CLEVE HILL SOLAR PARK

ENVIRONMENTAL STATEMENT
VOLUME 4 - TECHNICAL APPENDIX A10.1
FLOOD RISK ASSESSMENT

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CLEVE HILL
SOLAR PARK

ENVIRONMENTAL STATEMENT
TECHNICAL APPENDIX A10.1

FLOOD RISK ASSESSMENT FOR CLEVE HILL SOLAR PARK

NOVEMBER 2018

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1 INTRODUCTION

1.1 Background

1. Cleve Hill Solar Park Ltd ("the Applicant") is proposing to develop a solar photovoltaic array and energy storage facility ("the Development") on land to the south of Whitstable Bay Coastal Waters ("the Core Study Area"), 2 kilometres (km) northeast of Faversham, Kent, as is defined in Chapter 5 of the Environmental Statement (ES).

2. Arcus Consultancy Services Ltd ("Arcus") has been commissioned to undertake a Flood Risk Assessment (FRA) for the Development. This FRA is intended to meet the requirements of the Environment Agency (EA) and specifically the following documents:

- Revised National Planning Policy Framework (NPPF), paragraphs 155 to 165[1];
- Overarching National Policy Statement for Energy (EN-1)[2];
- The SuDS Manual (C753)[3];
- Swale Borough Council - Strategic Flood Risk Assessment for Local Development Framework (2009) (the "SFRA");
- Faversham Creek AAP - Developing proposals and future planning policy options to deliver regeneration of the Creek area (October 2010)[4];
- Water. People. Places. A guide for master planning sustainable drainage into developments. Prepared by the Lead Local Flood Authorities of the South East of England;
- Canterbury District Local Plan Adopted July 2017 - Policy CC4 Flood Risk, Policy CC5 Flood Zones, Policy CC12 Water Quality and Policy CC11 Sustainable Drainage Systems [5];
- Kent County Council ("KCC") Drainage and Planning Policy Statement. Local flood risk management strategy guidance[6];
- KCC - Flood Risk to Communities – Swale[7]; and
- Bearing Fruits 2031- The Swale Borough Local Plan (Adopted July 2017)[8].

1.2 Consultation

3. Following consultation, the EA and KCC have commented on the FRA submitted as part of the Preliminary Environmental Information Report (PEIR).

4. The EA stated that the Flood Risk Assessment detailed the development proposals and outlined flood mitigation measures. The EA had no concerns in terms of flood risk to the proposed development at this site and were satisfied with the application of the Exception Test in relation to the site layout and design, and had reviewed the tidal flood modelling undertaken and had no concerns. Therefore no action is needed other than to update the FRA in respect of the application layout design.

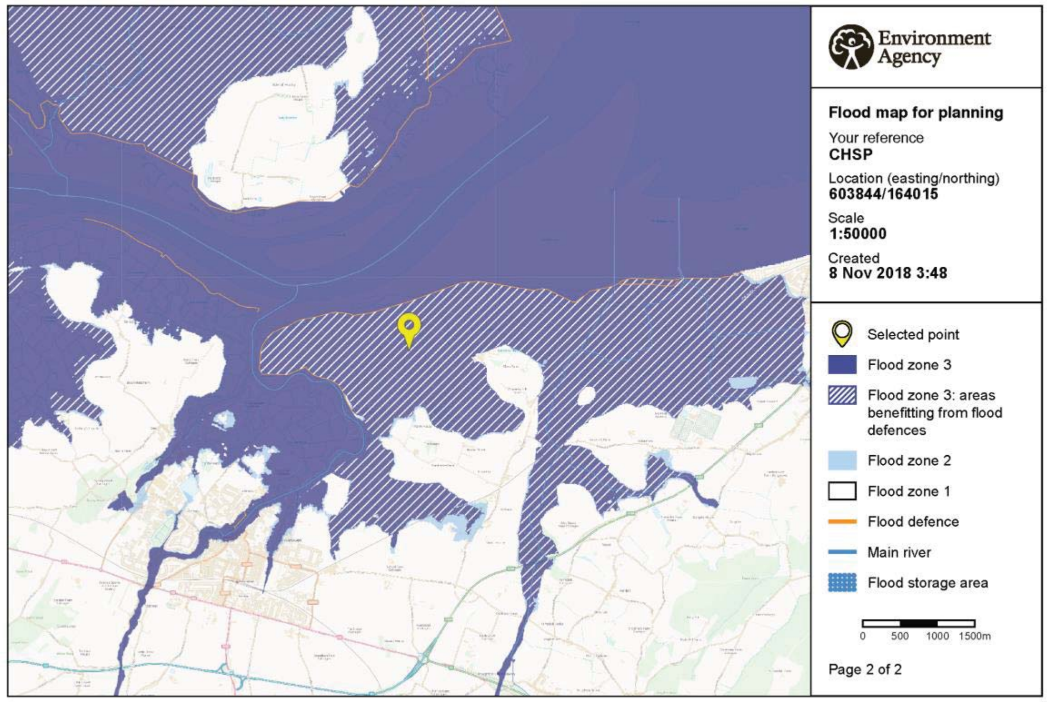
5. KCC as Lead Local Flood Authority (LLFA) notes that within Volume 1, Chapter 10 of the PEIR, environmental effects such as increased surface water runoff and potential transfer of pollutants to surface water during construction are mentioned. However, there is no elaboration of what these effects will be and no mention of surface water drainage.

[1] Ministry of Housing, Communities & Local Government (2018). "Revised National Planning Policy Framework" [online] Available at: https://www.gov.uk/government/collections/revised-national-planning-policy-framework [Accessed 07/11/2018].
[2] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/47854/1938-overarching-nps-for-energy-en1.pdf
[3] https://www.ciria.org/Resources/Free_publications/SuDS_manual_C753.aspx
[4] Tony Fullwood Associates
[5] https://www.canterbury.gov.uk/downloads/file/467/canterbury_district_local_plan_adopted_july_2017
[6] KCC (June 2017).
[7] https://www.kent.gov.uk/__data/assets/pdf_file/0010/71668/Flood-risk-to-communities-in-Swale.pdf
[8] http://services.swale.gov.uk/media/files/localplan/adoptedlocalplanfinalwebversion.pdf

6. The PEIR proposed surface water pollution prevention measures such as silt traps and buffer strips to minimise sedimentation and erosion; further details of these measures are outlined in Sections 2, 6 and 7 of the Outline Construction Environmental Management Plan, ES Technical Appendix A5.4. These measures will protect the hydrological environment during the construction phase. Subsequent communication with KCC has indicated that attenuation for the compound is unlikely to be required and that measures such as seeding the area under the PV arrays will be sufficient to control surface water run-off rates compared to the baseline scenario.

1.3 Site Characteristics

7. The Hydrological Core Study Area, which contains all proposed works comprising the Development and as shown in Plate 4, below, is located in Flood Zone 3a, which is the second highest flood risk category and comprises land assessed as having a 1 in 100 (>1 %) annual probability of river or 1 in 200 (0.5 %) sea flooding in any year. However, the EA flood map[9] identifies that the site is in an area that benefits from flood defences[10]:



8. Historical flood mapping shows that areas where Development infrastructure is proposed did not flood to any depth during the historic tidal flooding events of 1953 and 1978. The EA have stated during consultation, provided in Appendix 4 of this FRA, that "*We do not hold records of historic flood events from rivers and/or the sea affecting the area local to this site.*". Whilst this does not categorically mean the Hydrological Core Study Area has not flooded previously, the absence of recorded flooding at the Development site in EA

[9] https://flood-map-for-planning.service.gov.uk/confirm-location?easting=601721.695&northing=160864.51&placeOrPostcode=faversham
[10] https://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/

records correlates with descriptions in the KCC Flood Risk to Communities – Swale[11] document.

9. The Hydrological Core Study Area is located on arable agricultural land with a total site area of approximately 4,920,000 m^2 (492 hectares (ha)), which is essentially flat, as shown in Plate 1.

Plate 1: Site conditions

10. Site investigation borehole logs (provided as Technical Appendix A10.2 of the ES) and trial pit logs confirm that superficial cover consists of clays with gravel and sand to depths of between 7.5 m and 10.0 m BGL.

11. Soakage testing was anticipated to be undertaken at TP01 to TP03, but groundwater ingress in TP01 deemed it unsuitable for testing. To facilitate testing TP02 and TP03 were filled with 20 millimetre (mm) diameter gravel from 1.0 m to 2.0 m to provide a suitable test section. The tests were undertaken in accordance with Building Research Establishment Report 365 (BRE, 2016) by filling the test sections with water and recording the time taken for it to drain away. In addition to manual dipping, data loggers were installed to record the level of the water. However, both tests failed due to insufficient drainage over a 24 hour monitoring period.

12. Given the homogeneous superficial geology cover, it is therefore concluded that disposal of surface water runoff via infiltration to ground is not feasible at the Hydrological Core Study Area via traditional SuDS methods.

13. The hydrological regime within the Hydrological Core Study Area is typical of lowland agricultural plains, primarily being drained by deep man-made ditches with slow water being transferred slowly to the wider hydrological system. All infrastructure is located within the catchment of the Lower Medway Internal Drainage Board (the "IDB") drain,

[11] https://www.kent.gov.uk/__data/assets/pdf_file/0010/71668/Flood-risk-to-communities-in-Swale.pdf

identified as "46A – White A Drain" to the north of the Hydrological Core Study Area, which in turn discharges into Whitstable Bay Coastal waters.

14. Surface drains in the Hydrological Core Study Area appear to be relatively continuous and free from natural blockages (such as trees / rushes / brash).

15. Several manmade concrete flow controls were observed within the Hydrological Core Study Area, as shown in Plate 2.

Plate 2: Manmade flow control structures within drains

16. A topographical survey shows that the Hydrological Core Study Area lies between 1 m Above Ordnance Datum (AOD) and 4.5 m AOD. Isolated areas, such as those the south of the Core Study Area (in proximity to Graveney Hill), slope up to 15 m AOD.

17. The Hydrological Core Study Area is afforded flood protection in the form of a raised embankment with a concrete wall. Plate 3 shows a typical example with the concrete sea wall sitting on a clay bund with the seaward side protected by a block work apron.

Plate 3: Flood defences north of the Hydrological Core Study Area

18. The flood wall has a wave return profile and is in 'Good' and 'Fair' condition[12], although short sections are affected by differential settling. At the Sportsman Pub, approximately 50 m east of the Hydrological Core Study Area, the defence is a grass covered clay bund with a crest level of 5.7 m AOD that is set back but protected by a beach and high shingle ridge[13].

19. As outlined within Section 7.3.9 of the North Kent Coastal Modelling Volume 2 - Isle of Grain, Medway, Swale up to and including Whitstable, the embankment and wall to the north of the Core Study Area provides protection from flooding up to the 1:1,000 year return period (2012 tidal).

20. Historical timber groynes are intermittently placed along the length of the defences but in most cases these do little to control beach movement[14].

21. The SFRA outlined details on flood defences within the area surrounding the Development site. The defences around the mouth of Faversham Creek immediately northwest of the Hydrological Core Study Area have a standard of protection up to a 1 in 100 year event while Faversham Creek is protected from tidal flooding up to a 1 in 10 year event.

2 METHODOLOGY

22. Flood risk will be classed as Negligible (where little or no risk is identified), Low (where theoretical risk is identified but mitigating factors may influence flood levels) or Moderate to High (where modelled levels or historical events show risk to the Development).

[12] EA condition rating (2015).
[13] http://www.se-coastalgroup.org.uk/media/north-kent/main-report.pdf
[14] http://www.se-coastalgroup.org.uk/media/north-kent/main-report.pdf

Whether the risk is classed as Moderate or High is based on professional judgement and is influenced by factors such as the end use of a site.

23. Several factors will be taken into account when attributing the residual risk of flooding to the Development, including:

- Depth of flooding;
- Flooding extent / ingress into site;
- Type of infrastructure affected; and
- Intervening structures / flood protection.

24. A residual risk table is provided in the conclusion of this FRA and will provide comment and justification for the risk category using professional judgement and experience of assessing similar types of scenarios.

3 POTENTIAL SOURCES OF FLOODING

25. The following sections of this report evaluate the potential sources of flooding at the Hydrological Core Study Area.

3.1 Tidal / Coastal Flooding

26. The Hydrological Core Study Area is located immediately to the south of flood defences (as shown in Plate 2), which protect against tidal flooding up to the 1 in 1,000 year event.

27. EA data shows that the flood defences to the north of the Core Study Area have a condition rating of fair and good, whist other communication with the EA[15] indicates that the flood defences have a design life up to 2038, in the absence of maintenance.

28. Figure 7.13 of the North Kent Coastal Modelling Volume 2 - Isle of Grain, Medway, Swale up to and including Whitstable[16] illustrates that the modelled results for the 1:200 and 1:1,000 year tidal events predict some wave overtopping to occur at Graveney Marshes but the extent is minimal and follows the line of the coast.

29. A pre-development meeting was held with the EA in September 2017 to discuss flood risk and the appropriate scope of works to support a DCO application for the Development. In the absence of Flood Hazard Mapping, the EA agreed that the coastal flood model which informed the North Kent Coastal Modelling Volume 2 - Isle of Grain, Medway, Swale up to and including Whitstable should be re-run to include a breach scenario for the 1:200 year tidal event plus appropriate uplifts for climate change.

30. It was agreed that the North Kent Coastal Flood Model would be re-run by JBA Consulting (who developed the original model on behalf of the EA) to inform the design of the Development, using the following parameters and inputs:

- Topographical information for the flood wall from CHSP commissioned topographical survey;
- The most recent LIDAR data available;
- UK Climate Projections (UKCP09) for sea level rise for years 2017 and 2070;
- Existing wave model re-run using sea level parameters from UK Climate Projections (UKCP09); and
- Two breach locations chosen and model run in accordance with the EA Modelling and Forecasting Technical Guidance Note 2017:

[15] Pre-development meeting. September 2017.
[16] North Kent Coastal Modelling Volume 2 - Isle of Grain, Medway, Swale up to and including Whitstable. JBA (2013).

- Breach width set at 100 m for both locations;
- Defence failure water level of 4.6 m; and
- Defence failure time set at 56 hours.

31. The Cleve Hill Solar Park Coastal Flood Modelling report presented a total of 16 flood scenarios including 1 in 200 and 1 in 1,000 year events for present day (2017) and 2070 using the following scenarios:

- Defended – assumes that the existing flood defences are in place and are structurally sound;
- Defended Breach 1 – assumes a 100 m section of the flood defence is removed in the northwest of the Site and simulates tidal ingress through this breach location;
- Defended Breach 2 – assumes a 100 m section of the flood defence is removed in the northeast of the Site and simulates tidal ingress through this breach location; and
- Undefended – assumes the flood defences are not in place.

32. The 1 in 200 and 1 in 1,000 year flood events have been used to design to in accordance with guidance on Flood risk and coastal change[17], Engineering Design Standard, EDS 07-0106 Substation Flood Protection (2016)[18] and ETR138[19] and the NPPF.

33. For completeness, JBA ran breach analysis on a third location, approximately 1 km to the east of breach location 2. Under this scenario, the flood depths were much lower during the 1 in 200 and 1 in 1,000 year event, due to the presence of the topographical ridge to the east of the Development preventing the ingress of coastal waters. Whilst the results from the third breach location have not influenced the embedded development design, they are included in Appendix 1 of this FRA for completeness.

3.1.1 Model Outputs

34. The flood scenarios and maximum flood depths above ground level (AGL), across the Hydrological Core Study Area, are presented in Table 1.

Table 1: Tidal Flood Model Parameters

Model Scenario	Present Day (2017)		2070 (NPPF)	
	0.5% AEP*	0.1% AEP	0.5% AEP	0.1% AEP
	Max depth (m)	Max depth (m)	Max depth (m)	Max depth (m)
Defended (wave overtopping)	0.00	0.75	0.70	1.75
Defended – Breach 1	3.50	3.85	3.95	4.35
Defended – Breach 2	3.40	3.75	3.85	4.25
Undefended	3.85	4.30	4.40	4.85

*AEP – Annual Exceedance Probability

35. Whilst the maximum flood depths are associated with drainage ditches, in the absence of design measures / embedded mitigation, the Development is at risk of inundation during a defended breach of the flood defences to the north of the Hydrological Core Study Area. Given the significant modelled flood depths, the Development would be at High risk of flooding and damage during this scenario.

[17] https://www.gov.uk/guidance/flood-risk-and-coastal-change
[18] https://library.ukpowernetworks.co.uk/library/en/g81/Design_and_Planning/Substations_- Major/General/EDS+07-0106+Substation+Flood+Protection.pdf
[19] Energy Networks Association publish Engineering Technical Report (ETR) 138 – Resilience to Flooding of Grid and Primary Substations

36. Whilst the Development is classed as "Essential Infrastructure" i.e. "*Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including **electricity generating power stations and grid and primary substations***" in accordance with Table 2: Flood risk vulnerability classification[20] and therefore compatible (subject to passing the Exception Test) in Flood Zone 3[21] the site should be designed to still function even under extreme breach conditions.

37. As such, embedded design measures to ensure the functionality of the Development during a defended breach scenario are outlined in the following sections.

3.1.2 Embedded Mitigation

3.1.2.1 Flood Sensitive Equipment

38. The 1 in 200 and 1 in 1,000 year flood events have been used to design the Development in accordance with guidance on flood risk and coastal change[22], Engineering Design Standard, EDS 07-0106 Substation Flood Protection (2016)[23] and ETR13824 and the NPPF. Freeboard is an allowance applied to flood levels to account for residual uncertainty in flood modelling.

39. A freeboard allowance of 300 mm has been applied to maximum flood depths for the 1 in 1,000 year breach scenario for the substation, in accordance with Table 2 of the Engineering Design Standard, EDS 07-0106 Substation Flood Protection (2016) and ETR138.

40. Government guidance on flood risk and coastal change[25] states that proposed flood sensitive developments should be designed to be resilient against tidal flooding with a 0.5 % annual probability (a 1 in 200 chance of occurring each year).

41. Cleve Hill Solar Park Limited requested that the Development should be designed to be resilient to a 0.1 % annual probability (a 1 in 1,000 chance of occurring each year) event to provide an increased level of protection to the Development.

42. To achieve this, the developable area of the site has been split into separate development parcels, and the substation and energy storage compound area. The design of the Development has been informed by using maximum flood depths AGL or flood levels AOD as appropriate to each specific area of the site, and applying an additional freeboard allowance of 300 mm to identify the required level of protection.

43. Different model scenarios have been used to obtain different depths for critical infrastructure (flood sensitive equipment, long lead time, high cost items critical to operation – not the definition of critical national infrastructure (CNI)) and for the wider development (non-flood sensitive equipment which has some resilience to flooding such as the PV arrays).

[20] https://www.gov.uk/guidance/flood-risk-and-coastal-change#flood-zone-and-flood-risk-tables
[21] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/575184/Table_3_-_Flood_risk_vulnerability_and_flood_zone__compatibility_.pdf
[22] https://www.gov.uk/guidance/flood-risk-and-coastal-change
[23] https://library.ukpowernetworks.co.uk/library/en/g81/Design_and_Planning/Substations_- Major/General/EDS+07-0106+Substation+Flood+Protection.pdf
[24] Energy Networks Association publish Engineering Technical Report (ETR) 138 – Resilience to Flooding of Grid and Primary Substations
[25] https://www.gov.uk/guidance/flood-risk-and-coastal-change#design-flood

3.1.2.1.1 Critical Infrastructure (substation and battery storage area)

44. The critical infrastructure within the Development (the substation and battery storage compound) has been designed to be resistant to a 1 in 1,000 year plus climate change (year 2070) defended breach (breach 2) event.

45. The breach scenario 2 event has been used as it results in a greater flood depth (at the electrical compound) than breach scenario 1 and is therefore considered to be a more conservative approach to site design.

46. To achieve the required level of protection, an uninterrupted flood protection bund with a crest height of 5.316 m AOD will encircle the substation and energy storage compound to protect the critical infrastructure against this type of event.

47. To derive the flood protection level, flood data from the JBA Cleve Hill Solar Park Coastal Flood Modelling report was imported into a GIS model and the maximum flood levels within the substation and battery storage compound area was obtained. This derived a maximum flood level of 5.016 m AOD. With the addition of 300 mm freeboard this results in a flood protection level for critical infrastructure in the substation and battery storage compound area of 5.316 m AOD.

3.1.2.1.2 Wider Development

48. Non-flood sensitive infrastructure forming the wider development (photovoltaic (PV) arrays, cabling, inverters and transformer stations) has been designed to be resilient to a 1 in 1,000 year plus climate change (year 2070) defended (wave overtopping) event.

49. The wave overtopping event has been used as the design scenario for the wider Development rather than a breach scenario, as the PV arrays and associated ancillary infrastructure have resilience to flooding and are likely to be able to operate without replacement once floodwaters have subsided.

50. To achieve the required level of protection, the lowest electrical connections for the PV arrays, cabling and inverters will be located above the identified flood protection levels in each field (development parcel). This will result in the bottom edge of the PV panels being located approximately at the flood protection level. The transformers will be designed with flood resilience measures built in, which could include protection measures, or the transformers having the ability to float (secured by dolphins / fixed tethers) during a 1 in 1,000 year overtopping flood event in the year 2070.

51. To derive the required flood protection levels, flood data from the JBA Cleve Hill Solar Park Coastal Flood Modelling report was imported into a GIS model and the maximum flood levels within each field (development parcel) were obtained. This derived a range of maximum flood depths AGL within each land parcel from 0 m to 1.8 m. The minimum height of the bottom edge of PV panels and therefore all other electrical connections was set to 1.2 m AGL. With the addition of a 300 mm freeboard allowance, flood protection levels for non-flood sensitive infrastructure therefore range from 1.2 m to 2.1 m AGL.

52. The heights of the PV array bottom edge in each field (development parcel) are shown in Technical Appendix A5.1 and Figure 5.3 of the ES.

53. With the implementation of design measures, such as a bund around the critical infrastructure and the raising of the bottom edge of the PV arrays, the Development will be safe for its lifetime, even in the event of a breach in the flood defences to the north.

3.1.2.2 Evacuation Plan

54. The Development will not be permanently occupied but servicing personnel are likely to visit the Development on a regular basis.

55. As such, the operator of the Development will sign up to the EA's Flood Alert system to ensure that they and their employees are aware of the current flood risk and can plan accordingly. Additionally a Personal Flood Evacuation Plan[26] should be drawn up based on advice from the EA and the Local Authority.

3.1.2.3 Flood Defences

56. The design of the Development has ensured that the flood defences protecting the Development can be inspected and maintained by the operator of the Development to ensure their functionality throughout the lifetime of the Development. An inspection programme for the lifetime of the Development will be agreed with the EA and should form part of a suitably worded DCO requirement.

3.1.3 Floodplain Loss

57. As the Development does not act as a functional floodplain, no loss is predicted and no mitigation is proposed.

58. Additionally, during a breach of sea defences during the 1 in 200 year event the Development would not impede water flow during a flood event due to the thin nature and extremely small footprint of the PV racking system.

59. Whilst the bund around the compound has the potential to displace coastal waters under a managed retreat scenario, flood modelling shows that the parameters and flood conditions required for this scenario are extreme *i.e.* the 1 in 200 year tidal flood plus the complete removal of flood defences totalling approximately 100 m in length. Given the flat topography in the Hydrological Core Study Area, any displacement volume is likely to be distributed over a wide area and therefore limiting the overall flood depth and extent.

60. The Site is situated on a theoretical floodplain and the land only operates to store water under extreme breach or overtopping conditions. As such, in comparison to the area covered by the floodplain, the volume of water displaced under a flood defence breach scenario would be Negligible.

3.1.4 Tidal Flood Risk Summary

61. The Development is defended from tidal flooding up to the 1 in 1,000 year return period by raised embankments with a concrete wall.

62. In the event of a breach in the flood defences, the Development would be at risk of inundation to depths of up to 3.85 m during the 1 in 200 year return period and 4.25 m during the 1 in 1,000 year return period.

63. The Development has been designed to protect the electrical infrastructure in the event of a breach in flood defences.

64. Non-flood sensitive infrastructure forming the wider development (photovoltaic (PV) arrays, cabling, inverters and transformer stations) has been designed to be resilient to a 1 in 1,000 year plus climate change (year 2070) defended (wave overtopping) event.

[26] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/444659/LIT_4112.pdf

65. The critical infrastructure within the Development (the substation and electrical compound) has been designed to be resistant to a 1 in 1,000 year plus climate change (year 2070) defended breach (breach 2) event.

66. With the implementation of the embedded design measures, the residual risk of the Development flooding from tidal sources is considered to be Low.

3.2 Fluvial

3.2.1 Watercourses

67. Faversham Creek is located immediately to the west of the Hydrological Core Study Area.

68. Section 5.4.2 of the SFRA states that Faversham Creek has a standard of flood protection up to the 1:10 year event for tidal flooding.

69. Appendix 5: *Faversham: NaFRA mapping* of the Kent County Council Flood Risk to Communities – Swale[27] shows that the main areas associated with fluvial flooding from Faversham Creek are within the urban areas of Faversham and areas at Ham Marshes, on the opposite bank to the Development. These areas are shown as being at "High" risk of flooding, while the Development is shown to be at "Medium" and "Low" risk.

70. The document also states that Faversham Creek (and Oare) is *"…prone to tidal flooding during particularly high astronomical tides or storm surges when significant volumes of water propagate up their channels"*. As such, fluvial contribution to flooding in proximity to the Development is likely overwhelmed by inputs from tidal sources.

71. The major flooding events of 1953, 1978 and 2013 in Faversham are attributed to tidal surges pushing water levels up within Faversham Creek.

72. Tile D (map) of the SFRA shows the EA Flood Zones and EA fluvial flooding records. Although these zones are a combination of both tidal and fluvial flooding, there are no specific records of fluvial flooding in the vicinity of the Hydrological Core Study Area.

73. Section 3.4.3 of The North Kent Coastal Modelling Volume 2 - *Isle of Grain, Medway, Swale up to and including Whitstable document incorporated Faversham Creek* identifies that the was run as a linked fluvial tidal model[28] *i.e.* run with hydrological inflow boundaries and this scenario has been covered in the previous section of this FRA.

74. As such, it is considered that Faversham Creek has the potential to cause flooding at the Development only in conjunction with tidal flooding and therefore flooding from watercourses is considered to be Negligible.

3.2.2 Drainage Ditches

75. The IDB have confirmed that the drainage ditches onsite have flow controls and that the IDB generally control levels within Cleve Marshes[29].

76. The Flood Estimation Handbook ("FEH") web service[30] shows that the drainage ditches onsite drain a catchment area of 7.76 km^2.

[27] https://www.kent.gov.uk/__data/assets/pdf_file/0010/71668/Flood-risk-to-communities-in-Swale.pdf
[28] ISIS / Flood Modeller model provided to Arcus by the EA
[29] Mike Watson – Lower Medway IDB, telephone communications 03/05/2018.
[30] https://fehweb.ceh.ac.uk/

77. The ReFH2 method has been used to develop flood hydrographs for the catchment in which the Development is located, with catchment descriptors imported from the FEH web service for a number of return periods (as a 100 % rural model).

78. ReFH2 method, indicates that the peak flow for the 1 in 100 year summer flood event over the 7.76 km^2 catchment is 2.83 m^3/s (and 3.96 m^3/s with the addition of a 40 % climate change allowance), as shown in Appendix 2.

