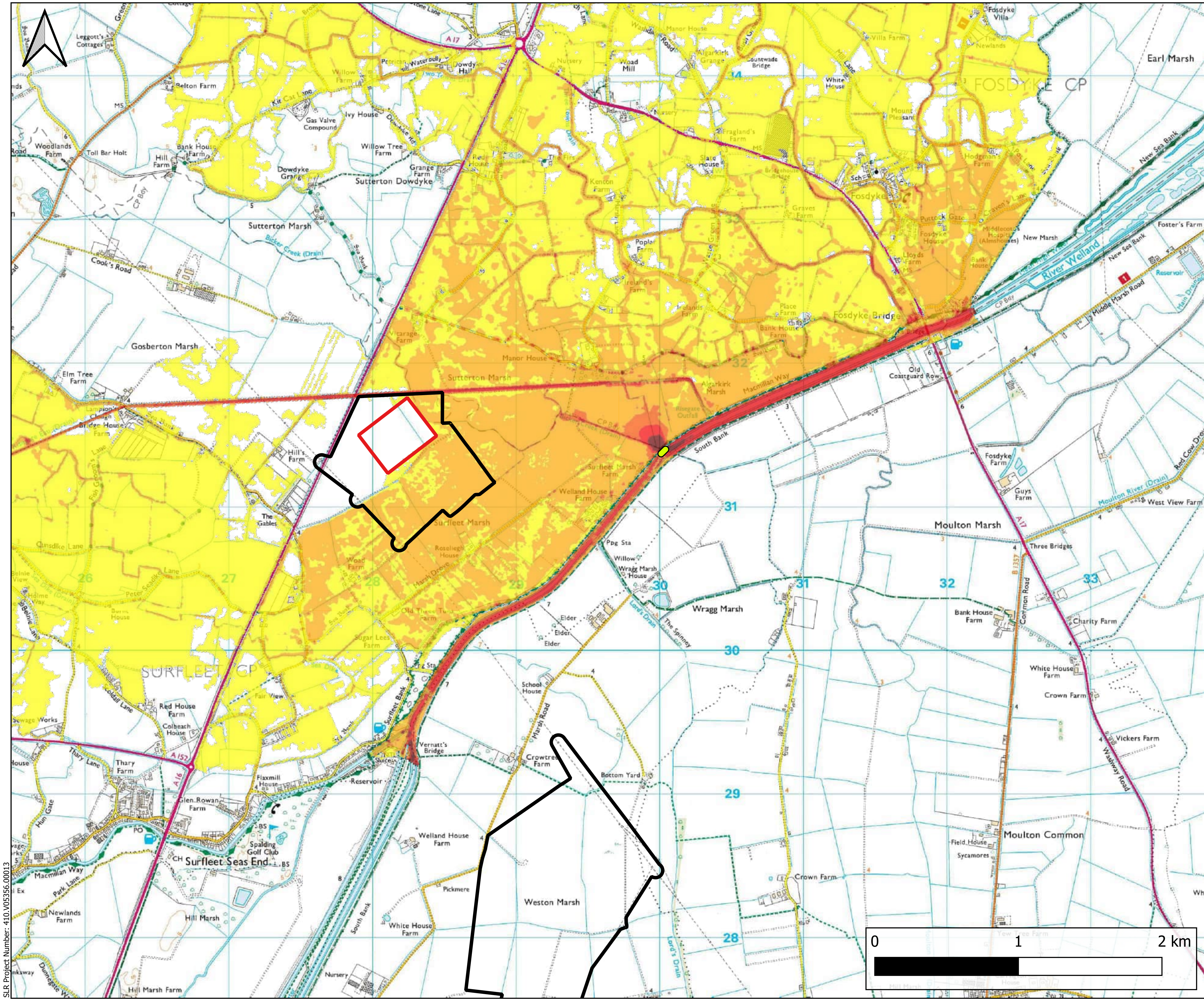
6 PRINCESS STREET
MANCHESTER
M1 6NG

www.slrconsulting.com

Maximum Flood Depths 1:1000yr+CC North Breach 1 Proposed Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

Substation Search Areas

Onshore Substation Area

Breach Location

Maximum Flood Velocity (m/s)

0.00 - 0.30

0.30 - 1.00

1.00 - 1.50

1.50 - 2.50

> 2.50

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 38

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

6 PRINCESS STREET
MANCHESTER
M1 6NG

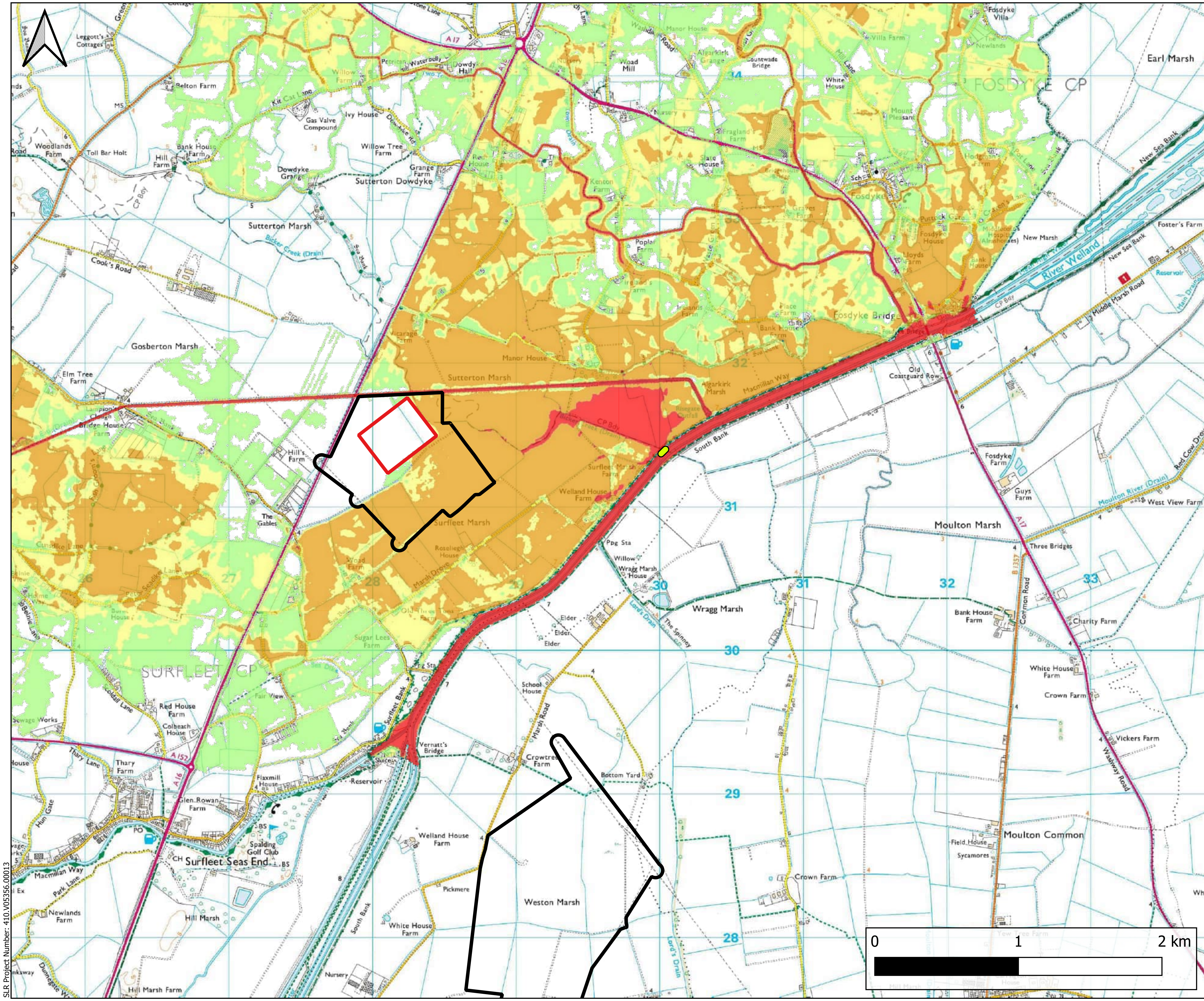
www.slrconsulting.com

Maximum Flood Velocity 1:1000yr+CC North Breach 1 Proposed Scenario

Scale A3

Date November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Onshore Substation Area
- Breach Location

Flood Hazard Rating

- <= 0.7500
- 0.7500 - 1.2500
- 1.2500 - 2.0000
- > 2.0000

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 39

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

6 PRINCESS STREET
MANCHESTER
M1 6NG
www.slrconsulting.com

Maximum Flood Hazard 1:1000yr+CC North Breach 1 Proposed Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013

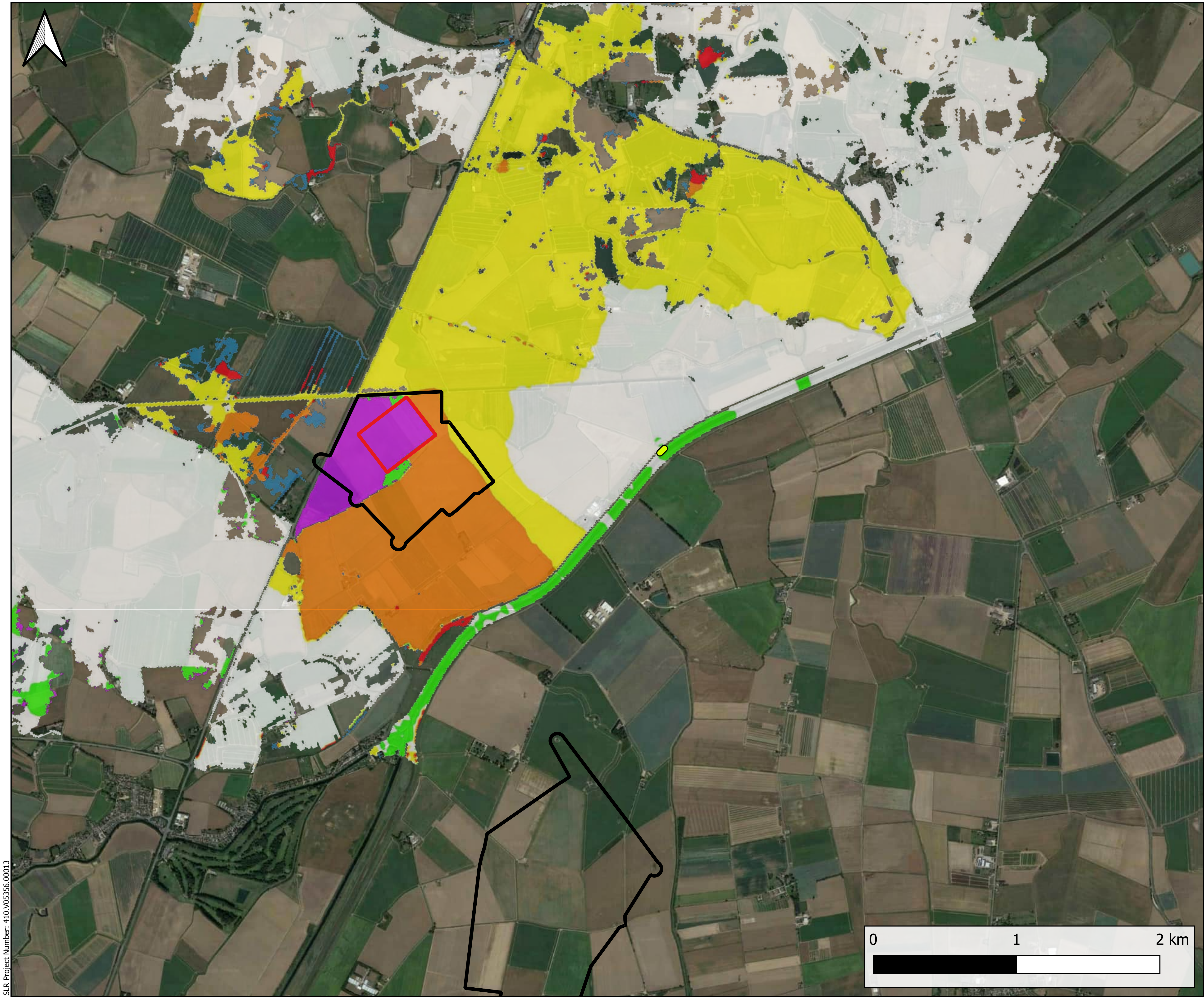


Figure No. 40

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

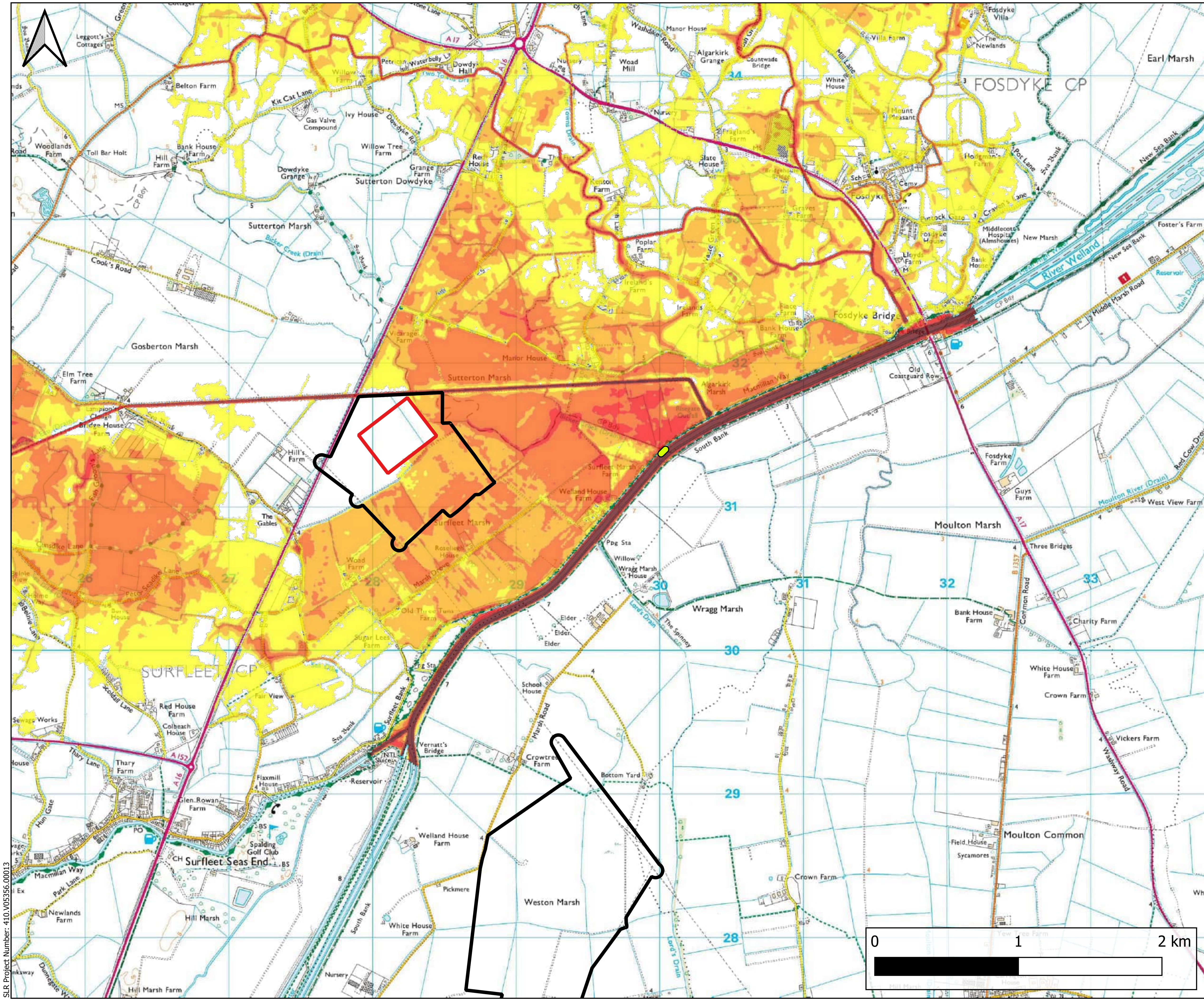
6 PRINCESS STREET
MANCHESTER
M1 6NG

www.slrconsulting.com

Flood Depth Difference 1:1000yr+CC North Breach 1 Proposed Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

Substation Search Areas
Onshore Substation Area
Breach Location

Maximum Flood Depth (m)

0.00 - 0.25
0.25 - 0.50
0.50 - 1.00
1.00 - 2.00
> 2.00

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 41

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

6 PRINCESS STREET
MANCHESTER
M1 6NG

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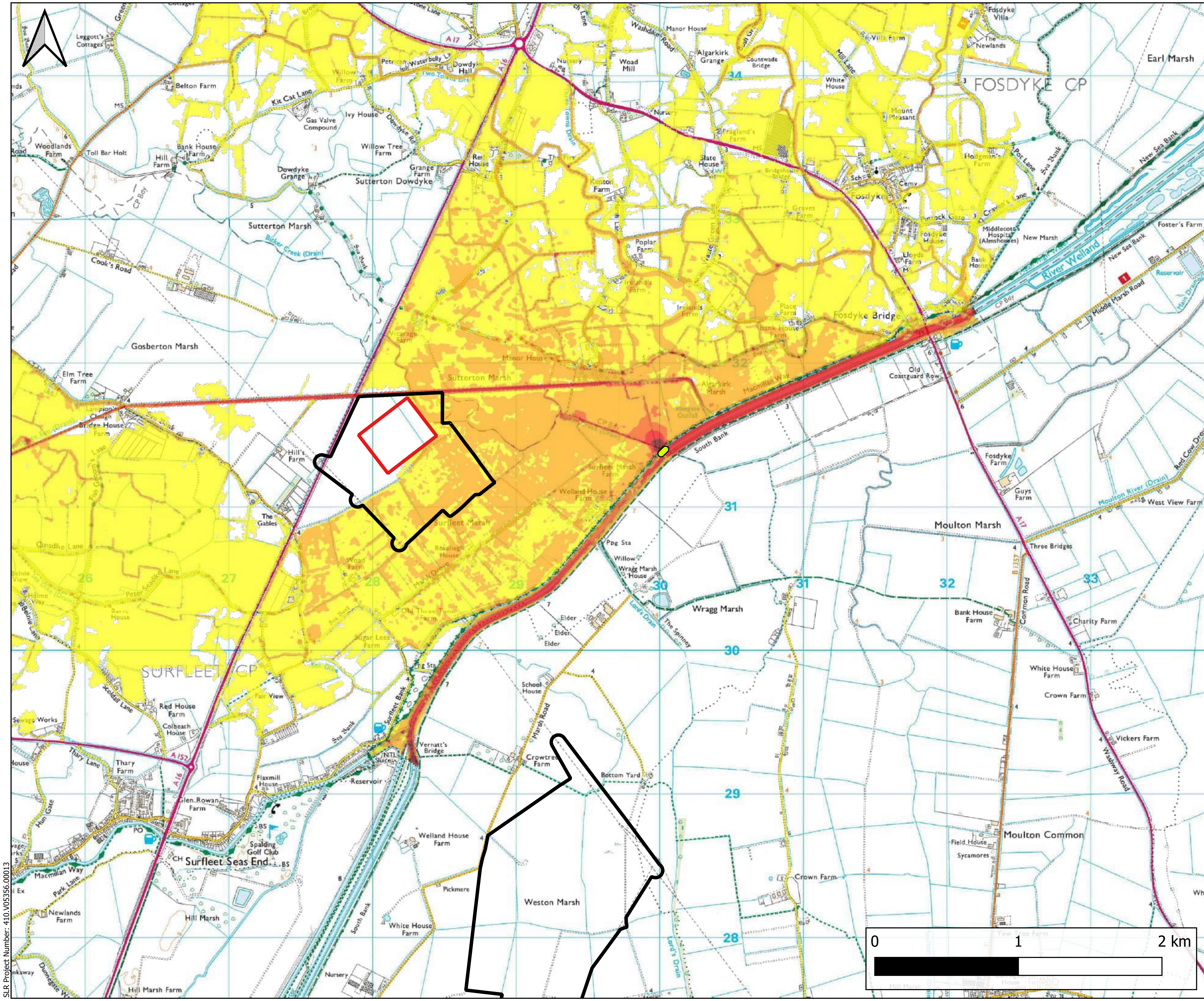
Maximum Flood Depths
1:1000yr North Breach 1
Proposed Scenario

