BATTLEFIELDS LANE SOUTH, HOLBEACH

FLOOD RISK ASSESSMENT & DRAINAGE STRATEGY

December 2021

Cicero Estates

RESIDENTIAL DEVELOPMENT
BATTLEFIELDS LANE SOUTH, HOLBEACH

FLOOD RISK ASSESSMENT & DRAINAGE STRATEGY

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1. INTRODUCTION

1.1 Paul Basham Associates have prepared this Flood Risk Assessment (FRA) and Drainage Strategy on behalf of Cicero Estates to support an outline planning application for a residential development of up to 185 dwellings, on a 6.2ha site. The land is to the South of Battlefields Lane South, Holbeach; the nearest postcode is PE12 7PQ.

2. SITE DETAILS

2.1 The proposed development is in Holbeach, in the South Holland District of South East Lincolnshire. The site is in a low-lying area, west of The Wash estuary. The area is protected from flooding by an extensive network of raised engineered defences.

2.2 The plot size is approximately 6.2ha, and the land is currently open field and used for agricultural purposes. The topographical survey shows the site to be mostly flat with levels varying gradually between 2.7m and 3.3m across the 6.2ha site. See **Figure 1** for the site location; the topographic survey is in **Appendix A**.

2.3 The development proposals are for a 185-dwelling residential development on a 6.2ha site.

Figure 1: Site Location Plan

2.4 The site is within Flood Zone 3a. According to the South East Lincolnshire strategic FRA, the site is predominantly at risk from a 1-in-200-year tidal flooding event. The site is defended from tidal flooding by raised engineered defences along The Wash estuary. However, this FRA will look to mitigate the risks should those defences be breached or overtopped, as per the guidance in the South East Lincolnshire Strategic Flood Risk Assessment (SFRA).

2.5 The SFRA predicts flooding of the site could occur in the future due to; *Climate change, particularly associated with the predicted effects on sea level rise, brings an increased likelihood of flooding that could be a danger to life affecting whole settlements. Such an extreme consequence would come about as a result of the highest tides (predicted to be common in 100 years time) coupled with storm surge conditions causing major breaches in coastal/tidal defences.* (SE Lincs, JSPC, 2017)

2.6 The site is allocated for residential development in the South East Lincolnshire Local Plan, adopted March 2019. The site's reference within the local plan is **Hob032.** See **Appendix B** for the local plan policies map, **Figure 2** below shows an excerpt from the map.

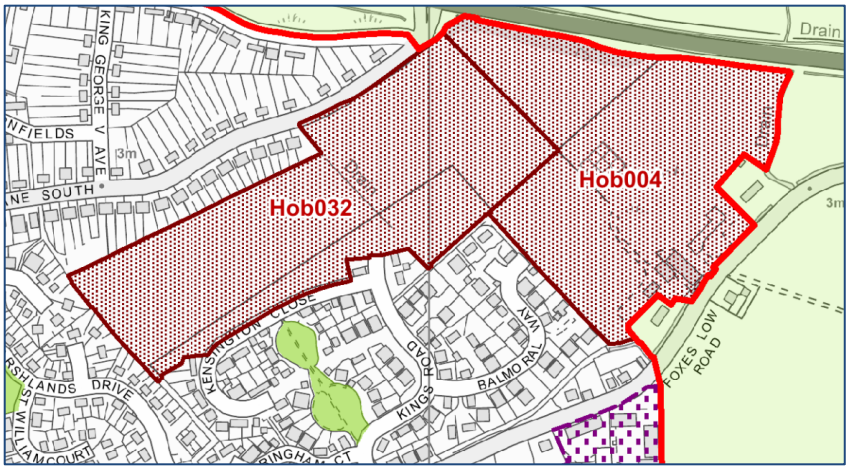


Figure 2 - Excerpt from Local Plan Policies Map showing the development site.

2.7 The South East Lincolnshire Local Plan, adopted March 2019, notes that;

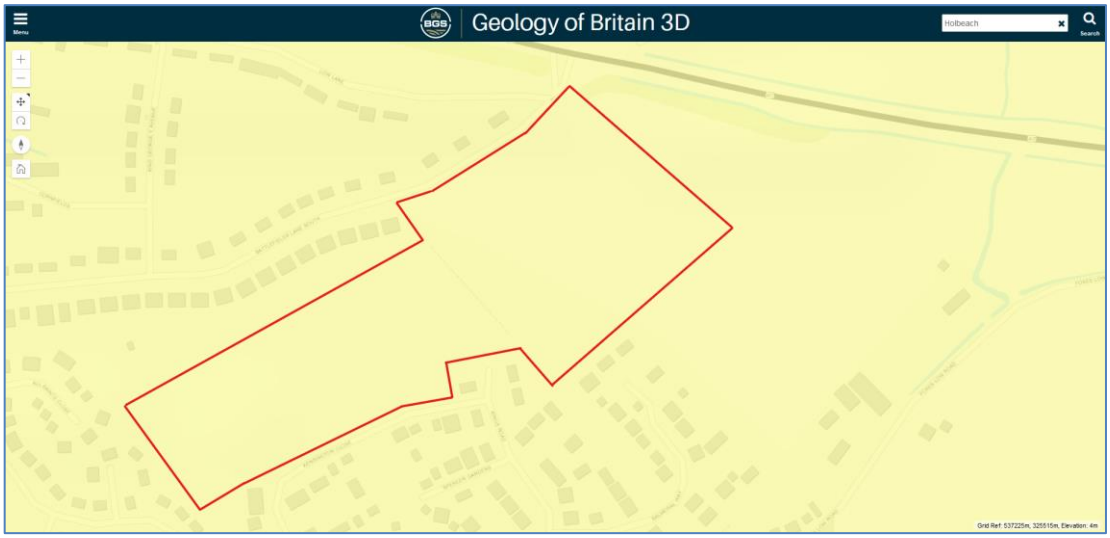
"The site is within Flood Zone 3a, and the SFRA identifies flood hazard in 2115 as a combination of 'danger for most' and 'danger for some' and flood depth in 2115 as up to 1.0m. Development will be required to include appropriate mitigation." (SE Lincs, 2019)

2.8 Therefore, any development on the site will require the existing site levels to be raised by a minimum of 1m to mitigate future flood risk.

2.9 As the site is allocated in the adopted local plan and is assessed as "developable" in the supporting Strategic Housing Land Availability Assessment (SHLAA) (SE Lincs, 2018) a further sequential test is not required.

3. SITE GEOLOGY

3.1 A review of the British Geological Survey (BGS) mapping indicates that the bedrock geology beneath the site is "*Ampthill Clay Formation - Mudstone. Sedimentary bedrock formed between 163.5 and 157.3 million years ago during the Jurassic period*"; overlain by superficial deposits of "*Tidal Flat Deposits - Clay and silt. Sedimentary superficial deposit formed between 11.8 thousand years ago and the present during the Quaternary period*". See **Figure 3** for the BGS map extract.



Geology

Superficial deposits: Tidal Flat Deposits - Clay and silt. Sedimentary superficial deposit formed between 11.8 thousand years ago and the present during the Quaternary period.

More information

Bedrock geology: Ampthill Clay Formation - Mudstone. Sedimentary bedrock formed between 163.5 and 157.3 million years ago during the Jurassic period.

More information

Figure 3: BGS bedrock mapping

3.2 Local boreholes from the BGS website show clay soils to the south of the site (TF32SE17 & TF32SE24) with fine silt encountered further to the north (TF32NE1 adjacent to the A17/Penny Hill Junction). Sitting groundwater was recorded at depths of between 0.6m 3.0m bgl. See **Appendix C** for the borehole records.

3.3 The borehole records and BGS mapping suggest an infiltration drainage system will not be suitable due to high groundwater and impermeable soils.

3.4 Ground investigations comprising five windowless sample boreholes were completed on the 20th January 2021, see **Appendix D** for the report.

3.5 The investigation confirms the data shown on the BGS mapping in **Figure 3,** very clayey soil was encountered in each of the 5 boreholes from 0.1m to depths of up to 5m. See **Figure 4** for an excerpt from the ground investigation report in **Appendix D.**

WS101:

0.0-0.1m	Soft brown silty CLAY (Topsoil)
0.1-2.9m	Brown very clayey SILT
2.9-5.0m	Grey very clayey SILT

Well: 0.72m unslotted, 2.0m slotted

Figure 4: Excerpt from Report J21-001-R01

3.6 Shallow standing groundwater as high as 0.75mbgl was encountered during the ground investigation works. See **Figure 5**.

Groundwater

Borehole ID	Standing Water Level (mbgl)	Installation Base Dip (mbgl)
WS101	0.79	2.72
WS102	0.93	1.56
WS103	0.75	2.47
WS104	1.08	3.02
WS105	1.24	3.10

Figure 5: Excerpt from Report J21-001-R01, Groundwater levels

3.7 The site is not suitable for an infiltration drainage system, as indicated by the heavy clay soils and high groundwater encountered during the ground investigation. Surface water shall therefore be discharged to either a watercourse or adopted surface water sewer.

4. EXISTING DRAINAGE

Existing Surface Water Drainage

4.1 The site is currently open agricultural land. There does not appear to be any existing positive drainage.

4.2 The P14 Foxes Low drain (Reach ID - DRN206G1405) runs parallel to the site's western boundary; South Holland Internal Drainage Board (IDB) maintain the drain and identify it as a high priority pipeline. The maximum water level is maintained at 2.1mAOD by the IDB.

4.3 There is also a drainage ditch running across the centre of the site. The ditch flows south and connects into the Foxes Low drain which runs along Foxes Low Road (Reach ID - DRN206G1404).