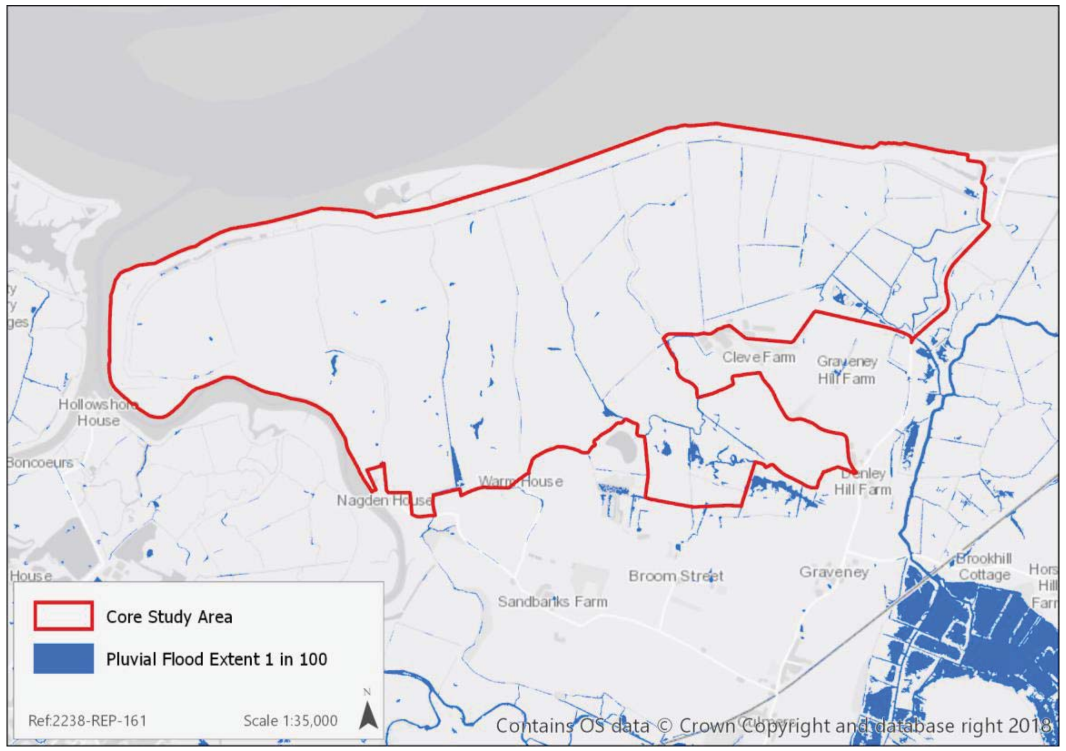
79. Given the low peak flow, the number of drainage ditches within the Hydrological Core Study Area, the dimensions of the ditches and the active flow regulation by the IDB, the flat nature of the site, even in the event that the ditches overtop it is likely that the out of channel flows would extend over a wide area and to shallow depths. The PV array would be installed above ground level, as described in Section 3.1.2 of this FRA, while ancillary infrastructure has been designed to be flood resilient or to float on a tether. The electrical compound will also be bunded preventing water ingress in the event that ditches overtop. Therefore the mitigation outlined for tidal flooding will prevent the site being damaged should these ditches overtop.

80. As such, the risk of the Development flooding from fluvial sources is considered to be Negligible.

3.3 Pluvial (Surface Water)

81. The EA flood map identifies that isolated areas of the Hydrological Core Study Area are at risk of flooding from surface water during the 1 in 100 year flood event, as shown in Plate 4.

Plate 4: 1 in 100 pluvial flood extent



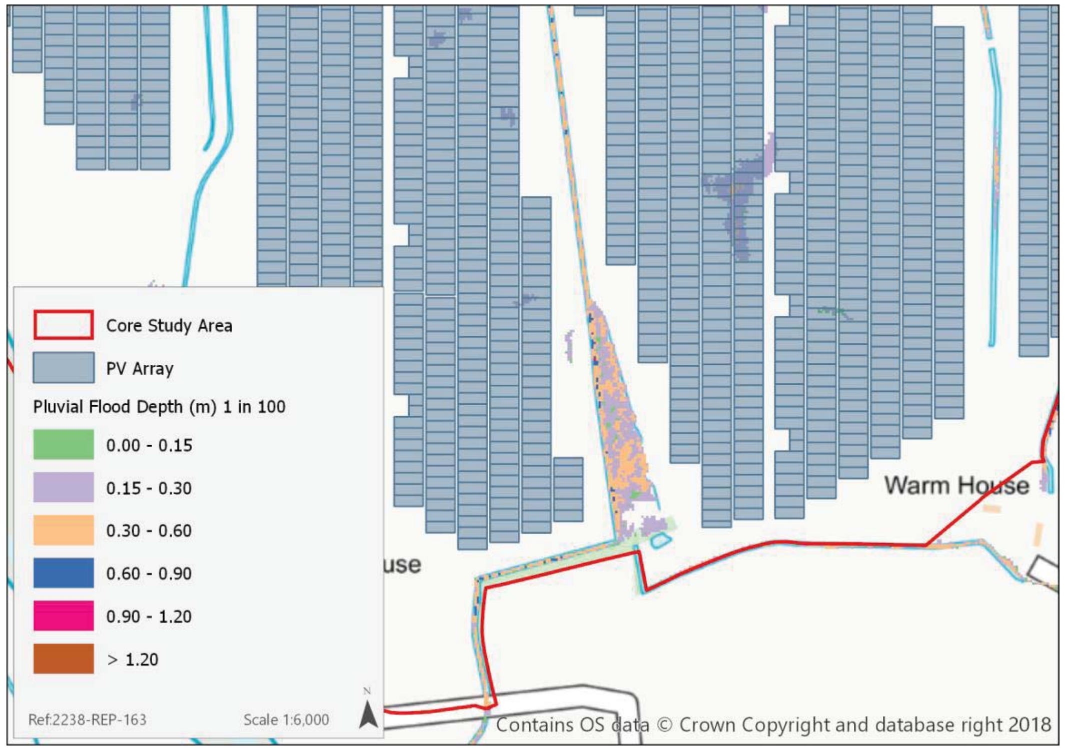
82. These areas largely correspond with the areas on Map 2 of the Swale Surface Water Management Plan (SSWMP)[31].

83. Figure 3.1 – *Hotspots in Swale* of the SSWMP does not identify the Hydrological Core Study Area as an area where pluvial flood risk has been identified and that further action is required to investigate.

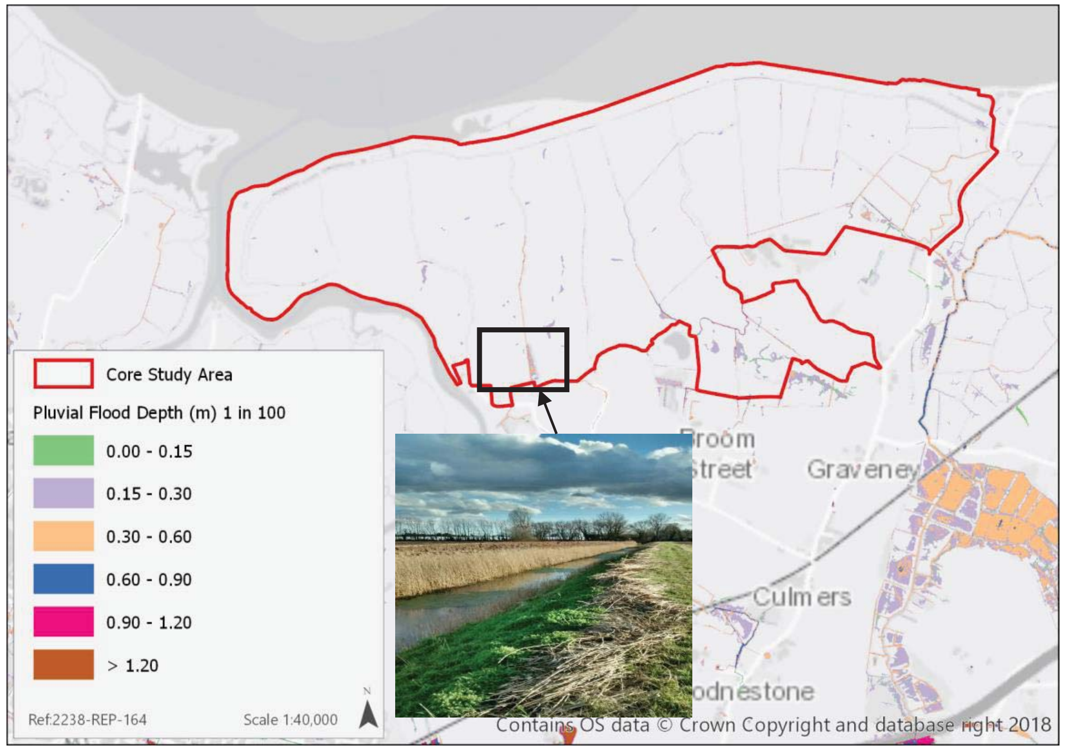
84. Inspection of the flood depths indicates that the deepest pluvial flood depths within the Development for the 1 in 100 year flood correspond with areas where drainage ditches exist.

85. The deepest pluvial flood depth out of drainage ditches occurs in the southern section of the Development site, approximately 150 m north of Sandbanks Lane, with a depth of between 0.3 m and 0.6 m. As shown in Plate 5, no Development infrastructure is located within this area.

Plate 5: Pluvial Flood Depth 1:100 year event in Proximity to Sandbanks Lane



[31] Kent County Council - https://www.kent.gov.uk/__data/assets/pdf_file/0011/50015/Swale_SWMP_Stage_1_Report.pdf



86. Other isolated areas of pluvial flooding up to 0.6 m exist across the Development, however it appears that these may be an error in the coarse EA pluvial flood model, as the areas in question are essentially flat, suggesting errors in the topography used to map pluvial flooding.

87. The PV array would be installed above ground level, as described in Section 3.1 of this FRA, while ancillary infrastructure has been designed to be flood resistant or float on a tether. Additionally, measures such as letting the Development vegetate with a grass or wildflower mix will provide an improvement in terms of overland flow and permitting infiltration compared to the baseline scenario.

88. As such, the risk of the Development flooding from pluvial sources is considered to be Negligible.

3.4 Reservoirs

89. There are no Southern Water reservoirs within 5 km of the Development site[32].

90. The EA Flood map shows that the Development site is not mapped to flood should the nearest reservoir fail.

91. As such, the Development is not considered to be at risk of flooding from reservoirs.

3.5 Groundwater

92. Map 3 of the SSWMP[33] identifies that the majority of the Hydrological Core Study Area is not at risk of groundwater flooding, with the exception of the western section where it is classified as having between 25-50% proportion of the square km susceptible to groundwater flooding.

[32] https://www.southernwater.co.uk/reservoir-levels
[33] https://www.kent.gov.uk/__data/assets/pdf_file/0010/50014/Swale_SWMP_Stage_1_Appendix-F.pdf

93. Given the shallow groundwater encountered at the substation compound, which is likely to be a perched layer, and the presence of clays to a depth of 10 m BGL, the clays are likely to act as a hydrological barrier to the upward movement of groundwater located at deeper depths.

94. In the unlikely event of groundwater reaching the surface, the measures to protect the Development against tidal flooding, such as rising electrical equipment, will ensure the Development is safe.

95. As such, the risk of the Development flooding from groundwater sources is considered to be Negligible.

3.6 Sewers / Highways Drainage

96. There is no highways drainage or Southern Water drainage infrastructure in proximity to the Development site. This was confirmed through visual observations from the site walkover.

97. As such, there is no risk of the Development flooding from sewers or highways drainage.

4 ACCESS TRACK / SPINE ROAD RUNOFF

98. A permeable spine road (1.01 ha) and a section of impermeable spine road (0.47 ha) will be installed across the central section of the Development site.

99. The introduction of areas of semipermeable aggregate track on a greenfield site will increase the discharge of water from the developed area relative to the current state. This effect could, in principle, lead to increased probability of down-stream flooding, especially in extreme rainfall events. The EA / DEFRA guidance document[34] identifies that suitable mitigation of this effect is to provide storage for the excess discharge to allow it to infiltrate into the ground, where possible, or otherwise to discharge to a watercourse at less than 2 l/s/ha above that of the greenfield runoff rate.

100. The method set out in the EA / DEFRA guidance document has been followed to identify approximate rainfall storage volumes required on site. As set out in the guidance, details of this would be designed and agreed with the EA at detailed design stage, and the method applied here is approximate, but appropriate to this phase of the Development.

101. The Development lies within Hydrological Region 7 of the UK.

102. The Flood Estimation Handbook[35] identifies that the Development site receives an average annual rainfall (SARR) of 617 mm.

103. Approximate greenfield runoff flow rates have been calculated using Micro Drainage software and used to estimate appropriate storage volumes required.

104. Calculations were derived using the IH124 method using Micro Drainage software and are shown in Appendix 3 of this report.

[34] Environment Agency/DEFRA (2005). "Flood Risk Assessment Guidance for New Development". R&D Technical Report FD2320/TR2. [online] Available at: http://evidence.environment-agency.gov.uk/FCERM/Libraries/FCERM_Project_Documents/FD2320_3363_TRP_pdf.sflb.ashx [Accessed 21/04/2018].
[35] Flood Estimation Handbook [online] Available at: https://www.ceh.ac.uk/services/flood-estimation-handbook-web-service [Accessed 21/04/2018].

105. The application of this approach leads to mean peak greenfield flow rates from the area to be developed for the 1-year, 30-year and 100-year return periods, as shown in Table 2.

Table 2: Estimated Runoff Flow Rates (Q) for 1, 30 and 100-year return periods (taken from Micro Drainage)

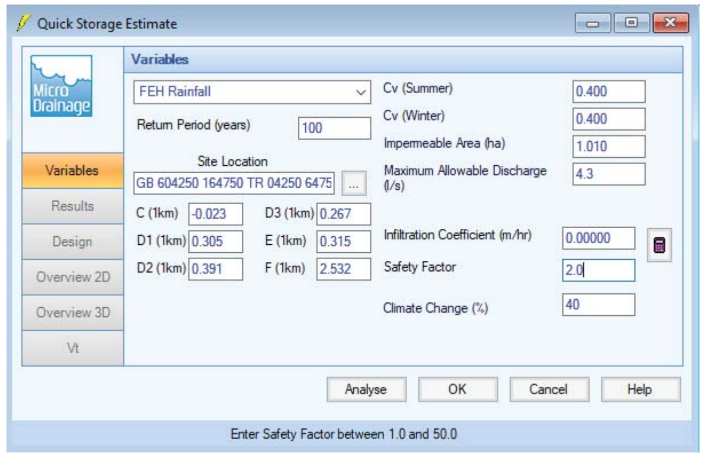
Return Period	Q (l/s)
QBAR Rural	4.3
QBAR Urban	4.3
1	3.7
30	9.8
100	13.8

106. A total of 1.01 ha of new Type 2 aggregate hardstanding will be introduced and is assumed to be 40 % permeable (Cv value of 0.4 *i.e.* 40 % permeable[36]).

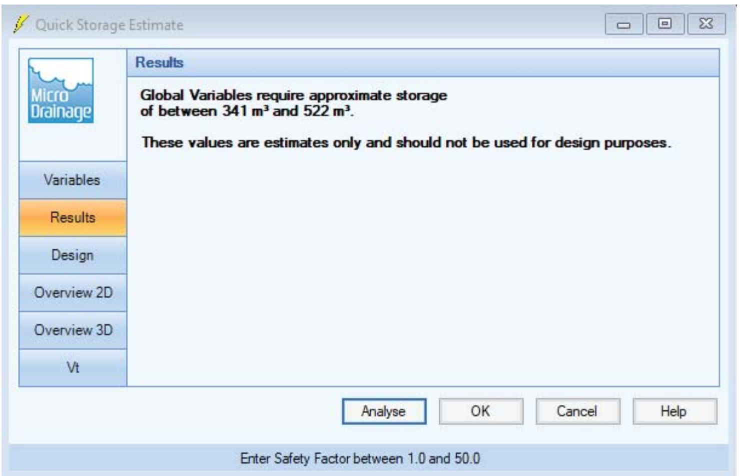
107. The temporary storage required to hold the increase in runoff from the site is shown below for the 1 in 100 year return period, as calculated using Micro Drainage software.

108. A 40 % increase in rainfall during these events has been included to account for the potential effects of climate change over the operational life of the Development, in accordance with the EA's "Upper end" allowance in Table 2: *peak rainfall intensity allowance in small and urban catchments*[37] and at the request of KCC.

109. The overall storage required is shown below, based on 1.01 ha of new hardstanding and assuming no infiltration:



[36] Taken from Table RO-3—Recommended Percentage Imperviousness Values - Gravel (packed). Drainage Criteria Manual
[37] https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

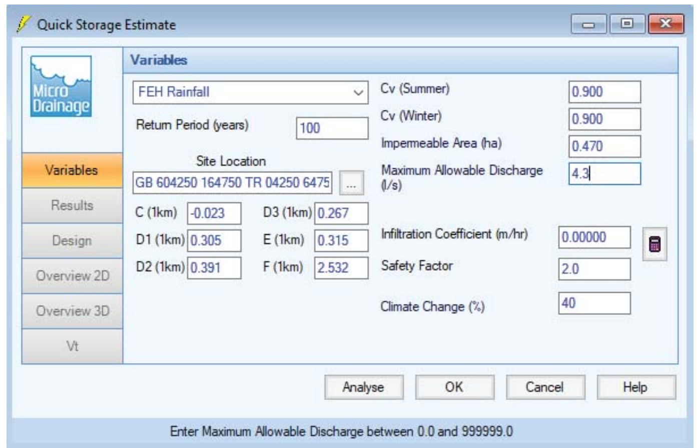


110. Additionally, 0.47 ha of asphalt road could be installed for the Development and is assumed to be 90 % impermeable (Cv value of 0.9 *i.e.* 90 % impermeable[38]).

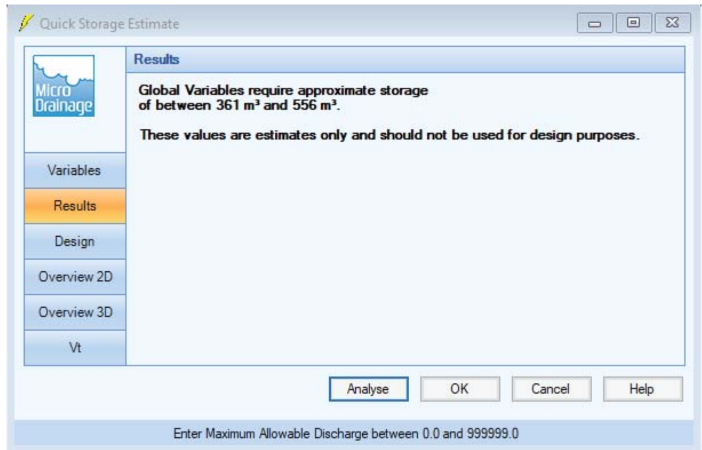
111. The temporary storage required to hold the increase in runoff from the site is shown below for the 1 in 100 year return period, as calculated using Micro Drainage software.

112. A 40 % increase in rainfall during these events has been included to account for the potential effects of climate change.

113. The overall storage required is shown below, based on 0.47 ha of new 90 % impermeable hardstanding and assuming no infiltration:



[38] Taken from Table RO-3—Recommended Percentage Imperviousness Values - Drive and walks. Drainage Criteria Manual



114. Table B.4 *Scheme design assessment checklist* of the SuDS Manual, which states that the following hierarchy for disposal of surface water should be observed unless '*acceptable justification for moving between levels*' is provided:

- Infiltration to the maximum extent that is practical – where it is safe and acceptable to do so;
- Discharge to surface waters;
- Discharge to surface water sewer, highway drain or other drain; and
- Discharge to combined sewer (last resort).

115. As infiltration testing demonstrated that the superficial deposits underlying the Development did not permit infiltration at a suitable rate to dispose of surface water via discharging to ground, storage will be provided by installing shallow drainage ditches immediately adjacent to the spine road and these will discharge to the existing drainage ditch network via appropriately sized outlets.

116. Given the total length of the spine road (approximately 2.8 km), this volume of storage can easily be accommodated via a shallow drainage ditches, as shown in Plate 6.

Plate 6: Typical drainage ditch adjacent to access track

117. Active management of runoff from all access tracks will reduce the potential of sediment laden runoff entering watercourses and ditches. Measures could include placing semi-permeable obstructions in the drainage ditches adjacent to the track. Outfall pipes will

drain into a bunded section of the drainage ditch to allow the attenuation of runoff flow before entering the wider catchment.

5 ANCILLARY INFRASTRUCTURE

118. Approximately 80 transformers are expected to be installed as part of the Development, which would cover an area of approximately 4,365 m^2 (0.43 ha), including the foundation pads.

119. Based on Arcus' previous drainage inspections of operational solar farms[39], ancillary infrastructure as part of the Development is considered to be 90 % impervious (Cv value of 0.9 *i.e.* 90 % impermeable)[40]:

120. A succinct quantitative assessment has been undertaken to identify runoff from the transformers compared to the baseline scenario, as follows:

121. Rainfall Depth (1 in 100 year 360 minute storm) x area of transformers x Soil Index / time (seconds).

122. A comparison is provided in Table 3.

Table 3: Runoff calculations for Transformers

Baseline Scenario						
Rainfall Depth for baseline area + 40 % for climate change*	**Total Site Area**	**Soil Index[41]**	**Volume (m^3)**	**Volume (l)**	**Time (seconds)**	**l/s**
103.236 mm = 0.103 m	3,876,000 m^2	0.47	187,637.16	187,637,160.00	21,600	8,686.91
With Development Scenario						
Rainfall Depth for baseline area + 40 % for climate change	**Area without Transformers**	**Soil Index**	**Volume (m^3)**	**Volume (l)**	**Time (seconds)**	**l/s**
103.2 mm = 0.103 m	3,871,634.40 m^2	0.47	187,425.82	187,425,821.30	21,600	8,677.12
Rainfall Depth for Development + 40 % for climate change	**Area with Transformers**	**Soil Index**	**Volume (m^3)**	**Volume (l)**	**Time (seconds)**	**l/s**
103.2 mm = 0.103 m	4,365.60 m^2	0.9**	404.69	404,691.12	21,600	18.74

[39] Malmaynes, Arkwright and Thorne Solar Farms drainage inspections
[40] Taken from Table RO-3—Recommended Percentage Imperviousness Values - Roofs. Drainage Criteria Manual
[41] http://www.uksuds.com/drainage-tools-members/greenfield-runoff-rate-tool.html

* Flood Estimation Handbook:

**taken as 0.9 to represent impermeable nature of the transformers

123. As a result of the installation of ancillary infrastructure, surface water runoff rates may increase by 8.95 l/s across the entire Development compared to the baseline, which equates to a 0.1 % percent increase in runoff rates.

124. As such, the transformers foundations will be surrounded by crushed stone, as shown in Plate 7.

Plate 7: Typical ancillary structures on crushed stone at solar farms

125. In areas where Type 1 and Type 2 stone will be installed there will be an improvement in the overall ability of the Hydrological Core Study Area to slow the conveyance of surface

water due to superficial deposit regrading during the construction phase and the introduction of stone with voids as opposed to the baseline superficial cover of clays.

126. As such, the potential increase in runoff rates from ancillary infrastructure is assessed as Negligible.

6 PV PANEL RUNOFF

127. The PV arrays have the potential to concentrate rainfall under the drip line. Research in the United States by Cook & McCuen[42], suggested this increase would not be great but is an increase nonetheless. Other studies quantified this increase ranging from 1.5 % to 8.6 %, depending on site specific parameters.

128. A succinct quantitative assessment has been undertaken to identify runoff from the PV arrays compared to the baseline scenario, as follows:

- Rainfall Depth (1 in 100 year 360 minute storm) x area of PV arrays x Soil Index / time (seconds).

129. A comparison is provided in Table 4.

Table 4: Runoff calculations for PV arrays

Baseline Scenario						
Rainfall Depth for baseline area + 40 % for climate change*	**Total Site Area**	**Soil Index[43]**	**Volume (m^3)**	**Volume (l)**	**Time (seconds)**	**l/s**
103.2 mm = 0.103 m	3,876,000 m^2	0.47	187,637.16	187,637,160.00	21,600	8,686.91
With Development Scenario						
Rainfall Depth for baseline area + 40 % for climate change	**Area without PV arrays**	**Soil Index**	**Volume (m^3)**	**Volume (l)**	**Time (seconds)**	**l/s**
103.2 mm = 0.103 m	2,112,601 m^2	0.47	102,271.01	102,271,014.41	21,600	4,734.77
Rainfall Depth for Development + 40 % for climate change	**Area with PV arrays**	**Soil Index**	**Volume (m^3)**	**Volume (l)**	**Time (seconds)**	**l/s**
103.2 mm = 0.103 m	m^2	0.9**	163,467.09	163,467,087.30	21,600	7,567.92

* Flood Estimation Handbook.

**taken as 0.9 to represent impermeable nature of PV arrays

[42] "Hydrologic Response of Solar Farms." J. Hydrol. Eng., 18(5), 536–541. 2013
[43] http://www.uksuds.com/drainage-tools-members/greenfield-runoff-rate-tool.html

130. As a result of the installation of PV panels, this calculation suggests that surface water runoff rates may increase by 3,615.78 l/s across the PV panel footprint compared to the baseline, which would equate to a 41.62 % percent increase in runoff rates.

131. However, the solar panels will be located above the ground, rather than on it, and will not prevent soil from absorbing rainwater as the panels will not be placed directly on the ground. The same area of soil will be available for infiltration.

132. Once rainfall has fallen off a PV panel, the water will be able to spread and flow along the ground under the PV panels. Given the flat nature of the Hydrological Core Study Area it is likely that rain falling on each row of solar panels would flow evenly into the rain-shadow of the row below, so as to mobilise the same percentage of the ground for infiltration as was available before the panels were installed.

133. Each table of panels will comprise several PV modules, with dimensions typically as set out in the ES chapter 5. Each module will be of the order of 1 m by 2 m, and water will drip off each module (there will be small gaps between modules). This means that the surface area to drip line length ratio will be the same as for "traditional" solar array layouts, which use the same modules.

134. Whilst the Natural England Technical Information Note 101 (TIN101) "Solar Parks: maximising environmental benefits"[44] has been archived, the principles relating to solar parks, their siting, their potential impacts and mitigation requirements for the safeguarding of the natural environment are still relevant. As such, this FRA considers the potential increase in runoff and soil erosion.

135. TIN101 states:

> "*The key to avoiding increased run-off and soil into watercourses is to maintain soil permeability and vegetative cover. Permeable land surfaces underneath and between panels should be able to absorb rainfall as long as they are not compacted and there is some vegetation to bind the soil surface".*

136. Apart from the construction of the substation compound, heavy machinery will only be used during the delivery of the solar panels. All vehicles would follow the onsite access tracks wherever possible. Where vehicles are required to travel off the access tracks this may lead to a temporary compaction of soils. Areas where infrastructure is located in the eastern part of the Core Study Area are largely flat or with very gentle gradients, and hence increased runoff would be unlikely to lead to fast moving surface water and consequent erosion except on the small areas of steeper slopes in the southern parts of the Development.

137. Furthermore, the percentage of the Core Study Area proposed for the new spine road is small (approximately 0.30 %[45]).

138. TIN101 highlights the effect of slope on runoff rates and soil erosion by concluding that:

> "*the risks of run-off and soil erosion are lowest on low gradient land with cohesive soils and highest on dry, sandy and steeply sloping soil surfaces.*"

139. As such, a Drainage Strategy will be implemented to ensure that grassed buffer strips are located underneath the PV panel drip lines.

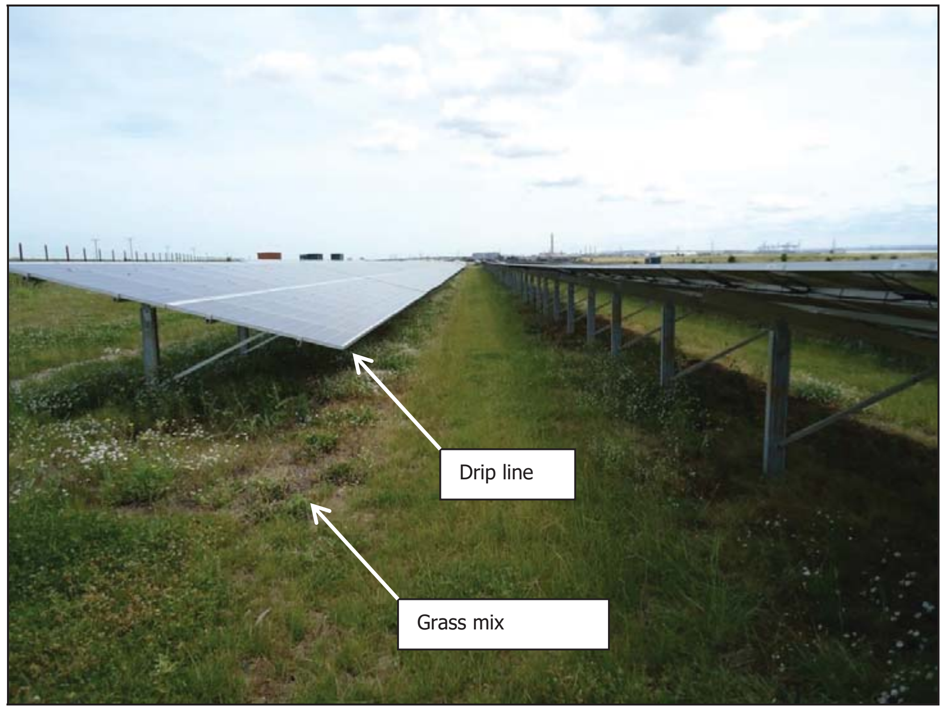
[44] Natural England Technical Information Note 101 "*Solar Parks: maximising environmental benefits*" [online] Available at: http://publications.naturalengland.org.uk/publication/32027 [Accessed 11/04/2018].
[45] Approximately 1.48 ha area of new access track / spine road in 492 ha site

140. The energy of the flow which drains from the solar panels will be greater than that of the rainfall. Therefore, this could result in erosion under the driplines and possibly lead to ground instability. In addition, intensification of the runoff from panels, along the 'drip line', into small channels / rivulets, could be exacerbated where solar panels are not positioned in alignment with the site topography. Given the flat topography in the Hydrology Core Study Area, the potential for rivulets to form is minimal. In order to avoid increased erosion rates, the grass beneath the panels would be well maintained throughout the lifetime of the Development.