Scale: A3
Date: November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Onshore Substation Area
- Breach Location

Maximum Flood Velocity (m/s)

- 0.00 - 0.30
- 0.30 - 1.00
- 1.00 - 1.50
- 1.50 - 2.50
- > 2.50

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 42

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

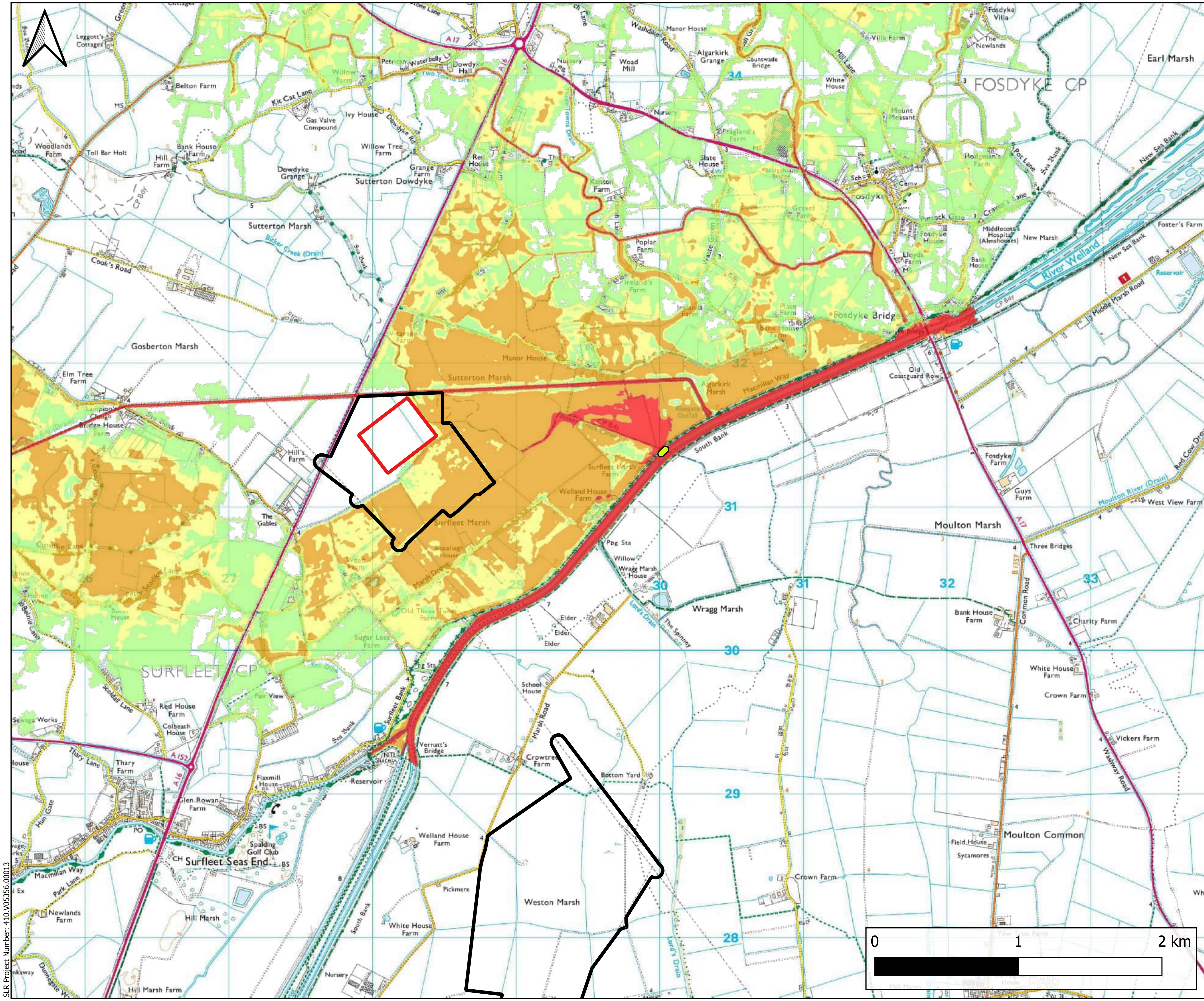
6 PRINCESS STREET
MANCHESTER
M1 6NG

www.slrconsulting.com

Maximum Flood Velocity 1:1000yr North Breach 1 Proposed Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Onshore Substation Area
- Breach Location

Flood Hazard Rating

- <= 0.7500
- 0.7500 - 1.2500
- 1.2500 - 2.0000
- > 2.0000

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 43

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

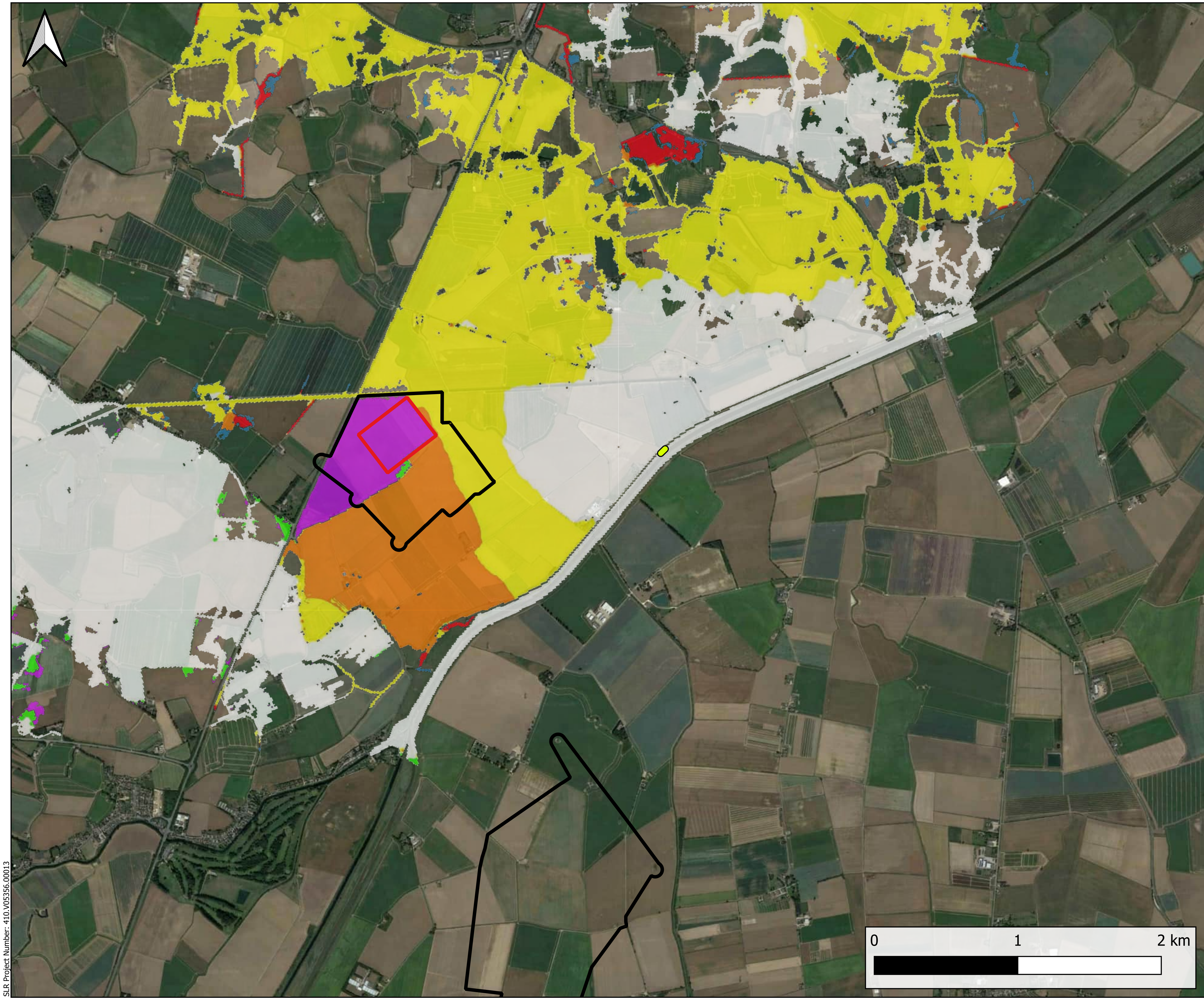
SLR

6 PRINCESS STREET
MANCHESTER
M1 6NG
www.slrconsulting.com

Maximum Flood Hazard 1:1000yr North Breach 1 Proposed Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Onshore Substation Area
- Breach Location

Difference in Depth (m)

- <= -0.01
- -0.01 - 0.01
- 0.01 - 0.03
- 0.03 - 0.05
- 0.05 - 0.15

Change in Conditions

- Was wet now dry
- Was dry now wet

Google Satellite

Figure No. 44

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

6 PRINCESS STREET
MANCHESTER
M1 6NG

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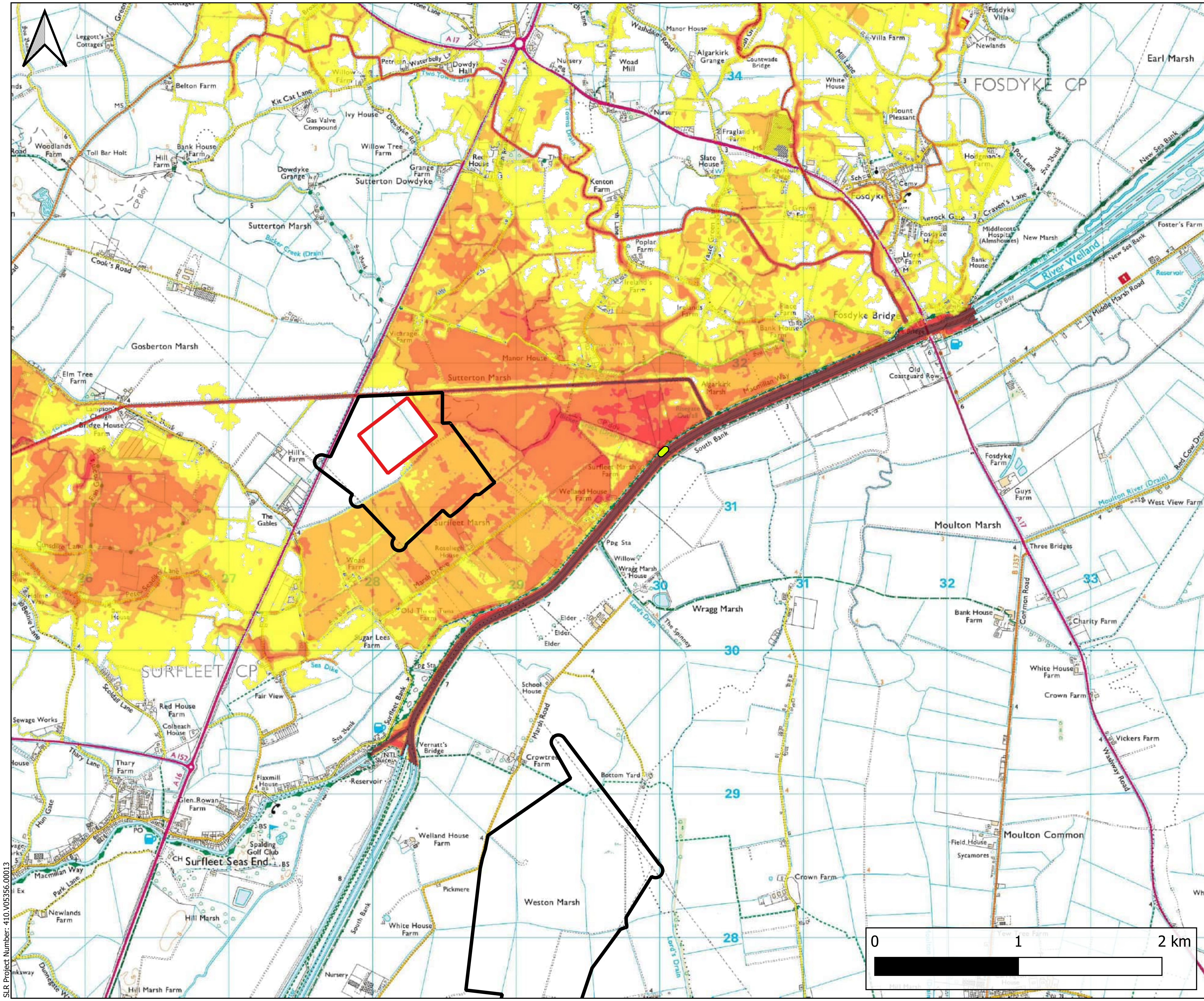
Flood Depth Difference 1:1000yr North Breach 1 Proposed Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Onshore Substation Area
- Breach Location

Maximum Flood Depth (m)

- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 2.00
- > 2.00

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 45

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

6 PRINCESS STREET
MANCHESTER
M1 6NG
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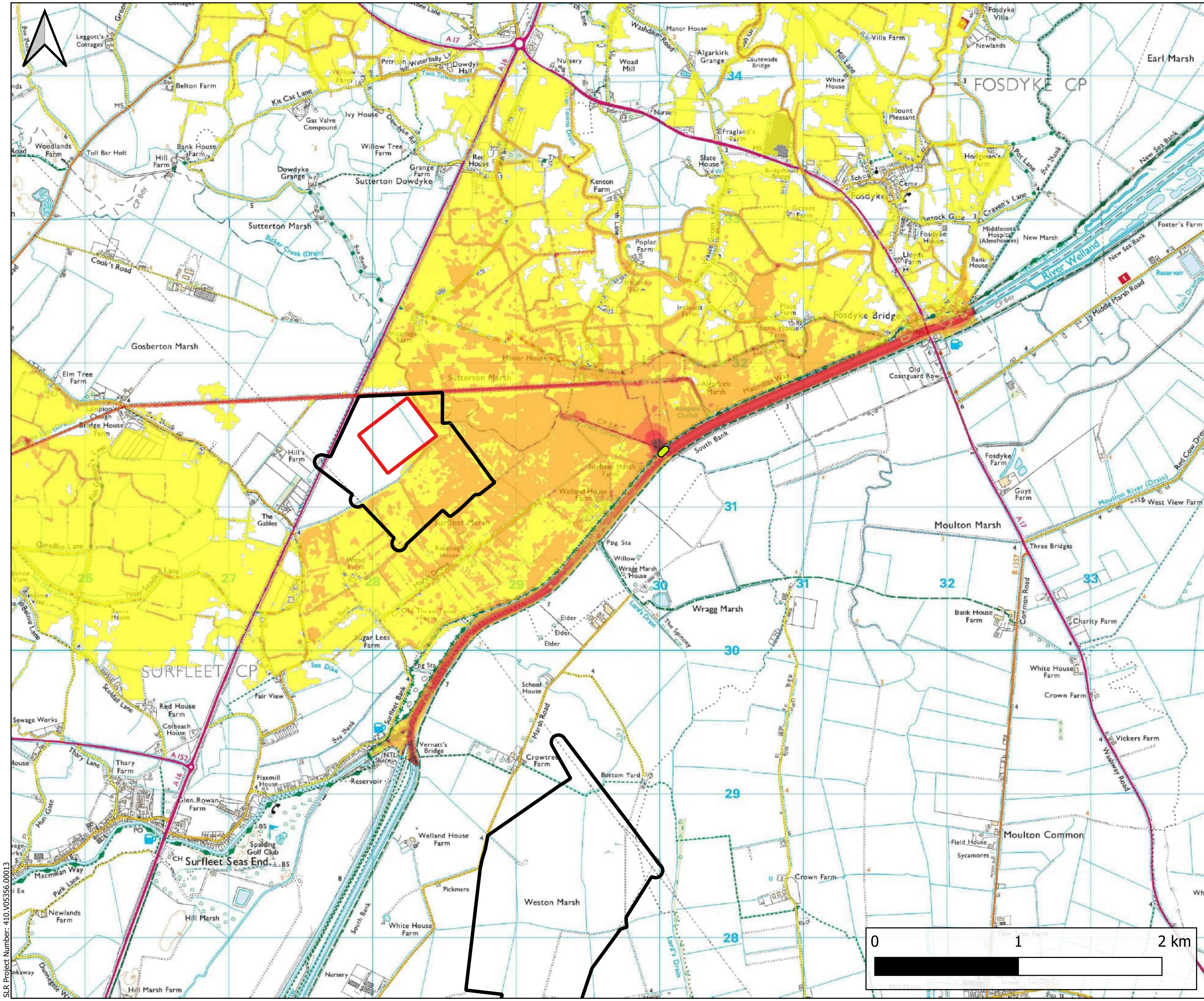
Maximum Flood Depths 1:200yr+CC North Breach 1 Proposed Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Onshore Substation Area
- Breach Location

Maximum Flood Velocity (m/s)

- 0.00 - 0.30
- 0.30 - 1.00
- 1.00 - 1.50
- 1.50 - 2.50
- > 2.50

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 46

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

6 PRINCESS STREET
MANCHESTER
M1 6NG
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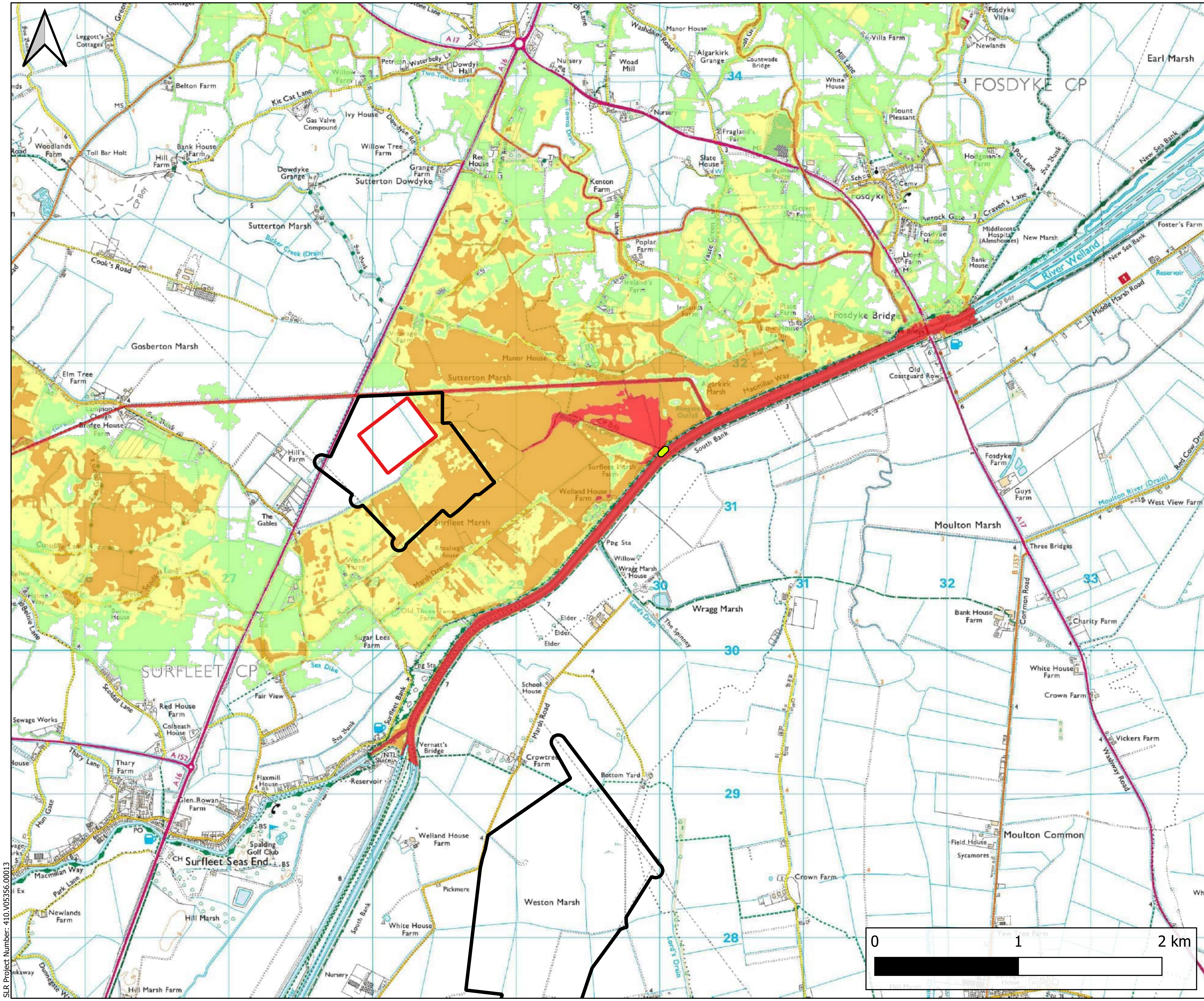
Maximum Flood Velocity 1:200yr+CC North Breach 1 Proposed Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Onshore Substation Area
- Breach Location