4.4 The site has a total area of 6.2ha. The site masterplan has not been finalised; however, the proposed impermeable area will be 62.5% of the site's total area, equal to 3.875ha.

4.5 The developed impermeable area of 3.875ha, gives the QBAR greenfield rate of 5.7l/s, as shown in **Figure 6** and **Appendix E**. The developed area is all the impermeable areas added together (roofs, driveways, internal road, footway and a nominal patio allowance of 3.0x3.0m).

Paul Basham Associates		Page 1
Lancaster Court Fareham Hampshire, PO15 5TU		Micro Drainage
Date 06/01/2021 14:17 File 087.5011 - SOURCE CONTR...	Designed by MicroDrainage Checked by	
Innovyze	Source Control 2019.1	

ICP SUDS Mean Annual Flood

Input

Return Period (years)	100	Soil	0.300
Area (ha)	3.875	Urban	0.000
SAAR (mm)	581	Region Number	Region 5

Results	l/s
QBAR Rural	5.7

Figure 6: Total developed area greenfield rate

4.6 Due to the topography of the site, the proposed development will be split into two catchments, east and west.

4.7 The eastern catchment is 2.9ha, it has a developed impermeable area of 1.813ha and a developed area QBAR greenfield rate of 2.7 l/s. See **Figure 7** and **Appendix E.**

Paul Basham Associates		Page 1
Lancaster Court Fareham Hampshire, PO15 5TU		Micro Drainage
Date 06/01/2021 14:22 File 087.5011 - SOURCE CONTR...	Designed by MicroDrainage Checked by	
Innovyze	Source Control 2019.1	

ICP SUDS Mean Annual Flood

Input

Return Period (years)	100	Soil	0.300
Area (ha)	1.813	Urban	0.000
SAAR (mm)	581	Region Number	Region 5

Results l/s

QBAR Rural 2.7

Figure 7 East Catchment, developed area greenfield rate.

4.8 The western catchment is 3.3ha, it has a developed impermeable area of 2.063ha, and a developed area QBAR greenfield rate of 3.0 l/s. See **Figure 8** and **Appendix E.**

Paul Basham Associates		Page 1
Lancaster Court Fareham Hampshire, PO15 5TU		Micro Drainage
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Innovyze	Source Control 2019.1	

ICP SUDS Mean Annual Flood

Input

Return Period (years)	100	Soil	0.300
Area (ha)	2.063	Urban	0.000
SAAR (mm)	581	Region Number	Region 5

Results l/s

QBAR Rural 3.0

Figure 8 West Catchment, developed area greenfield rate.

4.9 **Table 1** summarises the catchment areas and greenfield run off rates to which discharge from the development shall be limited.

Catchment	Area (ha)	Greenfield QBAR (l/s) Maximum allowable discharge rate from the proposed development
Total	3.875	5.7
East	1.813	2.7
West	2.063	3.0

Table 1 Developed area greenfield rate summary table

Existing Foul Water Drainage

4.10 The site is currently undeveloped and does not generate foul discharge. Anglian Water provides sewer services in the area. There are adopted foul sewers to the north of the site on Battlefields Lane South. And south of the site on Kensington Close and Kings Road. The sewer on Kings Road has a stub (MH Ref 9300, C.L - 3.102m I.L - 0.390m) which could serve as a connection point for the development's foul drainage, See **Figure 9**. The sewer in Kings Road is shown to be 225mm in diameter and of Vitrified Clay. See **Appendix F** for a copy of the Anglian Water asset map (up to date as of January 2021).

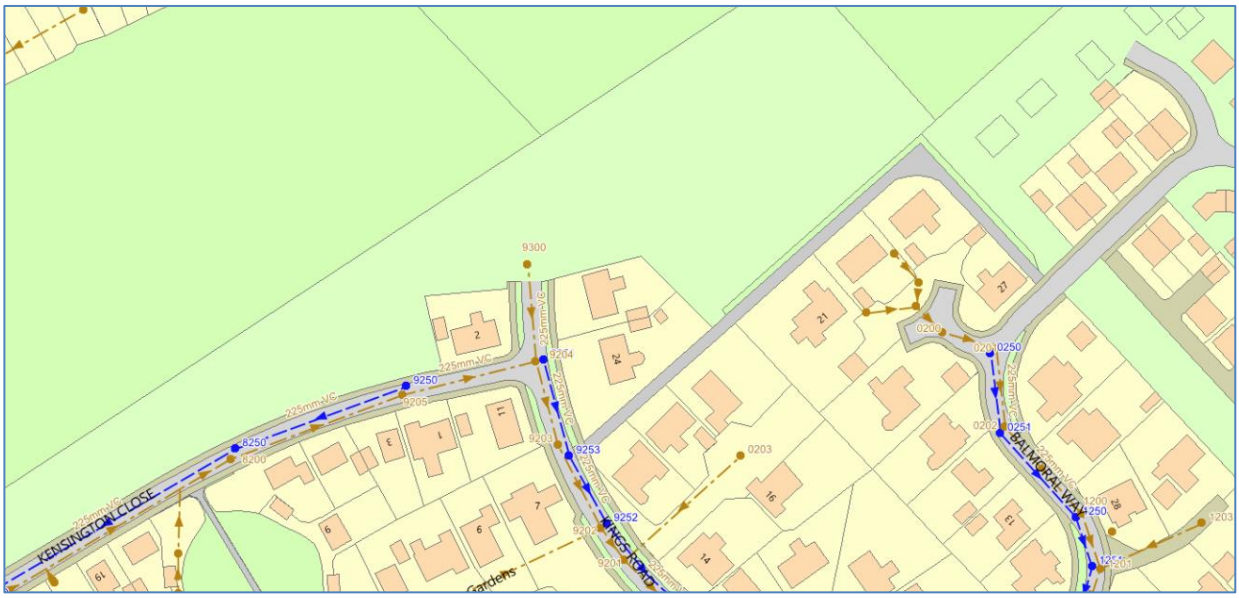


Figure 9: Excerpt from Anglian Water asset map

5. FLOOD RISKS

Fluvial/tidal flooding

5.1 Flood mapping obtained from the Environment Agencies 'flood map for planning' website has identified that the site falls within Flood Zone 3, see **Figure 10**. Indicating that the site is at 1 in 100 or greater annual probability of fluvial flooding (>1%), or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.

5.2 On the 13th of January 2021, the Environment Agency provided a Product 4 Flood Risk Data Report for the site, ref CCN/2020/198662. The EA data confirms that the site is considered to be at risk from tidal flooding in the 2115 scenario if The Wash estuary flood defences are breached. The EA does not consider the site to be at risk from fluvial flooding. See **Figure 11** and **Appendix G.**

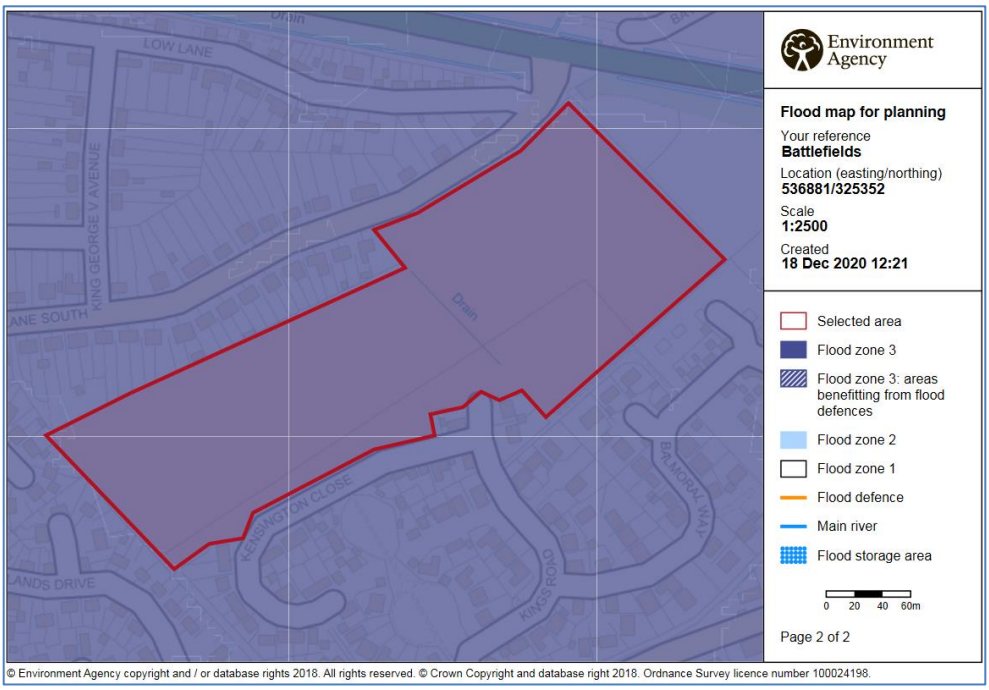


Figure 10: Flood Map for Rivers and Seas

4. Fluvial Flood Risk Information

This site is not considered to be at risk of flooding from main rivers.

The site may be at risk from local ordinary watercourses for which other risk management authorities, such as the Lead Local Flood Authority (ie top tier council) or Internal Drainage Board (where they exist) have responsibility.

5. Tidal Flood Risk Information

5.1 Tidal Defence Information

The existing tidal defences protecting this site consist of earth embankments. They are in fair condition and reduce the risk of flooding (at the defence) to a 0.67% (1 in 150) chance of occurring in any year. We inspect these defences routinely to ensure potential defects are identified.