141. During the operational phase of the Development the likelihood of soil erosion occurring as a result of the Development is therefore considered to be minimal. Implementation of mitigation measures will further reduce any potential effects. During the construction phase, unnecessary soil disturbance on saturated soils would be avoided in order to minimise soil compaction.

142. As such, the area under the drip line should be seeded with a suitable grass mix, as shown in Plate 8, to prevent rilling (incisions in soil caused by concentrated water flow) and an increase in surface water runoff rates.

Plate 8: Establishing grass mix under PV drip line[46][47]



[46] Photograph taken 6 months after construction of Malmaynes Solar Farm, Medway, 2016
[47] Delfzijl solarpark, Netherlands

143. Topography within the Hydrological Core Study Area is essentially flat, meaning rainfall will not drain quickly down slope and will preferentially infiltrate where it lands under the drip line. Should the rate of infiltration within the clay soils be exceeded then the velocity of any standing water that does begin to form will be slow, giving a greater likelihood that it will be absorbed by the drier land under the panels.

144. Furthermore, the baseline superficial geology cover is clay soils which are tilled or left as stubble for large parts of the year which is likely limit infiltration and promote surface water runoff and ponding of surface water. The proposed grass / vegetation cover during the operational period of the Development is likely to generate lesser surface water runoff rates.

145. It has been agreed in principal with Kent County Council and Upper and Lower Medway IDB that, with the implementation of suitable planting (such as a wildflower or grass mix), the ground cover is unlikely to generate surface water runoff rates beyond the baseline scenario.

146. As such, effects associated with runoff from the PV array are assessed as Negligible.

7 COMPOUND SURFACE WATER MANAGEMENT

147. As discussed and agreed in principal with KCC and Lower Medway IDB, given the absence of residential properties and the proximity of coastal waters to the north there is no requirement for attenuation or traditional SuDS at the electrical compound. The compound will be drained by a 600 mm surface water sewer with a pump which will discharge into a drainage ditch to the north of the compound.

148. A schematic of the proposed drainage network is provided in Appendix 5 of this FRA.

149. The detailed drainage design for the electrical compound area will be provided prior to construction phase of the Development.

8 NPPF SEQUENTIAL AND EXCEPTION TESTS

8.1 Sequential Test

150. Paragraph 158 in NPPF states that developments located within Flood Zone 3 should apply a risk based sequential test in order to steer the proposed development towards areas classed as having a lower probability of flooding. Paragraph 159 and 160 in NPPF does, however, acknowledge that under certain circumstances it may not be possible to locate the development on land identified as having a lower risk of flooding (Flood Zone 1) but the benefits of the development should be clearly stated.

151. The Development site was identified through an ongoing site search exercise undertaken by the Applicant as solar PV developers. A large number of sites have been identified by a team of project developers at Hive via direct approaches and a network of land agents across the country. The south of England was of particular interest to Hive due to the higher levels of solar irradiation experienced relative to other parts of the UK.

152. A range of technical, environmental and economic factors are considered when Hive investigate any potential site for large-scale ground-mounted solar PV development, whether it is identified by Hive or brought to the attention of the developers by a third party. Key factors for consideration included:

- Solar irradiation levels;
- Proximity to an available grid connection;
- Proximity to local population;
- Topography;
- Field size / shading;
- Access to the site for construction;
- Archaeological interest;
- Agricultural land classification;
- Landscape designations;
- Nature conservation designations; and
- Commercial agreement with a landowner.

153. Following consideration of the above factors (as set out in Chapter 4: *Site Selection, Development Design and Consideration of Alternatives* and Technical Appendix A4.1: *Sequential Test Analysis*), the area in which the Development has been located was identified as having good potential for a substantial large-scale ground mounted solar PV array.

154. Given the proximity to an available grid connection and the area required for the PV array, it has been concluded that there are no available sites that met the criteria in

Flood Zones 1 or 2 in a Sequential Study Area of 5 km of Cleve Hill substation (see Figures 1 and 2 of the Technical Appendix A4.1: *Sequential Test Analysis*).

155. As identified on Figure 2 of Technical Appendix A4.1: *Sequential Test Analysis* there is a section of land on the Isle of Sheppey that is in Flood Zone 1 but the land parcel is much smaller than the proposed footprint of the Development. Additionally, in order to connect to the existing Cleve Hill substation cables would have to be installed under or on the bed of the Swale Channel, potentially having significant effects on the costal environment, which is designed as an SPA, Ramsar and Marine Conservation Area and would render the Development unviable.

156. For these reasons, it is considered that the Development meets the requirements set out in Table 3 of the Planning Practice Guidance and meets the requirements of the Sequential Test.

8.2 Exception Test

157. The Planning Practice Guidance to the NPPF also states that the two criteria set out in the Exception Test should be applied to developments. The two criteria are listed below:

1. It must be demonstrated that the Development provides wider sustainability benefits to the community that outweigh flood risk, informed by a Strategic Flood Risk Assessment; and
2. A site-specific flood risk assessment must demonstrate that the development 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.

158. The Exception Test criteria are addressed in the following points:

1. The primary function of the Development is to produce green energy for export to the National Grid. Sections 3 to 7 of this FRA have demonstrated that onsite flood risk, and the potential risk of offsite flooding, will not increase as a result of the Development. Additionally, it is considered that the Development will provide significant wider sustainability benefits in terms of a significant supply of renewable energy to the National Grid; and
2. Sections 4 to 7 of this FRA demonstrate that current surface water runoff rates will be maintained for the life time of the Development, as climate change allowances have been factored into surface water runoff calculations.

   The embedded Development design ensures that the non-critical elements of the Development have been designed to be flood resilient while the critical infrastructure has been designed to be flood resistant. An evacuation plan for construction contractors will be established in the event of a breach in flood defences to the north of the Core Study Area during the construction phase. Similarly, an evacuation plan for visiting servicing personnel will also be in place during the operational phase.

   Additionally, the Development is classed as "Essential Infrastructure" in Table 2 of the Planning Practice Guidance, which is appropriate in the high risk Flood Zone 3a, in terms of flood risk vulnerability.

159. As such, the Development passes the requirements of the Exception Test.

9 CONCLUSION

160. The Development is located in areas classed as Flood Zone 3a but is located in an "Area Benefitting from Flood Defences".

161. The Development is classed as "Essential Infrastructure" in accordance with Table 2: *Flood risk vulnerability classification* and therefore compatible in Flood Zone 3a[48], the classification states that these types of development "*need to remain operational in times of flood*".

162. Non-flood sensitive infrastructure forming the wider development (PV arrays, cabling, inverters and transformer stations) has been designed to be resilient to a 1 in 1,000 year plus climate change (year 2070) defended (wave overtopping) event, which is above the requirements of the 1 in 200 event identified by the NPPF and Government guidance.

163. The Development has been designed to safeguard the critical electrical infrastructure (electrical compound) from a breach scenario for the 1 in 1,000 year flood event plus climate change (year 2070), and a 300 mm freeboard allowance for the lifetime of the Development.

164. Following implementation of the embedded design measures, the introduction of hard-standing associated with the Development will not lead to an increase in discharge rates above greenfield levels, for a 100-year return period. The residual effect of the Development on flood risk is therefore considered to be negligible.

165. For lower return periods, the implemented mitigation measures will act to reduce any effects of runoff from the site in the wider catchment relative to the greenfield levels and therefore provide a beneficial effect.

166. Table 5 shows that the risk of the Development flooding from all sources is Negligible, with the exception of tidal sources, which is classed as Low risk, following the implementation of embedded design measures.

[48] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/575184/Table_3_-_Flood_risk_vulnerability_and_flood_zone__compatibility_.pdf

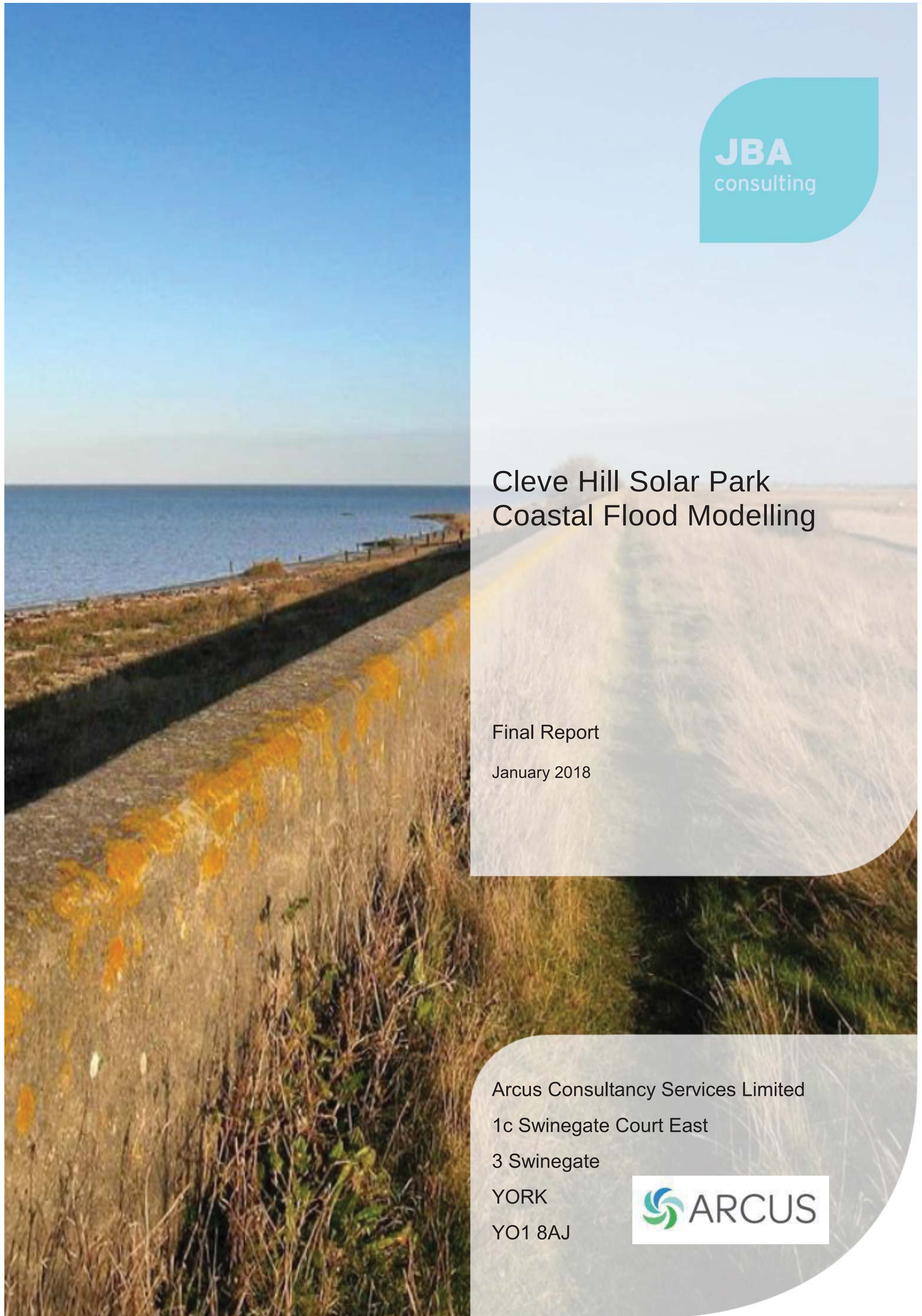
Table 5: Risk of Flooding

Flooding Source	Potential Risk				Comment	Residual Risk
	Negligible	Low	Mod	High		
Tidal **(during defence breach event)**				✓*	Site afforded flood protection up to the 1:1,000 year event. Flood defences are in 'Good' and 'Fair' condition. Breach of flood defences would inundate a wide area up to 4.25 m depth during the 1 in 1,000 year flood. Critical infrastructure at the Development has been designed to be safe for the 1 in 1,000 year flood defence breach scenario, with an allowance for climate change and the application of 300 mm freeboard.	Low
Fluvial (watercourses and drainage ditches)	✓				No records of fluvial flooding in proximity to the Development. Mechanism for flooding on Faversham Creek is tidal surge. Drainage ditches drain the Core Study Area and convey water slowly. The IDB actively manage water levels within the ditches with flow control.	Negligible
Pluvial (Surface Water)	✓				Development located in rural area and only isolated areas mapped to flood from pluvial sources. Critical electrical infrastructure has been located outside these areas.	Negligible
Groundwater	✓				Development site underlain by clay deposits. Given lack of previous groundwater flooding and shallow water levels risk is considered to be negligible.	Negligible
Sewer / Surface water drains	✓				Development located in rural area and does not have highways drains.	Negligible
Reservoirs / Lochs	✓				Not modelled to flood should the retaining wall of the nearest reservoir fail.	Negligible

* assuming a worst-case scenario of a catastrophic breach to existing flood defences

167. This report has been written to meet the requirements of the NPPF, NPS, Policy DM 21 Water, flooding and drainage of the Swale Borough Local Plan and the EA.

APPENDIX 1 – CLEVE HILL SOLAR PARK COASTAL FLOOD MODELLING - JBA



Cleve Hill Solar Park Coastal Flood Modelling

Final Report

January 2018

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Draft v1.0 / December 2017		Liam Nevins, Senior Environmental Consultant
Final v2.0 / January 2018	Addressed comments from draft report	Liam Nevins, Senior Environmental Consultant
Final v3.0 / January 2018	Additional figure added	Liam Nevins, Senior Environmental Consultant

Contract

This report describes work commissioned by Arcus Consultancy Services Limited, on behalf of a private client, by email dated 06th October 2017. Ian Gaskell of JBA Consulting carried out this work.

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Purpose

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Acknowledgements

We would like to thank Arcus Consultancy Services Limited for providing site location information and topographic survey data.

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JBA is aiming to reduce its per capita carbon emissions.

Contents

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Abbreviations

ABD ..... Areas Benefitting from Defences
AEP ..... Annual Exceedance Probability
Defra ..... Department for Environment, Food and Rural Affairs
EA ..... Environment Agency

FRA ..... Flood Risk Assessment
Ha ..... Hectares
JBA ..... Jeremy Benn Associates Limited
LIDAR ..... Light Detection and Ranging
NPPF ..... National Planning Policy Framework
UKCP09 ..... The UK Climate Projections

1 Background

1.1 Terms of reference

Arcus Consultancy Services Limited commissioned JBA Consulting to re-run the North Kent Coastal Flood Model, on behalf of their client. It is understood that the client wishes to turn the site, which is currently farmland, into a solar park.

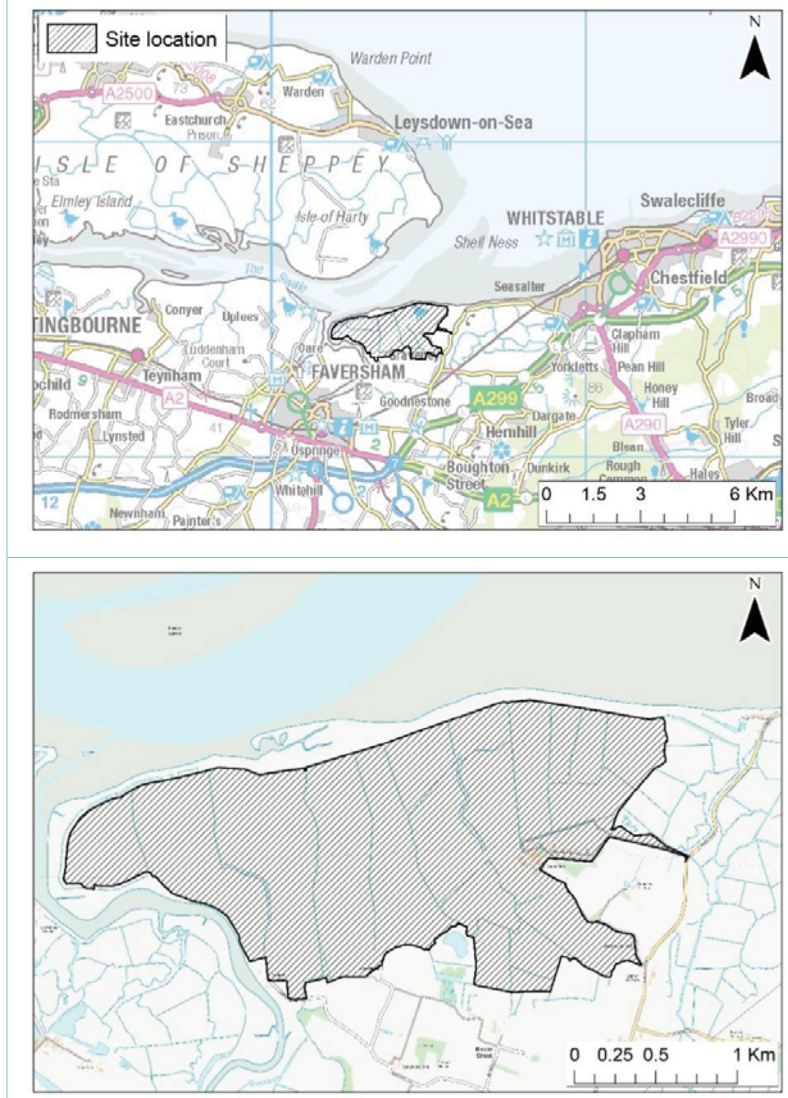
This report will investigate the flood risk at the site using the Environment Agency (EA) North Kent Domain 2 coastal models (2015). This coastal flood modelling provides information on the nature of flood risk at the site. The main flood risk is considered to be a consequence of tidal flooding from The Swale, as such, flood risk will be assessed from a tidal perspective.

1.2 Site location

The site is situated 2km northeast of Faversham, to the northwest of the village of Graveney in Kent (Figure 1-1). The site is located on the southern bank of The Swale, a 21km channel that separates the Isle of Sheppey from the mainland of north Kent. The Swale is a tidal channel and the flood risk to the site is predominantly tidal.

The site covers Cleve and Graveney Marshes; an area of roughly 400ha currently used as farmland.

Figure 1-1: Site location



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2 Tidal modelling

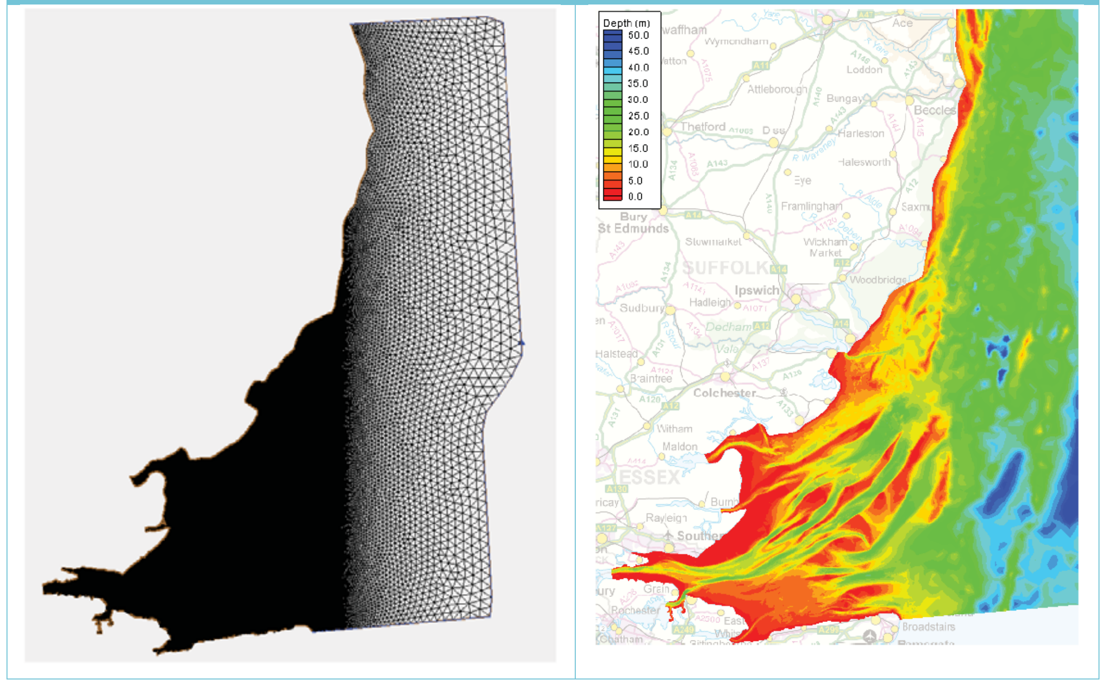
2.1 Assessment of flood risk methodology

Existing wave, overtopping and inundation models were used to assess tidal flood risk at the site. The models were constructed as part of the EA North Kent Domain 2 coastal modelling, dating from 2015.

The existing wave model (Figure 2-1) was run for joint probability combinations of extreme water levels and wind speeds based on EA Department for Environment, Food and Rural Affairs (Defra) best practice guidance from 2005[1], as per the original modelling. The wave climate for each combination of variables was extracted from the defence toes surrounding the site and used as boundary conditions in the overtopping model. The worst-case (largest) overtopping rate for each return period was determined and used to create a time series of overtopping (mean overtopping discharge). The overtopping discharges were then simulated in the inundation model, along with water level time series boundaries to determine tidal flood risk at the site. The inundation model spans the North Kent coastline from Allhallows-on-Sea in the west to Whitstable in the east (Figure 2-2).

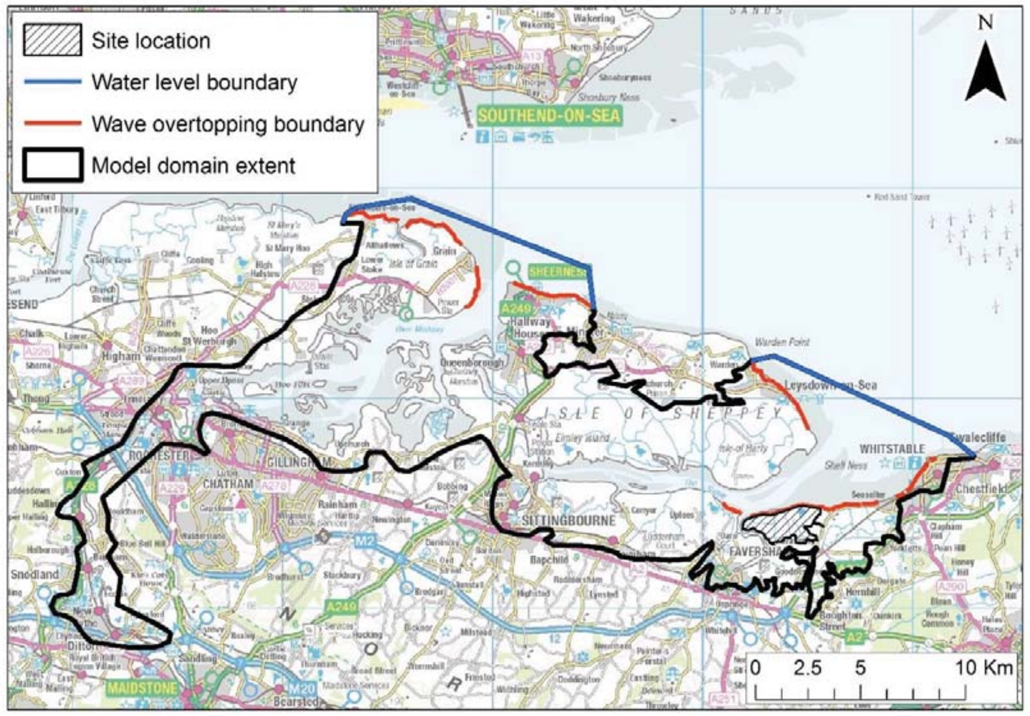
A series of updates were made to the model boundary conditions and topography as discussed below.

Figure 2-1: Existing North Kent wave model computational mesh and bathymetry



1 Use of Joint Probability Methods in Flood Management: A Guide to Best Practice, Defra and the Environment Agency, March 2005

Figure 2-2: Existing North Kent Domain 2 inundation model domain



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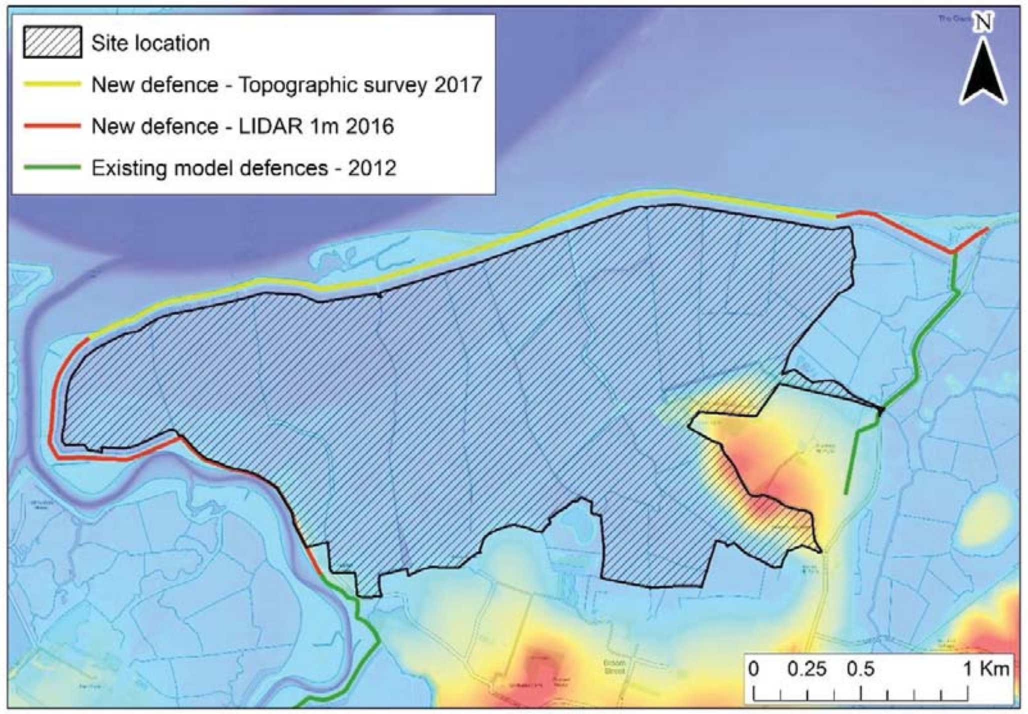
2.2 Flood inundation model modifications

The flood inundation modelling was completed using the existing Environment Agency North Kent Coastal Domain 2 model. The model has a 10m grid resolution and was updated with the new topographic and breach data. All modelling was completed using TUFLOW version 2013-12-AB-iSP-w64 to match the version used for the original Environment Agency coastal model simulations. All model runs were completed with no stability problems, very few negative depths and with a Cumulative Mass Error that peaks at 0.03%, well within the recommended ±1%.

2.2.1 Topographic

New defence crest information was available from several sources and incorporated into the model (Figure 2-3). The defence data surrounding the site were derived from two sources, new topographic survey data and Light Detection and Ranging (LIDAR) data. Other defence information was already incorporated in the existing model.

Figure 2-3: Updated defence information



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2.2.2 Boundary conditions

The existing model boundary conditions were based on the UK Climate Projections (UKCP09) sea level rise projections.

For the purposes of planning and design the boundary conditions were updated to use the National Planning Policy Framework (NPPF) sea level rise projections[2] (Table 2-1). Tidal curves were generated for present day (2017) and climate change (2070) to span the design life of the project.

Table 2-1: NPPF Sea level rise from 2008 base year

Epoch	Sea Level Rise (m)
2017	0.036
2070	0.521

2.3 Wave model modifications

2.3.1 Boundary conditions

The existing wave model was run for the joint probability combinations of water levels and wind speeds used in the original modelling. The joint probability water levels were adjusted for NPPF sea level rise (Table 2-1). In addition, an allowance for wind speed was applied based on EA sensitivity guidance for climate change. Wind speed was increased by 10% for the 2070 epoch.