Flood Hazard Rating

- <= 0.7500
- 0.7500 - 1.2500
- 1.2500 - 2.0000
- > 2.0000

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 47

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

6 PRINCESS STREET
MANCHESTER
M1 6NG

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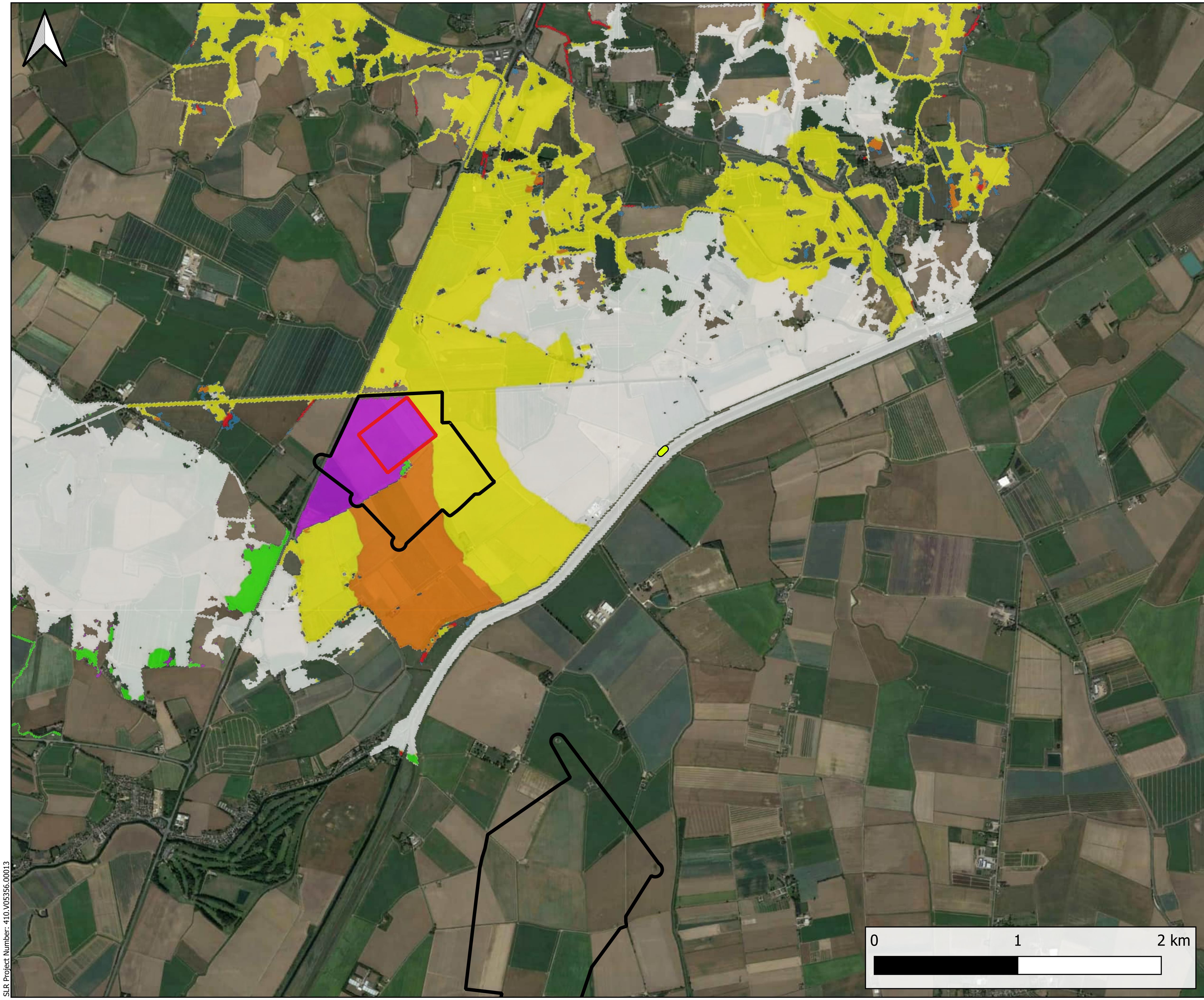
Maximum Flood Hazard 1:200yr+CC North Breach 1 Proposed Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Onshore Substation Area
- Breach Location

Difference in Depth (m)

- <= -0.01
- -0.01 - 0.01
- 0.01 - 0.03
- 0.03 - 0.05
- 0.05 - 0.15

Change in Conditions

- Was wet now dry
- Was dry now wet

Google Satellite

Figure No. 48

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

6 PRINCESS STREET
MANCHESTER
M1 6NG

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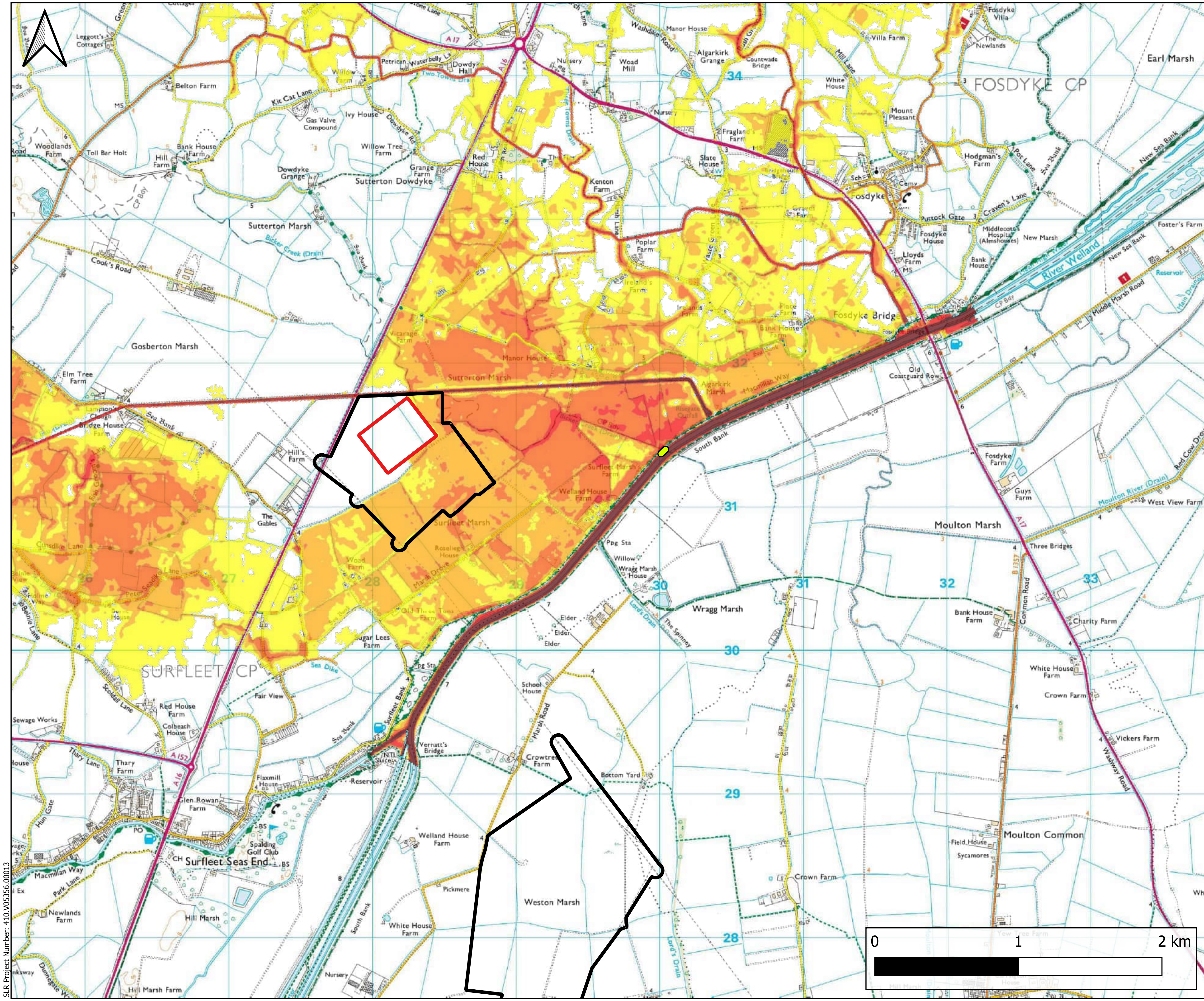
Flood Depth Difference 1:200yr+CC North Breach 1 Proposed Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Onshore Substation Area
- Breach Location

Maximum Flood Depth (m)

- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 2.00
- > 2.00

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 49

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

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MANCHESTER
M1 6NG
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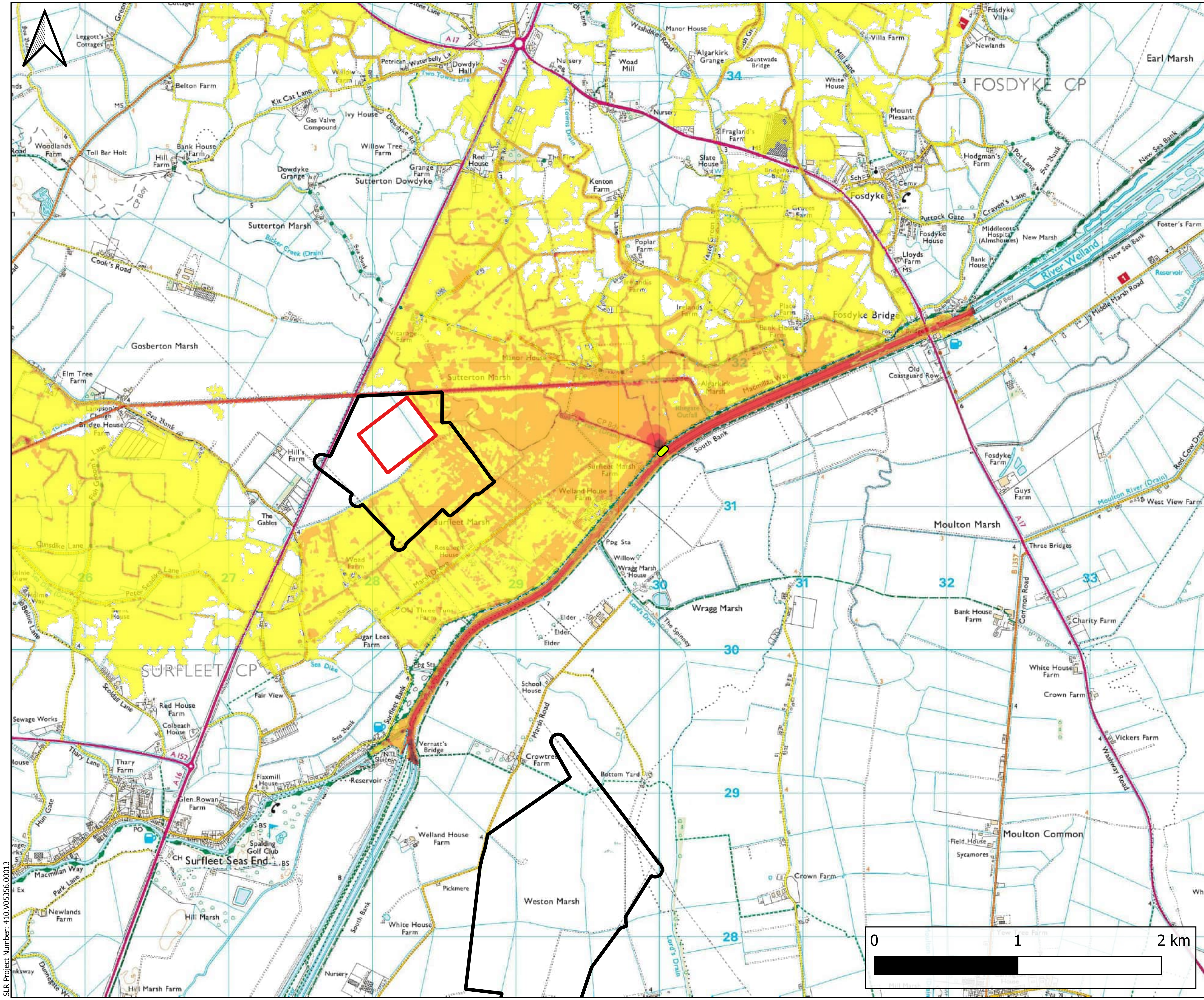
Maximum Flood Depths 1:200yr North Breach 1 Proposed Scenario

Scale: A3

Date: November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Onshore Substation Area
- Breach Location

Maximum Flood Velocity (m/s)

- 0.00 - 0.30
- 0.30 - 1.00
- 1.00 - 1.50
- 1.50 - 2.50
- > 2.50

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 50

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

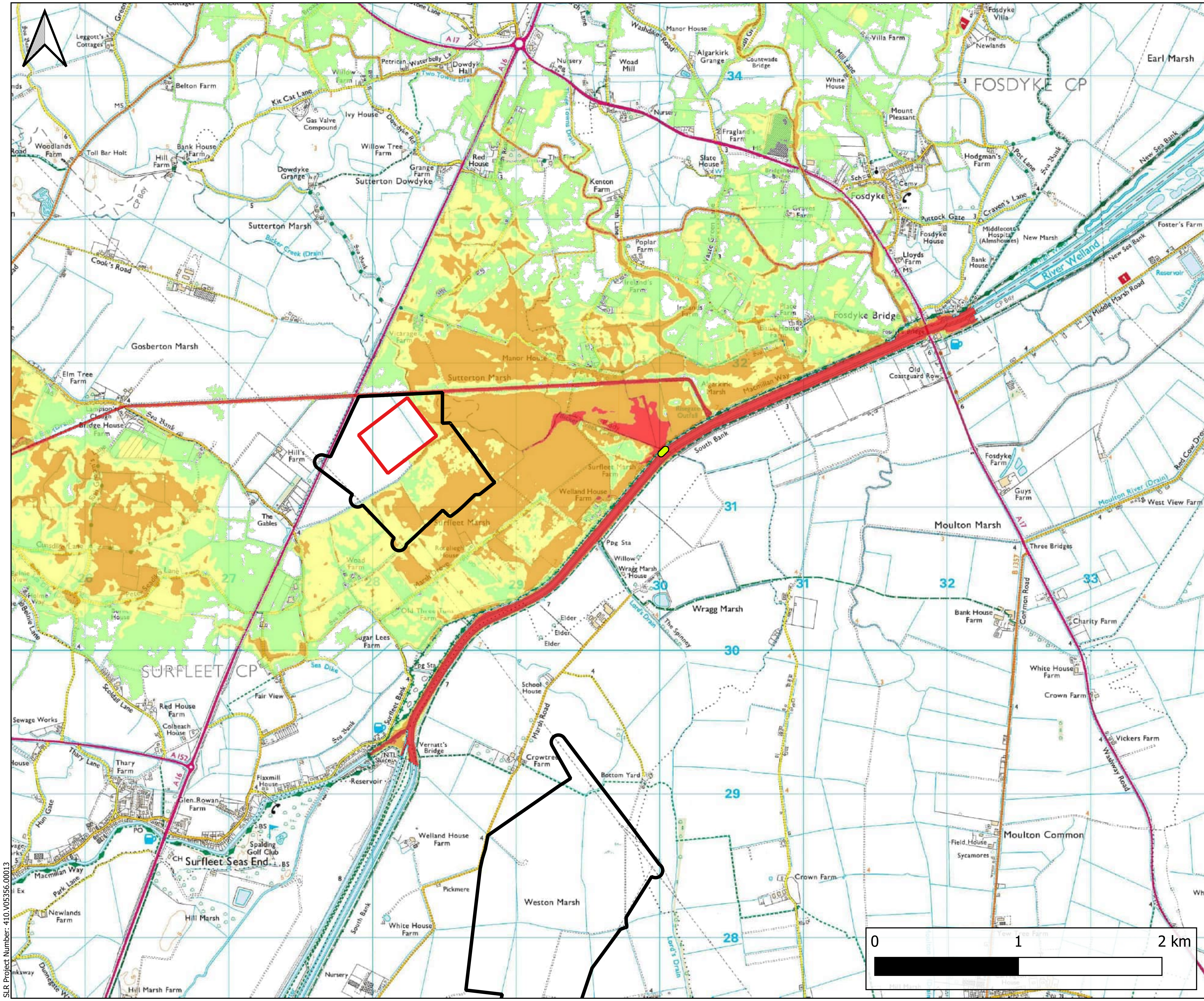
SLR

6 PRINCESS STREET
MANCHESTER
M1 6NG
www.slrconsulting.com

Maximum Flood Velocity 1:200yr North Breach 1 Proposed Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Onshore Substation Area
- Breach Location

Flood Hazard Rating

- <= 0.7500
- 0.7500 - 1.2500
- 1.2500 - 2.0000
- > 2.0000

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 51

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

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MANCHESTER
M1 6NG
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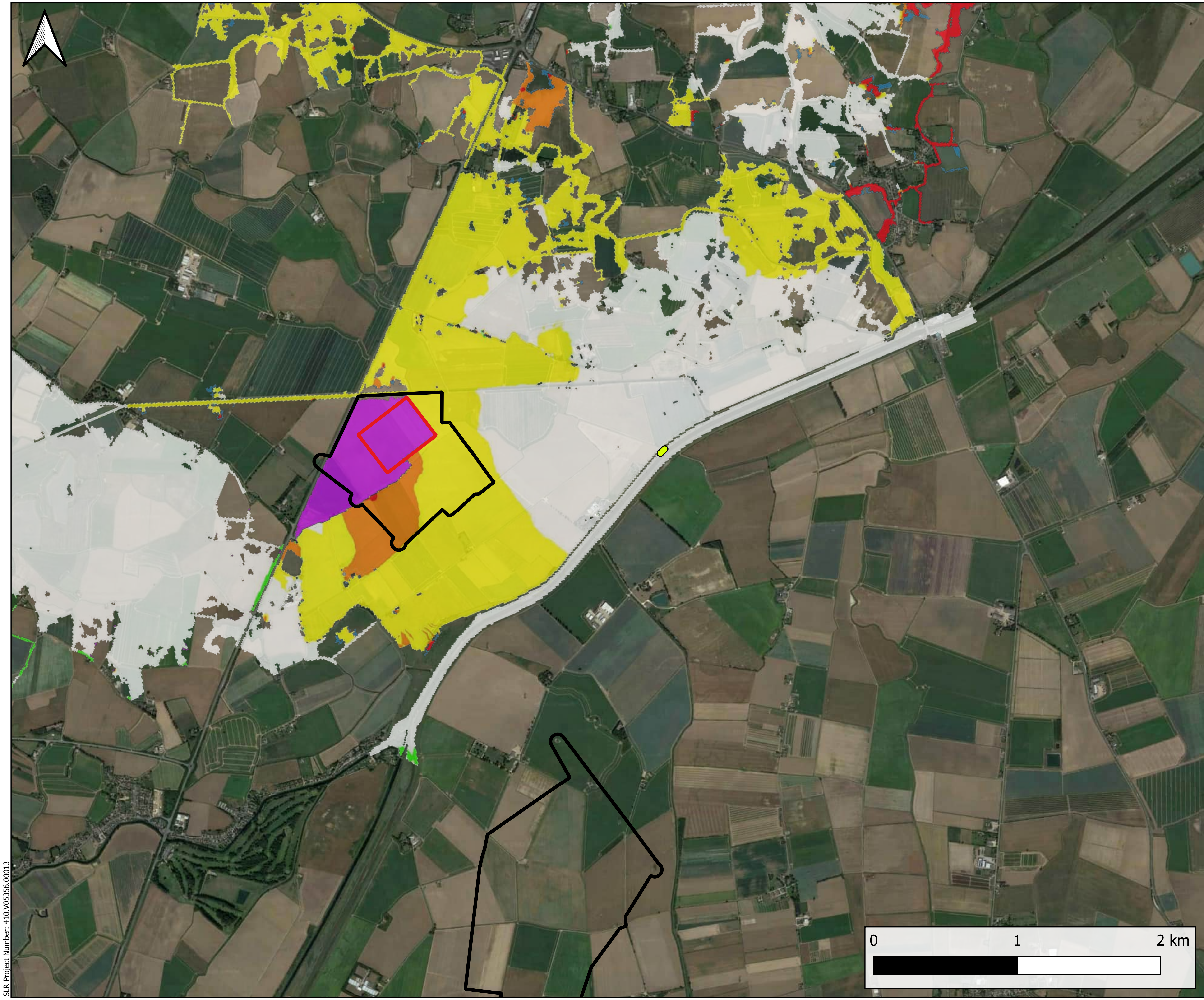
Maximum Flood Hazard 1:200yr North Breach 1 Proposed Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Onshore Substation Area
- Breach Location