Figure 11: Excerpt from EA report ref CCN/2020/198662

5.3 Tidal breach hazard mapping from the EA Product 4 Flood Risk report is shown below in **Figure 13**, **Figure 15** and **Figure 16**. The full report is available in **Appendix G**.

5.4 The EA max depth mapping, shown in **Figure 13,** confirms that the western part of the site is at risk of flooding up to 1m in depth, as per the comments in the adopted local plan (See **Para 2.7**).

5.5 **Figure 14** identifies that during a 1-in-1000-year event the maximum depth is still 1m; however, it is spread over a large area of the site.

5.6 During a 1-in-200-year flooding event in 2115, the EA mapping shows that conditions across the majority of the site will pose a "Danger to most", with remaining areas posing a "danger to some", see **Figure 15**. This assessment is a combination of the predicted max depths and max velocities.

5.7 The EA product 4 report shows that the site is at risk of tidal flooding from a breach of The Wash estuary flood defences resulting during a 1-in-200-year (0.5%) storm event. The EA product 4 report also confirms that the flood defences have a 1-in-150 (0.67%) chance of failing in any given year. The EA product 4 report and the SFRA have both identified that a breach of The Wash estuary flood defences during a 1-in-200-year storm event poses the main flood risk to the site.

★ Modelled Breach Locations - see also the accompanying plan "Location of Modelled Breaches"							
Max Hazard (Flood Risk to People : FD2320)		**Max Depth (m)**		**Max Velocity (m/s)**			
Less than 0.75 (Low Hazard)		0 - 0.25		0 - 0.3			
Between 0.75 and 1.25 (Danger for Some)		0.25 - 0.50		0.3 - 1.0			
Between 1.25 and 2.0 (Danger for Most)		0.50 - 1.0		1.0 - 1.5			
Greater than 2.0 (Danger for All)		1.0 - 1.6		1.5 - 2.5			
		1.6 +		2.5 +			
Date Printed	January 2021	**Scenario year**	2115	**Scenario Annual Chance**	0.5% (1 in 200)	**CCN Number**	CCN-2020-198573

Figure 12: EA Mapping Legend

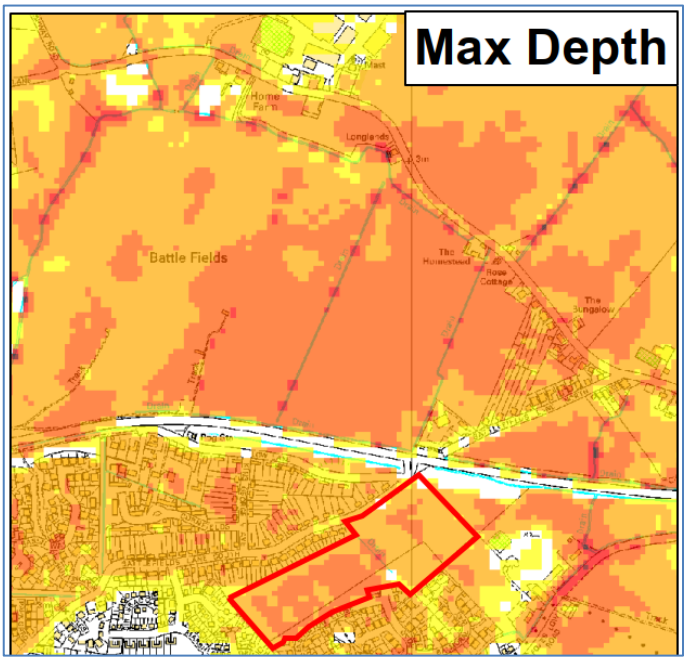


Figure 13: EA PRODUCT 4, YEAR 2115, 0.5% ANNUAL EVENT, MAX DEPTH, TIDAL BREACH

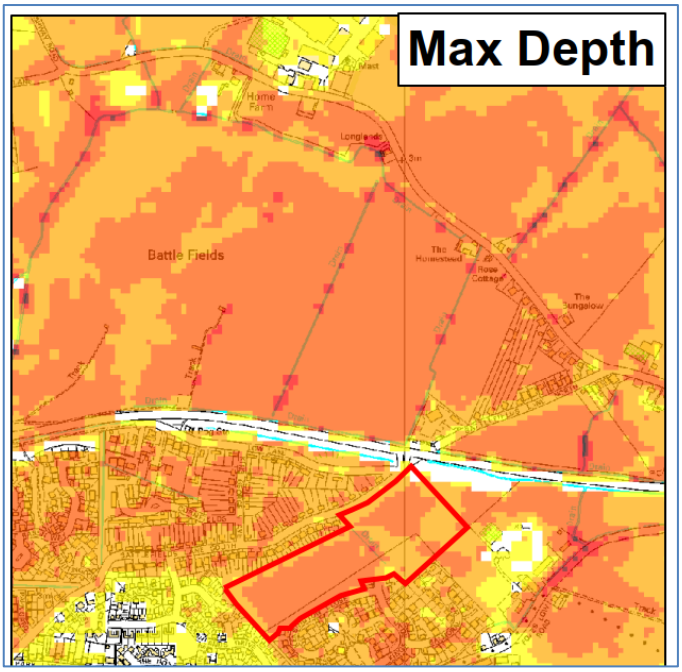


Figure 14: EA PRODUCT 4, YEAR 2115, 0.1% ANNUAL EVENT, MAX DEPTH, TIDAL BREACH

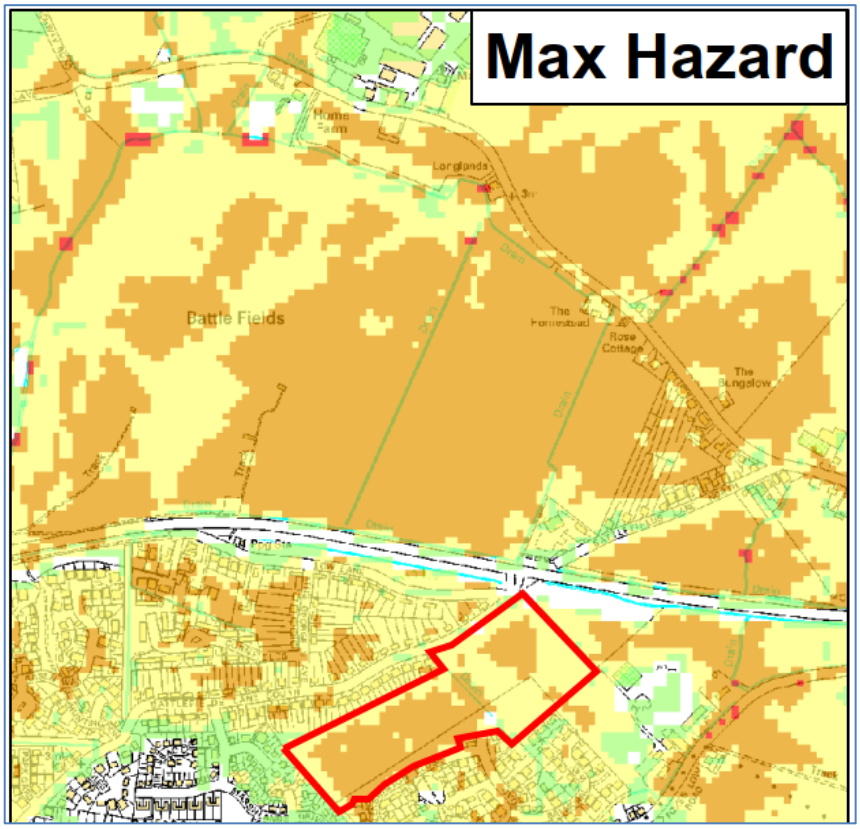


Figure 15: EA PRODUCT 4, YEAR 2115, 0.5% ANNUAL EVENT, MAX HAZARD, TIDAL BREACH

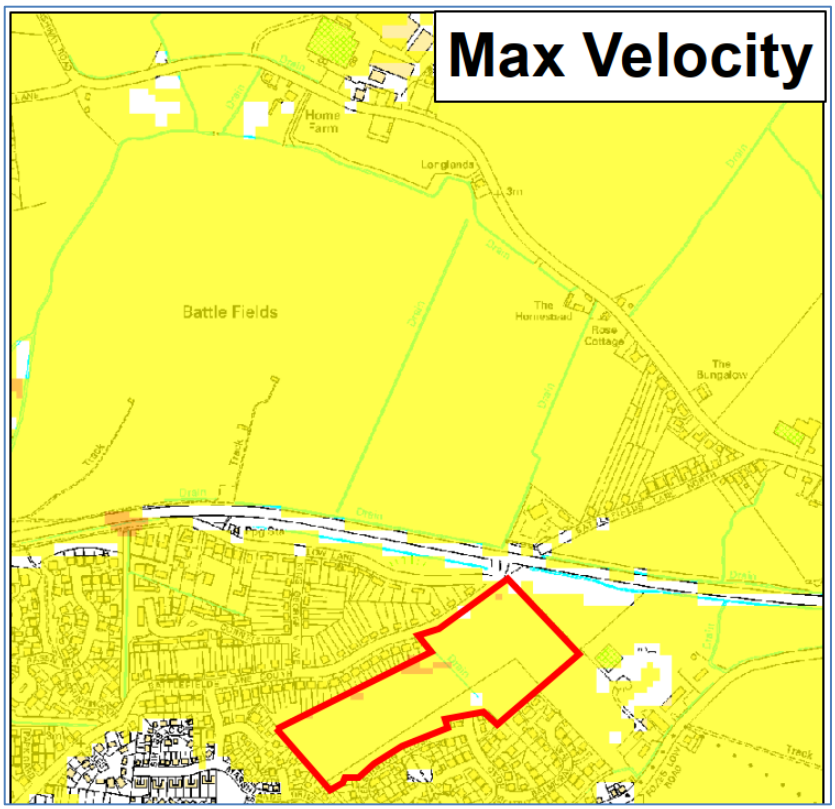


Figure 16: EA PRODUCT 4, YEAR 2115, 0.5% ANNUAL EVENT, MAX VELOCITY, TIDAL BREACH

Long term flood risk from rivers and seas

5.8 The long-term flood risk from rivers and seas mapping shows that the majority of the site is at very low risk, with a small area at low risk, see **Figure 17**. As stated in the SFRA and EA Product 4 Report (See **Figure 11**), the site is predominantly at risk from tidal flooding, not fluvial flooding.