2.4 Wave overtopping model modifications

2.4.1 Defence schematisation

At the site, the existing model set up included a wave overtopping boundary located immediately on the landward side of the coastal defence (Figure 2-4). The overtopping calculations were based

2 https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

on the primary defence at the site, a raised embankment and concrete wall (Figure 2-5), with the defence profile being schematised using a mean beach profile and surveyed data (Figure 2-6). The newly provided topographic survey was used to check the existing defence schematisation crest level of 6.22mAOD. The survey showed that a level of 6.10mAOD would better represent this length of defence and was therefore adjusted.

Figure 2-4: Wave overtopping boundary at the site

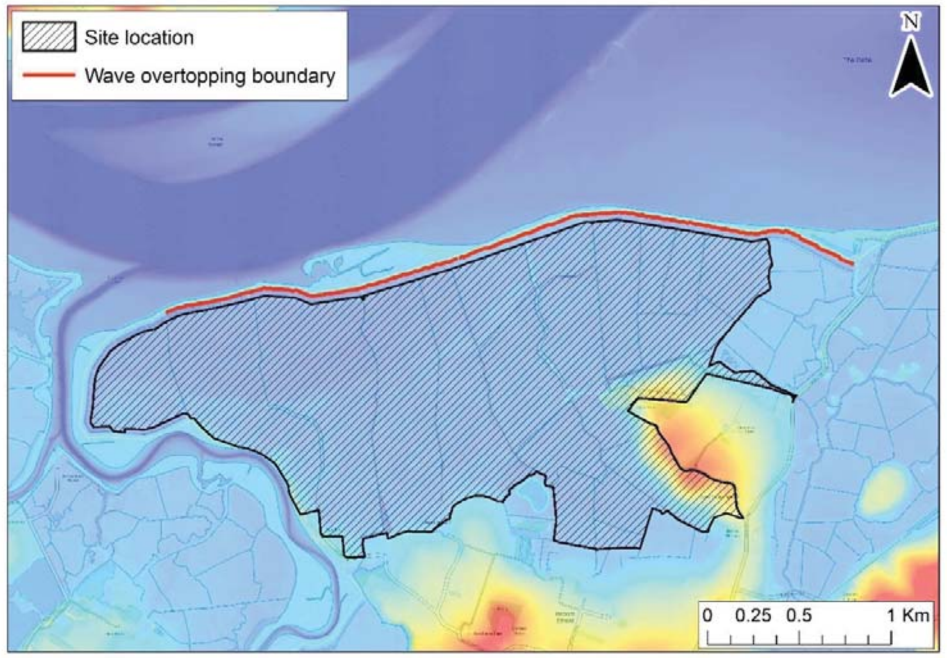

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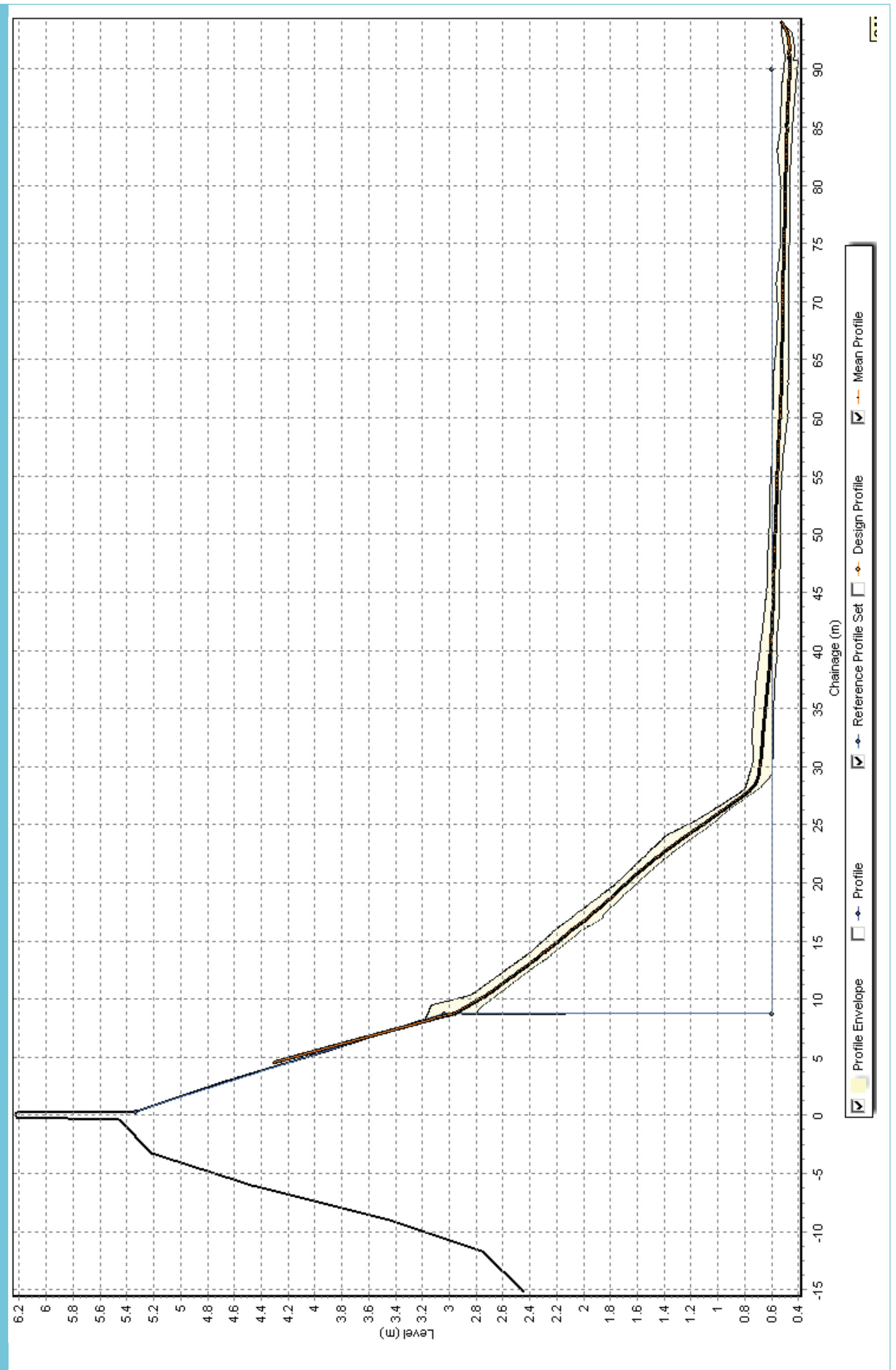
Figure 2-5: Defence image

Figure 2-6: Defence profile



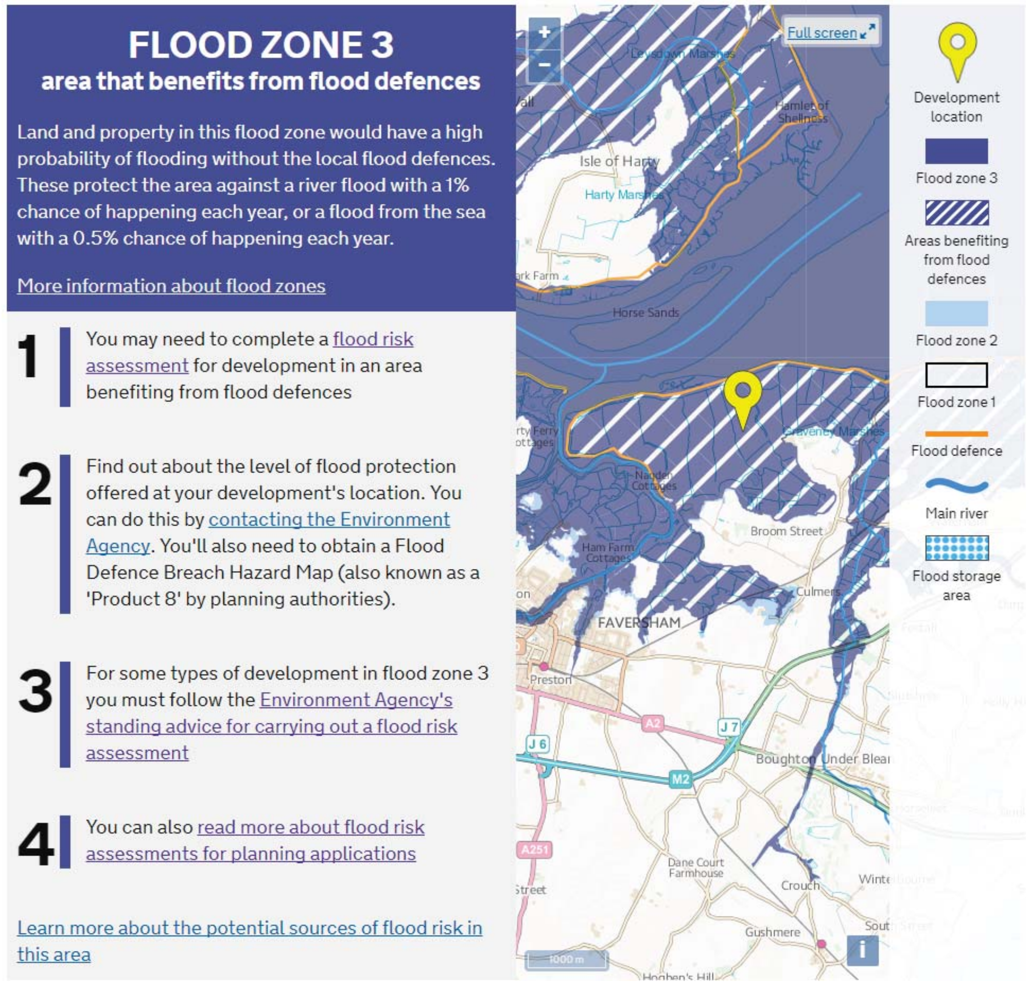
3 Assessment of tidal flood risk

3.1 Environment Agency Flood Zones

The EA has developed a Flood Map that shows the risk of flooding in England and Wales for different return period events. It should be noted that the EA Flood Map is an indication of the potential flood risk to a site and the actual risk may differ.

The EA Flood Map shows that the site is within Flood Zone 3, Area Benefitting from Defences (ABD), as shown on Figure 3-1 taken from the EA website. Land and property in this Flood Zone would have a high probability of flooding without the local flood defences. The defences protect the site against a 1% (1:100) and 0.5% (1:200) or greater probability of flooding from rivers and the sea respectively in any given year; this is often referred to as the Annual Exceedance Probability (AEP).

Figure 3-1: Environment Agency flood probability maps



(Source: https://flood-map-for-planning.service.gov.uk/summary/518295/415550)

3.2 Modelled flood outputs

Flood risk at the site was assessed using the North Kent Domain 2 coastal models (2015). The models were simulated for the 0.5% (1:200) and 0.1% (1:1,000) AEP events for present day (2017) and climate change (2070) conditions for the following scenarios:

- Defended - represents existing defence network and includes flooding from extreme sea levels and wave overtopping of coastal defences.
- Undefended - represents the removal of all coastal defences and includes flooding from extreme sea levels (but does not account for wave action).

- Breach - represents existing defence network with a localised defence breach. Flooding is from both wave overtopping of the intact defence network and extreme sea levels through the breached defence.

3.2.1 Breach modelling and locations

Two defence breach locations, one on the western side of the site (breach 1) and one on the eastern side (breach 2), have been simulated (Figure 3-2). The western breach is located at a sluice gate through the primary coastal embankment (602716, 164486), and the eastern breach through Saxon Shore Way embankment (605367, 164847).

The breach parameters were taken from the EA Modelling and Forecasting Technical Guidance Note 2017 (Table 3-1).

Figure 3-2: Breach locations

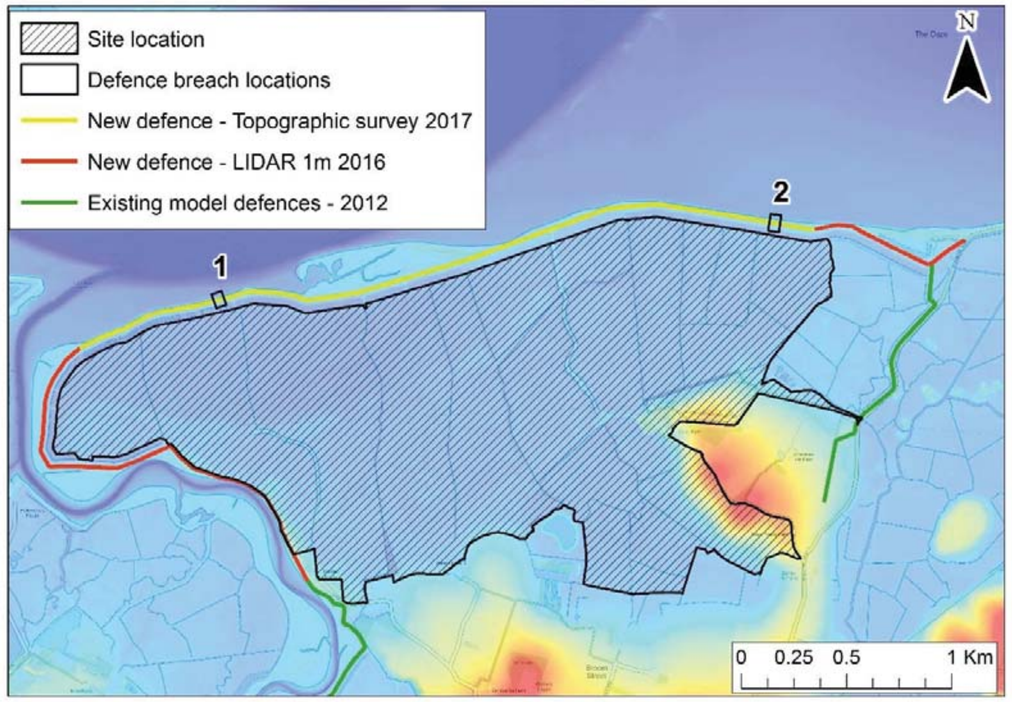


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Table 3-1: Breach parameters

Parameter	Breach 1	Breach 2
Source	Open coast	Open coast
Defence type	Earth bank with facing	Earth bank with facing
Toe level	0.26m	1.02m
Width	100.00m	100.00m
Defence failure water level	4.60m	4.60m
Failure time	56.00hrs	56.00hrs

3.3 Assessment of flood risk at the site

3.3.1.1 Defended present day flood risk

The site is afforded protection predominantly by raised earth embankments, with the primary embankment running along the northern limit of the site incorporating a raised concrete wall on top.

The 0.5% and 0.1% AEP flood extents for the defended scenario are shown on Figure 3-3. The site is afforded a high level of protection from tidal flood risk. During the 0.5% AEP flood event, a small volume of wave overtopping occurs over the tidal embankment, but does not extend past the drain on the landward side of the flood defence. During the 0.1% AEP flood event, wave overtopping is more considerable, impacting primarily on the western part of the site. Flood depths during this event are generally <0.20m but reach 0.75m on low ground with the site (Figure 3-4).

Figure 3-3: Defended - 0.5 and 0.1% AEP present day flood extents

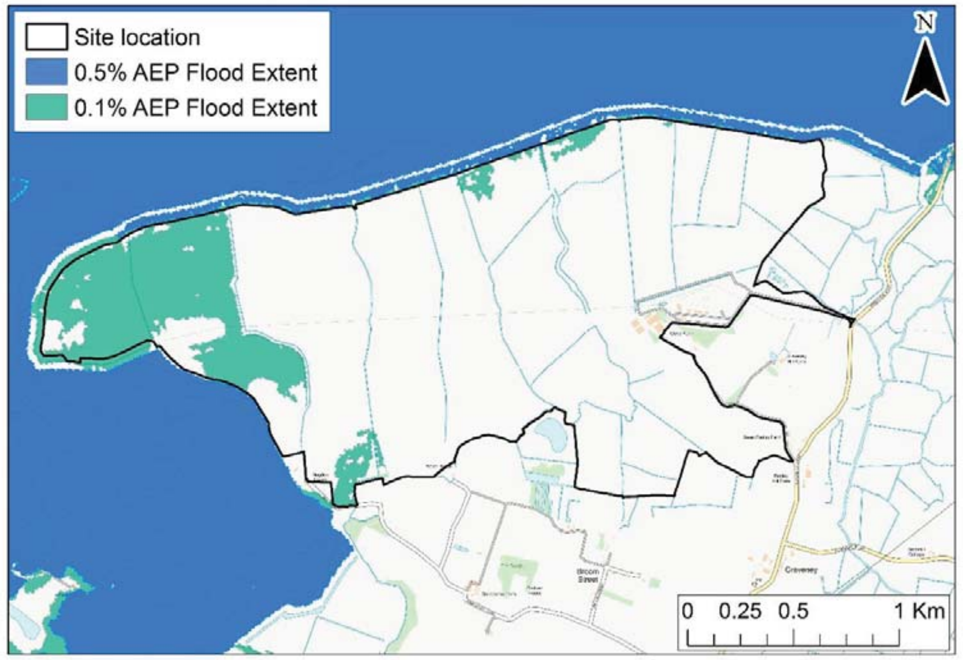
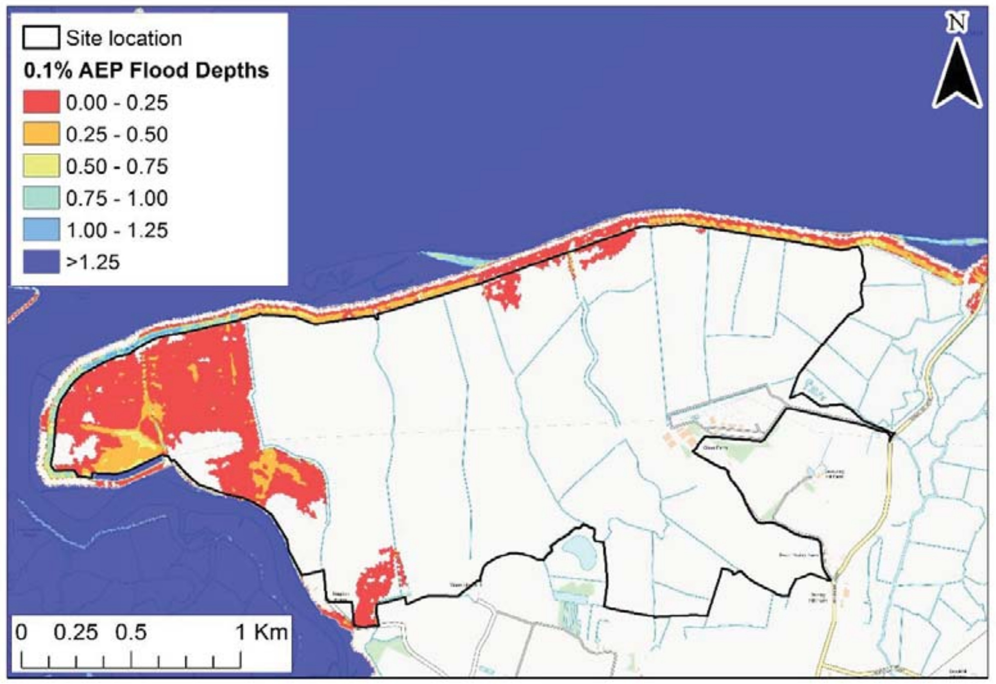


Figure 3-4: Defended - 0.1% AEP present day flood depths



3.3.1.2 Undefended present-day flood risk

When considering the comprehensive removal of all tidal flood defences from the model, flood risk at the site would be significant. The 0.5% AEP undefended flood extent would inundate the entire site, with the 0.1% AEP flood extent being only slightly more extensive (Figure 3-5). Flood depths during the 0.5% AEP event are generally between 2.50 and 3.00m across the site, but flood depths reach 3.85m at a low point towards the north-western area of the site (Figure 3-6). During the 0.1% AEP undefended event, flood depths show a similar spatial pattern to the 0.5% AEP event albeit roughly 0.40m deeper across the site.

Based on the results of the 0.5% AEP present day defended and undefended outputs, the entire site area would be classified as an ABD, as it would be at significant flood risk if the current defences were not in place.

Figure 3-5: Undefended - 0.5 and 0.1% AEP present day flood extents

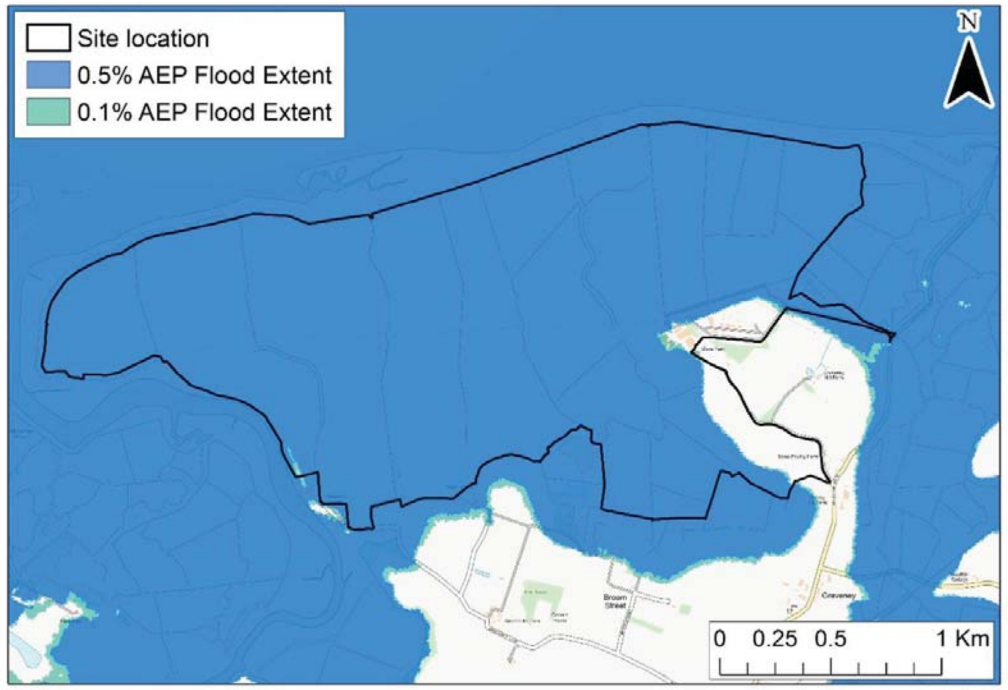
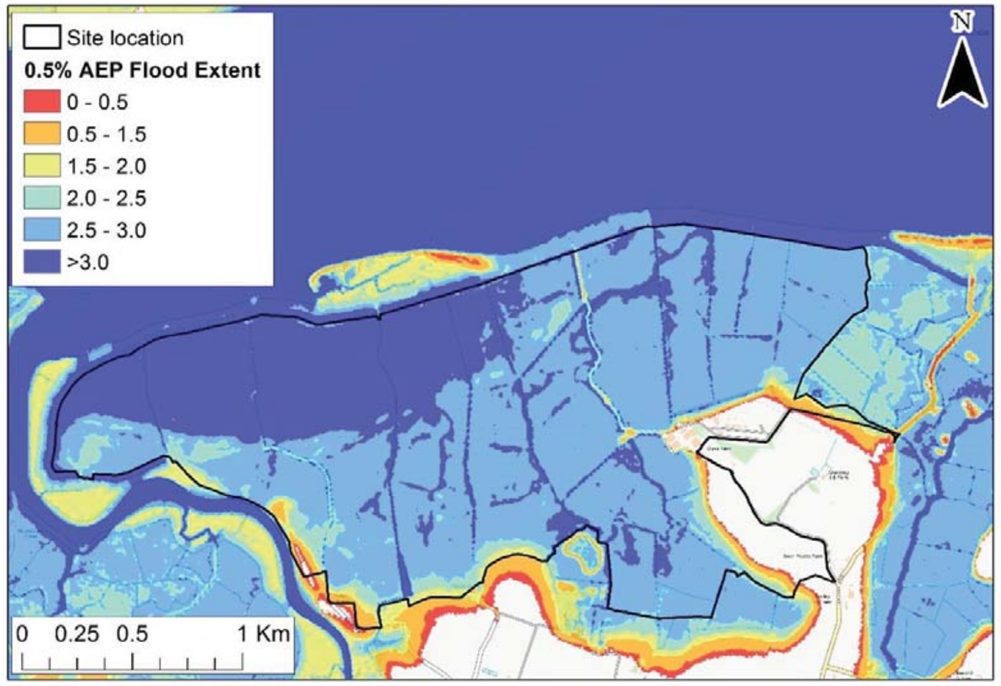


Figure 3-6: Undefended - 0.5% AEP present day flood depth



3.3.1.3 Defence breach present-day flood risk

Figure 3-7 and Figure 3-8 show that during a present-day 0.5% AEP flood event the site is at flood risk from a defence breach. A defence breach at location 1, to the western part of the site at the sluice gate, would lead to flood depths generally between 2.40 and 2.80m, while the lower part of the site to the north west reaches 3.85m. A defence breach at location 2, through the embankment to the eastern part of the site, would lead to flood depths generally between 2.30 and 2.50m, while depths in the north-west of the site reach 3.75m at one or two low points.

Figure 3-7: Defended defence breach location 1 - 0.5% AEP present day flood depths

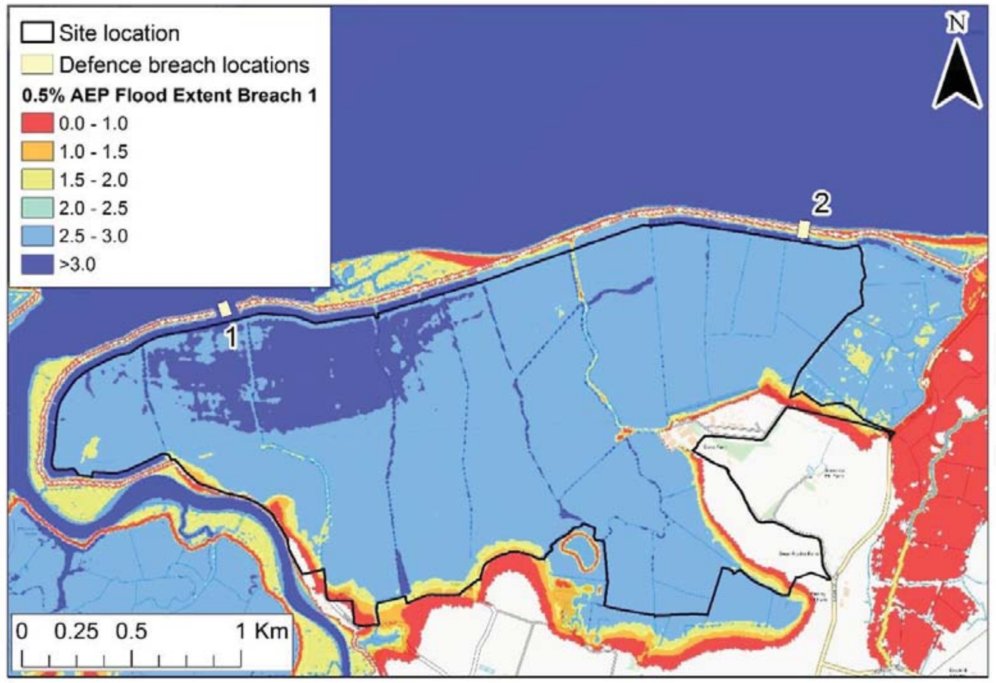
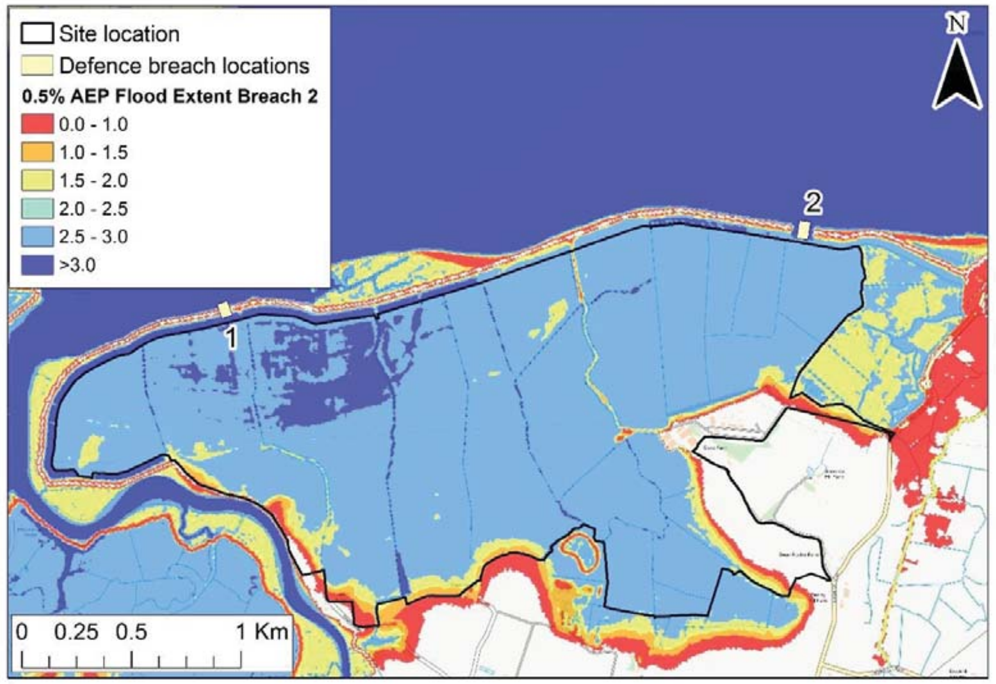


Figure 3-8: Defended defence breach location 2 - 0.5% AEP present day flood depths



3.3.1.4 Defended future flood risk

Under future sea level rise conditions (2070), the site would be at greater risk of flooding. Figure 3-9 shows a comparison between the 0.5% AEP present day and future sea level rise (2070) flood extents. The impact of sea level rise shows that the northern and western parts of the site would be at increased risk with flood depths generally reaching between 0.20 and 0.40m (Figure 3.10). During the 0.1% AEP event, sea level rise modelled outputs show the entire site will be at flood risk (Figure 3-11) with flood depths generally between 0.50 and 0.80m, with the north-western part of the site reaching 1.75m (Figure 3-12).