Difference in Depth (m)

- <= -0.01
- -0.01 - 0.01
- 0.01 - 0.03
- 0.03 - 0.05
- 0.05 - 0.15

Change in Conditions

- Was wet now dry
- Was dry now wet

Google Satellite

Figure No. 52

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

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MANCHESTER
M1 6NG
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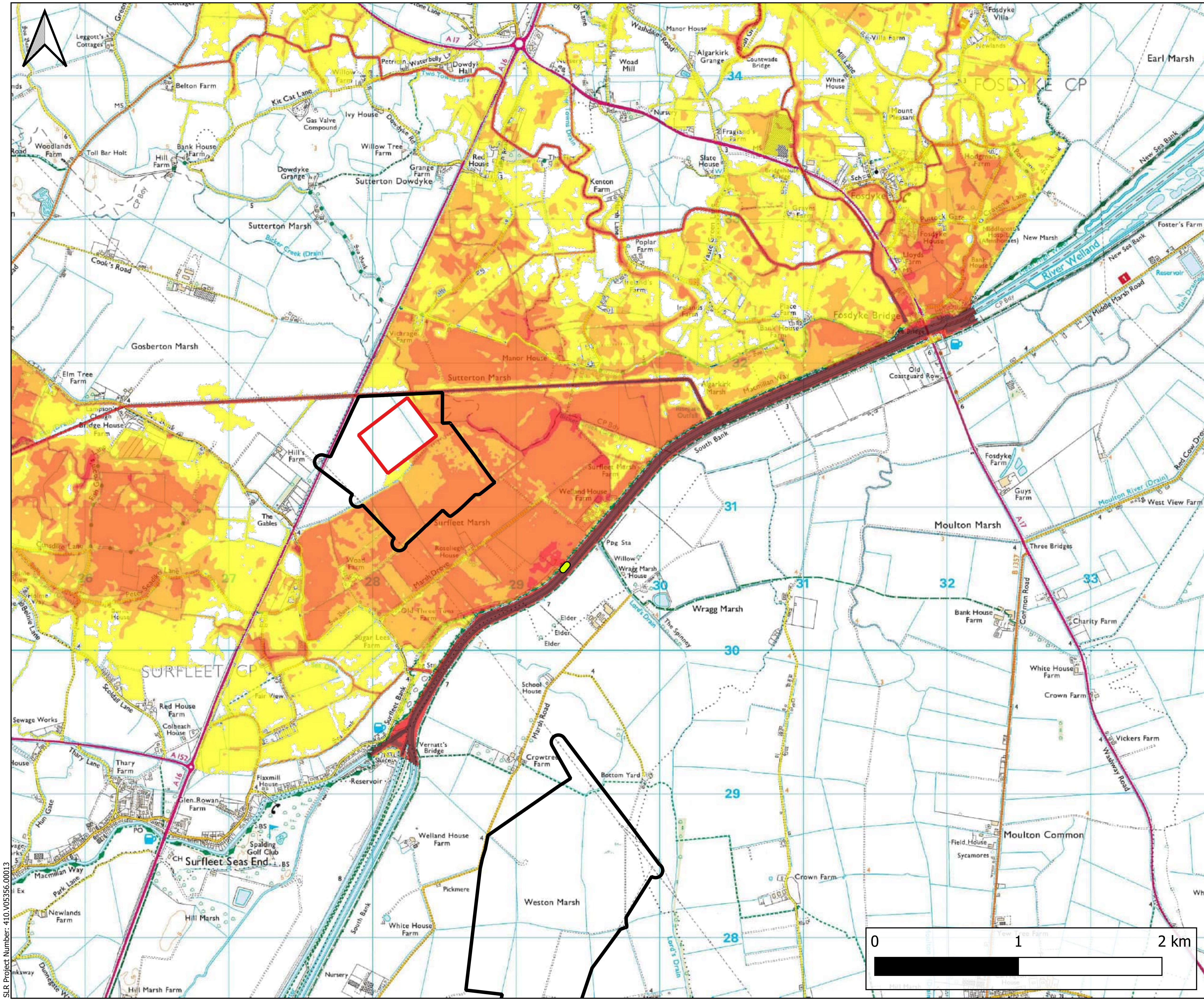
Flood Depth Difference 1:200yr North Breach 1 Proposed Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Onshore Substation Area
- Breach Location

Maximum Flood Depth (m)

- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 2.00
- > 2.00

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 53

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

6 PRINCESS STREET
MANCHESTER
M1 6NG

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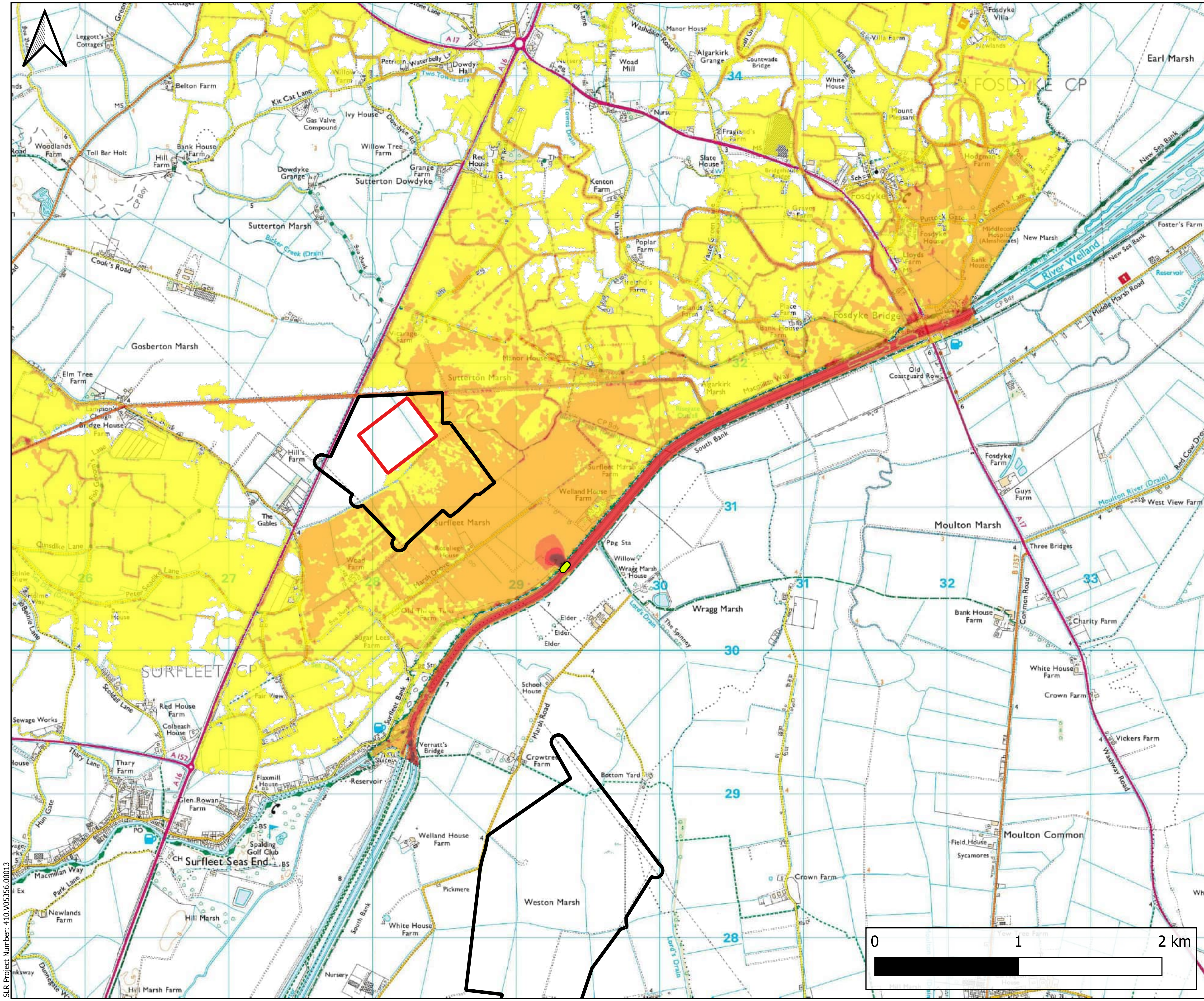
Maximum Flood Depths 1:1000yr+CC North Breach 2 Proposed Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Onshore Substation Area
- Breach Location

Maximum Flood Velocity (m/s)

- 0.00 - 0.30
- 0.30 - 1.00
- 1.00 - 1.50
- 1.50 - 2.50
- > 2.50

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 54

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

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MANCHESTER
M1 6NG

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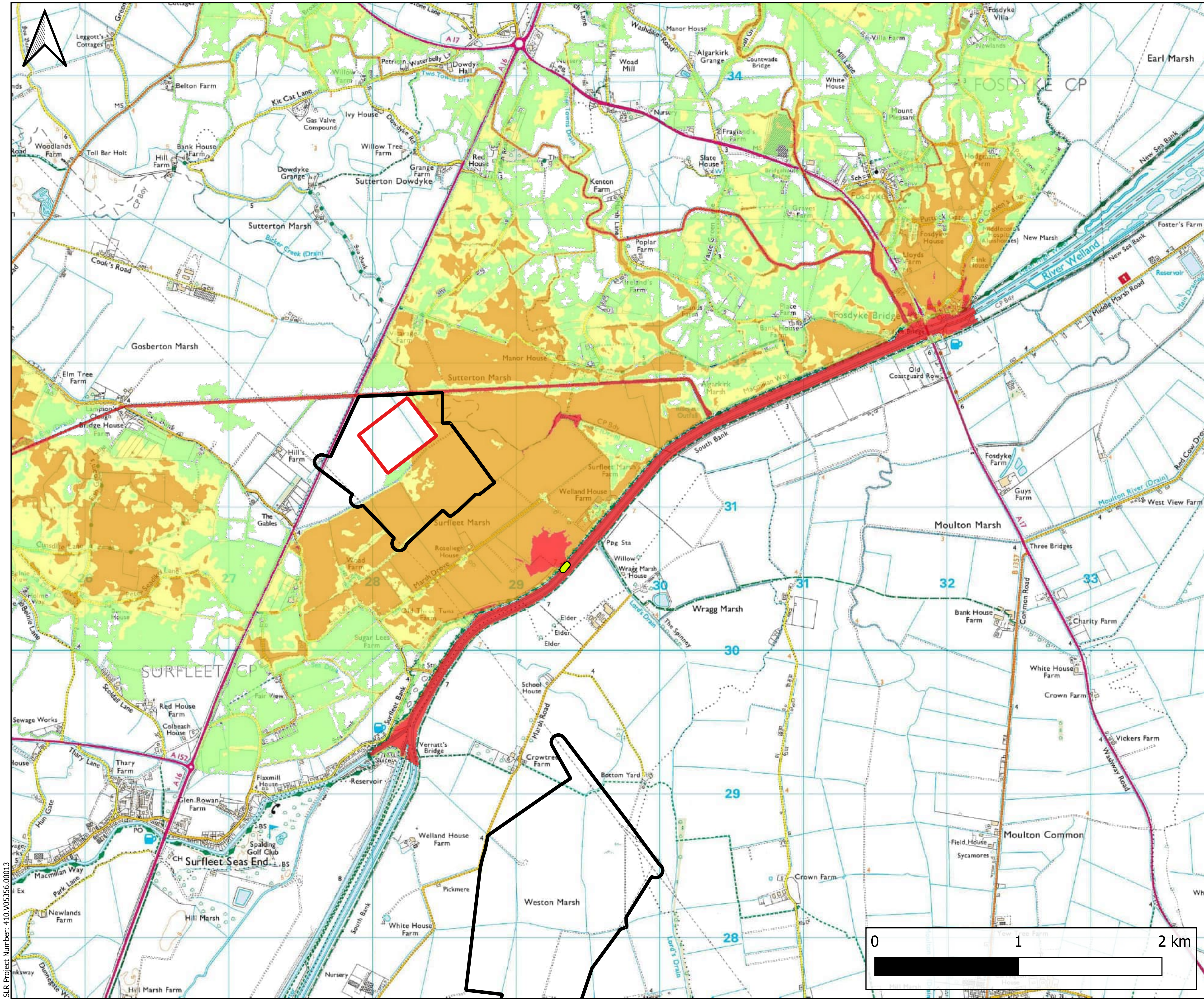
Maximum Flood Velocity 1:1000yr+CC North Breach 2 Proposed Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Onshore Substation Area
- Breach Location

Flood Hazard Rating

- <= 0.7500
- 0.7500 - 1.2500
- 1.2500 - 2.0000
- > 2.0000

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 55

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

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MANCHESTER
M1 6NG

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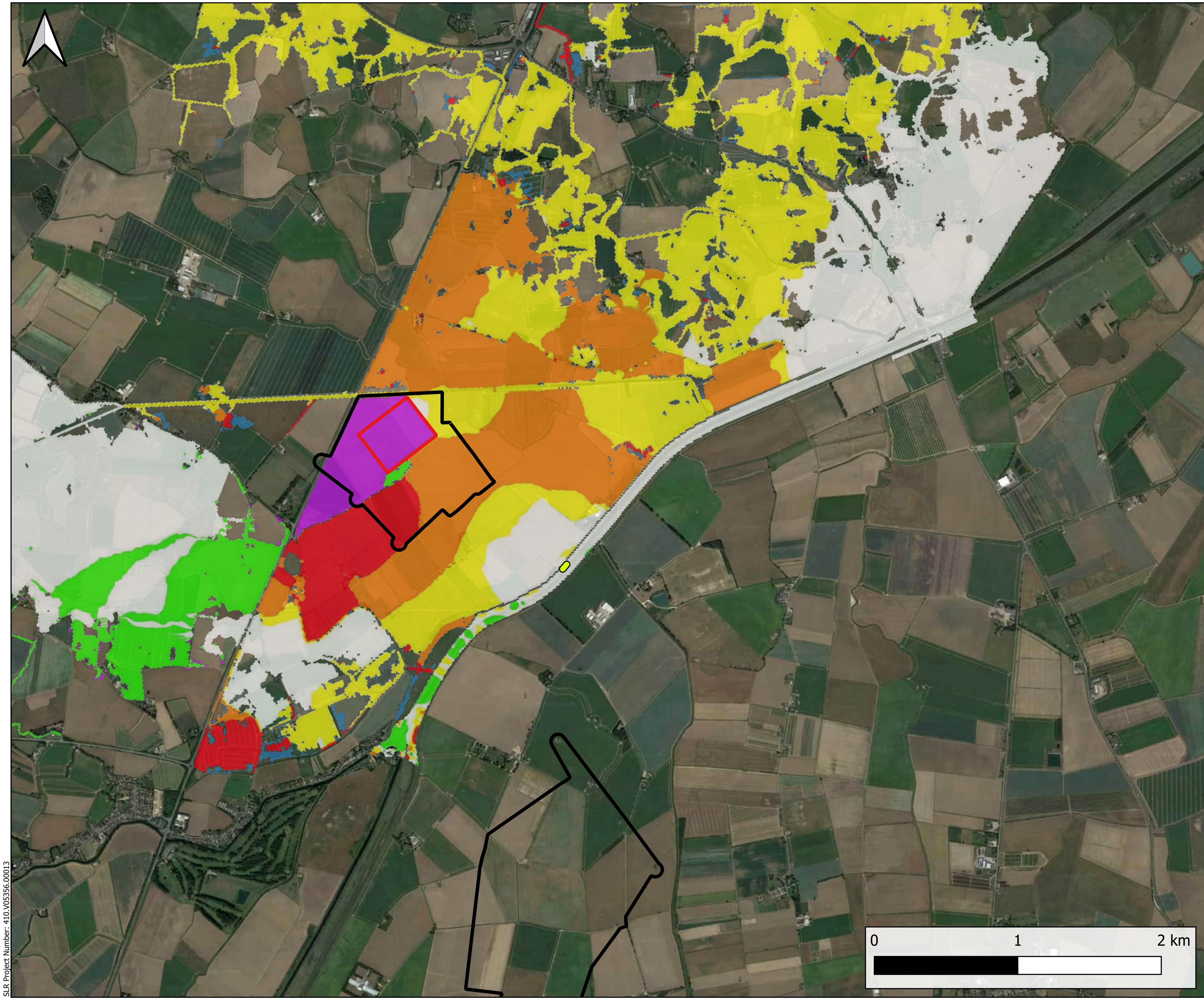
Maximum Flood Hazard 1:1000yr+CC North Breach 2 Proposed Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Onshore Substation Area
- Breach Location

Difference in Depth (m)