5.9 Although most of the site is shown to be at very low risk of long term flooding from rivers or the sea, the key flooding risk to the site is a breach of the coastal flood defences along the Wash Estuary, as identified in the SFRA and EA Product 4 report.

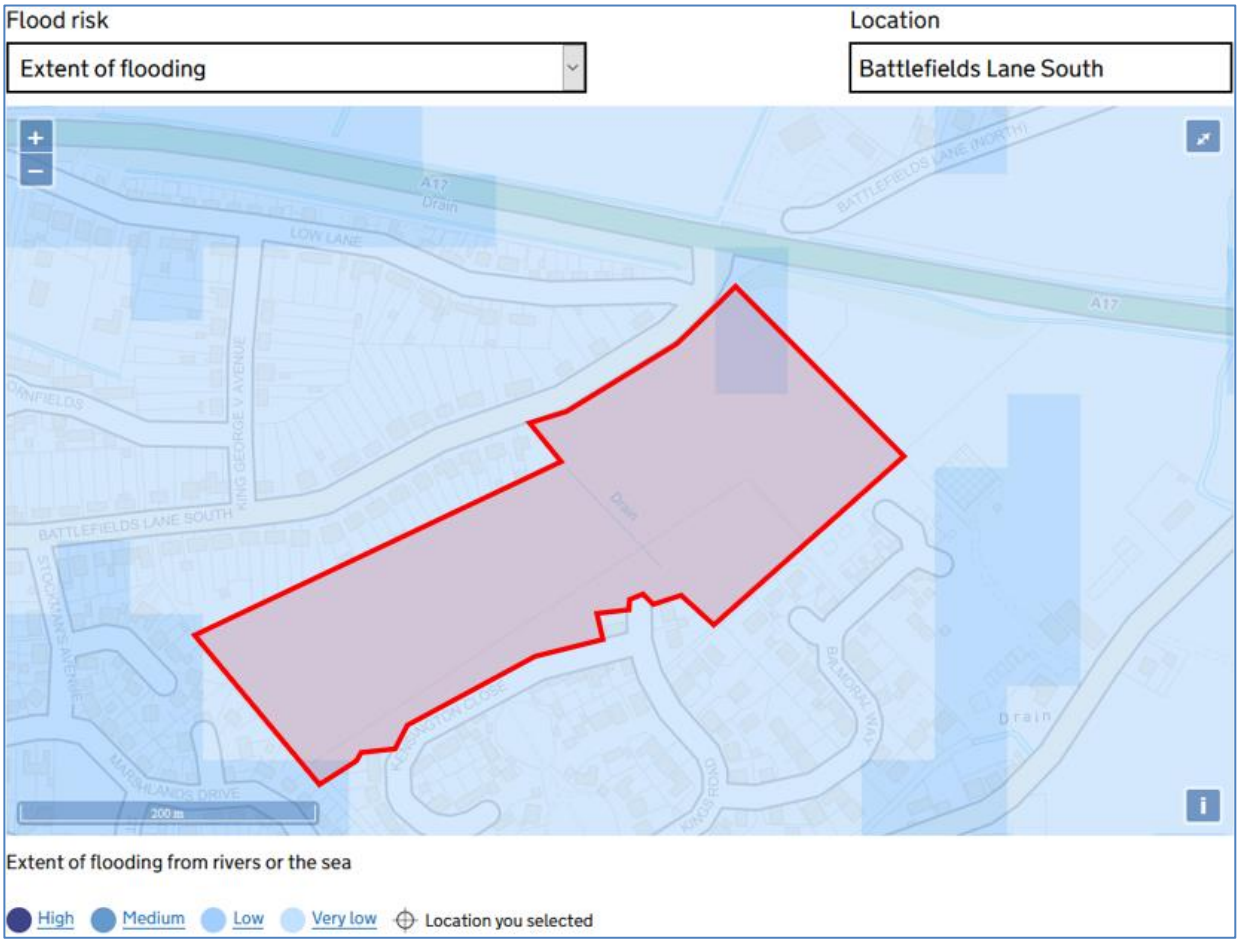


Figure 17: Long-term flood risk from rivers and seas map

Long-term flood risk from reservoirs

5.10 The site is entirely outside of the maximum extent of flooding from reservoirs. See **Figure 18**.

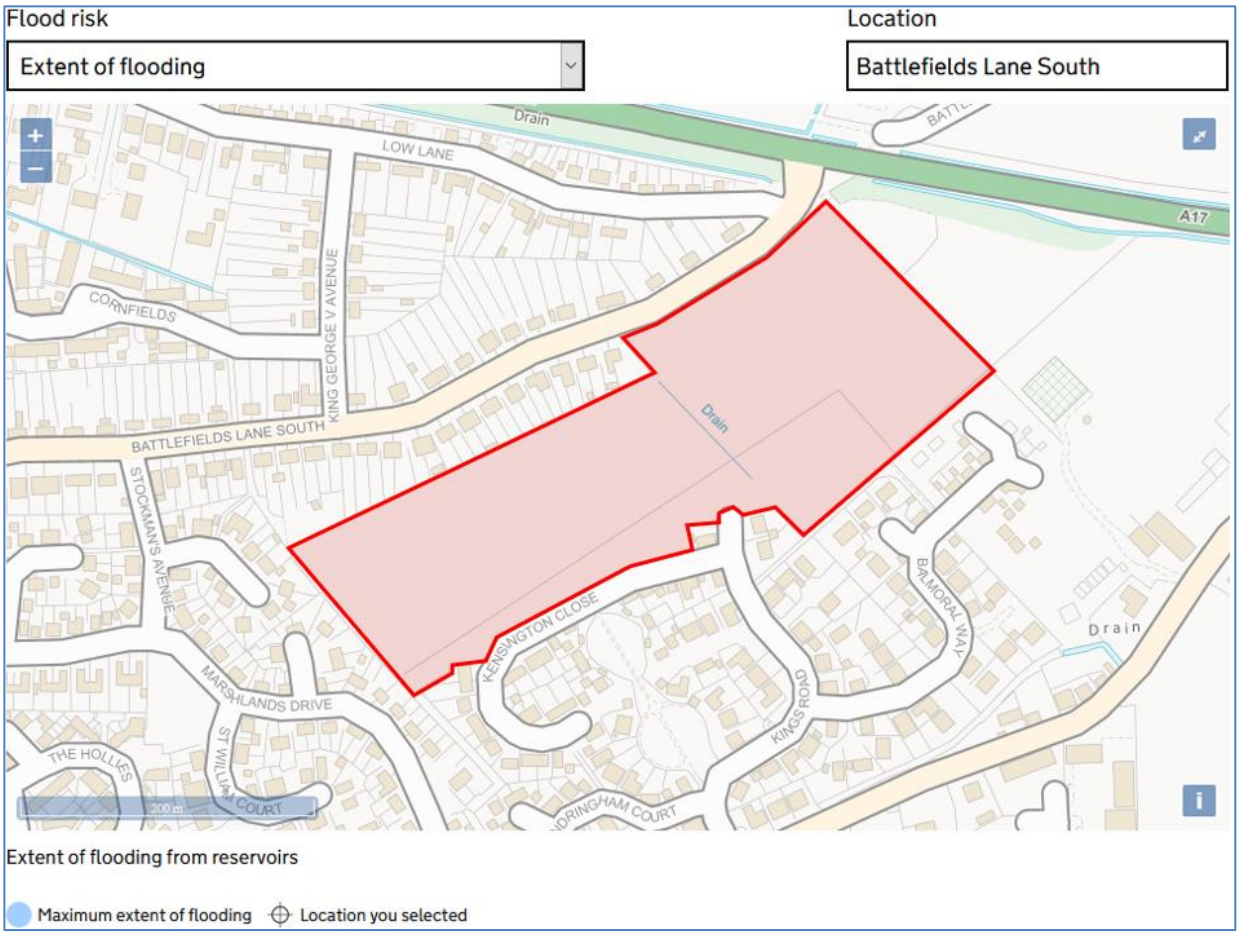


Figure 18: Long term flood risk from reservoirs map

Long-term surface water flood risk

5.11 Surface water or 'pluvial' flooding results from rainfall running over ground before eventually entering a watercourse or sewer. It is usually associated with high intensity rainfall events but can also occur with lower intensity rainfall or melting snow where the ground is already saturated, frozen, developed (for example in an urban setting), or otherwise has low permeability.

5.12 Isolated areas of the site's western half are shown to be at low risk of surface water flooding; the remainder of the site is considered to be at very low risk. See **Figure 19**.