Figure 3-9: Defended 0.5% AEP present day and future sea level rise flood extents

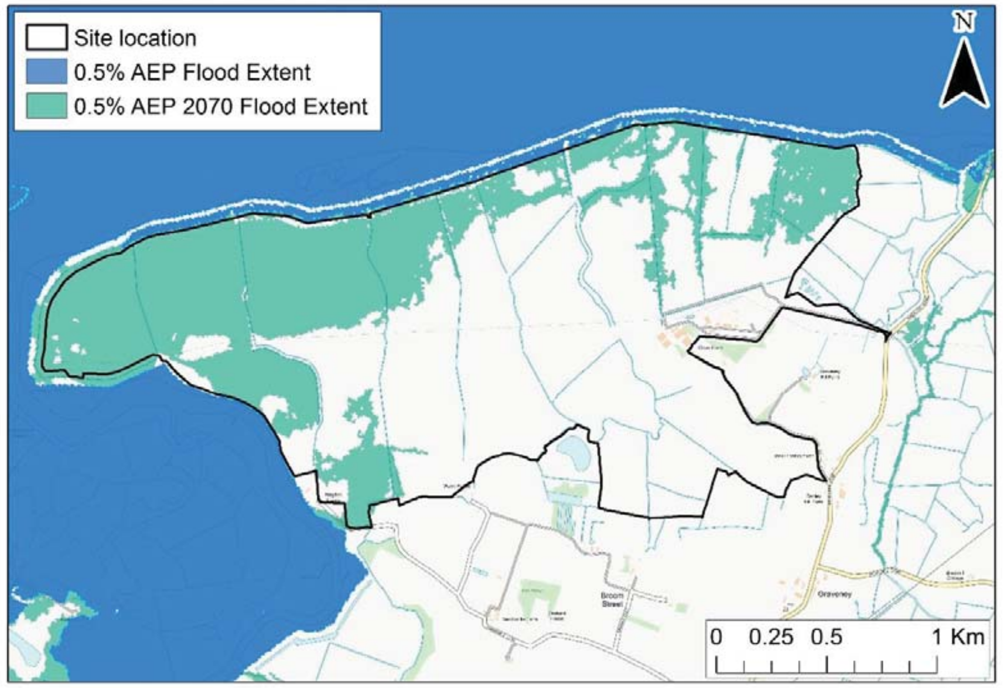


Figure 3-10: Defended 0.5% AEP future sea level rise flood depths 2070

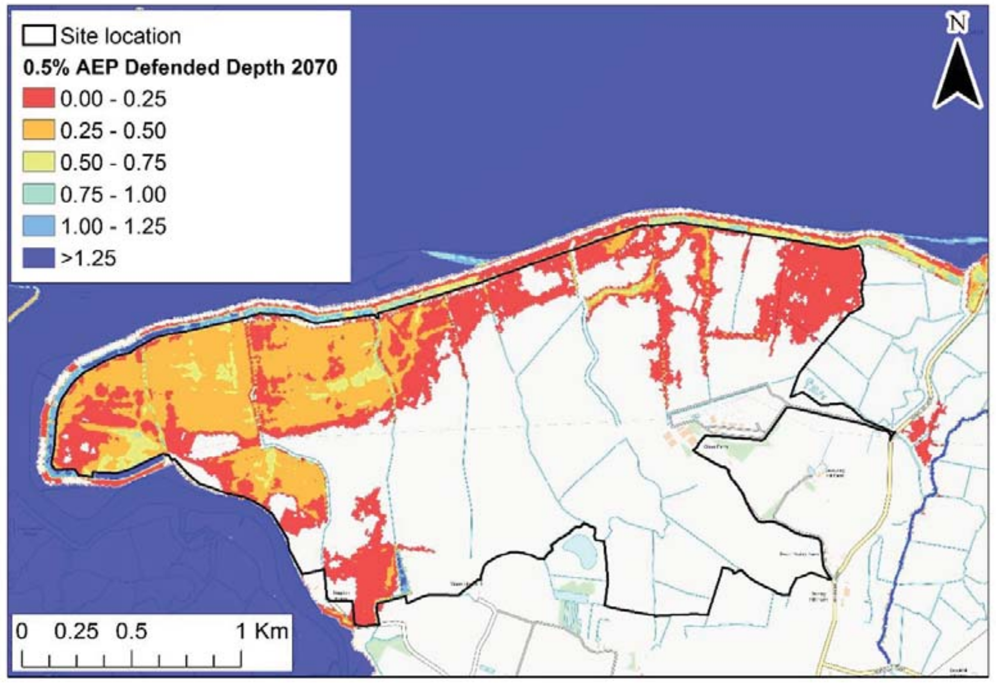


Figure 3-11: Defended 0.1% AEP present day and future sea level rise flood extents

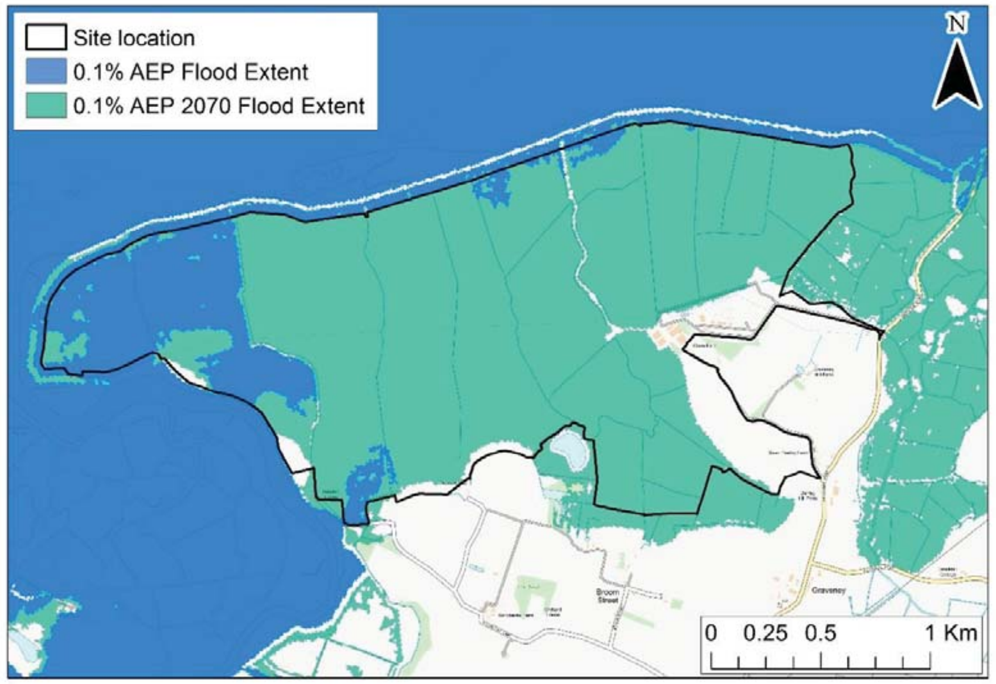
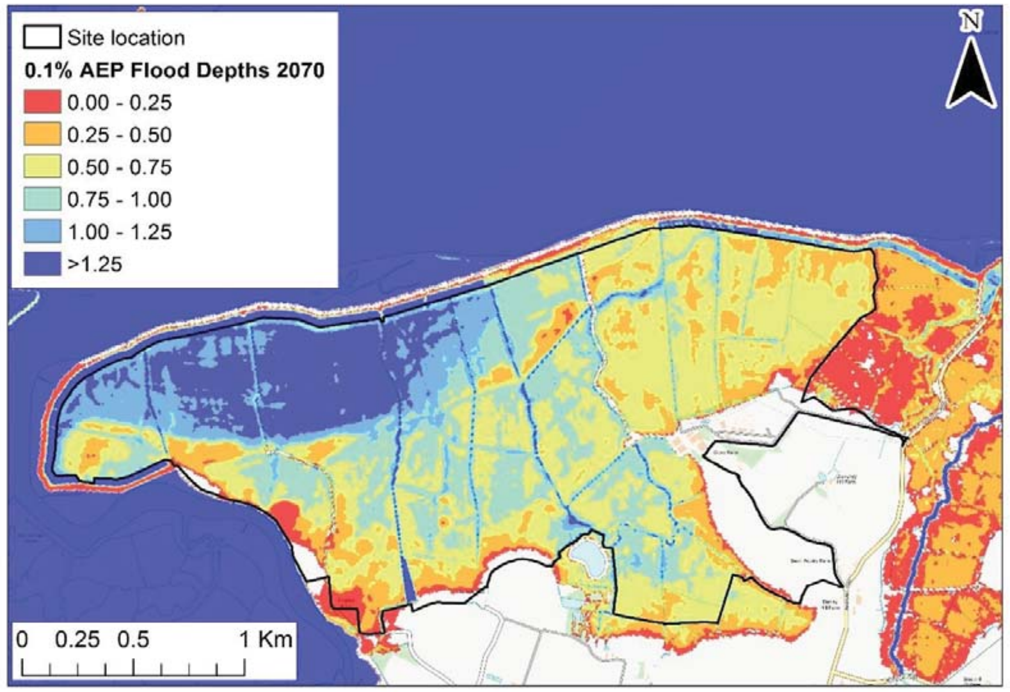


Figure 3-12: Defended 0.1% AEP future sea level rise flood depths



3.3.1.5 Undefended future flood risk

Under future sea level rise conditions (2070), the comprehensive removal of all tidal flood defences from the model produces similar flood extents to the present-day equivalent simulations (Figure 3-13 and Figure 3-14). However, flood depths are generally 0.50m deeper than their present-day equivalent. The 0.5% and 0.1% AEP undefended maximum flood depths reach 4.40 and 4.85m respectively.

Figure 3-13: Undefended 0.5% AEP present day and future sea level rise flood extents

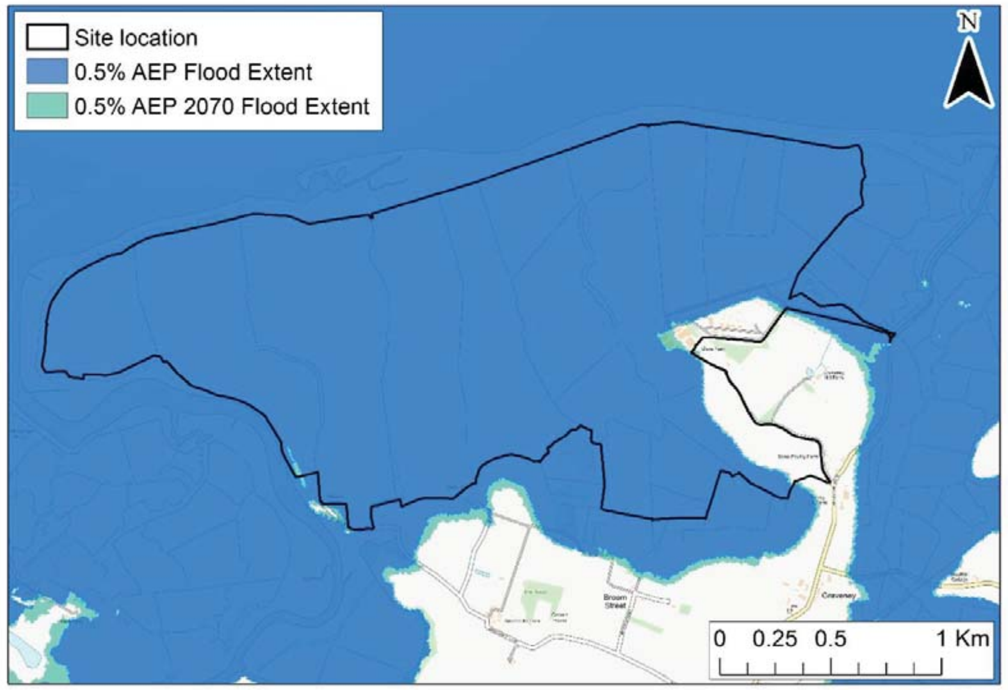
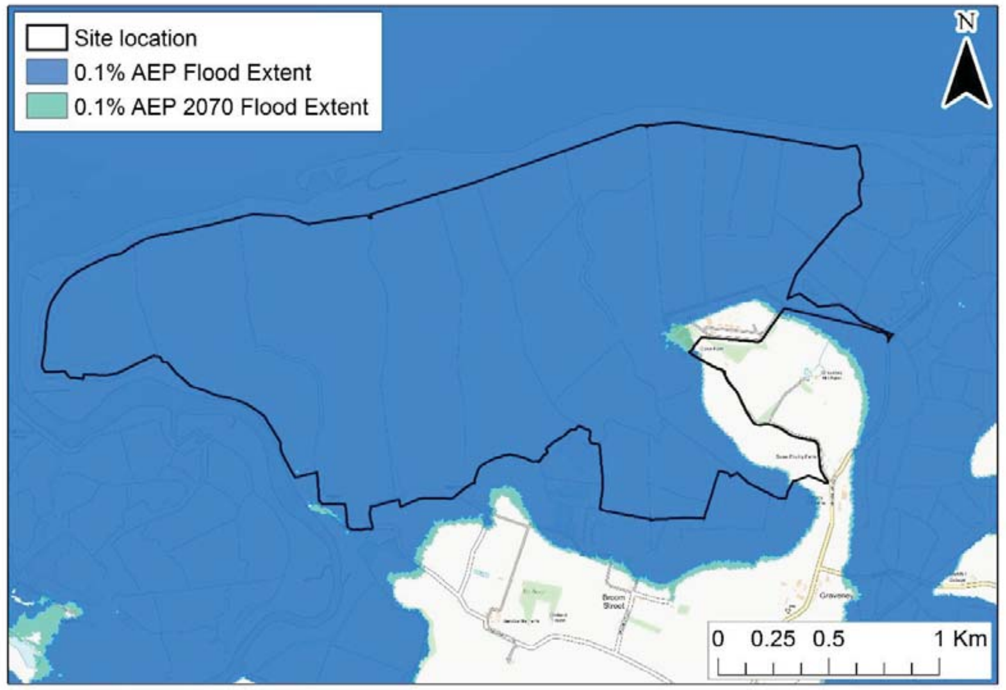


Figure 3-14: Undefended 0.1% AEP present day and future sea level rise flood extents



3.3.1.6 Defence breach future flood risk

Figure 3-15 and Figure 3-16 show a 0.5% AEP flood event under future sea level rise conditions (2070) for a defence breach in the west and east of the site respectively. Under sea level rise conditions, the flood extents are similar to those for present day, albeit slightly more extensive. Flood depths, shown in Figure 3-17 and Figure 3-18, are similar to those for present day but generally 0.40m deeper. For breach 1, flood depths generally range between 2.80 and 3.00m with maximum depths in the western part of the site reaching 3.85m. For breach 2, flood depths generally range between 2.60 and 2.90m with maximum depths in the western part of the site reaching 3.75m. For the 0.1% AEP event the maximum flood depths increase to 4.35m and 4.25m for breaches 1 and 2 respectively.

Figure 3-15: Defended defence breach location 1 - 0.5% AEP future sea level rise flood depths 2070

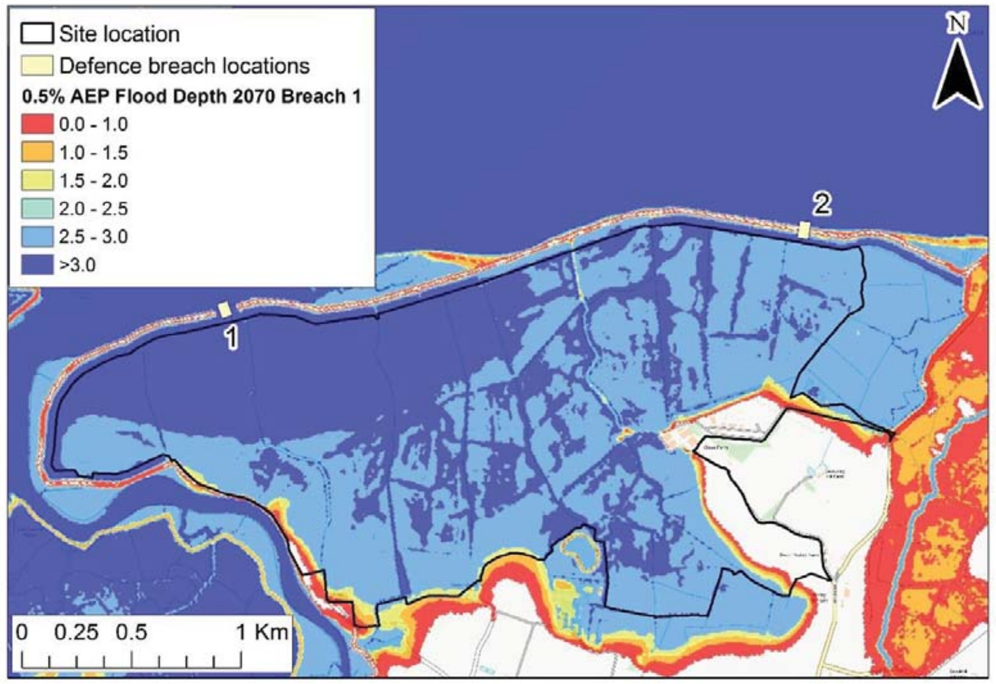


Figure 3-16: Defended defence breach location 2 - 0.5% AEP future sea level rise flood depths 2070

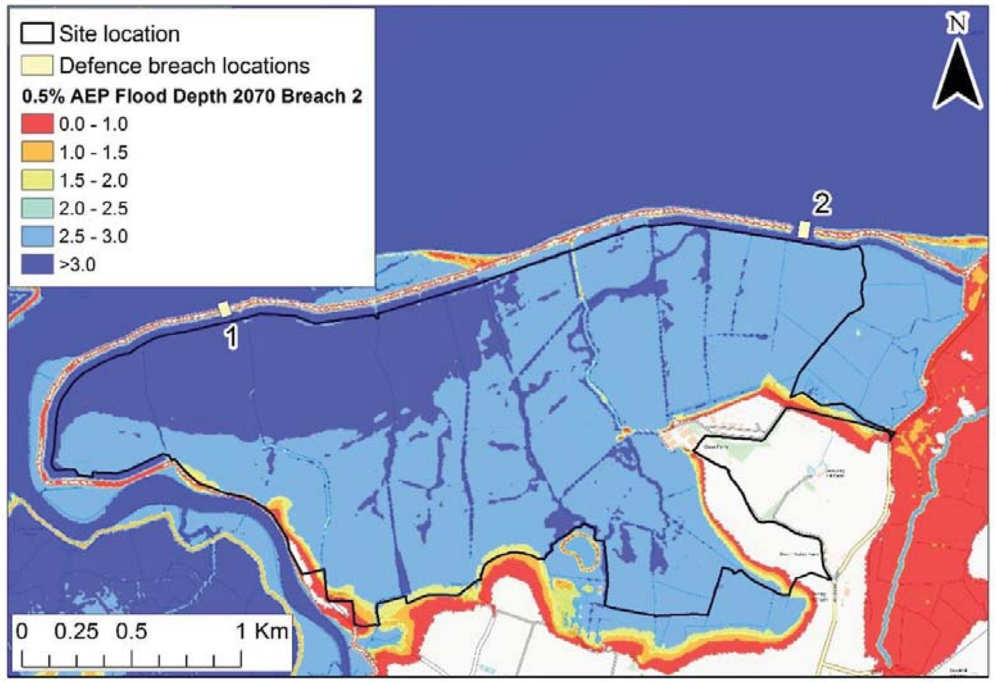


Figure 3-17: Defended defence breach location 1 - 0.1% AEP future sea level rise flood depths 2070

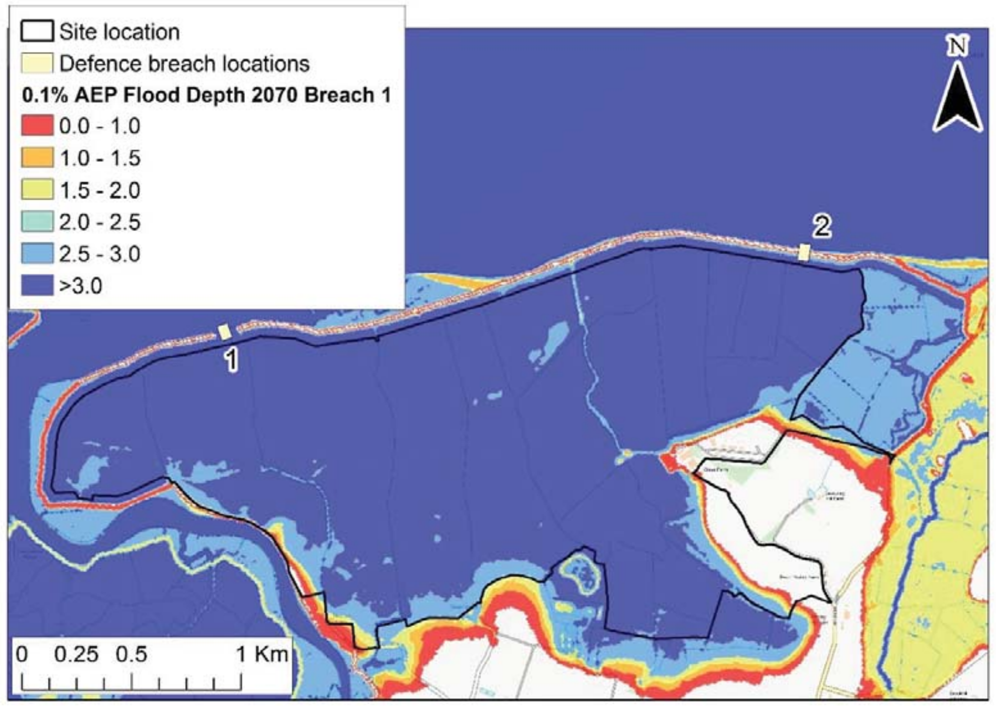
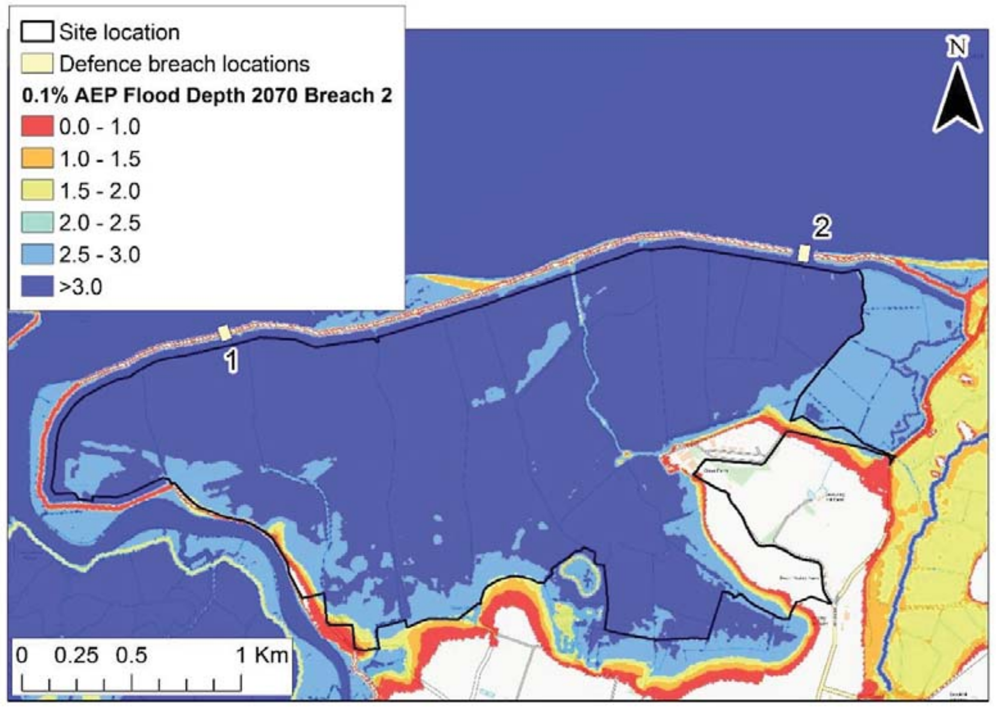


Figure 3-18: Defended defence breach location 2 - 0.1% AEP future sea level rise flood depths 2070



3.4 Summary of modelled flood depths

Table 3.2 summarises the modelled flood depths for all defended, undefended and breach scenarios. The depths are taken from low points in the site, excluding the ditches.

Table 3-2: Summary of modelled flood depths

Model Scenario	Present Day		2070 (NPPF)	
	0.5% AEP	0.1% AEP	0.5% AEP	0.1% AEP
	Max depth	Max depth	Max depth	Max depth
Defended (wave overtopping)	0.00	0.75	0.70	1.75
Defended – Breach 1	3.50	3.85	3.95	4.35
Defended Breach 2	3.40	3.75	3.85	4.25
Undefended	3.85	4.30	4.40	4.85

4 Findings of modelling

4.1 Findings

Arcus Consultancy Services Limited commissioned JBA Consulting to re-run the North Kent Coastal Flood Model, on behalf of their client. The site is situated 2km northeast of Faversham and covers Cleve and Graveney Marshes; an area of roughly 400ha currently used as farmland. The main flood risk to the site is tidal, from The Swale, a tidal channel that separates the Isle of Sheppey from the mainland of north Kent.

The EA's North Kent Domain 2 coastal models (2015) were used to investigate flood risk at the site under the Open Government Licence. Updates were made to the boundary conditions and model topography. New model outputs were generated to include defended, undefended and breach scenarios for present day and future sea level rise events.

The following findings were made:

- The proposed development site is located within Flood Zones 3 of the EA Flood Maps. The site is located in an ABD meaning that land and property in this Flood Zone would have a high probability of flooding without the local flood defences.
- Defended present day model outputs for the 0.5% and 0.1% AEP events show the site is afforded a high level of protection from the existing defences. During the 0.5% AEP flood event wave overtopping flood waters are limited to the drain behind the primary coastal defence, while during the 0.1% AEP flood event, wave overtopping impacts the western part of the site to depths of generally <0.20m.
- Under future sea level rise conditions (2070) for the defended scenario, the site is increasingly at risk, inundated to depths generally ranging between 0.20 and 0.40m and between 0.50 and 0.80m during the 0.5% and 0.1% AEP flood events respectively. Maximum flood depths occur in the north-western portion of the site where flood depths reach 1.75m during the 0.1% AEP 2070 event.
- During the undefended scenario, which considers the comprehensive removal of all tidal flood defences from the North Kent tidal model, the entire site would be inundated. Flood depths during the 0.5% AEP event are generally between 2.50 and 3.00m, but flood depths reach 3.85m towards the north-western part of the site.
- Under future sea level rise conditions (2070), the undefended scenario shows similar extents to the present-day equivalent, but depths are generally 0.50m deeper across the site.
- Due to the low-lying nature of the topography behind the coastal defence, a defence breach would lead to significant still water flooding to the site. During present day conditions for the 0.5% and 0.1% AEP events respectively, a defence breach would lead to food depths generally ranging between 2.30 and 2.80m across the site, with maximum depths reaching 3.85m in the north west of the site. Sea level rise for the 2070 epoch would increase flood depths by roughly 0.40m across the site from the present-day equivalent.