- <= -0.01
- -0.01 - 0.01
- 0.01 - 0.03
- 0.03 - 0.05
- 0.05 - 0.15

Change in Conditions

- Was wet now dry
- Was dry now wet

Google Satellite

Figure No. 56

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

6 PRINCESS STREET
MANCHESTER
M1 6NG

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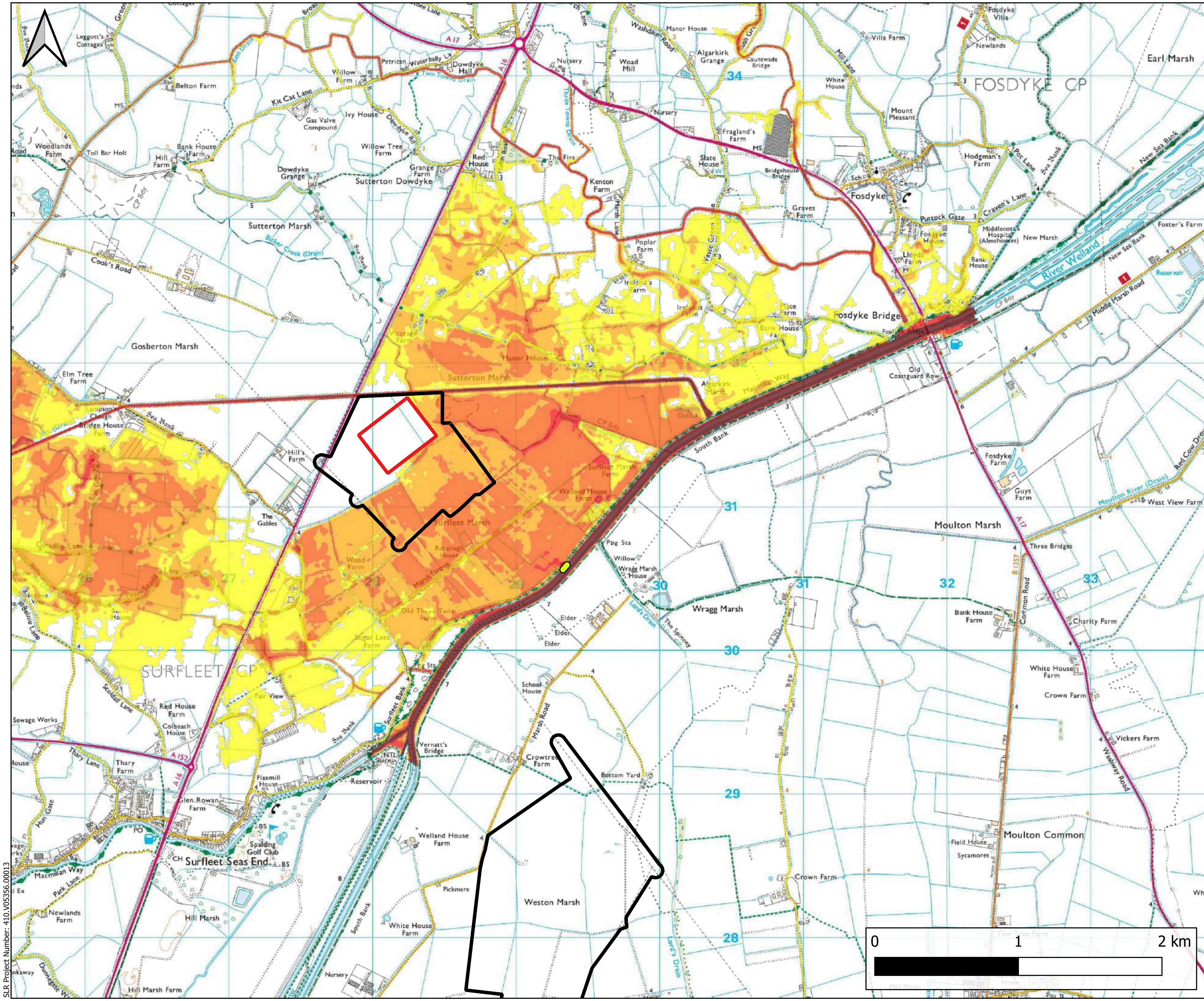
Flood Depth Difference 1:1000yr+CC North Breach 2 Proposed Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Onshore Substation Area
- Breach Location

Maximum Flood Depth (m)

- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 2.00
- > 2.00

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 57

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

6 PRINCESS STREET
MANCHESTER
M1 6NG
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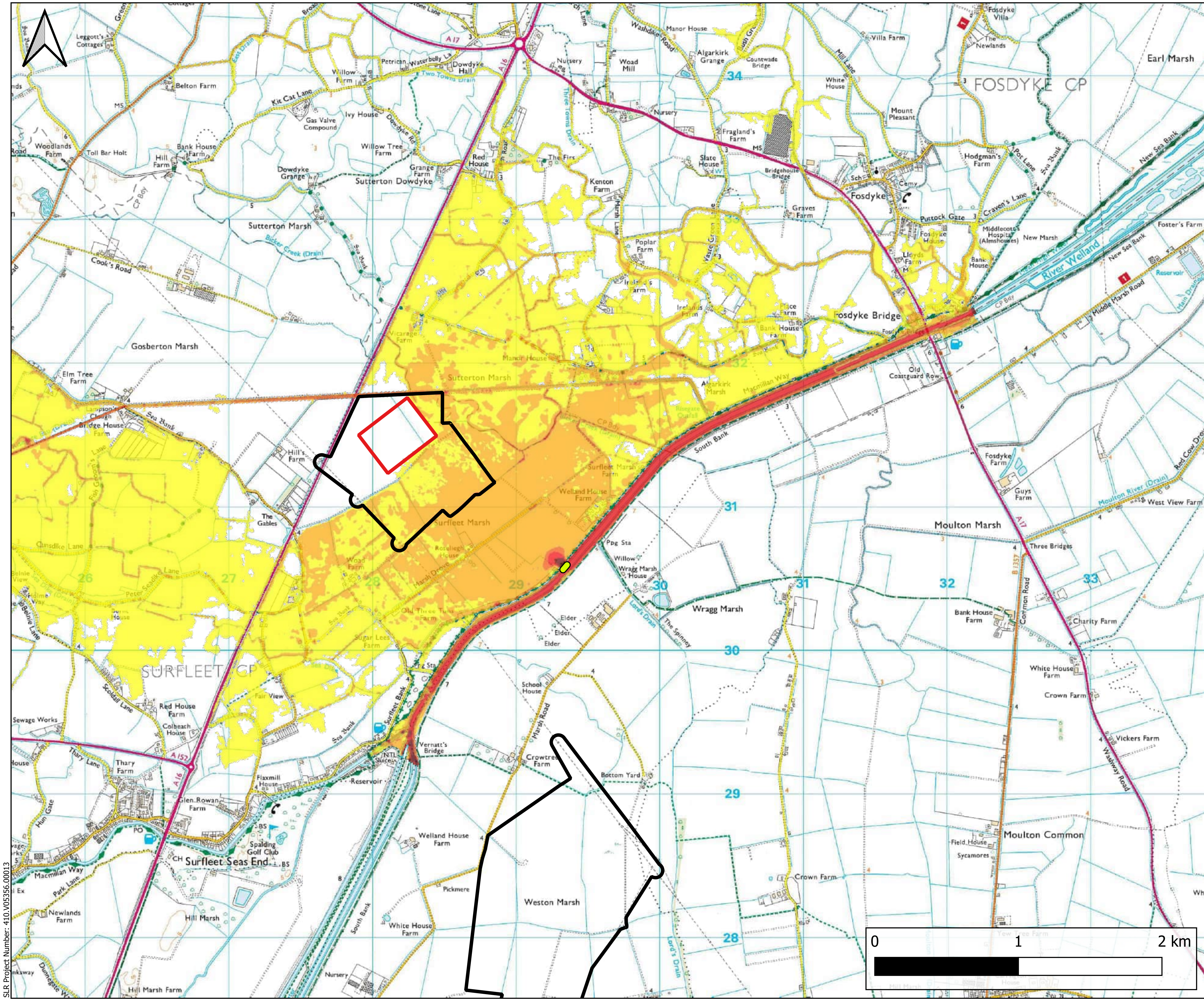
Maximum Flood Depths 1:1000yr North Breach 2 Proposed Scenario

Scale: A3

Date: November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Onshore Substation Area
- Breach Location

Maximum Flood Velocity (m/s)

- 0.00 - 0.30
- 0.30 - 1.00
- 1.00 - 1.50
- 1.50 - 2.50
- > 2.50

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 58

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

6 PRINCESS STREET
MANCHESTER
M1 6NG
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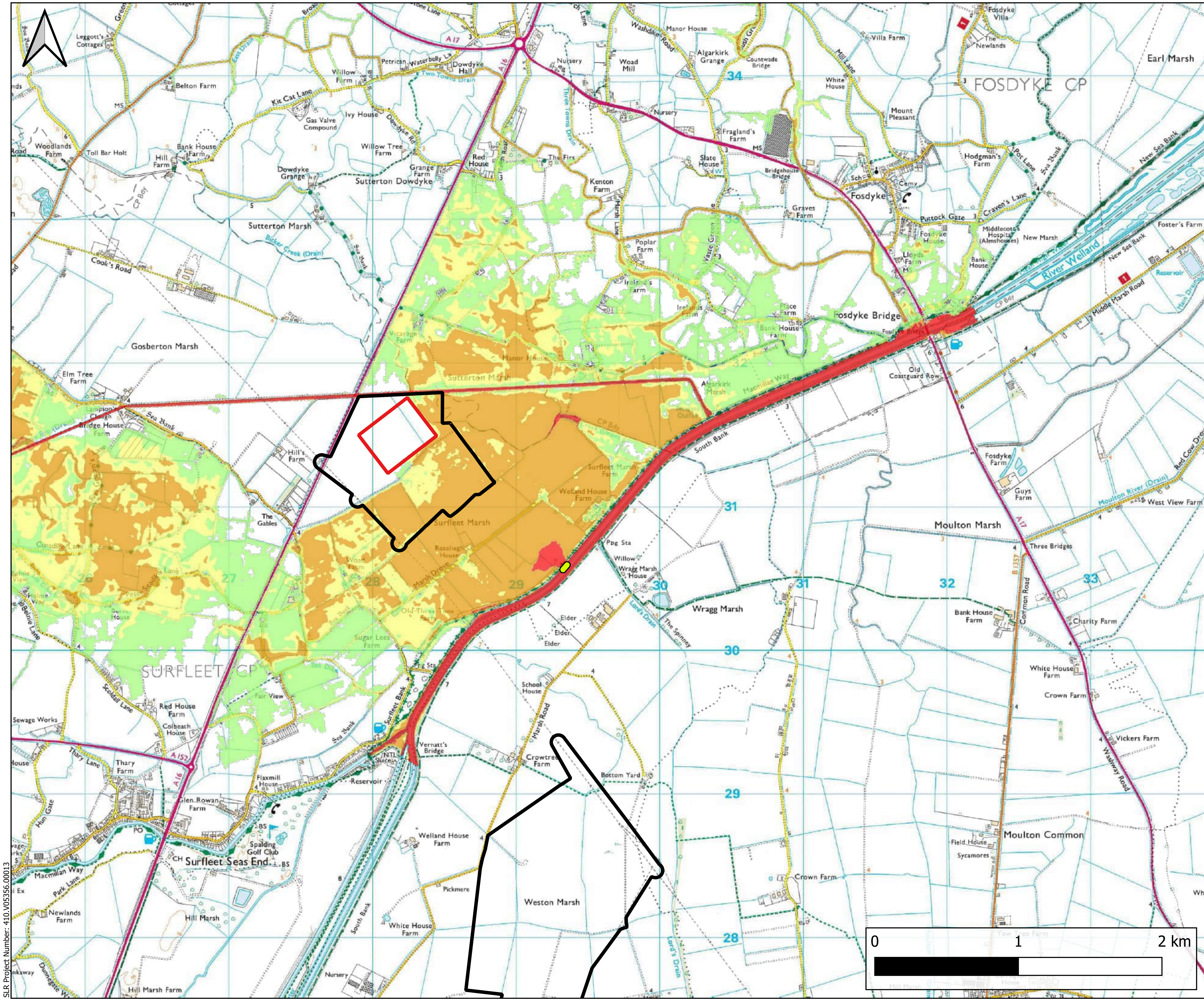
Maximum Flood Velocity 1:1000yr North Breach 2 Proposed Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Onshore Substation Area
- Breach Location

Flood Hazard Rating

- <= 0.7500
- 0.7500 - 1.2500
- 1.2500 - 2.0000
- > 2.0000

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 59

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

6 PRINCESS STREET
MANCHESTER
M1 6NG

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Maximum Flood Hazard 1:1000yr North Breach 2 Proposed Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013

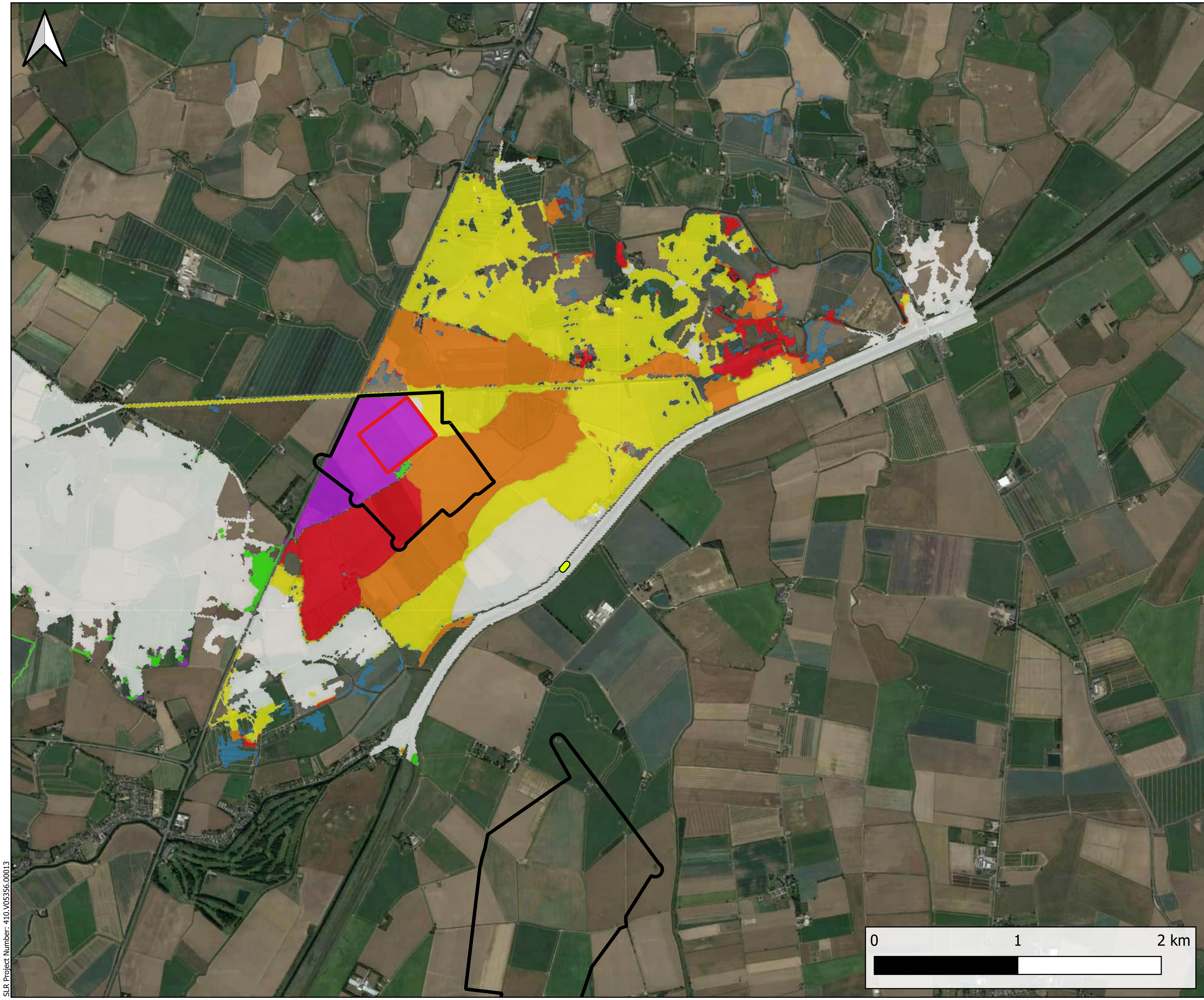

Figure No. 60

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

6 PRINCESS STREET
MANCHESTER
M1 6NG

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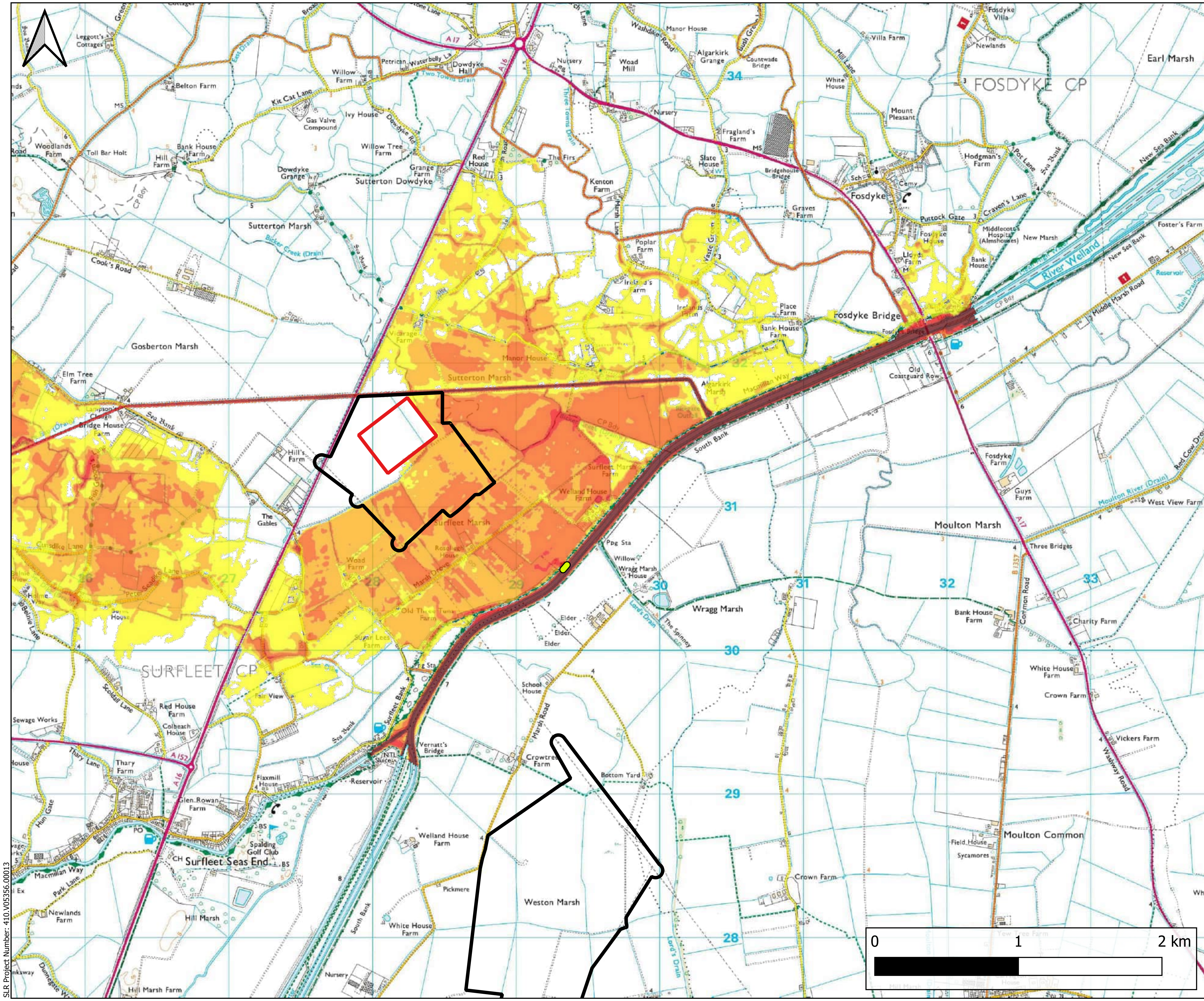
Flood Depth Difference 1:1000yr North Breach 2 Proposed Scenario

Scale: A3

Date: November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Onshore Substation Area
- Breach Location

Maximum Flood Depth (m)

- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 2.00
- > 2.00

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 61

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

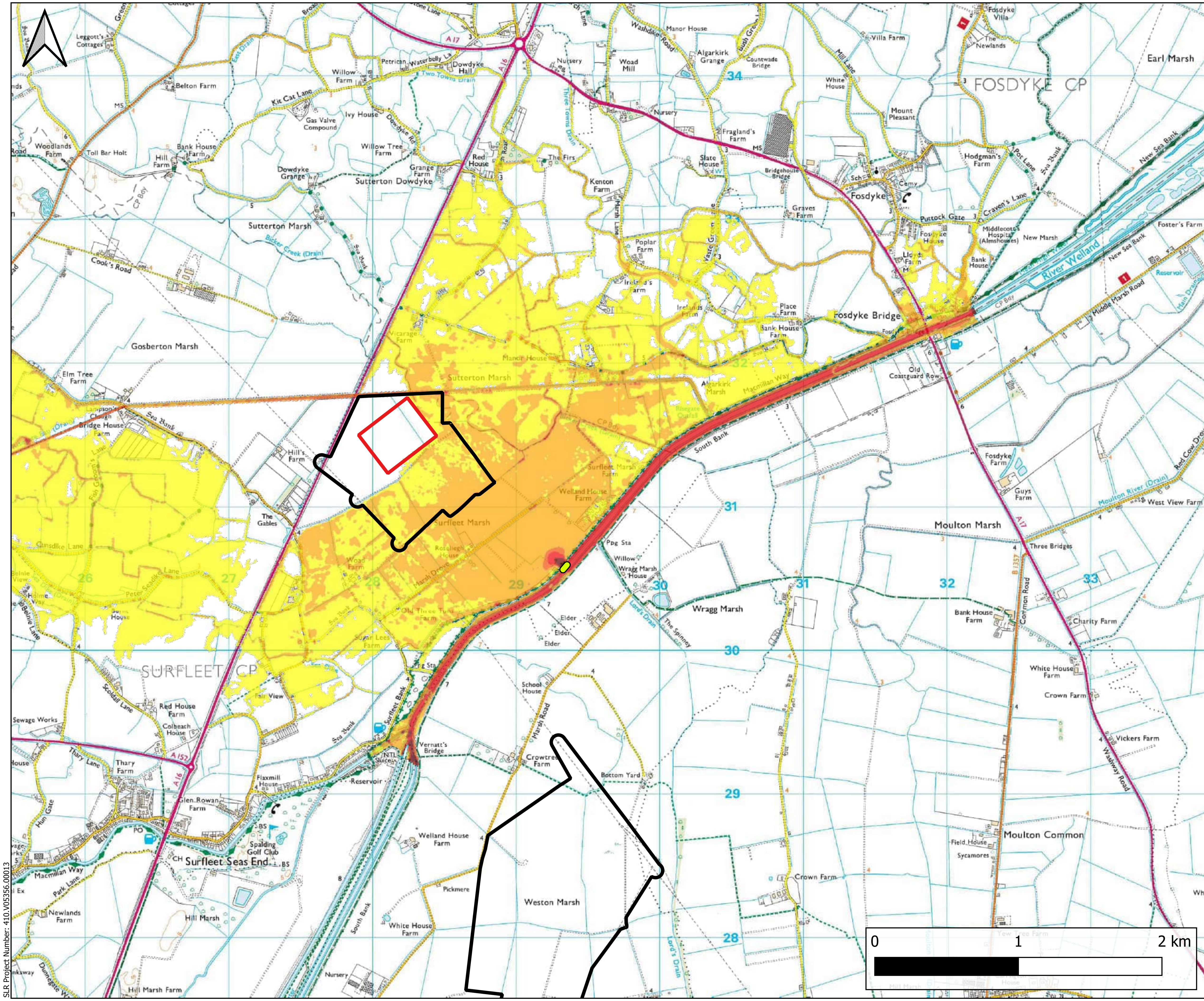
SLR

6 PRINCESS STREET
MANCHESTER
M1 6NG
www.slrconsulting.com

Maximum Flood Depths 1:200yr+CC North Breach 2 Proposed Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Onshore Substation Area
- Breach Location

Maximum Flood Velocity (m/s)

- 0.00 - 0.30
- 0.30 - 1.00
- 1.00 - 1.50
- 1.50 - 2.50
- > 2.50

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 62

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

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MANCHESTER
M1 6NG
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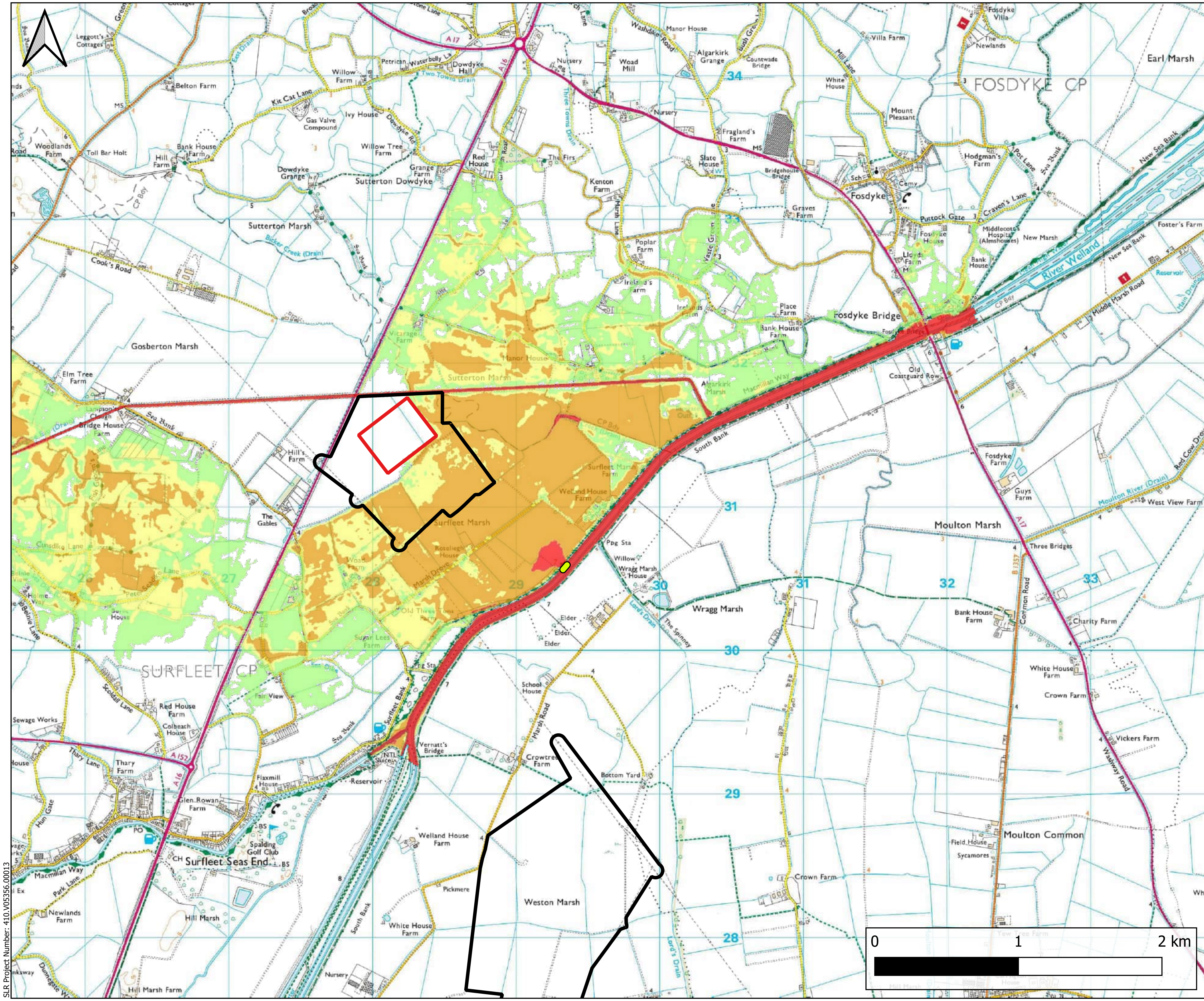
Maximum Flood Velocity 1:200yr+CC North Breach 2 Proposed Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Onshore Substation Area
- Breach Location

Flood Hazard Rating

- <= 0.7500
- 0.7500 - 1.2500
- 1.2500 - 2.0000
- > 2.0000

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 63

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

6 PRINCESS STREET
MANCHESTER
M1 6NG

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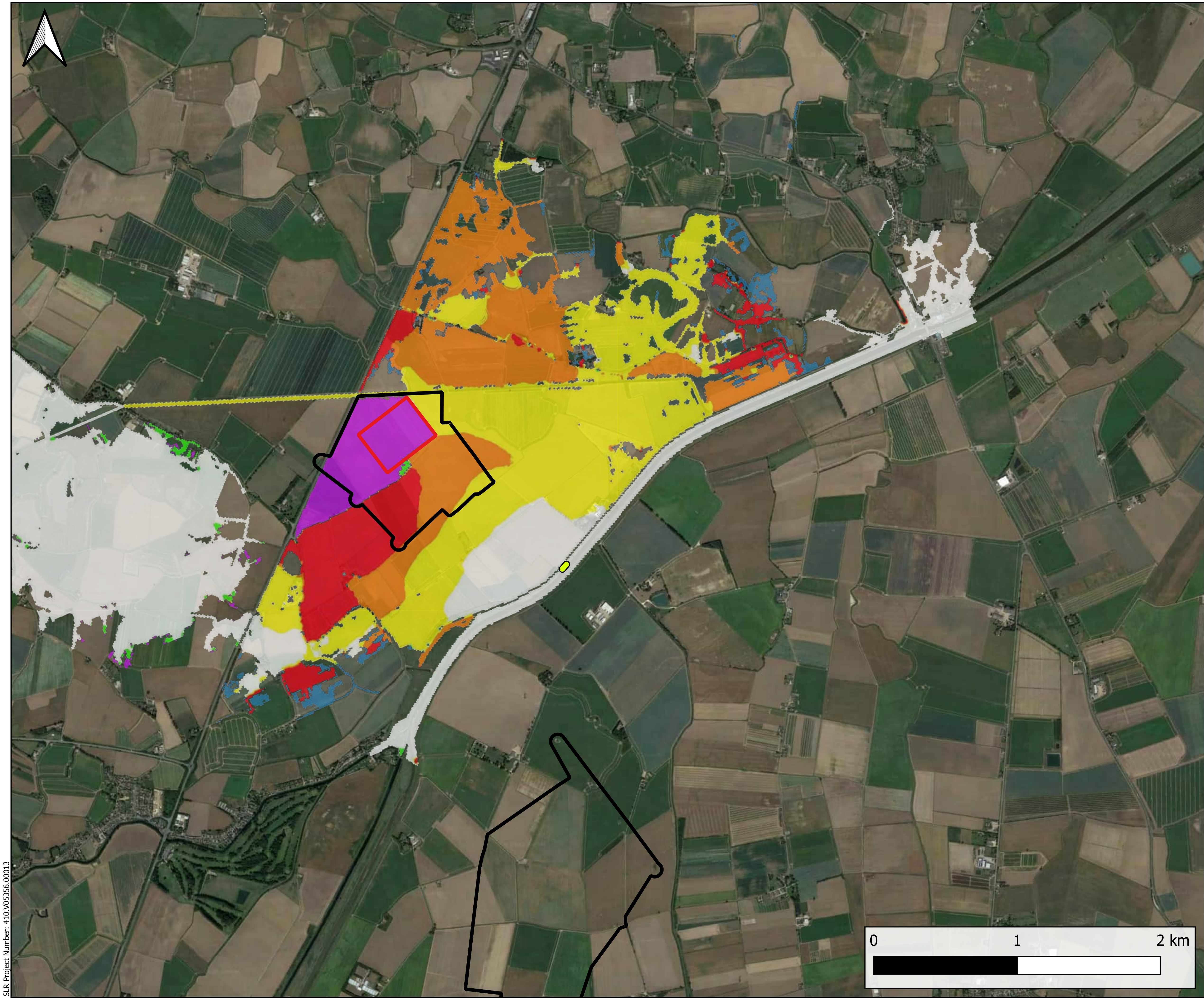
Maximum Flood Hazard 1:200yr+CC North Breach 2 Proposed Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

Substation Search Areas
Onshore Substation Area
Breach Location
Difference in Depth (m)
<= -0.01
-0.01 - 0.01
0.01 - 0.03
0.03 - 0.05
0.05 - 0.15
Change in Conditions
Was wet now dry
Was dry now wet
Google Satellite

Figure No. 64

Project
Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client
Outer Dowsing Offshore Wind

SLR
6 PRINCESS STREET
MANCHESTER
M1 6NG
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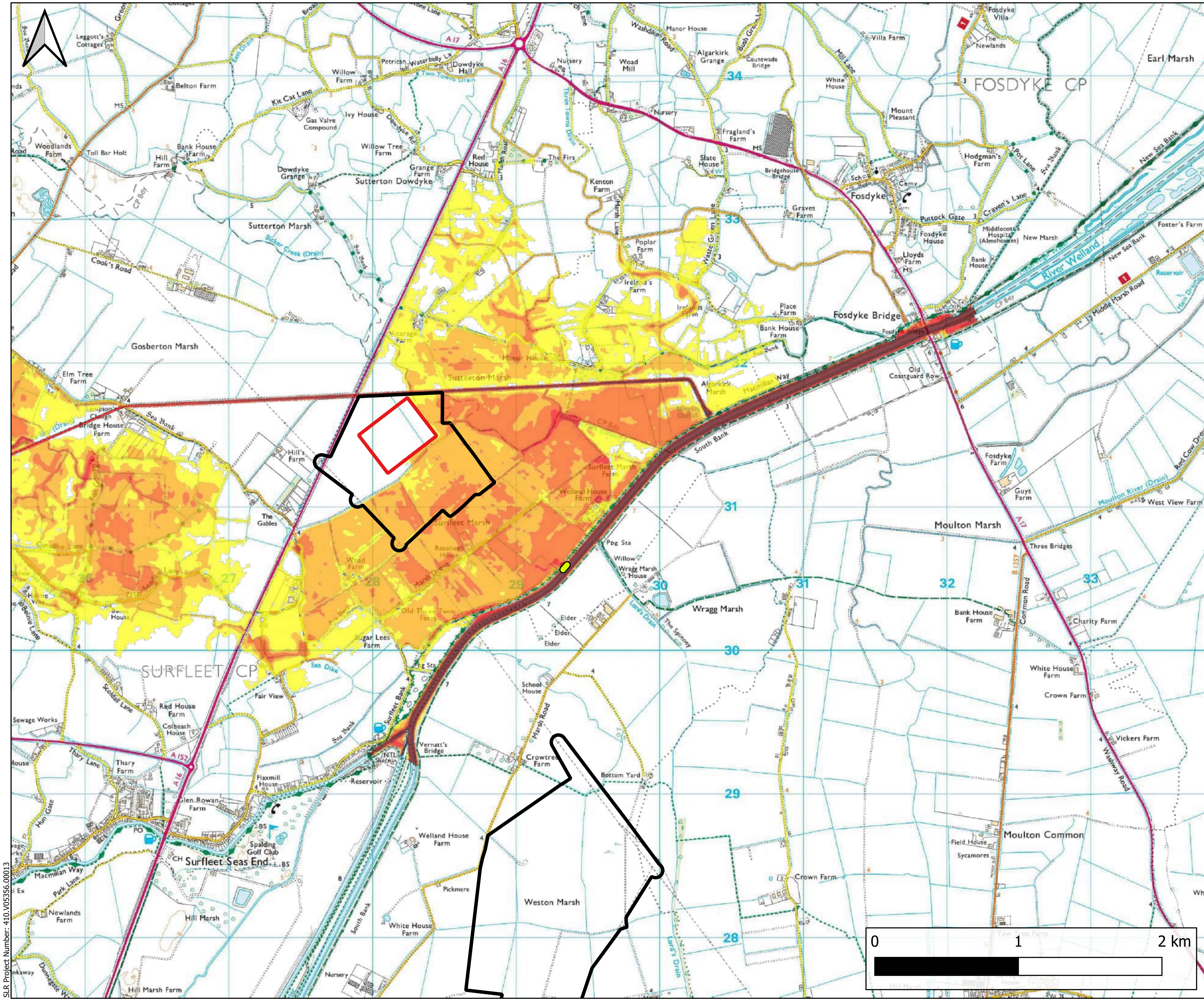
Flood Depth Difference 1:200yr+CC North Breach 2 Proposed Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Onshore Substation Area
- Breach Location

Maximum Flood Depth (m)

- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 2.00
- > 2.00

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 65

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

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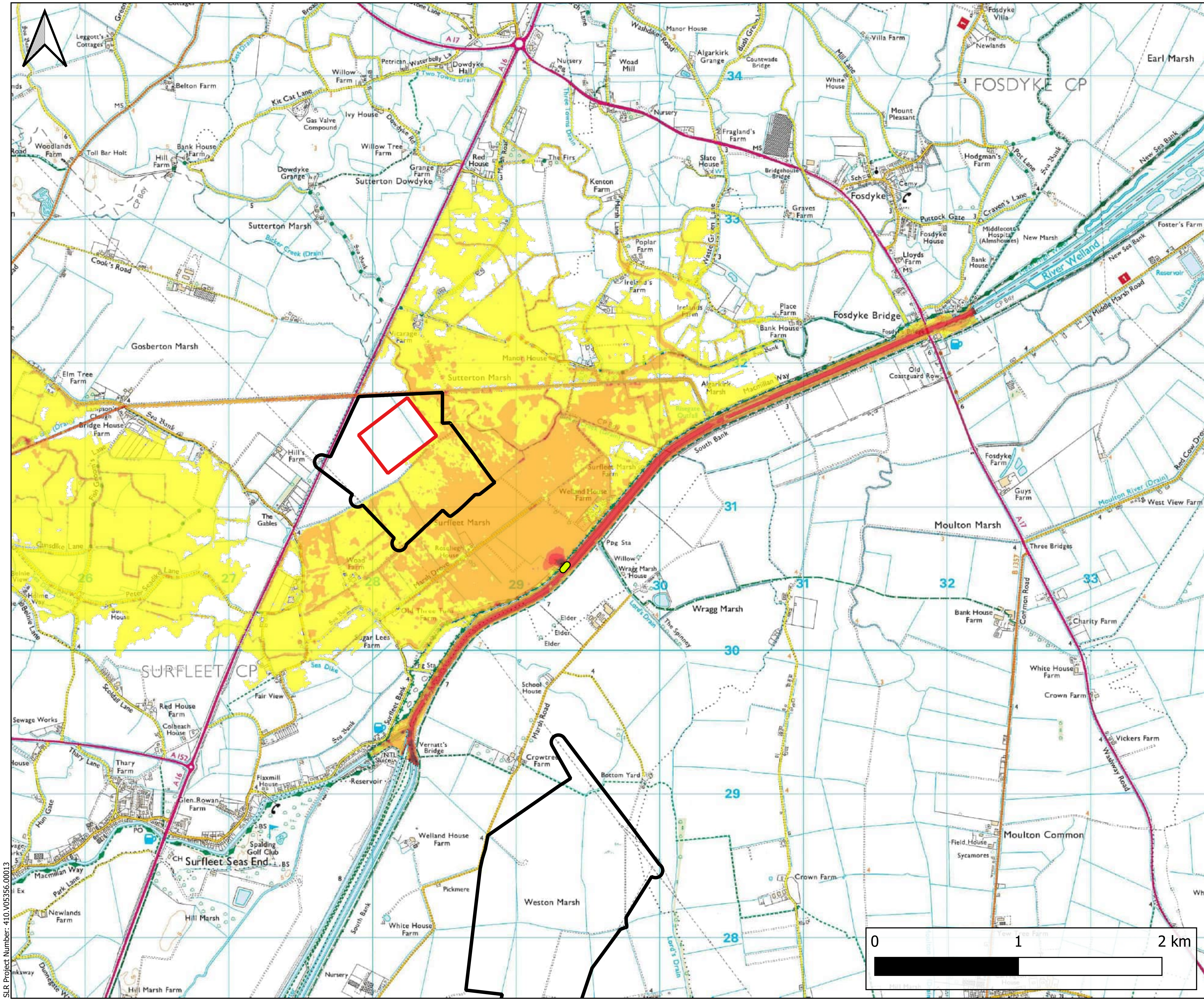
MANCHESTER
M1 6NG
www.slrconsulting.com

Maximum Flood Depths 1:200yr North Breach 2 Proposed Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Onshore Substation Area
- Breach Location

Maximum Flood Velocity (m/s)