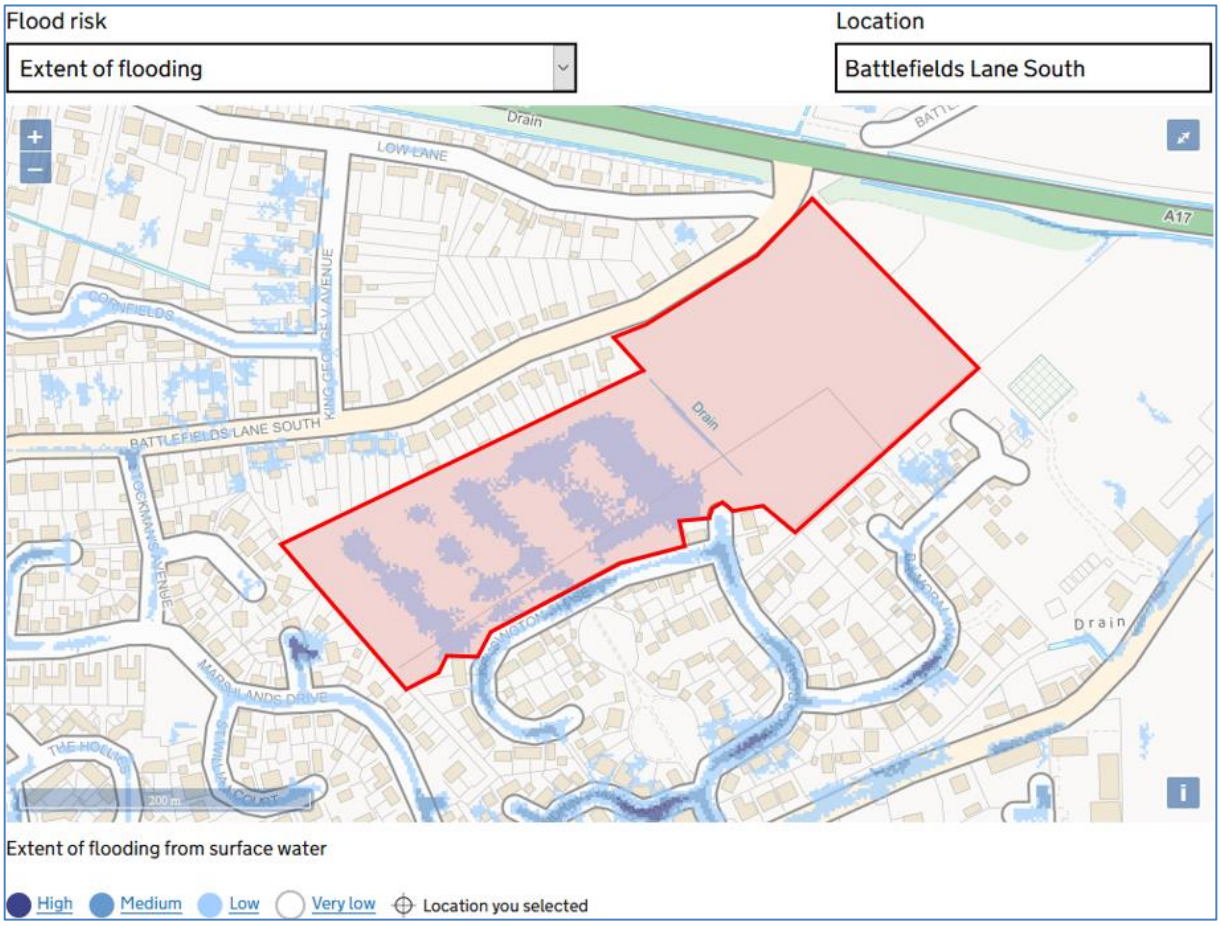


Figure 19: Long term flood risk from surface water

5.13 Areas of the site shown to be at low risk from surface water flooding are predominantly at risk of flooding up to 300mm. There are some small, isolated areas where surface water flooding is expected to be between 300 to 900mm. See **Figure 20**.

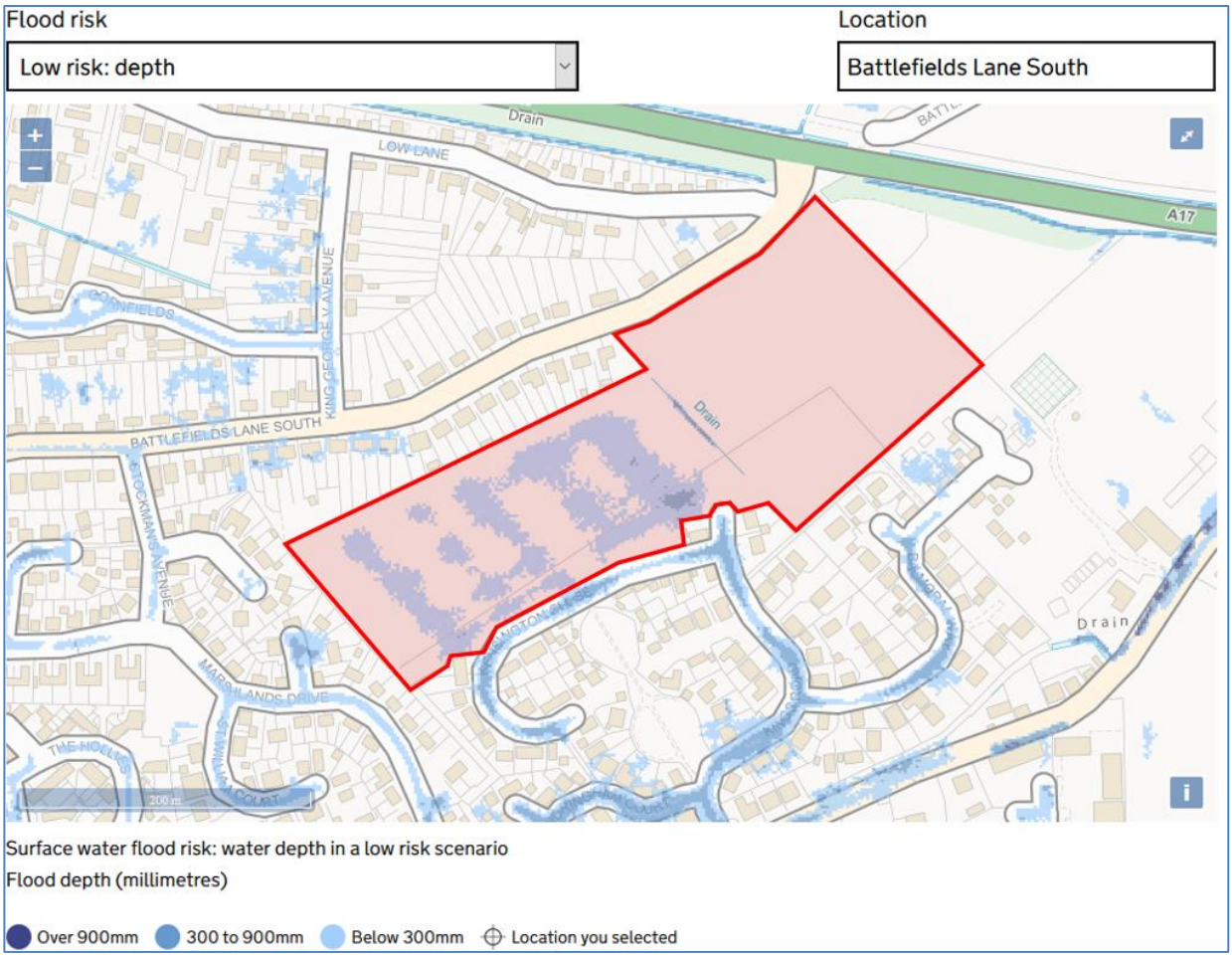


Figure 20: Surface Water Flood Risk: Water Depth in a Low-Risk Scenario

National Planning Policy Framework (NPPF)

5.14 This report has been prepared considering the National Planning Policy Framework (NPPF) Technical Guidance and the Environment Agency's (EA) flood risk standing advice.

5.15 Table 3 from the NPPF Technical Guidance has been included as **Figure 21** below. Table 3 provides the classes of development (based on flood risk vulnerability) that are permitted within each of the flood zones. The Flood Risk Vulnerability Classification for the site is 'More Vulnerable' as it is a housing development, as defined in Table 2 of the Planning Practice Guidance. The development is in Flood Zone 3a.

5.16 Although classed as more vulnerable, and situated in Flood Zone 3a, the development does not require an additional sequential test as it has been allocated for residential development in the South East Lincolnshire Adopted local plan. The development will be required to pass exception test; however, that is beyond th scope of this report.

Flood Zones	Essential infrastructure	Highly vulnerable	More vulnerable	Less vulnerable	Water compatible
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	Exception Test required	✓	✓	✓
Zone 3a †	Exception Test required †	X	Exception Test required	✓	✓
Zone 3b *	Exception Test required *	X	X	X	✓*

Table 3 - Flood risk vulnerability and flood zone 'compatibility'

Key: ✓ Development is appropriate X Development should not be permitted.

Notes to table 3:

- *This table does not show the application of the Sequential Test which should be applied first to guide development to Flood Zone 1, then Zone 2, and then Zone 3; nor does it reflect the need to avoid flood risk from sources other than rivers and the sea;*
- *The Sequential and Exception Tests do not need to be applied to minor developments and changes of use, except for a change of use to a caravan, camping or chalet site, or to a mobile home or park home site;*
- *Some developments may contain different elements of vulnerability and the highest vulnerability category should be used, unless the development is considered in its component parts.*

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

*" * "In Flood Zone 3b (functional floodplain) essential infrastructure that has to be there and has passed the Exception Test, and water-compatible uses, should be designed and constructed to:*

- *remain operational and safe for users in times of flood;*
- *result in no net loss of floodplain storage;*
- *not impede water flows and not increase flood risk elsewhere*

Figure 21: NPPF Planning Practice Guidance Table – Flood Risk Vulnerability and Flood Zone Compatibility

Groundwater Flooding

5.17 Groundwater flooding occurs when groundwater levels increase sufficiently for the water table to intersect the ground surface. Groundwater flooding can occur in a variety of geological settings including valleys and in areas underlain by chalk, and in river valleys with thick deposits of alluvium and river gravels.