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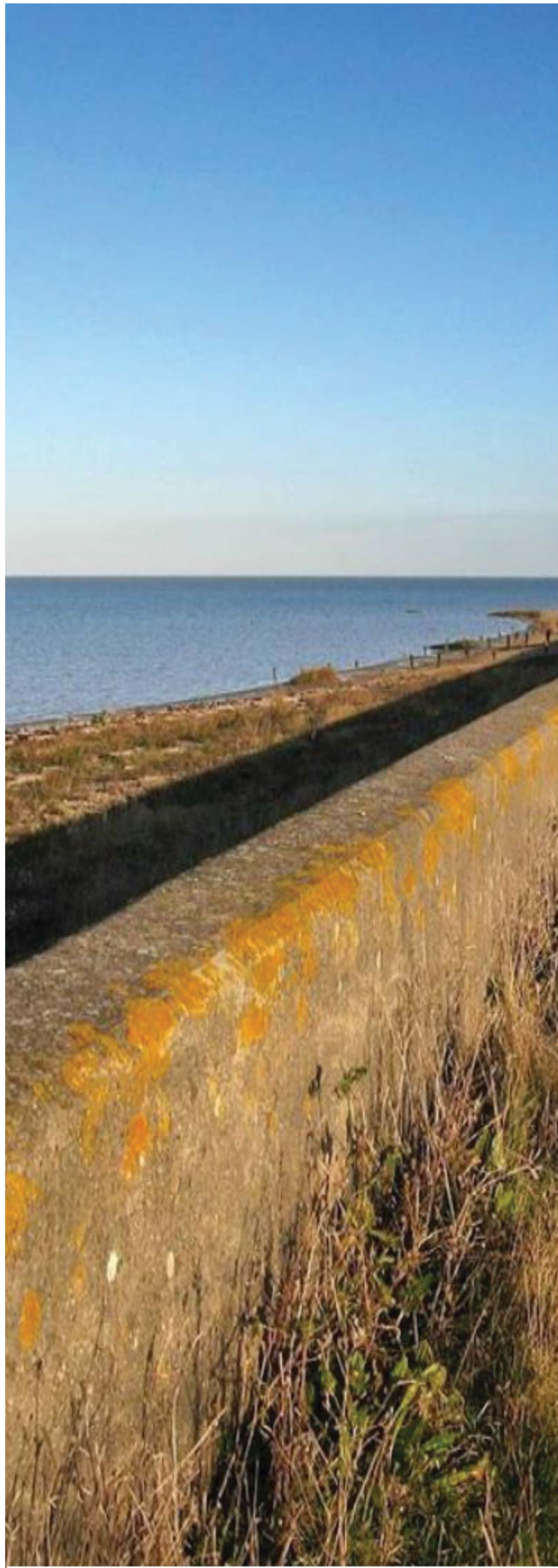

JBA consulting

Cleve Hill Solar Park Coastal Flood Modelling

Additional breach modelling - Addendum

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Revision History

Revision Ref / Date Issued	Amendments	Issued to
Draft v1.0 / April 2018		Mike Bird, Principal Environmental Consultant Simon McCarthy

Contract

This report describes work commissioned by Simon McCarthy of Wirsol Energy Limited on behalf of Cleve Hill Solar Park Limited, by email dated 05th April 2018. Ian Gaskell of JBA Consulting carried out this work.

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Senior Analyst

Reviewed by .... Matthew Hird BSc MCIWEM C.WEM CEnv CSci
Team Leader Marine and Coastal Risk Management

Purpose

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JBA Consulting has no liability regarding the use of this report except to Cleve Hill Solar Park Limited.

Acknowledgements

We would like to thank Arcus Consultancy Services Limited for providing site location information and topographic survey data.

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1 Background

1.1 Terms of reference

In October 2017, Arcus Consultancy Services Limited commissioned JBA Consulting to undertake tidal flood risk modelling of Cleve Hill Marshes on the north Kent coast, where the construction of a solar park is being proposed.

This report forms an addendum to the existing reporting[1], where a full description about the modelling and methodology can be found. This report investigates the consequences of a defence breach to the east of the proposed development, and how flood waters may impact the bund running south from the Sportsman pub along Seasalter Road and affect the site.

1.2 Model set up and simulations

In-line with the breach modelling already carried out within the site boundary, an additional breach was simulated. Breach parameters using the EA Modelling and Forecasting Technical Guidance Note 2017 are detailed in Table 1.1.

The new breach location (breach 3) and the previously simulated breach locations (breach 1 and 2) are shown on Figure 1.1. The breach location was chosen based on the existing topography and what would likely lead to the worst-case flooding to the east of the site. The location chosen has the shortest defence width of the defences eastwards to Seasalter, and some of the defences towards the east have a secondary line of defences which would limit flooding. Therefore, it is likely that a breach in this location would provide a worst-case breach flood extent and depth along the defence length from the Sportsman pub to Seasalter.

Due to the location of Faversham Road directly behind the defence, two different versions of the breach were tested:

Breach 3a) Defence lowered/breached to the level of Faversham road behind at 2.50mAODN (assuming the road would remain intact).

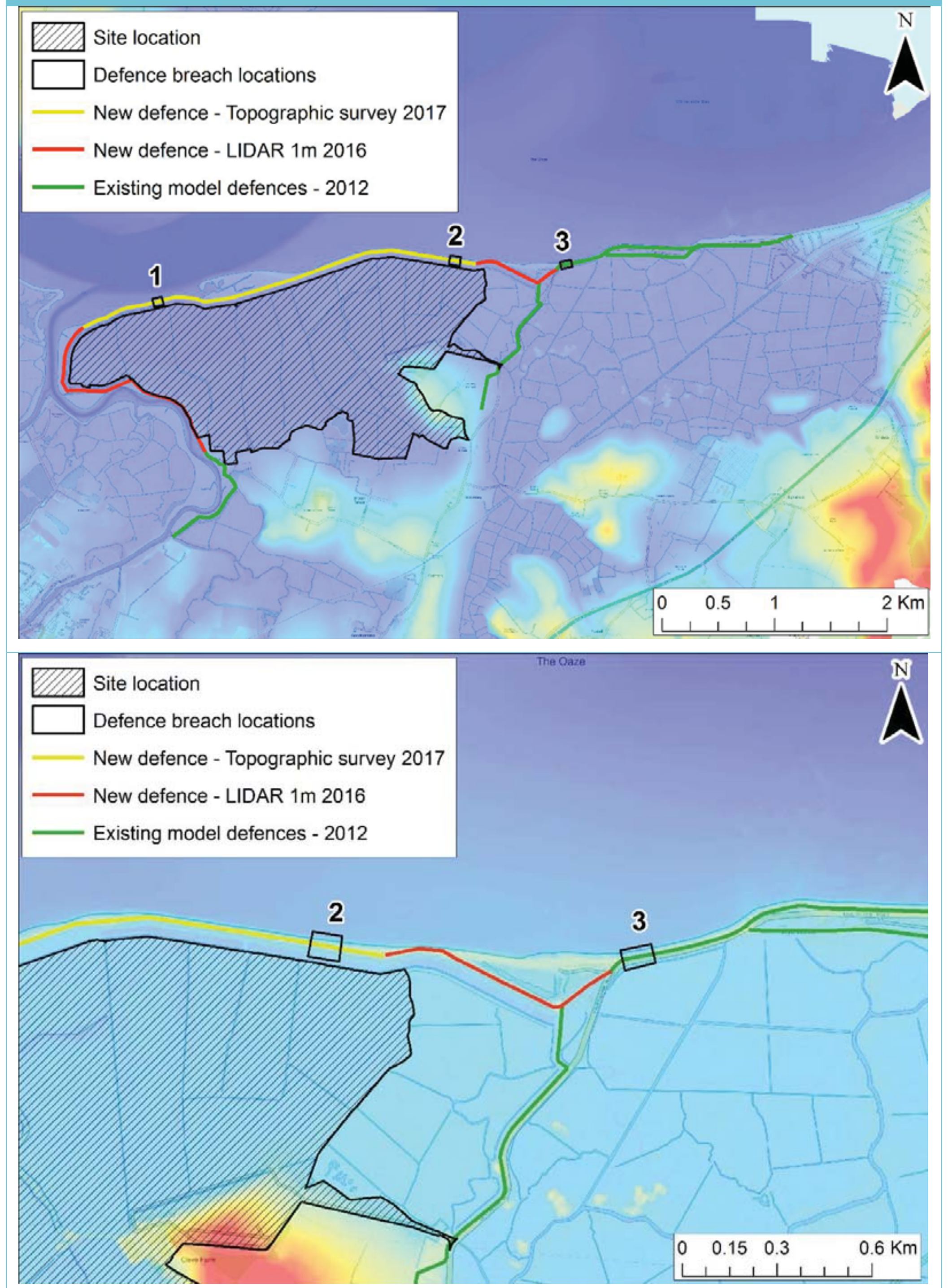
Breach 3b) Defence lowered/breached to the level of the farmland behind at 1.8mAODN (assuming the road would also be breached in any defence failure).

Table 1.1: Breach parameters

Parameter	Breach 3
Source	Open coast
Defence type	Earth bank with facing
Toe level	1.10m
Width	100.00m
Defence failure water level	4.95m
Failure time	56.00hrs

1 Arcus Consultancy Services Limited. Cleve Hill Solar Park Coastal Flood Modelling. Final Report. January 2018.

Figure 1.1: Breach location



Contains Ordnance Survey data © Crown copyright and database right 2018

1.3 Model results

Figures 1.2 and 1.3 show the modelled results for breach location 3 for the 0.1% AEP future sea level rise flood depths 2070 event when the breach is lowered to the level of the road and farm land respectively.

The modelled results show that a breach to the coastal defence to the east of the site would result in flooding of the farmland south of Faversham Road. Flood depths would be significant enough to enable flood waters to then pass westwards over the crest of the bund running south from the Sportsman Pub along Seasalter Road and inundate the site.

Food depths within the site are generally 0.2m greater across the site during a complete breach (breach 3b including Faversham Road) than if just the raised section of defence from the road failed (breach 3a). Flood depths during the complete defence failure scenario are general between 1.0 and 1.30m across the site, with depths being generally 1.70m in the lowest part of the site to the north west.

Flood depths are considerably lower than during a breach of the defence within the site boundary, where flood depths reach >4.0m within the site.

Figure 1.2: Defended defence breach 3a – 0.1% AEP future sea level rise flood depths 2070 (road level)

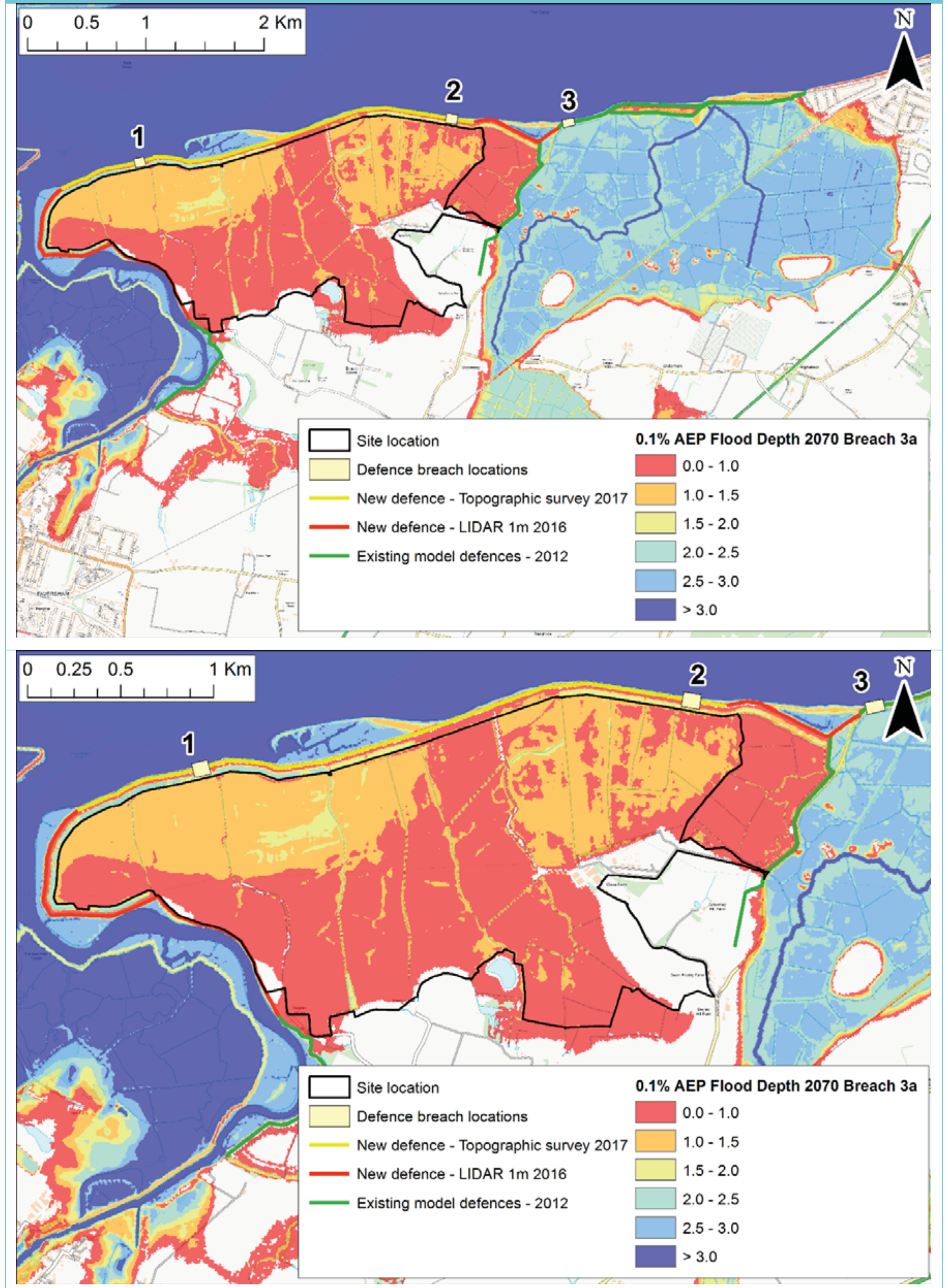
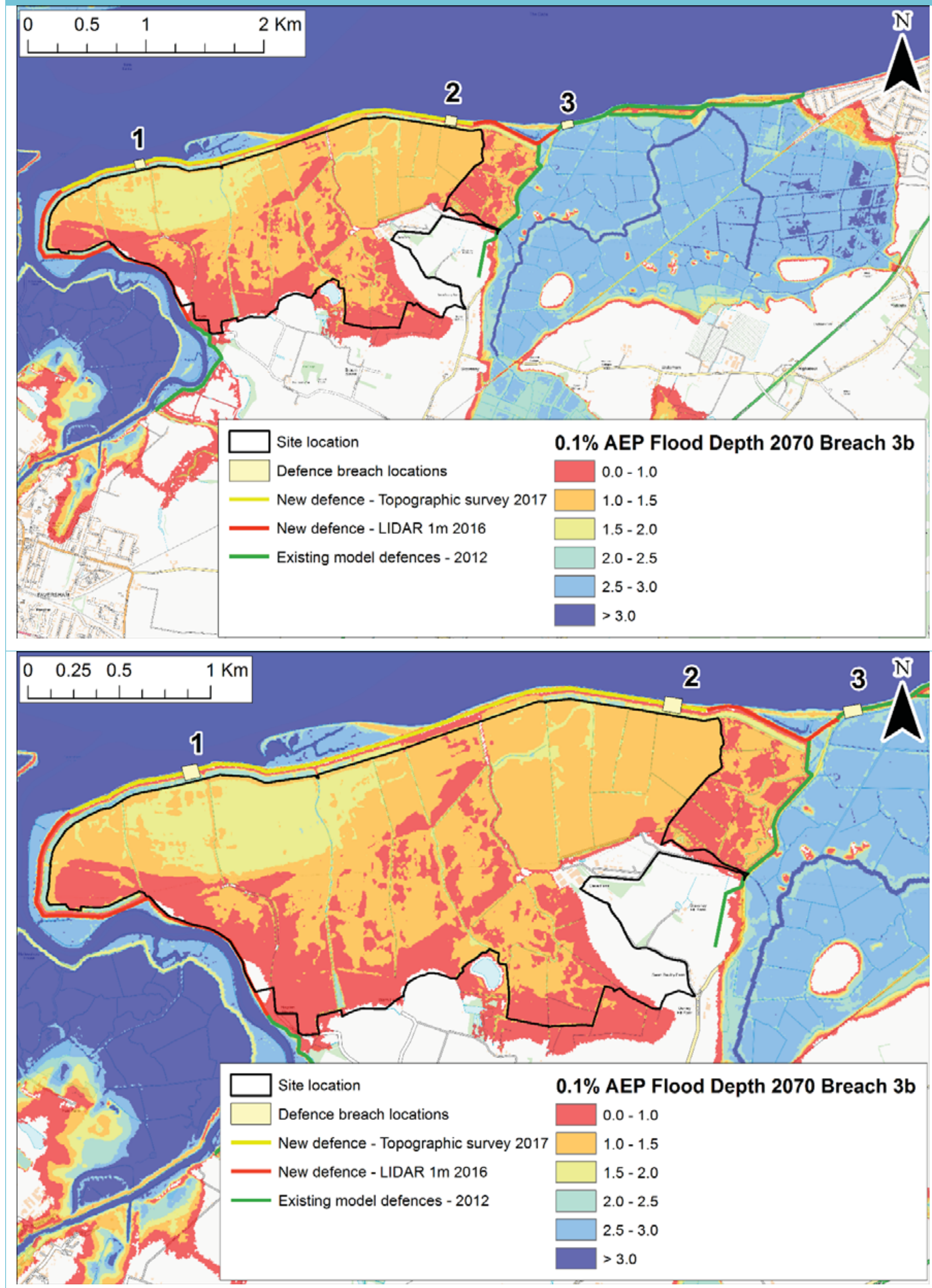


Figure 1.3: Defended defence breach 3b – 0.1% AEP future sea level rise flood depths 2070 (farm level)



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APPENDIX 2 – REFH2 CALCULATIONS

UK Design Flood Estimation

Generated on 21 May 2018 12:51:26 by liamn
Printed from the ReFH Flood Modelling software package, version 2.2.6589.25305

Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH)

Site details Checksum: D119-D968

Site name: 2238_Cleve

Easting: 605250

Northing: 164800

Country: England, Wales or Northern Ireland

Catchment Area (km²): 7.76

Using plot scale calculations: No

Site description: None

Model run: 100 year

Summary of results

Rainfall - FEH 2013 (mm):	109.40	Total runoff (ML):	175.23
Total Rainfall (mm):	105.32	Total flow (ML):	420.74
Peak Rainfall (mm):	37.33	Peak flow (m³/s):	2.83

Parameters

Where the user has overriden a system-generated value, this original value is shown in square brackets after the value used.
** Indicates that the user locked the duration/timestep*

Rainfall parameters (Rainfall - FEH 2013 model)

Name	Value	User-defined?
Duration (hh:mm:ss)	18:00:00	No
Timestep (hh:mm:ss)	02:00:00	No
SCF (Seasonal correction factor)	0.99	No
ARF (Areal reduction factor)	0.97	No
Seasonality	Summer	n/a

Loss model parameters

Name	Value	User-defined?
Cini (mm)	93.59	No
Cmax (mm)	683.35	No
Use alpha correction factor	No	No
Alpha correction factor	n/a	No

Routing model parameters

Name	Value	User-defined?
Tp (hr)	11.15	No
Up	0.65	No
Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m³/s)	0.17	No
BL (hr)	65.64	No
BR	1.41	No

Urbanisation parameters

Name	Value	User-defined?
Urban area (km²)	0.03	No
Urbext 2000	0	No
Impervious runoff factor	0.7	No
Imperviousness factor	0.3	No
Tp scaling factor	0.5	No
Sewered area (km²)	0.00	Yes
Sewer capacity (m³/s)	0.00	Yes

Time series data

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
00:00:00	3.112	0.000	0.435	0.000	0.166	0.166
02:00:00	5.093	0.000	0.743	0.005	0.161	0.167
04:00:00	8.789	0.000	1.371	0.024	0.157	0.181
06:00:00	17.003	0.000	2.973	0.066	0.154	0.221
08:00:00	37.328	0.000	8.008	0.159	0.154	0.313
10:00:00	17.003	0.000	4.323	0.377	0.161	0.537
12:00:00	8.789	0.000	2.400	0.733	0.179	0.912
14:00:00	5.093	0.000	1.443	1.149	0.212	1.362
16:00:00	3.112	0.000	0.900	1.578	0.263	1.841
18:00:00	0.000	0.000	0.000	1.980	0.329	2.309
20:00:00	0.000	0.000	0.000	2.278	0.408	2.686
22:00:00	0.000	0.000	0.000	2.334	0.493	2.827
24:00:00	0.000	0.000	0.000	2.222	0.573	2.795
26:00:00	0.000	0.000	0.000	2.021	0.645	2.666
28:00:00	0.000	0.000	0.000	1.772	0.706	2.478
30:00:00	0.000	0.000	0.000	1.506	0.754	2.259
32:00:00	0.000	0.000	0.000	1.270	0.789	2.059
34:00:00	0.000	0.000	0.000	1.083	0.815	1.898
36:00:00	0.000	0.000	0.000	0.922	0.833	1.755
38:00:00	0.000	0.000	0.000	0.777	0.844	1.621
40:00:00	0.000	0.000	0.000	0.642	0.849	1.490
42:00:00	0.000	0.000	0.000	0.511	0.847	1.359
44:00:00	0.000	0.000	0.000	0.384	0.841	1.225
46:00:00	0.000	0.000	0.000	0.263	0.829	1.093
48:00:00	0.000	0.000	0.000	0.155	0.813	0.968
50:00:00	0.000	0.000	0.000	0.076	0.794	0.870
52:00:00	0.000	0.000	0.000	0.034	0.772	0.806
54:00:00	0.000	0.000	0.000	0.013	0.750	0.763
56:00:00	0.000	0.000	0.000	0.003	0.728	0.731
58:00:00	0.000	0.000	0.000	0.000	0.706	0.706
60:00:00	0.000	0.000	0.000	0.000	0.685	0.685
62:00:00	0.000	0.000	0.000	0.000	0.664	0.664
64:00:00	0.000	0.000	0.000	0.000	0.644	0.644
66:00:00	0.000	0.000	0.000	0.000	0.625	0.625
68:00:00	0.000	0.000	0.000	0.000	0.606	0.606

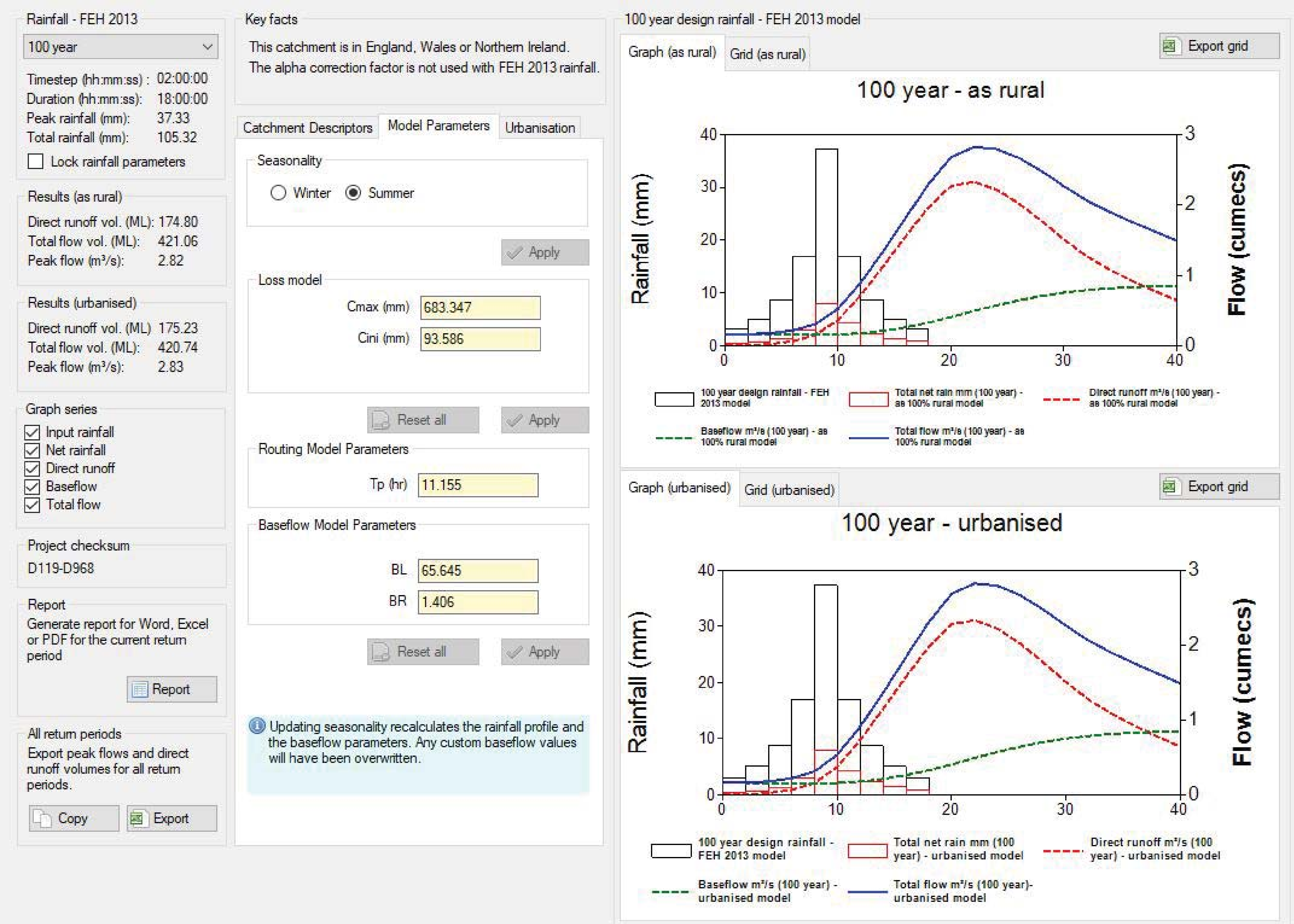
Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
70:00:00	0.000	0.000	0.000	0.000	0.588	0.588
72:00:00	0.000	0.000	0.000	0.000	0.570	0.570
74:00:00	0.000	0.000	0.000	0.000	0.553	0.553
76:00:00	0.000	0.000	0.000	0.000	0.537	0.537
78:00:00	0.000	0.000	0.000	0.000	0.521	0.521
80:00:00	0.000	0.000	0.000	0.000	0.505	0.505
82:00:00	0.000	0.000	0.000	0.000	0.490	0.490
84:00:00	0.000	0.000	0.000	0.000	0.475	0.475
86:00:00	0.000	0.000	0.000	0.000	0.461	0.461
88:00:00	0.000	0.000	0.000	0.000	0.447	0.447
90:00:00	0.000	0.000	0.000	0.000	0.434	0.434
92:00:00	0.000	0.000	0.000	0.000	0.421	0.421
94:00:00	0.000	0.000	0.000	0.000	0.408	0.408
96:00:00	0.000	0.000	0.000	0.000	0.396	0.396
98:00:00	0.000	0.000	0.000	0.000	0.384	0.384
100:00:00	0.000	0.000	0.000	0.000	0.372	0.372
102:00:00	0.000	0.000	0.000	0.000	0.361	0.361
104:00:00	0.000	0.000	0.000	0.000	0.350	0.350
106:00:00	0.000	0.000	0.000	0.000	0.340	0.340
108:00:00	0.000	0.000	0.000	0.000	0.330	0.330
110:00:00	0.000	0.000	0.000	0.000	0.320	0.320
112:00:00	0.000	0.000	0.000	0.000	0.310	0.310
114:00:00	0.000	0.000	0.000	0.000	0.301	0.301
116:00:00	0.000	0.000	0.000	0.000	0.292	0.292
118:00:00	0.000	0.000	0.000	0.000	0.283	0.283
120:00:00	0.000	0.000	0.000	0.000	0.275	0.275
122:00:00	0.000	0.000	0.000	0.000	0.266	0.266
124:00:00	0.000	0.000	0.000	0.000	0.258	0.258
126:00:00	0.000	0.000	0.000	0.000	0.251	0.251
128:00:00	0.000	0.000	0.000	0.000	0.243	0.243
130:00:00	0.000	0.000	0.000	0.000	0.236	0.236
132:00:00	0.000	0.000	0.000	0.000	0.229	0.229
134:00:00	0.000	0.000	0.000	0.000	0.222	0.222
136:00:00	0.000	0.000	0.000	0.000	0.215	0.215
138:00:00	0.000	0.000	0.000	0.000	0.209	0.209
140:00:00	0.000	0.000	0.000	0.000	0.202	0.202