- 0.00 - 0.30
- 0.30 - 1.00
- 1.00 - 1.50
- 1.50 - 2.50
- > 2.50

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 66

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

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MANCHESTER
M1 6NG

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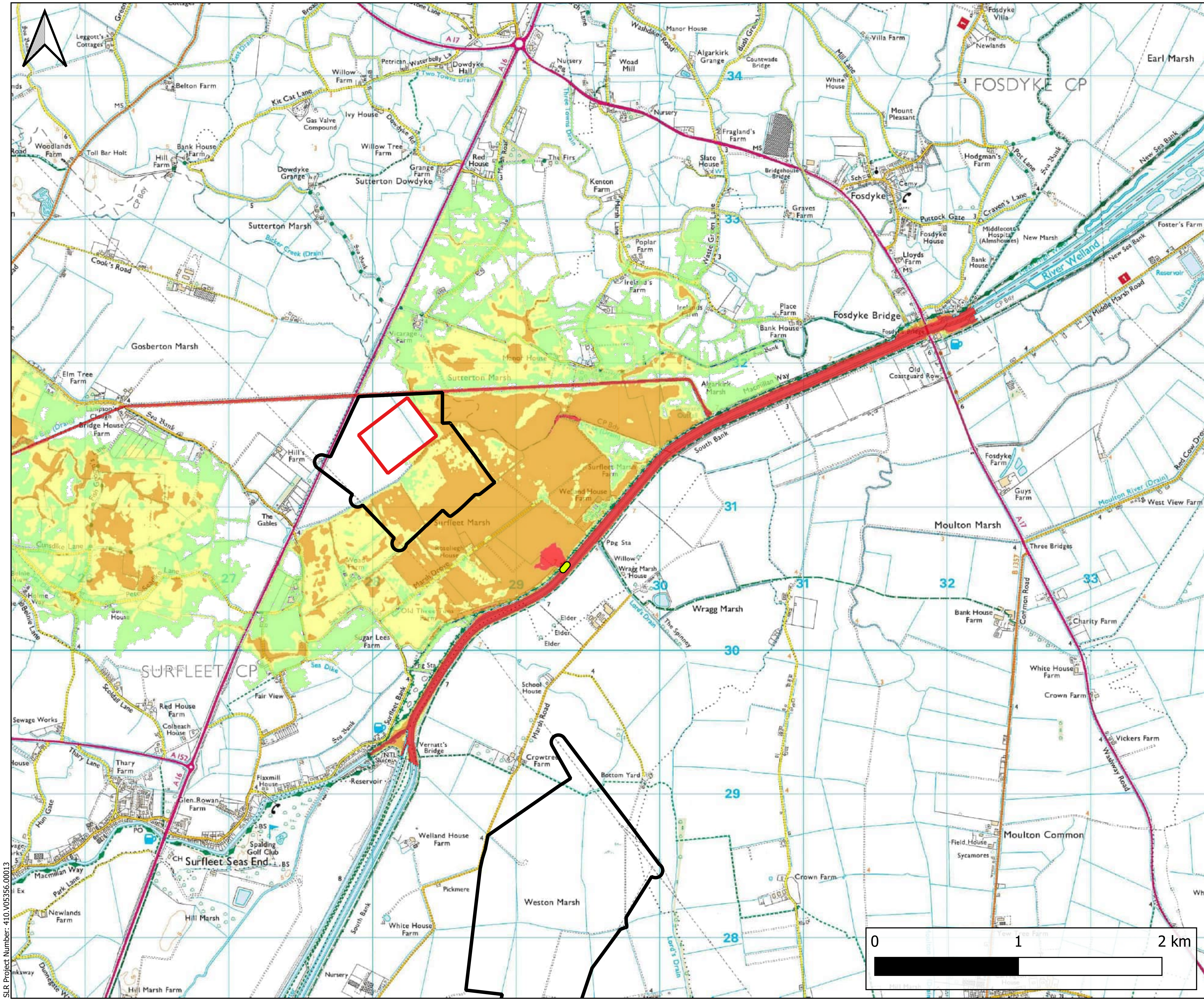
Maximum Flood Velocity 1:200yr North Breach 2 Proposed Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Onshore Substation Area
- Breach Location

Flood Hazard Rating

- <= 0.7500
- 0.7500 - 1.2500
- 1.2500 - 2.0000
- > 2.0000

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 67

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

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Maximum Flood Hazard 1:200yr North Breach 2 Proposed Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013

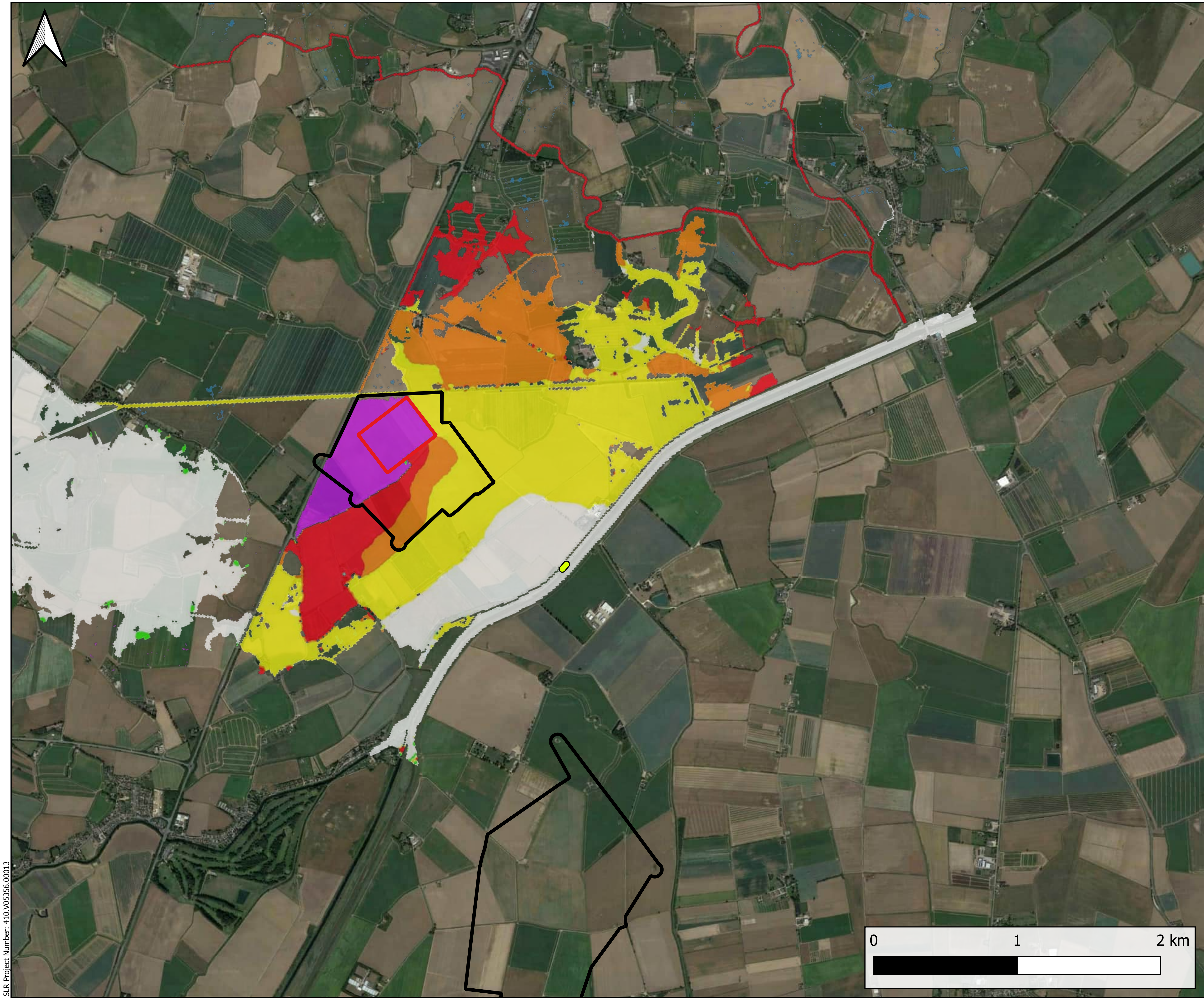

Figure No. 68

Project
Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client
Outer Dowsing Offshore Wind

SLR
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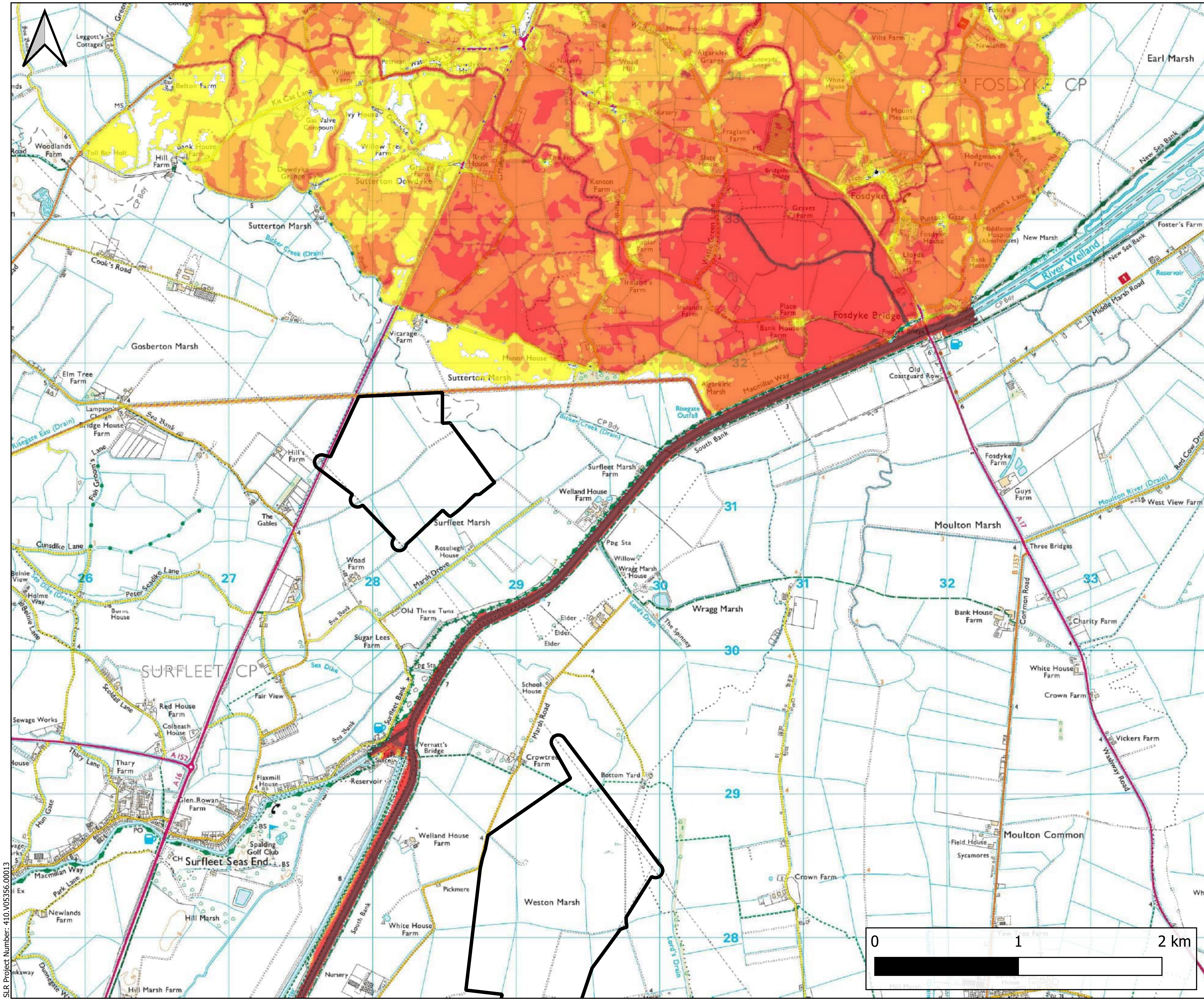
Flood Depth Difference 1:200yr North Breach 2 Proposed Scenario

Scale A3
Date November 2023

SLR Project Number: 410.V05356.00013

Appendix B Sensitivity Analysis Maps – Peak Results



LEGEND

Substation Search Areas

Breach Location

Maximum Flood Depth (m)

- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 2.00
- > 2.00

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 69

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

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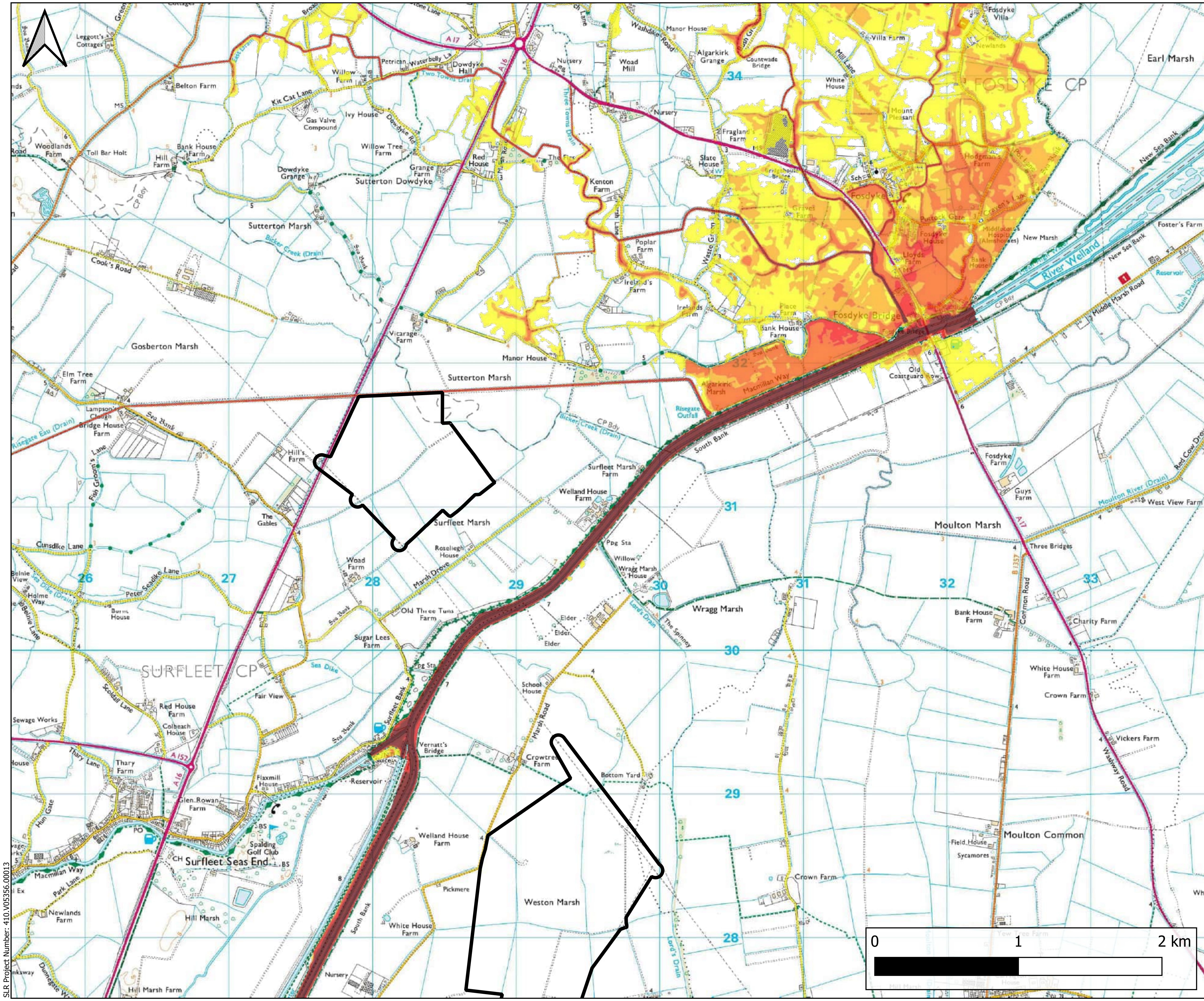
Sensitivity Analysis Grid Size 14m Maximum Flood Depths 1:1000yr+CC Overtopping Baseline Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Breach Location

Maximum Flood Depth (m)

- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 2.00
- > 2.00

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 70

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

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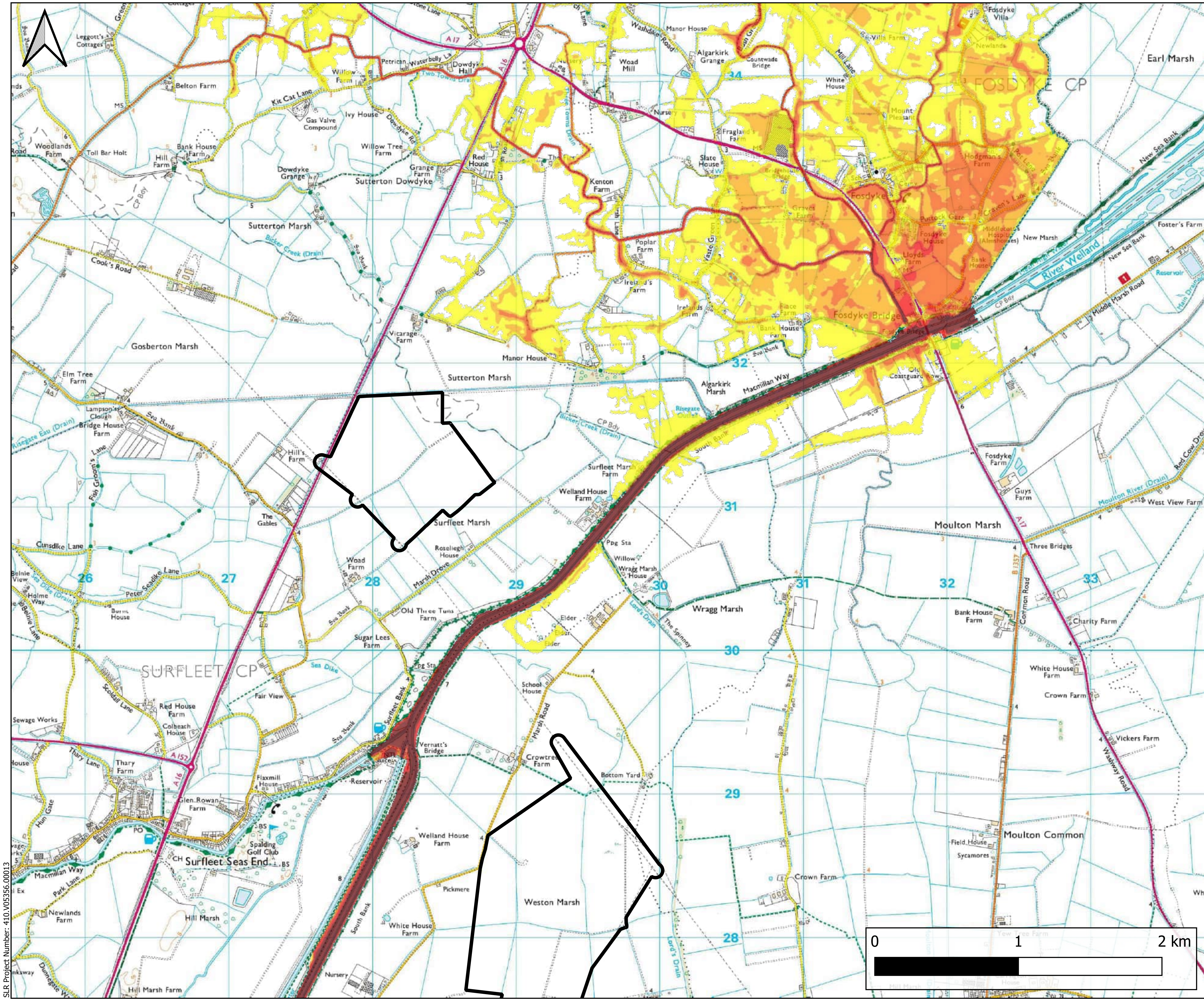
Sensitivity Analysis Grid Size 6m Maximum Flood Depths 1:1000yr+CC Overtopping Baseline Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

Substation Search Areas

Breach Location

Maximum Flood Depth (m)

- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 2.00
- > 2.00

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 71

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

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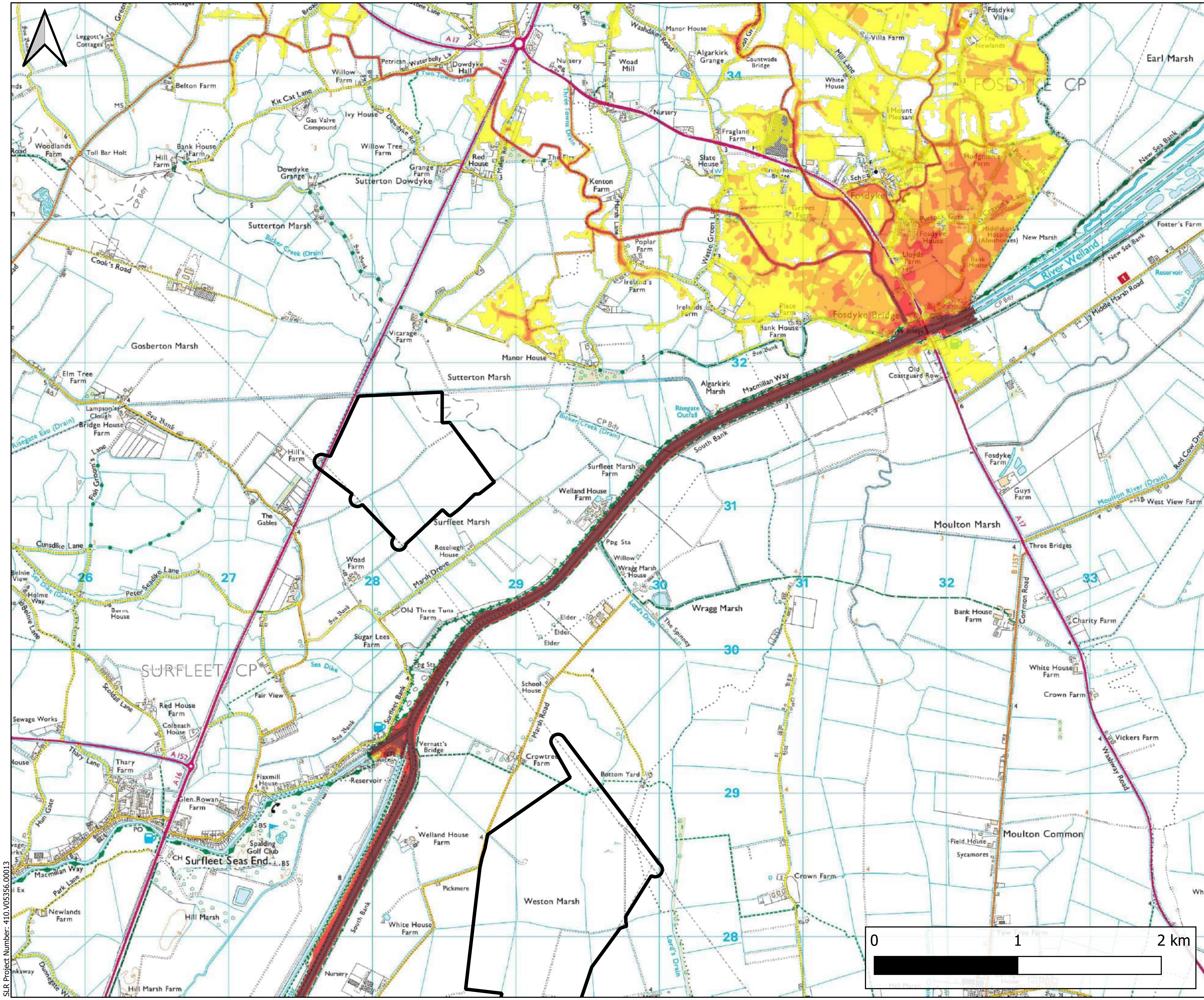
Sensitivity Analysis Manning's Roughness -20% Maximum Flood Depths 1:1000yr+CC Overtopping Baseline Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Breach Location

Maximum Flood Depth (m)

- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 2.00
- > 2.00

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 72

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

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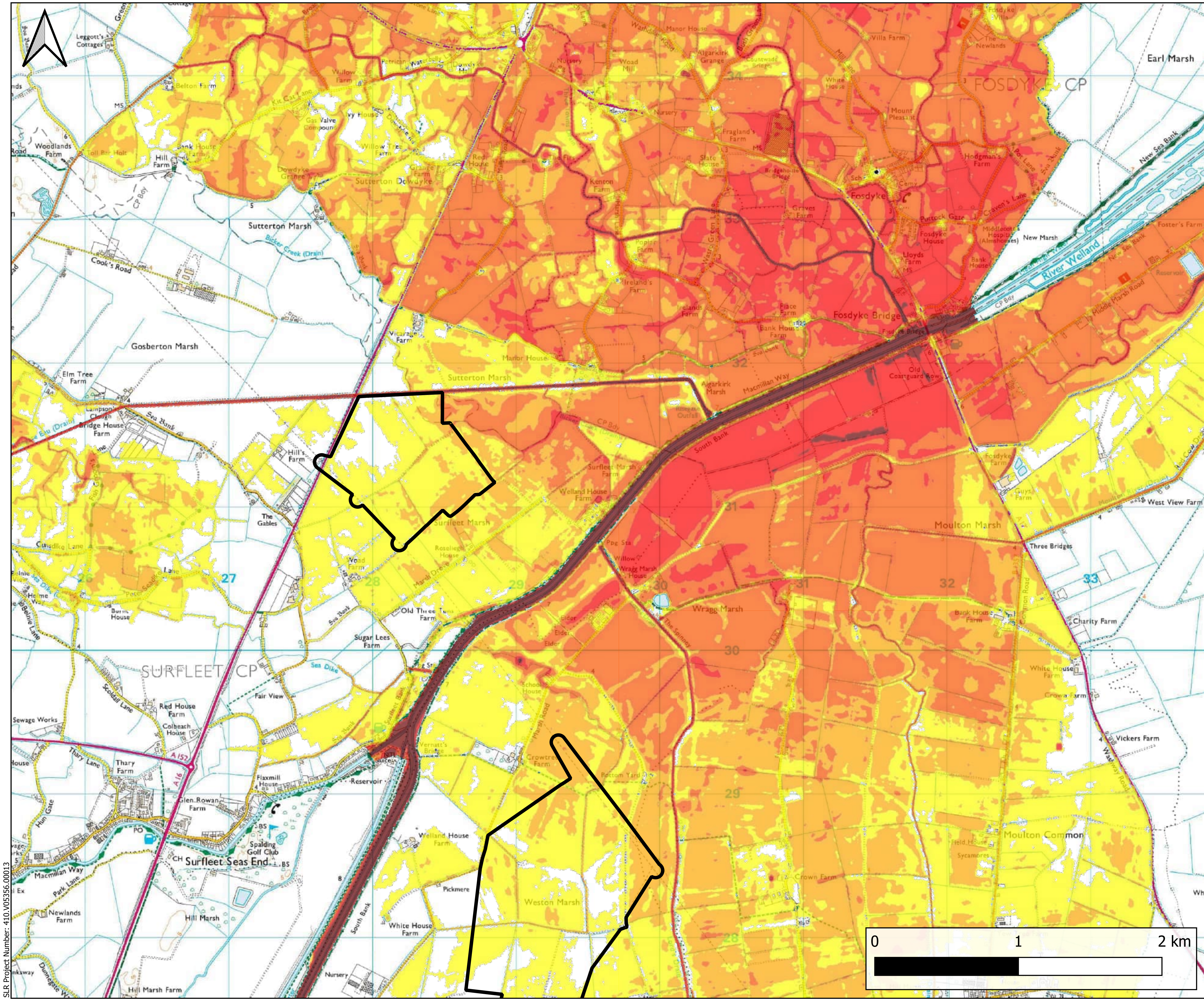
Sensitivity Analysis Manning's Roughness +20% Maximum Flood Depths 1:1000yr+CC Overtopping Baseline Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Breach Location

Maximum Flood Depth (m)

- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 2.00
- > 2.00

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 73

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

SLR

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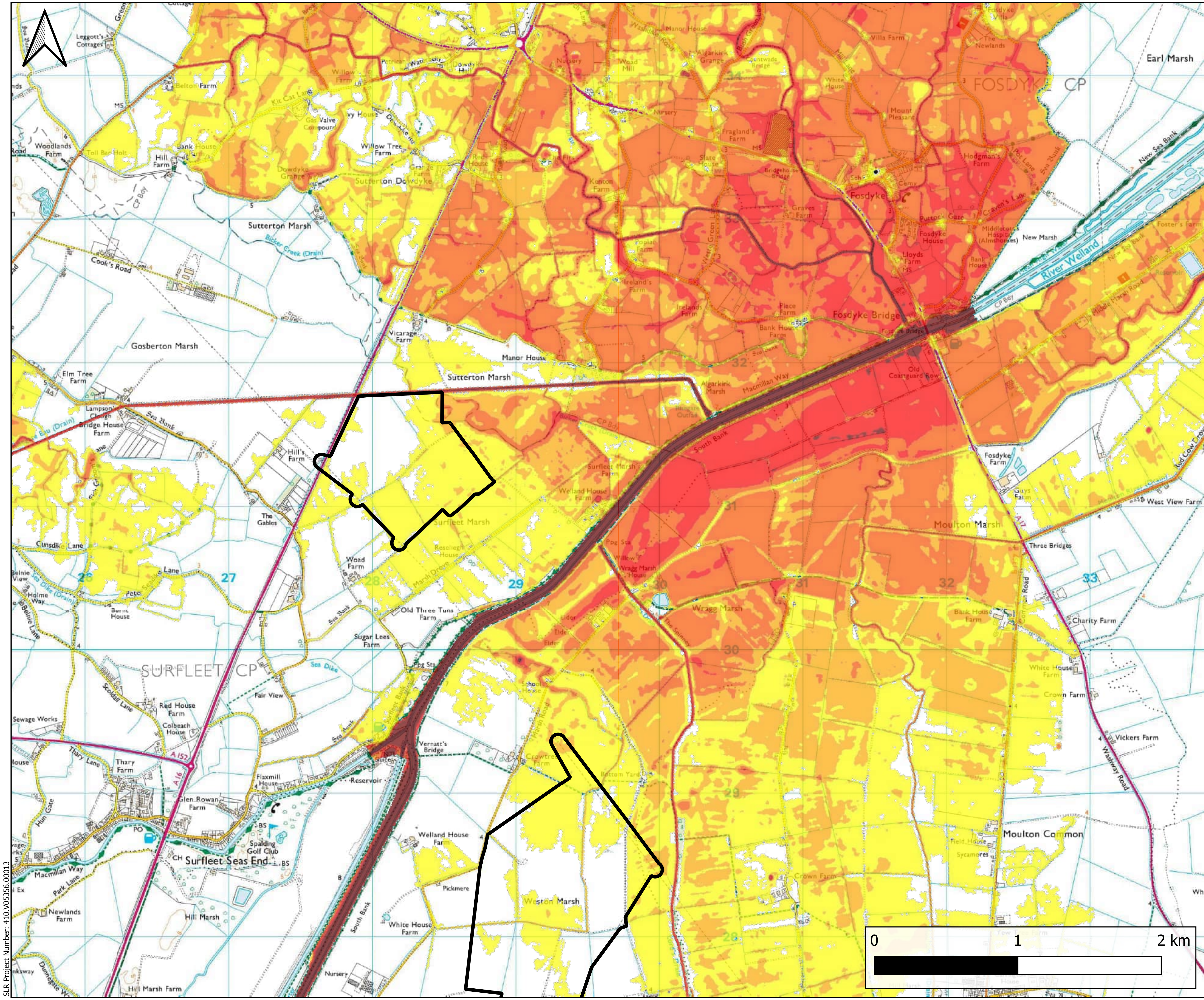
Sensitivity Analysis H++ Climate Change Allowances Maximum Flood Depths 1:1000yr Overtopping Baseline Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Breach Location

Maximum Flood Depth (m)

- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 2.00
- > 2.00

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 74

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

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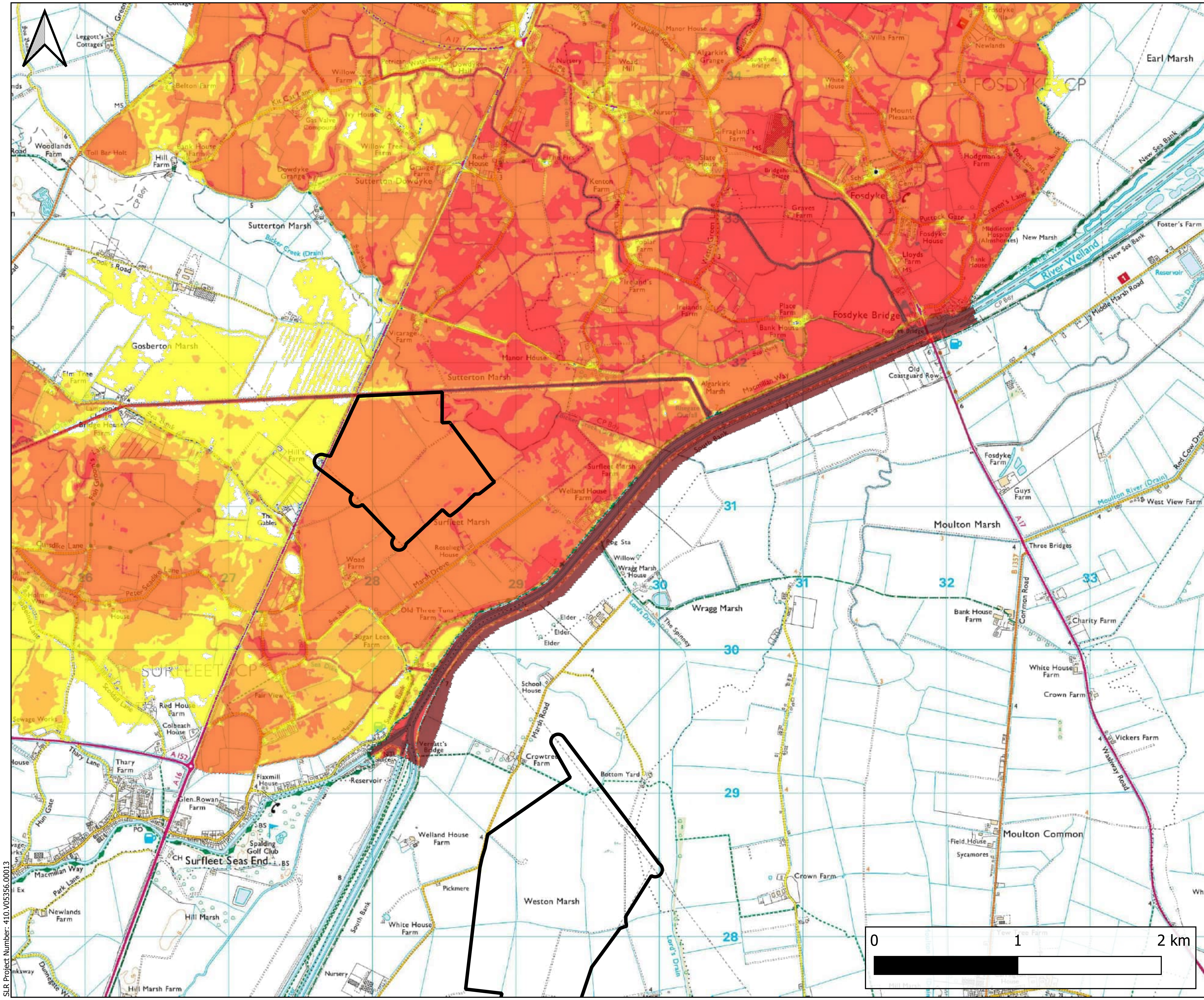
Sensitivity Analysis H++ Climate Change Allowances Maximum Flood Depths 1:200yr Overtopping Baseline Scenario

Scale	Date
A3	November 2023



LEGEND

- Substation Search Areas
- Breach Location

Maximum Flood Depth (m)

- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 2.00
- > 2.00

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 75

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

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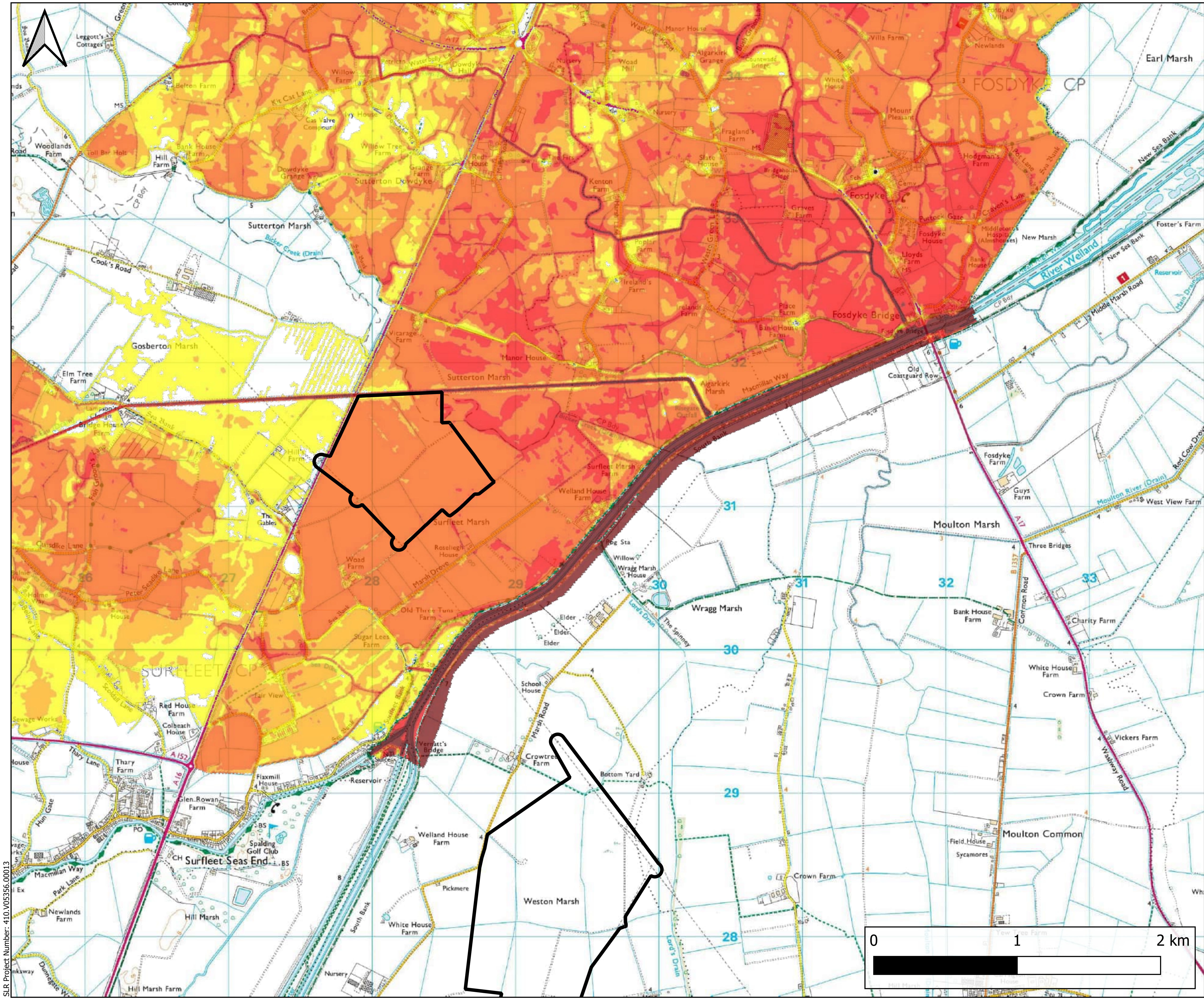
Sensitivity Analysis H++ Climate Change Allowances Maximum Flood Depths 1:1000yr North Breach 2 Baseline Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013



LEGEND

- Substation Search Areas
- Breach Location

Maximum Flood Depth (m)

- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 2.00
- > 2.00

Ordnance Survey(OS) 1:25000 Raster Basemap

Figure No. 76

Project

Outer Dowsing Offshore Wind Farm - Flood Inundation Mapping

Client

Outer Dowsing Offshore Wind

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Sensitivity Analysis H++ Climate Change Allowances Maximum Flood Depths 1:200yr North Breach 2 Baseline Scenario

Scale	Date
A3	November 2023

SLR Project Number: 410.V05356.00013

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