5.18 The site is not considered to be at high risk from groundwater flooding. The ground investigation was completed on the 20th of January 2021, during storm Christopher and following a period of wet weather. However, the highest groundwater level encountered was 0.75mbgl, see **Figure 5**.

5.19 The EA Product 4 flood risk report, **Appendix G**, confirms there are no records of groundwater flooding in the vicinity of the site.

6. DRAINAGE STRATEGY

Potential Surface Water Drainage Strategy

6.1 In line with the Building Regulations Part H3, surface water shall discharge to one of the following, listed in order of priority:

- An adequate infiltration system: or, where not reasonably practicable,
- A watercourse; or, where not reasonably practicable,
- A sewer.

6.2 The records from the ground investigation undertaken on the 20th of January 2021 confirm the geology shown in the BGS mapping, encountering very clayey soils from 0.1m-5mbgl and high groundwater, see Appendix D.

6.3 Based on the site's geology, superficial deposits of clay underlain by clay bedrock, an infiltration system is not considered feasible for this development.

6.4 As infiltration is not considered to be feasible, initially it was considered that both the east and west sections of the site surface water could discharge to a watercourse and a pipeline (Foxes Low Drain), both maintained by the South Holland Internal Drainage Board.

6.5 In response to the planning application with this proposed in, Lincolnshire County Council queried the route of the watercourse that the east catchment was proposed to connect to, and its termination point. Their query is as noted below:

"The submitted Flood Risk Assessment and Drainage Strategy advises that the proposed outfall point for the eastern catchment is the riparian watercourse running across the centre of the site flowing in a southerly direction. It goes on to say that after leaving the site it connects to Foxes Low Drain – presumably along the route of the dotted orange line on the attached plan. In fact, this watercourse ends within the site. There is no evidence of the existence of this supposed watercourse beyond the green circle on the attached plan. I am not able to 'clear' this Application with the proposed drainage strategy."

6.6 To address this, a further survey was undertaken in October 2021 to explore the route of the watercourse past the heavily vegetated area that it appeared to previously end at. The survey uncovered the continuation of the watercourse which runs in a southerly direction past the previously visible end point. The survey also discovered 2 outgoing pipes from the end of the ditch which have invert levels of 1.99 and 1.98. The route of these pipes was traced approximately 15m, however no off-site connection to a watercourse was able to be traced. These additional survey extents are shown in the topographical survey within **Appendix A**.

6.7 Based on the above, the outfall point from the eastern catchment system is now proposed to connect to the existing Anglian Water surface water network within Kings Road, at manhole 9254 (the Anglian Water mapping is shown in **Appendix F**) The invert level of this manhole was also determined by the above mentioned survey, which is 1.97m. All other aspects of the drainage strategy for the rest of the site remains the same and the western catchment is still proposed to connect to the Foxes Low drain maintained by South Holland IDB. The updated drainage strategy drawing 087.5011.501 is shown in **Appendix I**.

6.8 In accordance with the *DEFRA Sustainable Drainage Systems Non-statutory technical standards for sustainable drainage systems March 2015*, and the *Lincolnshire County Council Sustainable Drainage Design and Evaluation Guide*, surface water run-off from the proposed development will be limited to greenfield rates. See **Table 1** for the site's developed area greenfield rates.

6.9 The proposed drainage system will include attenuation capacity designed to accommodate surface water run-off for a 1-in-100-year storm event, including a 40% allowance for climate change, with no flooding.

MicroDrainage Calculations

6.10 The eastern catchment is 2.9ha, assuming a proposed impermeable area of 62.5%, the developed impermeable area will be 1.813ha, with a greenfield Qbar rate of 2.7l/s, see **Table 1**. To accommodate a 1-in-100-year storm event, plus 40% climate change, while limiting discharge to 2.7l/s an attenuation capacity of 2188m^3 will be required. See **Appendix H** for a copy of the MicroDrainage Calculations, and **Appendix I** for the proposed drainage layout drawing.

6.11 The western catchment is 3.3ha, assuming a proposed impermeable area of 62.5%, the developed impermeable area will be 2.063ha, with a greenfield Qbar rate of 3.0l/s, see **Table 1.** To accommodate a 1-in-100-year storm event, plus 40% climate change, while limiting discharge to 3.0l/s an attenuation capacity of 2224m^3 will be required. See **Appendix H** for a copy of the MicroDrainage Calculations, and **Appendix I** for the proposed drainage layout drawing.

Catchment	Required attenuation m^3
East – 1.813ha	2188
West – 2.063ha	2224

Table 2: Summary of required attenuation

6.12 The MicroDrainage seasonal return period wizard was used to assess storm durations for a 1-in-30-year storm event too, and found no risk of flooding; see **Appendix H** for a summary of the critical storm events.

6.13 As shown on drawing 087.5011.501, it is proposed to provide the required attenuation via basins in public amenity spaces within the development. Due to the site's topography, high groundwater levels and the invert level of the proposed outfall points, below-ground storage is unlikely to be a feasible solution.

6.14 The attenuation basins can be landscaped and used for open amenity space (see

6.15 **Figure** 22) whilst not being used for surface water management; however, suitable access must be provided to avoid erosion of the banks. Residents of the development must be made aware of the function of the attenuation basins, that they will be flooded during storm events and the hazards associated with open water.

Figure 22: Landscaped Attenuation Basin

Flood Mitigation

6.16 The proposed attenuation will manage the development's surface run-off during a 1-in-100-year storm event, plus 40% climate change, and ensure flooding risk is not increased elsewhere following the development.

6.17 However, as identified in the South East Lincolnshire adopted local plan, South East Lincolnshire Strategic Flood Risk assessment and EA Product 4 report, the site is at risk from tidal flooding in the event of a storm surge breaching the raised engineered coastal defences along The Wash estuary (Environment Agency, 2021).

6.18 In the event the sea defences along The Wash estuary are breached, the site could be flooded by water up to 1m in depth, as identified in The South East Lincolnshire adopted local plan;

"The site is within Flood Zone 3a, and the SFRA identifies flood hazard in 2115 as a combination of 'danger for some', 'danger for most', 'no hazard' and 'low hazard' and flood depth in 2115 as 'no hazard' up to 1.0m. Development will be required to include appropriate mitigation." (SE Lincs, 2019)

6.19 Site levels should be raised to at least 4.17m AOD (in accordance with the adopted local plan, and above flood levels shown on **Figure 13 & Figure 14**) to protect the proposed dwellings from flooding during a flood event caused by a breach of The Wash estuary defences. Minimum Finished Floor Levels (FFLs) for the residential dwellings should be 4.32m AOD, 150mm above the proposed site levels.

Flood Resilience

6.20 Architects and other design professionals should follow the guidance outline in *Improving the flood performance of new buildings: flood resilient construction, 2011,* published by the Ministry of Housing, Communities & Local Government.

6.21 As this strategy recommends a minimum FFL of 4.32m, above predicted flood levels, many of the recommendations within the report will be followed by default. However, additional resilience can be provided by ensuring flood water cannot penetrate builds through walls, floors and foundations.

6.22 The flood resilience advice within *Improving the flood performance of new buildings: flood resilient construction, 2011*, should be followed for all construction within the development site.

Safe access, Egress, and Refuge

6.23 The proposed sites levels and minimum FFL of 4.17m and 4.32m respectively, will provide safe refuge within dwellings if flood waters reach the maximum 1m depth identified in the EA Product 4 mapping shown in **Figure 13 & Figure 14.**

6.24 **Figure 13 & Figure 14** identify that the A17, directly north of the site, would not be flooded during a 1-in-200 or 1-in-1000-year flood events. Therefore, emergency access to and from the site should be achievable, and movement throughout the site should be possible providing site levels are raised to 4.17m as specified above.

6.25 Battlefields Lane South itself will likely be flooded, but only up to 0.5m max depth during a 1-in-1000-year flood event, see **Figure 14**; therefore, it is reasonable to assume emergency services would be able to access the site from the A17 if required to do so during a flood.

6.26 Prior to purchasing a property on the site, residents should be informed of the flood risk and associated mitigation measures. Residents should be encouraged to sign up to the Environment Agencies Floodline flood risk alert service; these alerts should give residents time to prepare for a possible flooding situation.

Potential Foul Water Drainage Strategy

6.27 The site is to the south of Battlefields Lane South, and the north of Kings Road and Kensington Close. Anglian Water has adopted sewers in each of these roads, see **Appendix F**. The sewer on Kings Road has a stub (MH Ref 9300, C.L - 3.102m I.L - 0.390m) which could serve as a connection point for the developments foul drainage, See **Figure 9**. The sewer in Kings Road is shown to be 225mm in diameter and of Vitrified Clay.

7. SUDS MANAGEMENT AND MAINTENANCE

7.1 The management and Maintenance of SuDS will be responsibility of the developer/freeholder or their appointed management agent.

Attenuation Basin

7.2 The proposed drainage strategy comprises two large, landscaped attenuation basins in the development's public open spaces; one to serve the east catchment and one the west. A typical detention/attenuation basin is shown in **Figure 23**.