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
142:00:00	0.000	0.000	0.000	0.000	0.196	0.196
144:00:00	0.000	0.000	0.000	0.000	0.190	0.190
146:00:00	0.000	0.000	0.000	0.000	0.185	0.185
148:00:00	0.000	0.000	0.000	0.000	0.179	0.179
150:00:00	0.000	0.000	0.000	0.000	0.174	0.174
152:00:00	0.000	0.000	0.000	0.000	0.169	0.169

Appendix

Catchment descriptors

Name	Value	User-defined value used?
Area (km^2)	7.76	No
ALTBAR	8	No
ASPBAR	349	No
ASPVAR	0.36	No
BFIHOST	0.66	No
DPLBAR (km)	3.79	No
DPSBAR (mkm^{-1})	11.6	No
FARL	0.97	No
LDP	8.1	No
PROPWET (mm)	0.21	No
RMED1H	12.1	No
RMED1D	31.8	No
RMED2D	40.2	No
SAAR (mm)	595	No
SAAR4170 (mm)	614	No
SPRHOST	30.73	No
Urbext2000	0	No
Urbext1990	0	No
URBCONC	0	No
URBLOC	0	No
Urban Area (km^2)	0.03	No
DDF parameter C	-0.02	No
DDF parameter D1	0.32	No
DDF parameter D2	0.38	No
DDF parameter D3	0.28	No
DDF parameter E	0.31	No
DDF parameter F	2.52	No
DDF parameter C (1km grid value)	-0.02	No
DDF parameter D1 (1km grid value)	0.31	No
DDF parameter D2 (1km grid value)	0.38	No
DDF parameter D3 (1km grid value)	0.27	No
DDF parameter E (1km grid value)	0.32	No
DDF parameter F (1km grid value)	2.53	No



Rainfall - FEH 2013
100 year
Timestep (hh:mm:ss) : 02:00:00
Duration (hh:mm:ss): 18:00:00
Peak rainfall (mm): 37.33
Total rainfall (mm): 105.32
Lock rainfall parameters
Results (as rural)
Direct runoff vol. (ML): 174.80
Total flow vol. (ML): 421.06
Peak flow (m³/s): 2.82
Results (urbanised)
Direct runoff vol. (ML) 175.23
Total flow vol. (ML): 420.74
Peak flow (m³/s): 2.83
Graph series
Input rainfall
Net rainfall
Direct runoff
Baseflow
Total flow
Project checksum
D119-D968
Report
Generate report for Word, Excel or PDF for the current return period
Report
All return periods
Export peak flows and direct runoff volumes for all return periods.
Copy
Export
Key facts
This catchment is in England, Wales or Northern Ireland.
The alpha correction factor is not used with FEH 2013 rainfall.
Catchment Descriptors
Model Parameters
Urbanisation
Seasonality
Winter
Summer
Apply
Loss model
Cmax (mm) 683.347
Cini (mm) 93.586
Reset all
Apply
Routing Model Parameters
Tp (hr) 11.155
Baseflow Model Parameters
BL 65.645
BR 1.406
Reset all
Apply
Updating seasonality recalculates the rainfall profile and the baseflow parameters. Any custom baseflow values will have been overwritten.
100 year design rainfall - FEH 2013 model
Graph (as rural)
Grid (as rural)
Export grid
100 year - as rural
Rainfall (mm)
Flow (cumecs)
100 year design rainfall - FEH 2013 model
Total net rain mm (100 year) - as 100% rural model
Direct runoff m³/s (100 year) - as 100% rural model
Baseflow m³/s (100 year) - as 100% rural model
Total flow m³/s (100 year) - as 100% rural model
Graph (urbanised)
Grid (urbanised)
Export grid
100 year - urbanised
Rainfall (mm)
Flow (cumecs)
100 year design rainfall - FEH 2013 model
Total net rain mm (100 year) - urbanised model
Direct runoff m³/s (100 year) - urbanised model
Baseflow m³/s (100 year) - urbanised model
Total flow m³/s (100 year)- urbanised model

APPENDIX 3 - MICRO DRAINAGE CALCULATIONS

IPC SuDS METHOD

Spine Road

ICP SUDS Mean Annual Flood

Input

Return Period (years)	100	Soil	0.400
Area (ha)	1.480	Urban	0.000
SAAR (mm)	615	Region Number	Region 7

Results	**l/s**
QBAR Rural	4.3
QBAR Urban	4.3
Q100 years	13.8
Q1 year	3.7
Q30 years	9.8
Q100 years	13.8

APPENDIX 4 – EA DATA

Product 4 (Detailed Flood Risk) for: Cleve Marshes
Requested by: Liam Nevins – arcus consulting
Reference: KSL150901/TT07
Date: 10 September 2015

Contents

- Flood Map Confirmation
- Flood Map Extract
- Model Output Data
- Data Point Location Map
- Modelled Flood Outlines Map
- Defence Details
- Historic Flood Data
- Historic Flood Event Map
- Additional Data
- Environment Agency Standard Notice

The information provided is based on the best data available as of the date of this letter.

You may feel it is appropriate to contact our office at regular intervals, to check whether any amendments/ improvements have been made to the data for this location. Should you re-contact us after a period of time, please quote the above reference in order to help us deal with your query.

This information is provided subject to the enclosed notice which you should read.

Orchard House, Endeavour Park, London Road, Addington, West Malling, Kent, ME19 5SH.
Email: kslenquiries@environment-agency.gov.uk

Flood Map Confirmation

The Flood Map:

Our Flood Map shows the natural floodplain for areas at risk from river and tidal flooding. The floodplain is specifically mapped ignoring the presence and effect of defences. Although flood defences reduce the risk of flooding they cannot completely remove that risk as they may be over topped or breached during a flood event.

The Flood Map indicates areas with a 1% (0.5% in tidal areas), Annual Exceedance Probability (AEP) - the probability of a flood of a particular magnitude, or greater, occurring in any given year, and a 0.1% AEP of flooding from rivers and/or the sea in any given year. The map also shows the location of some flood defences and the areas that benefit from them.

The Flood Map is intended to act as a guide to indicate the potential risk of flooding. When producing it we use the best data available to us at the time, taking into account historic flooding and local knowledge. The Flood Map is updated on a quarterly basis to account for any amendments required. These amendments are then displayed on the internet at www.gov.uk/prepare-for-a-flood.

At this Site:

The Flood Map shows that this site lies within the outline of the 0.5% chance of flooding in any given year from the sea.

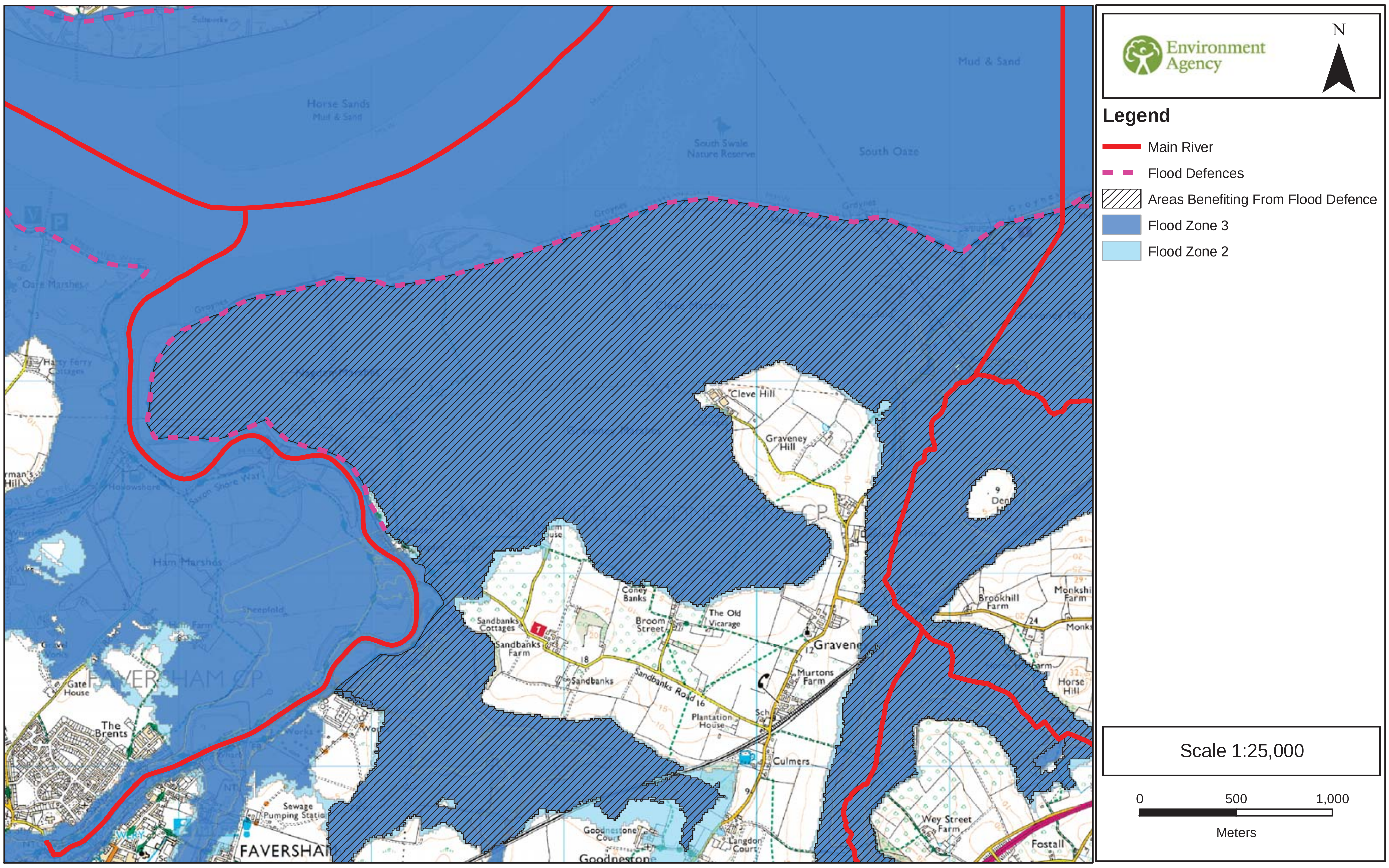
Enclosed is an extract of our Flood Map which shows this information for your area.

Method of production

The Flood Map at this location has been derived using detailed tidal modelling of the North Kent Coast, completed in August 2013.

Orchard House, Endeavour Park, London Road, Addington, West Malling, Kent, ME19 5SH.
Email: kslenquiries@environment-agency.gov.uk

Undefended Modelled Tidal Flood Outlines Centred on Cleve Marshes
Created 10 September 2015 (Ref KSL150901/TT07)



Contact us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 03708 506 506. Email:enquiries@environment-agency.gov.uk

Environment Agency

Model Output Data

You have requested flood levels for various return periods at this location.

The modelled flood levels for the closest most appropriate model grid cells, any additional information you may need to know about the modelling from which they are derived and/or any specific use or health warning for their use are set out below.

Using a 2D TuFLOW model the floodplain has been represented as a grid. The flood water levels have been calculated for each grid cell.

A map showing the location of the points from which the data is taken is enclosed. Please note you should read the notice enclosed for your specific use rights.

Table 1: Defended Modelled Tidal Flood levels for Annual Exceedance Probability shown in mAOD

Node Location ID	Modelled Tidal Flood levels for Annual Exceedance Probability shown in mAOD						
	National Grid Ref		Defended				
	Easting	Northing	5% AEP 2012	0.5% AEP 2012	0.5% AEP 2070	0.5% AEP 2115	0.1% AEP (2012)
1	603467	164397	0.00	0.00	0.00	2.66	0.00
2	604232	164620	0.00	0.00	0.00	2.66	0.00
3	604893	164779	0.00	0.00	0.00	1.75	0.00
4	605793	164644	0.00	0.00	0.00	0.00	0.00
5	603969	164070	0.00	0.00	0.00	2.66	0.00
6	604758	164261	0.00	0.00	0.00	1.76	0.00
7	605594	164094	0.00	0.00	0.00	0.00	0.00
8	603889	163624	0.00	0.00	0.00	2.66	0.00
9	604654	163600	0.00	0.00	0.00	2.68	0.00
10	604782	163130	0.00	0.00	0.00	2.69	0.00

Orchard House, Endeavour Park, London Road, Addington, West Malling, Kent, ME19 5SH.
Email: kslenquiries@environment-agency.gov.uk

Table 2: Undefended Modelled Tidal Flood levels for Annual Exceedance Probability shown in mAOD

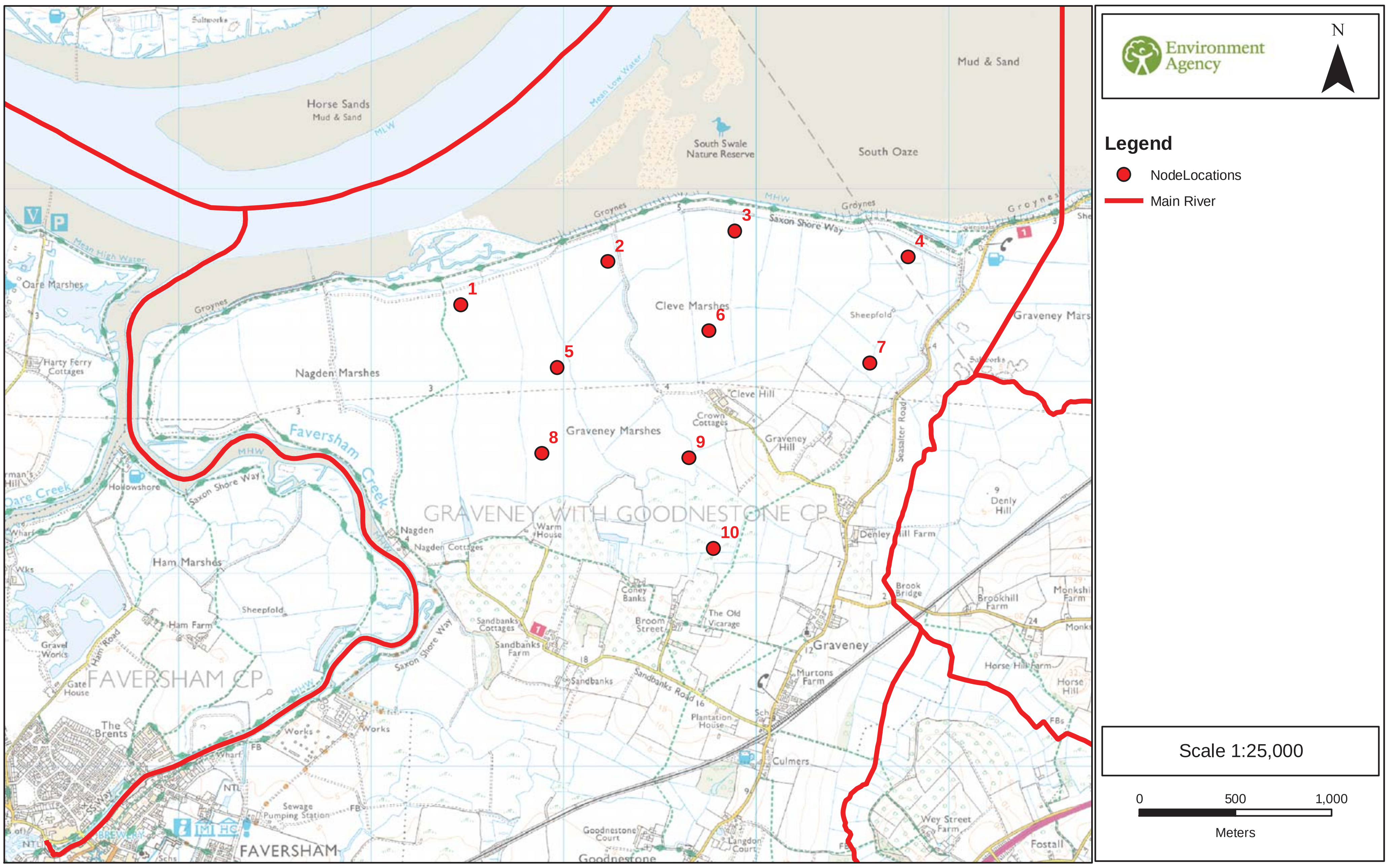
Node Location ID	Modelled Tidal Flood levels for Annual Exceedance Probability shown in mAOD						
	National Grid Ref		Undefended				
	Easting	Northing	5% AEP 2012	0.5% AEP 2012	0.5% AEP 2070	0.5% AEP 2115	0.1% AEP 2012
1	603467	164397	4.00	4.53	5.08	5.79	4.94
2	604232	164620	4.02	4.54	5.08	5.78	4.94
3	604893	164779	4.04	4.55	5.08	5.77	4.95
4	605793	164644	4.06	4.56	5.08	5.75	4.95
5	603969	164070	4.01	4.53	5.08	5.79	4.94
6	604758	164261	4.03	4.54	5.08	5.77	4.94
7	605594	164094	4.06	4.56	5.09	5.76	4.95
8	603889	163624	4.01	4.53	5.08	5.79	4.95
9	604654	163600	4.01	4.53	5.08	5.78	4.95
10	604782	163130	4.02	4.54	5.08	5.79	4.95

Data taken from North Kent Coast Modelling and Mapping Study, completed by JBA Consulting, in August 2013.

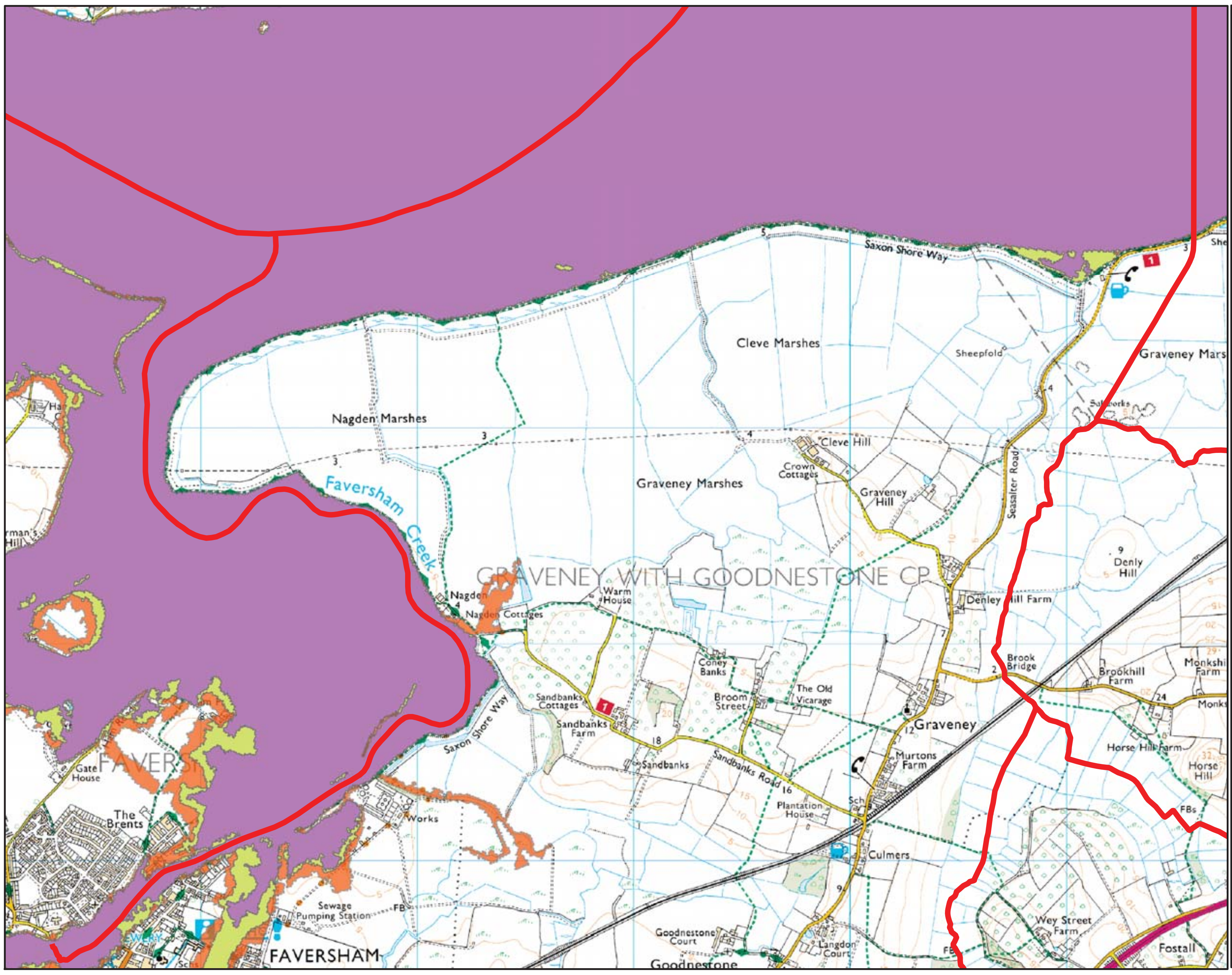
There are no health warnings or additional information for these levels or the model from which they were produced.

Orchard House, Endeavour Park, London Road, Addington, West Malling, Kent, ME19 5SH.
Email: kslenquiries@environment-agency.gov.uk

Modelled Node Locations Centred on Cleve Marshes
Created 10 September 2015 (Ref KSL150901/TT07)



Defended Modelled Tidal Flood Outlines Centred on Cleve Marshes
Created 10 September 2015 (Ref KSL150901/TT07)



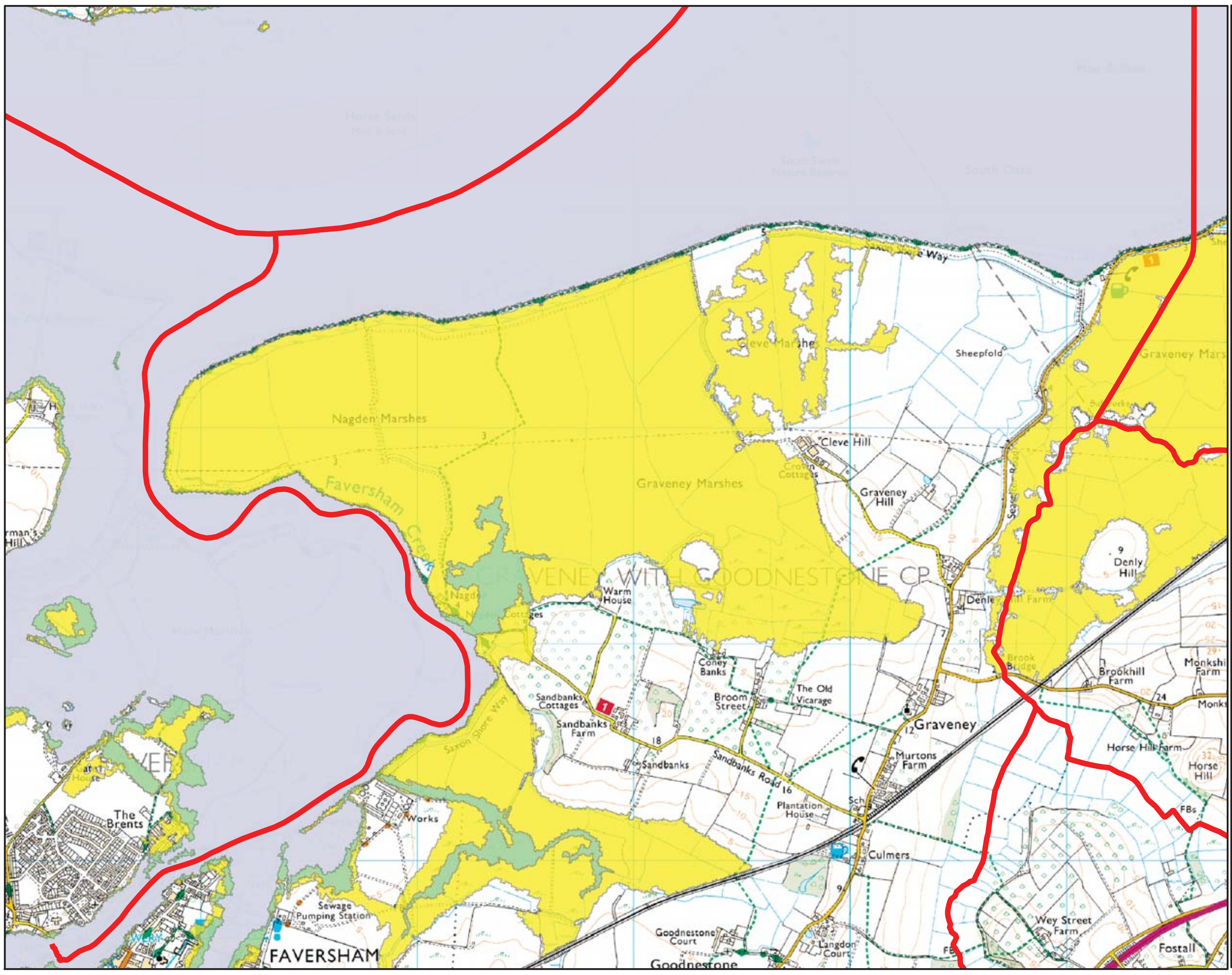
Legend
- Main River
- 5% AEP (2012)
- 1.3% AEP (2012)
- 0.1% AEP (2012)

Annual Exceedance Probability (AEP) The probability of a flood of a particular magnitude, or greater occuring in any given year.

Scale 1:25,000

0 500 1,000 Meters

Defended Modelled Tidal Flood Outlines Centred on Cleve Marshes
Created 10 September 2015 (Ref KSL150901/TT07)



Legend
- Main River
- 0.5% AEP (2012)
- 0.5% AEP (2070)
- 0.5% AEP (2115)

Annual Exceedance Probability (AEP) The probability of a flood of a particular magnitude, or greater occuring in any given year.