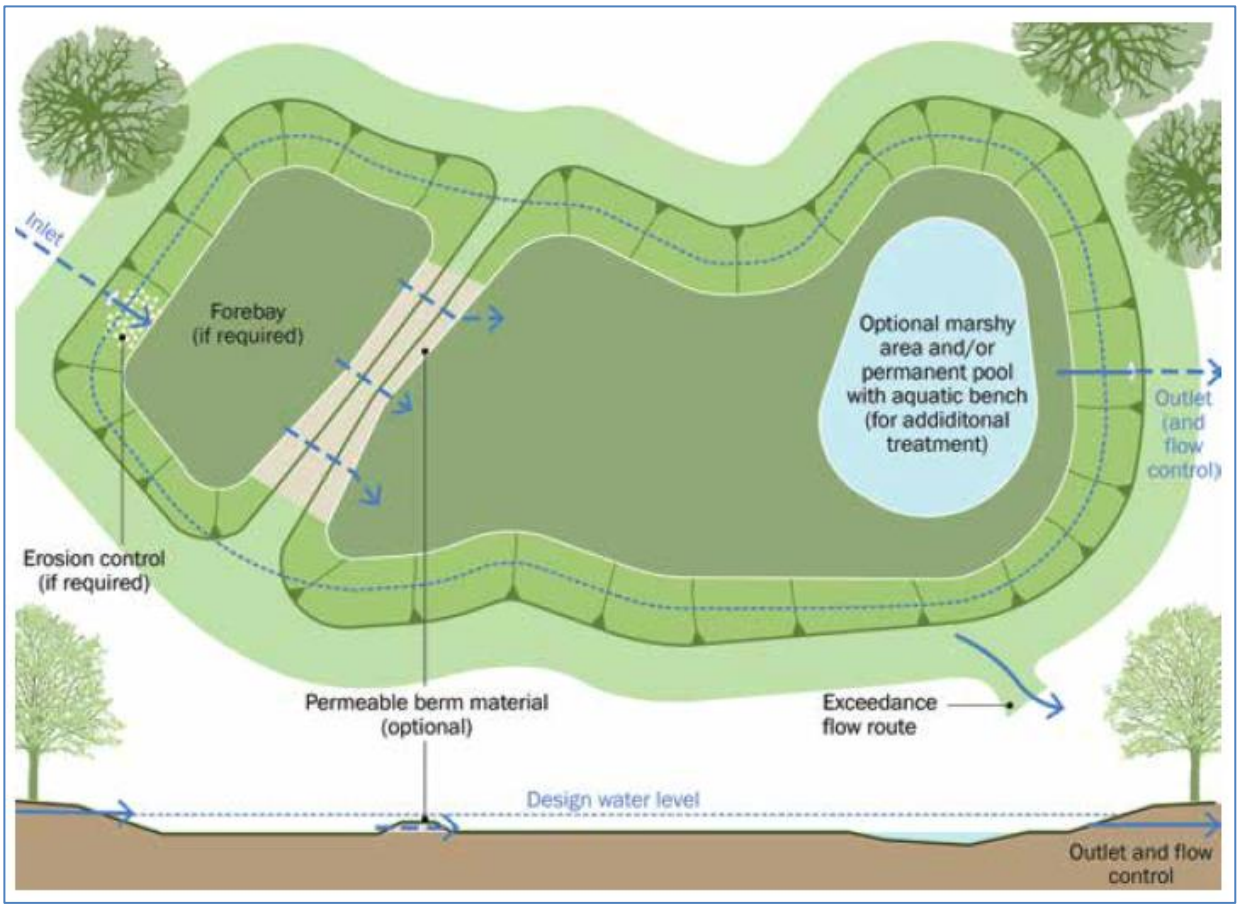


Figure 23: Typical Attenuation Basin, Plan and Elevation (Figure 22.2 CIRIA C753)

7.3 The proposed maintenance schedule for an attenuation basin is shown in **Table 3**.

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Remove litter, debris and trash.	Monthly
	Cut grass – for spillways and access routes	Monthly (during growing season) or as required.
	Cut grass – meadow grass in and around basin.	Half Yearly: Spring (before nesting season) and autumn.
	Manage other vegetation and remove nuisance plants	Monthly at start, then as required.
	Inspect inlets, outlets, and overflows for blockages, and clear if required.	Monthly
	Inspect Banksides, structures, pipework, etc. for evidence of physical damage.	Monthly
	Inspect inlets and facility surface for silt accumulation. Establish appropriate silt removal frequencies.	Monthly (for first year), then annually or as required.
	Check any penstocks and other mechanical devices.	Annually.
	Tidy all dead growth before start of growing season	Annually
	Remove sediments from inlets, outlets and forebay.	Annually (or as required)
	Manage wetland plants in outlet pool – where provided.	Annually (or as required)
Occasional Maintenance	Reseed areas of poor vegetation growth	As required
	Prune and trim any trees and remove cuttings	Every two years, or as required
	Remove sediment from inlets, outlets forebay and main basin when required	Every 5 years or as required
Remedial Actions	Repair erosion or other damage by reseeding or re-turfing	As required
	Re-align the rip-rap	As required
	Repair or rehabilitate inlets, outlets and overflows	As required
	Relevel uneven surfaces and reinstate design levels	As required

Table 3: Attenuation Basin Typical Maintenance Schedule

Vortex flow control device (HydroBrake, or similar)

7.4 Vortex flow control devices (HydroBrake or similar) are proposed to limit the discharge from the proposed attenuation basins to developed area greenfield rates.

7.5 A flow control device usually comprises of a fixed orifice or an alternative form of throttle such as a vortex flow control unit. Its principal function is to throttle the discharge passed down stream and thereby retain water upstream within associated storage facilities.

7.6 Vortex flow controls provide a non-linear flow curve and as such, can respond to both high and low intensity rainfall events. The drainage strategy proposes to utilise a vortex flow control device (HydroBrake or similar) to control the discharge from the attenuation basins. The device will usually contain a sump within the flow control chamber and associated parts for access and maintenance.

7.7 Normally, little maintenance is required as there are no moving parts within the flow control device, and generally, if blockages occur, they do so at the intake and can be due to poor installation or upstream treatment of water entering the system. Vortex flow control devices are to be fitted with a pivoting by-pass door, which allows the manhole chamber to be drained down should a blockage occur. Figure 24 shows a typical HydroBrake.

Figure 24: Typical HydroBrake Device

7.8 The proposed maintenance schedule for a vortex flow control device is shown in Table 4.

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Inspect and identify any areas that are not operating correctly	Monthly (for the first 3 months), then six monthly
	Remove sediment from upstream silt trap (sump)	Six monthly, or as required
	Hose down unit/chamber	Six monthly, or as required

Table 4: HydroBrake, Typical Maintenance Schedule

8. WATER TREATMENT

8.1 Water treatment will be provided through the incorporation of SuDS features in the development's drainage. If designed per CIRIA C753 guidance, attenuation basins can provide a good level of water treatment according to the C753 pollution mitigation indices.

8.2 Under the CIRIA C753 guidance, the development is categorised as having a "Low" pollution hazard level. The proposed attenuation basins would provide sufficient treatment for discharge to a watercourse.

Pollution Hazard Indices	Pollution Hazard Level	Total Suspended Solids	Metals	Hydro-carbons
Individual property driveways, residential car parks, low traffic roads and non-residential perking with infrequent change i.e.<300 movements/day.	Low	0.5	0.4	0.4
SuDS Mitigation Indices for Discharge to Surface Water				
SuDS Component Pollution Hazard Level		Total Suspended Solids	Metals	Hydro-carbons
Attenuation Basin		0.5	0.5	0.5
		Sufficient	Sufficient	Sufficient

Table 5: Water Treatment Indices

9. SUMMARY AND CONCLUSION

9.1 This FRA has been prepared by Paul Basham Associates to help assess the suitability of the site south of Battlefields Lane South, Holbeach, for a residential development of up to 185 dwellings.

9.2 The site is generally at low risk from flooding. It is not at risk from fluvial flooding and is defended from Tidal flooding events by the engineered flood defences along The Wash Estuary (Environment Agency, 2021). However, if The Wash Estuary defences were to be breached, for which there is a 1-in-150 chance of occurring in any given year (Environment Agency, 2021). Then the site could be flooded with a max flood depth of 1m, see **Figure 10 & Figure 11**.

9.3 To protect the development and the provide safe refuge within the dwellings from tidal/sea flooding, occurring as a result of a breach of The Wash Estuary defences site, proposed sited levels shall be;

- Site Levels = 4.17m
- Finished Floor levels for residential dwellings – 4.32m

9.4 Surface water discharge from the development will be limited to developed area greenfield rates. Assuming 62.5% of the site will be impermeable post development, the following attenuation capacities shall be required to maintain developed area greenfield run-off rates.

Catchment (developed Area)	Developed Area Greenfield Run-Off Rate (l/s)	Required attenuation m^3
East – 1.813ha	2.7	2188
West – 2.063ha	3.0	2224

9.5 The proposed attenuation will manage the development's surface run-off during a 1-in-100-year storm event, plus 40% climate change, and ensure flooding risk is not increased elsewhere following the development.

9.6 During the detailed design phase, it should be possible to reduce the footprint of the two main attenuation basins through spreading attenuation capacity across the site. For example, highway swales, permeable pavements and attenuation basins on roundabout islands could all contribute to providing the required attenuation capacity.

9.7 Given the overall low risk of flooding to the site, it's allocation in the South East Lincolnshire Adopted Local Plan, the ability to provide safe refuge and protection from flooding if site levels are increased as per **para 9.3**, and the practicality of attenuating additional surface run-off onsite; this report concludes that the site is suitable for residential development in terms of flood risk.