Scale 1:25,000

0 500 1,000 Meters

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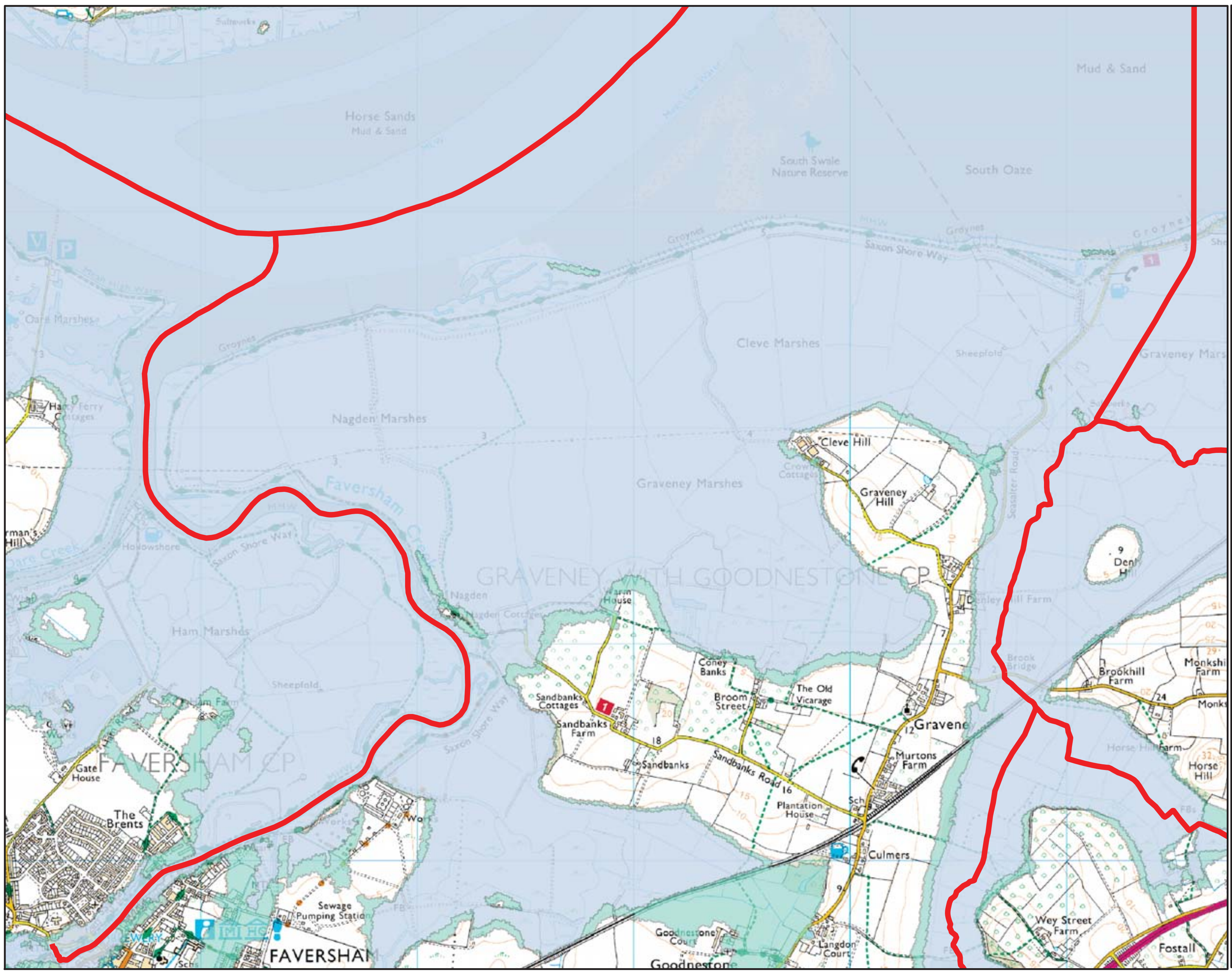
Contact us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 03708 506 506. Email:enquiries@environment-agency.gov.uk

Undefended Modelled Tidal Flood Outlines Centred on Cleve Marshes
Created 10 September 2015 (Ref KSL150901/TT07)



Legend

- Main River
- 5% AEP (2012)
- 0.1% AEP (2012)

Annual Exceedance Probability (AEP) The probability of a flood of a particular magnitude, or greater occuring in any given year.

Scale 1:25,000

0 500 1,000 Meters

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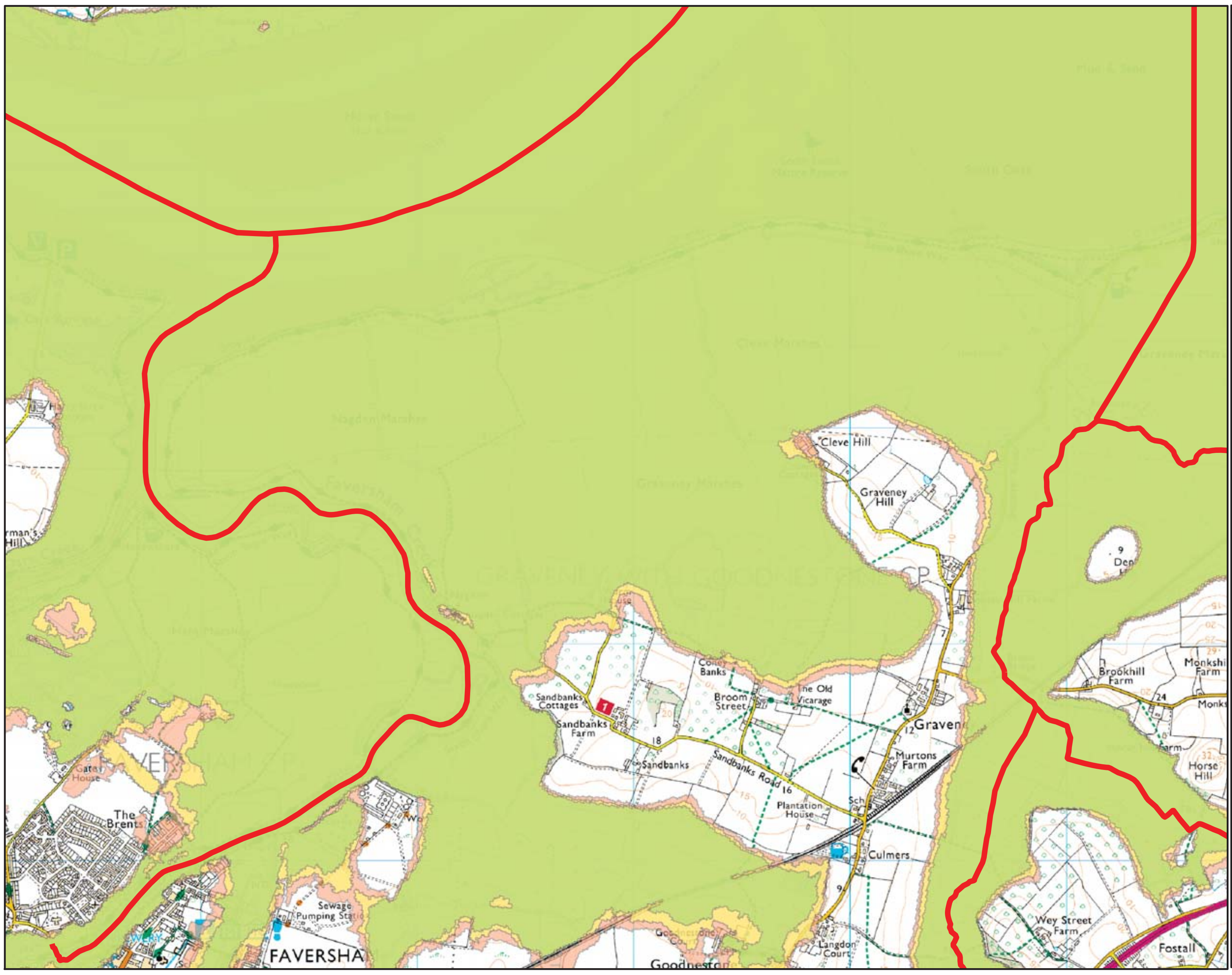

Legend

- Main River
- 0.5% AEP (2012)
- 0.5% AEP (2070)
- 0.5% AEP (2115)

Annual Exceedance Probability (AEP) The probability of a flood of a particular magnitude, or greater occuring in any given year.

Scale 1:25,000

0 500 1,000 Meters

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Defence Details

Existing flood defences in this area are comprised of concrete sea walls and raised earth embankments. These defences currently provide a 1 in 1000 year standard of protection.

The Environment Agency has no planned improvement works to the existing defences.

Historic Flood Data

We hold records of historic flood events from rivers and the sea. Information on the floods that may have affected the area local to your site are provided below and in the enclosed map (if relevant).

Flood Event Data

We do not hold records of historic flood events from rivers and/or the sea affecting the area local to this site. However, please be aware that this does not necessarily mean that flooding has not occurred here in the past, as our records are not comprehensive.

Please note that our records are not comprehensive. We would therefore advise that you make further enquiries locally with specific reference to flooding at this location. You should consider contacting the relevant Local Planning Authority and/or water/sewerage undertaker for the area.

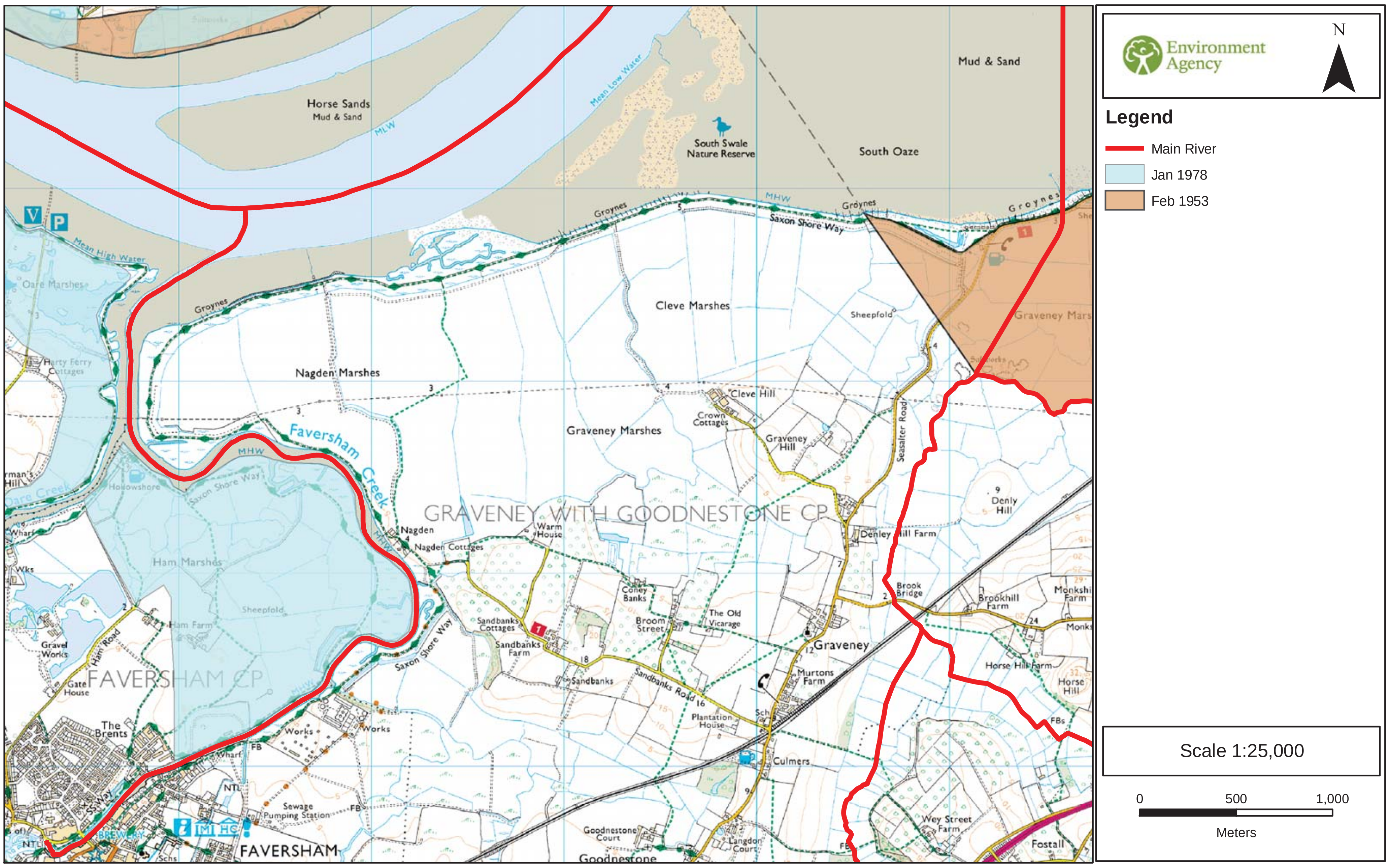
We map flooding to land, not individual properties. Our historic flood event record outlines are an indication of the geographical extent of an observed flood event. Our historic flood event outlines do not give any indication of flood levels for individual properties. They also do not imply that any property within the outline has flooded internally.

Please be aware that flooding can come from different sources. Examples of these are:
- from rivers or the sea;
- surface water (i.e. rainwater flowing over or accumulating on the ground before it is able to enter rivers or the drainage system);
- overflowing or backing up of sewer or drainage systems which have been overwhelmed,
- groundwater rising up from underground aquifers

Currently the Environment Agency can only supply flood risk data relating to the chance of flooding from rivers or the sea. However you should be aware that in recent years, there has been an increase in flood damage caused by surface water flooding or drainage systems that have been overwhelmed.

Orchard House, Endeavour Park, London Road, Addington, West Malling, Kent, ME19 5SH.
Email: kslenquiries@environment-agency.gov.uk

Historic Flood Outlines Centred on Cleve Marshes
Created 10 September 2015 (Ref KSL150901/TT07)



Contact us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 03708 506 506. Email:enquiries@environment-agency.gov.uk

Additional Information

Use of Environment Agency Information for Flood Risk / Flood Consequence Assessments

Depending on the enquiry, we may also provide advice on other issues related to our responsibilities including flooding, waste, land contamination, water quality, biodiversity, navigation, pollution, water resources, foul drainage or Environmental Impact Assessment.

In **England**, you should refer to the Environment Agency's Flood Risk Standing Advice, the technical guidance to the National Planning Policy Framework and the existing PPS25 Practice Guide for information about what flood risk assessment is needed for new development in the different Flood Zones. These documents can be accessed via:

https://www.gov.uk/government/publications/flood-risk-standing-advice-for-local-planning-authorities-frsa
http://planningguidance.planningportal.gov.uk/

You should also consult the Strategic Flood Risk Assessment produced by your local planning authority.

You should note that:

1. Information supplied by the Environment Agency may be used to assist in producing a Flood Risk / Consequence Assessment (FRA / FCA) where one is required, but does not constitute such an assessment on its own.

2. This information covers flood risk from main rivers and the sea, and you will need to consider other potential sources of flooding, such as groundwater or overland runoff. The information produced by the local planning authority referred to above may assist here.

3. Where a planning application requires a FRA / FCA and this is not submitted or deficient, the Environment Agency may well raise an objection.

4. For more significant proposals in higher flood risk areas, we would be pleased to discuss details with you ahead of making any planning application, and you should also discuss the matter with your local planning authority.

Orchard House, Endeavour Park, London Road, Addington, West Malling, Kent, ME19 5SH.
Email: kslenquiries@environment-agency.gov.uk

Environment Agency

Surface Water

We have provided two national Surface Water maps, under our Strategic Overview for flooding, to your Lead Local Flood Authority –Kent County Council, who are responsible for local flood risk (i.e. surface runoff, ground water and ordinary watercourse), which alongside their existing local information will help them in determining what best represents surface water flood risk in your area.

Kent County Council have reviewed these and determined what it believes best represents surface water flood risk. You should therefore contact this authority so they can provide you with the most up to date information about surface water flood risk in your area.

You may also wish to consider contacting the appropriate relevant Local Planning Authority and/or water/sewerage undertaker for the area. They may be able to provide some knowledge on the risk of flooding from other sources. We are working with these organisations to improve knowledge and understanding of surface water flooding.

Orchard House, Endeavour Park, London Road, Addington, West Malling, Kent, ME19 5SH.
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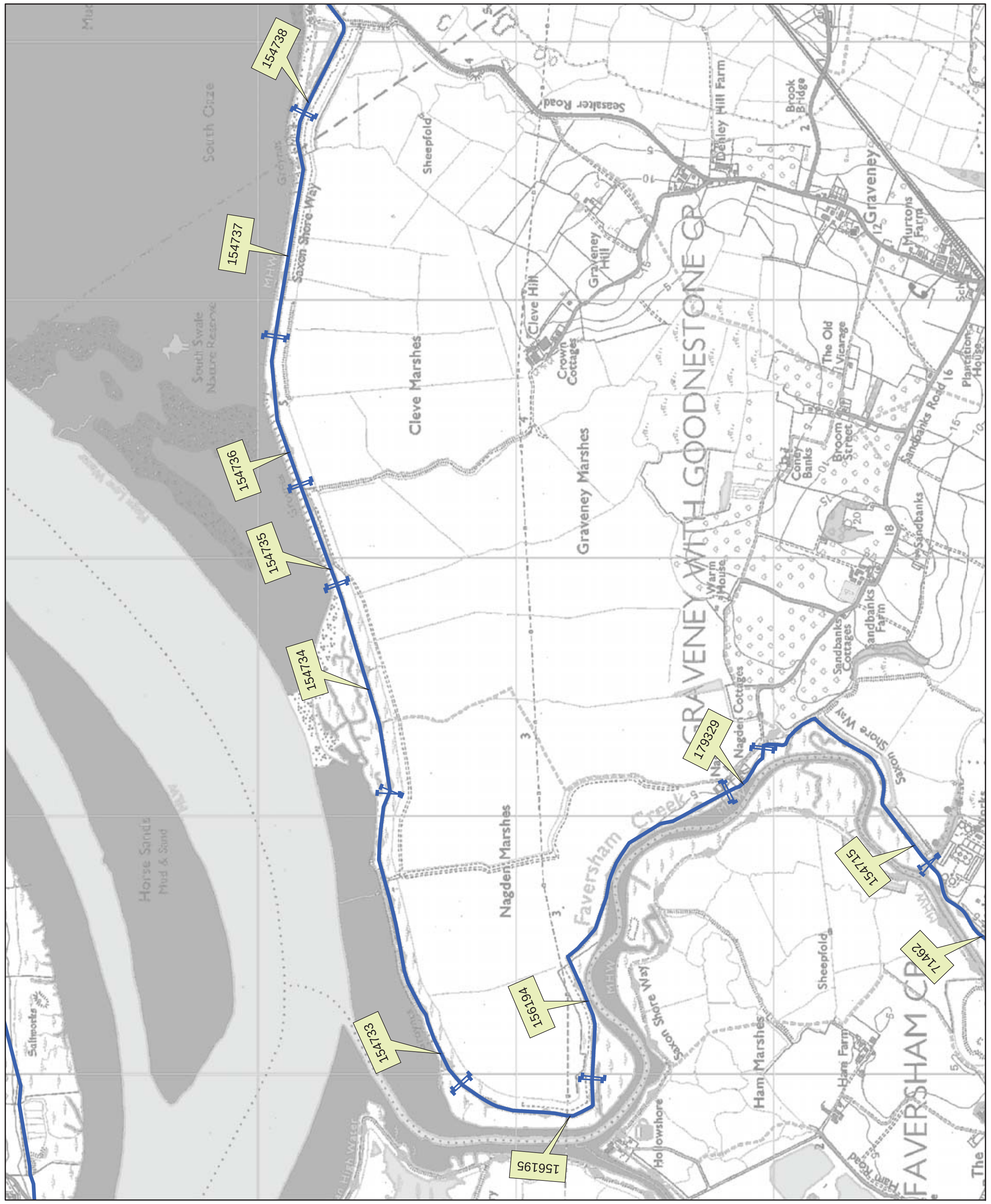


AIMS ID	Target Condition	Actual Condition	Date Inspected
71462	3	3	05/10/2015
154715	3	2	03/12/2014
179329	3	3	03/12/2014
156194	3	2	03/12/2014
156195	3	3	03/12/2014
154733	3	3	03/12/2014
154734	3	3	03/12/2014
154735	3	3	03/12/2014
154736	3	3	03/12/2014
154737	3	3	03/12/2014
154738	3	3	03/12/2014

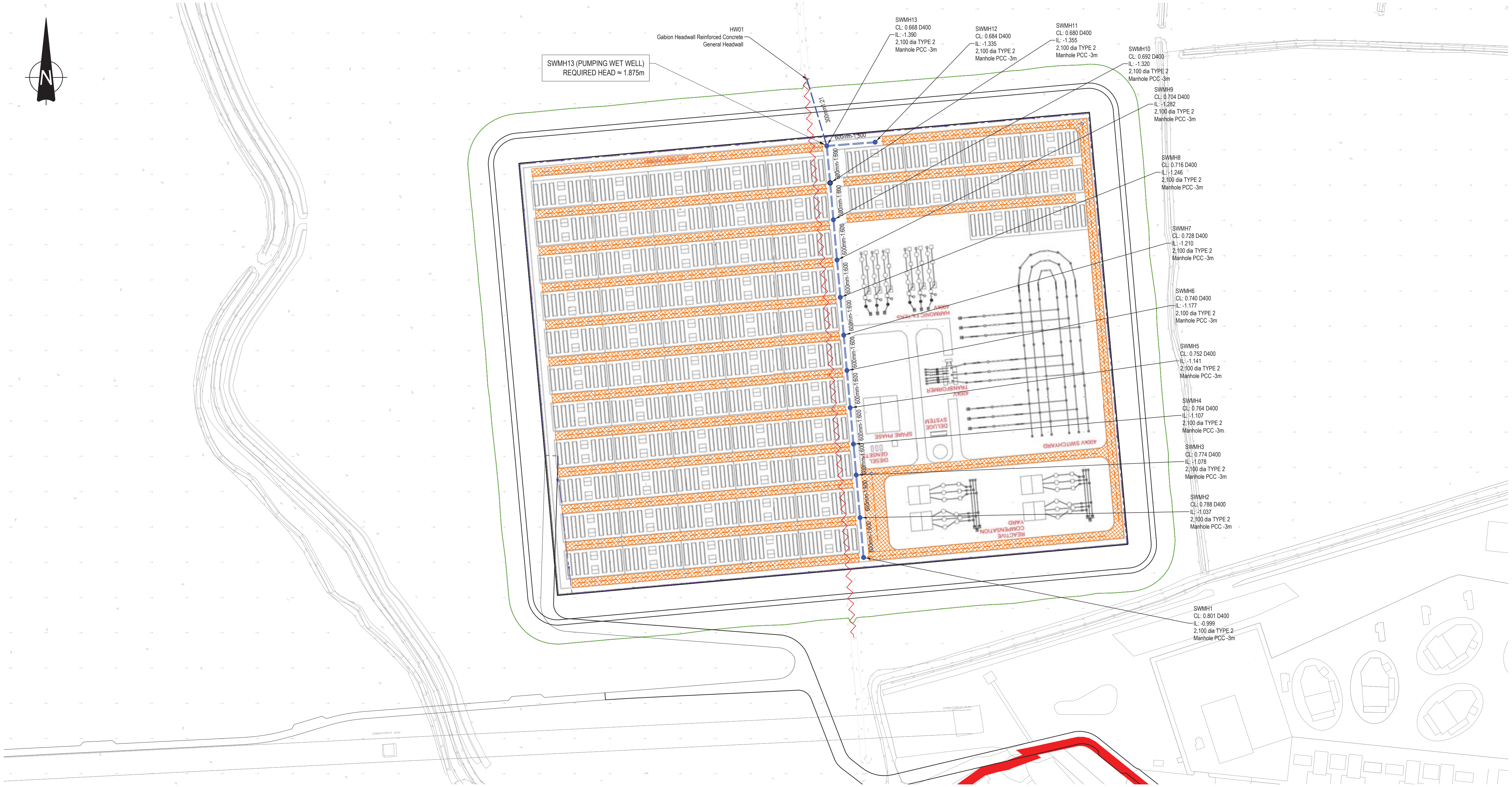
2.0 Visual inspection condition grades

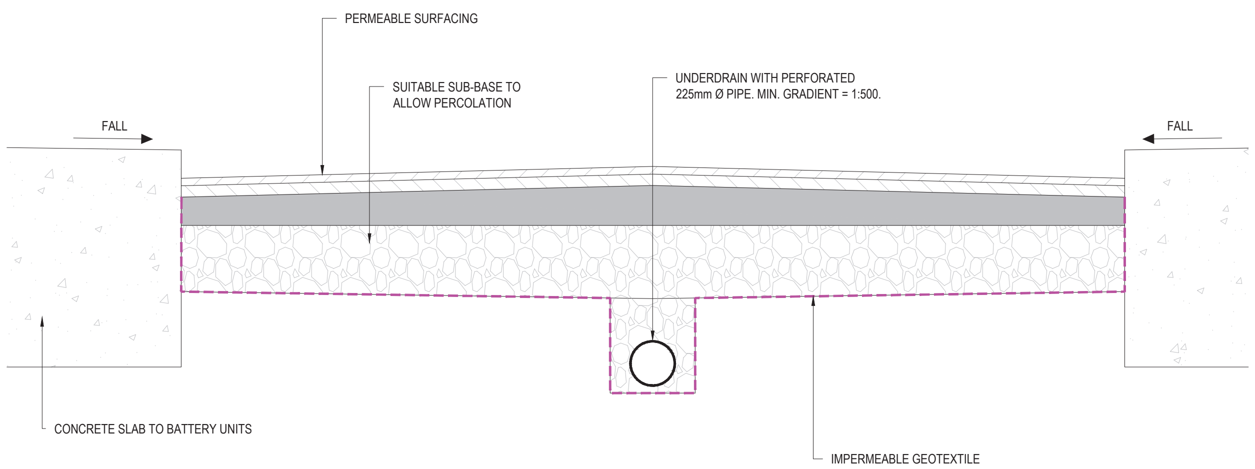
The condition grading and descriptions given below are the standards adopted by the Environment Agency. The five condition grades range from 'very good' to 'very poor', and the descriptions reflect condition according to flood defence performance.

2.1 General assessment

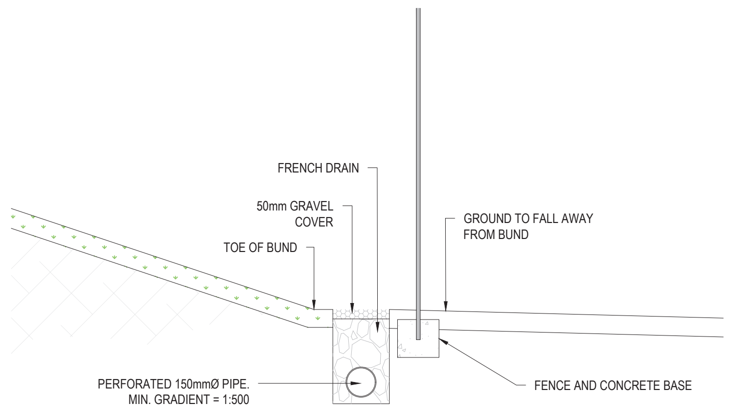
Grade	Rating	Description
1	Very Good	Cosmetic defects that will have no effect on performance
2	Good	Minor defects that will not reduce the overall performance of the asset
3	Fair	Defects that could reduce performance of the asset
4	Poor	Defects that would significantly reduce the performance of the asset. Further investigation needed
5	Very Poor	Severe defects resulting in complete performance failure

APPENDIX 5 – OUTLINE DRAINAGE SCHEMATIC





PROPOSED SITE ROAD CONSTRUCTION
PERMEABLE WITH UNDERDRAIN
SCALE: 1:20



PROPOSED FRENCH DRAIN
TO TOE OF BUND
SCALE: 1:20

GENERAL NOTES:

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS AND ENGINEERS DRAWINGS AND SPECIFICATIONS.
2. DO NOT SCALE THIS DRAWING. ANY AMBIGUITIES, OMISSIONS AND ERRORS ON DRAWINGS SHALL BE BROUGHT TO THE ENGINEERS ATTENTION IMMEDIATELY. ALL DIMENSIONS MUST BE CHECKED / VERIFIED ON SITE.
3. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.
4. FOR GENERAL NOTES REFER TO DRAWING.
5. SITE LAYOUT TO BE CONFIRMED.
6. EXISTING SITE LEVELS ARE BASED ON EXTRACTION OF AVAILABLE TOPOGRAPHICAL SURVEY DATA AND LIDAR DATA. CONFIRMATION IS REQUIRED PRIOR TO FURTHER WORKS.
7. AREA OF PARK IS AS PER APPROXIMATE DRAWINGS BY XERO ENERGY.

KEY:

- PROPOSED SURFACE WATER SEWER
- PROPOSED FRENCH DRAIN (TOE OF BUND)
- PROPOSED PERMEABLE ROAD SURFACE WITH UNDERDRAIN
- EXISTING DRAINAGE DITCH TO BE FILLED IN
- EXISTING DITCH DIVERSION/REPROFILING

Rev:	Description:	Date:	By:	Chkd:
P05	UPDATED TO SHOW NEW ACCESS (S1)	26/09/18	JDB	AR
P04	UPDATED DRAINAGE LAYOUT (S1)	18/09/18	JDB	AR
P03	COMPOUND LAYOUT UPDATED (S1)	03/09/18	JDB	AR
P02	ISSUED FOR CO-ORDINATION (S1)	03/07/18	JDB	AD
P01	ISSUED FOR COMMENT (S0)	24/05/18	JDB	AD

curtins
Merchant Exchange, 17-19 Whitworth Street, West Manchester M1 5WG
0161 236 2394
manchester@curtins.com
www.curtins.com

Status: ISSUED FOR CO-ORDINATION S1

Project: CLEVE HILL SOLAR PARK

Drg Title: SUBSTATION & BATTERY PARK DRAINAGE GENERAL ARRANGEMENT

Size:	Date:	Drawn By:	Designed By:	Checked By:
A1	24/05/2018	JDB	JDB	AD
Scale: 1:1,250				

Project No:	Originator:	Volume:	Level:	Type:	Role:	Category / Number:	Rev:
066705	CUR	00	XX	DR	D	72001	P05

Production\4B Models & Drawings_Civil-C\CAD\