10. REFERENCES

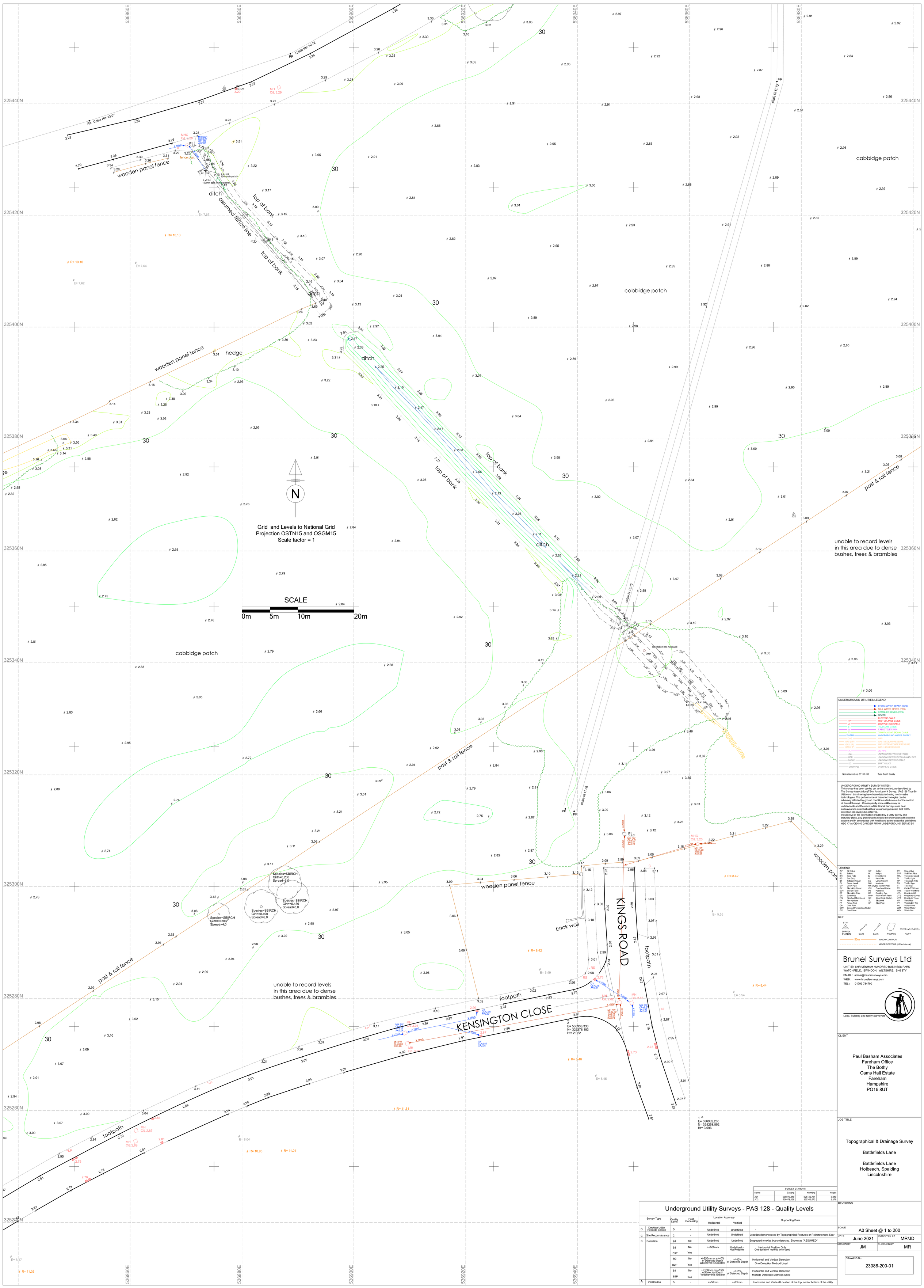
Environment Agency. (2021). *CCN/2020/198662, Product 4, Flood Risk Report .* Lincoln: Environment Agency.

SE Lincs. (2018). *South East Lincolnshire Strategic Housing Land Availability Assessment.* South East Lincolnshire Joint Strategic Planning Committee.

SE Lincs. (2019). *South East Lincolnshire Local Plan 2011-2036.* South East Lincolnshire Joint Strategic Planning Committee.

SE Lincs, JSPC. (2017). *South East Lincolnshire Strategic Flood Risk Assesment.* South East Lincolnshire Joint Strategic Planning Committee.

Appendix A



UNDERGROUND UTILITIES LEGEND

STORM WATER SEWER (SWS)
FOUL WATER SEWER (FWS)
COMBINED SEWER (CWS)
SEWER
ELECTRIC CABLE
HV HIGH VOLTAGE CABLE
LV LOW VOLTAGE CABLE
ET TELECOMS CABLE
TV CABLE TELEVISION
TS TRAFFIC LIGHT SIGNAL CABLE
WATER UNDERGROUND WATER SUPPLY
GAS GAS
GAS (MP) GAS MEDIUM PRESSURE
GAS (IP) GAS INTERMEDIATE PRESSURE
GAS (HP) GAS HIGH PRESSURE
OIL OIL PIPE
Unk UNKNOWN SERVICE METALLIC
GPR UNKNOWN SERVICE FOUND WITH GPR
CABLE UNKNOWN SERVICE CABLE
ED EMPTY DUCT
OH (TYPE) OVERHEAD CABLE

Note attached eg, BT 0/6 B2 Type Depth Quality

UNDERGROUND UTILITY SURVEY NOTES:
This survey has been carried out to the standard, as described by The Survey Association (TSA), for a Level 4 Survey, (PAS128 Type B) Utilities on this drawing have been detected using non invasive technologies. The performance of these technologies can be adversely affected by ground conditions which are out of the control of Brunel Surveys. Consequently some utilities may be undetectable and therefore, whilst Brunel Surveys uses best endeavours to detect all utilities we cannot guarantee that 100% detection can always be achieved.
Irrespective of the information provided by a utility survey and statutory plans, any groundworks should be undertaken with extreme caution and in accordance with health and safety executive guidelines HSG 47 AVOIDING DANGER FROM UNDERGROUND SERVICES

LEGEND

AV	Air Valve	GY	Gulley	SV	Stop Valve
BL	Bollard	HI	Hatght	SVP	Soil Vent Pipe
BH	Bore Hole	IL	Invert Level	THL	Threshold Level
BS	Bus Stop	KI	Kerb Inlet	TL	Traffic Light
BT	Telecom Cover	LC	Lamp Column	TP	Telegraph Pole
CL	Cover Level	MH	Manhole	TS	Traffic Sign
DP	Down Pipe	MK(Type)	Marker Post	TT	Tree Top
EV	Electric Cover	PB	Post Box / Cable	TV	Top of TV Cover
EOT	End of Fence	PR	Road Sign	TWL	Top of Wall level
EP	Electricity Pole	RE	Rodding Eye	UTL	Unable to Lift
ER	Earth Rod	RNP	Road Name Plate	UTS	Unable to Survey
FFL	Finished Floor Level	SC	Stop Cock (Water)	UTT	Unable to Trace
FH	Fire Hydrant	SL	Silt Level	VP	Vent Pipe
FP	Fence Post	SP	Sign Post	VT	Vegetation Top
GP	Gate Post			WL	Water Level
GPR	Ground Penetrating Radar			WM	Water Meter
GV	Gas Valve			WO	Wash Out

KEY

STN1 SURVEY STATION | GATE | BANK | FOLIAGE | CLIFF

50m MAJOR CONTOUR
MINOR CONTOUR (0.25m interval)

Brunel Surveys Ltd
UNIT 59, SHRIVENHAM HUNDRED BUSINESS PARK
WATCHFIELD, SWINDON, WILTSHIRE, SN6 8TY
EMAIL : admin@brunelsurveys.com
WEB : www.brunelsurveys.com
TEL : 01793 784700
Land, Building and Utility Surveyors

CLIENT

Paul Basham Associates
Fareham Office
The Bothy
Cams Hall Estate
Fareham
Hampshire
PO16 8UT

JOB TITLE

Topographical & Drainage Survey

Battlefields Lane

Battlefields Lane
Holbeach, Spalding
Lincolnshire

SURVEY STATIONS

Name	Easting	Northing	Height
JD1	536876.840	325442.784	3.349
JD2	536978.638	325366.573	3.276

Underground Utility Surveys - PAS 128 - Quality Levels

	Survey Type	Quality Level	Post Processing	Location Accuracy Horizontal	Location Accuracy Vertical	Supporting Data
D	Desktop Utility Records Search	D	-	Undefined	Undefined	-
C	Site Reconnaisance	C	-	Undefined	Undefined	Location demonstrated by Topographical Features or Reinstatement Scar
B	Detection	B4	No	Undefined	Undefined	Suspected to exist, but undetected. Shown as "ASSUMED"
		B3	No	+/-500mm	Undefined - Not Reliable	Horizontal Position Only One location method only used
		B3P	Yes			
		B2	No	+/-250mm or +/-40% of Detected Depth Whichever is Greatest	+/-40% of Detected Depth	Horizontal and Vertical Detection One Detection Method Used
		B2P	Yes			
		B1	No	+/-150mm or+/-15% of Detected Depth Whichever is Greater	+/-15% of Detected Depth	Horizontal and Vertical Detection Multiple Detection Methods Used
		B1P	Yes			
A	Verification	A	-	+/-50mm	+/-25mm	Horizontal and Vertical Location of the top, and/or bottom of the utility

REVISIONS

SCALE	A0 Sheet @ 1 to 200
DATE	June 2021
SURVEYED BY	MR/JD
DRAWN BY	JM
CHECKED BY	MR
DRAWING No.	23086-200-01

Appendix B

South East Lincolnshire
Local Plan 2011-2036

Adopted March 2019

Policies Map Inset Map No 5

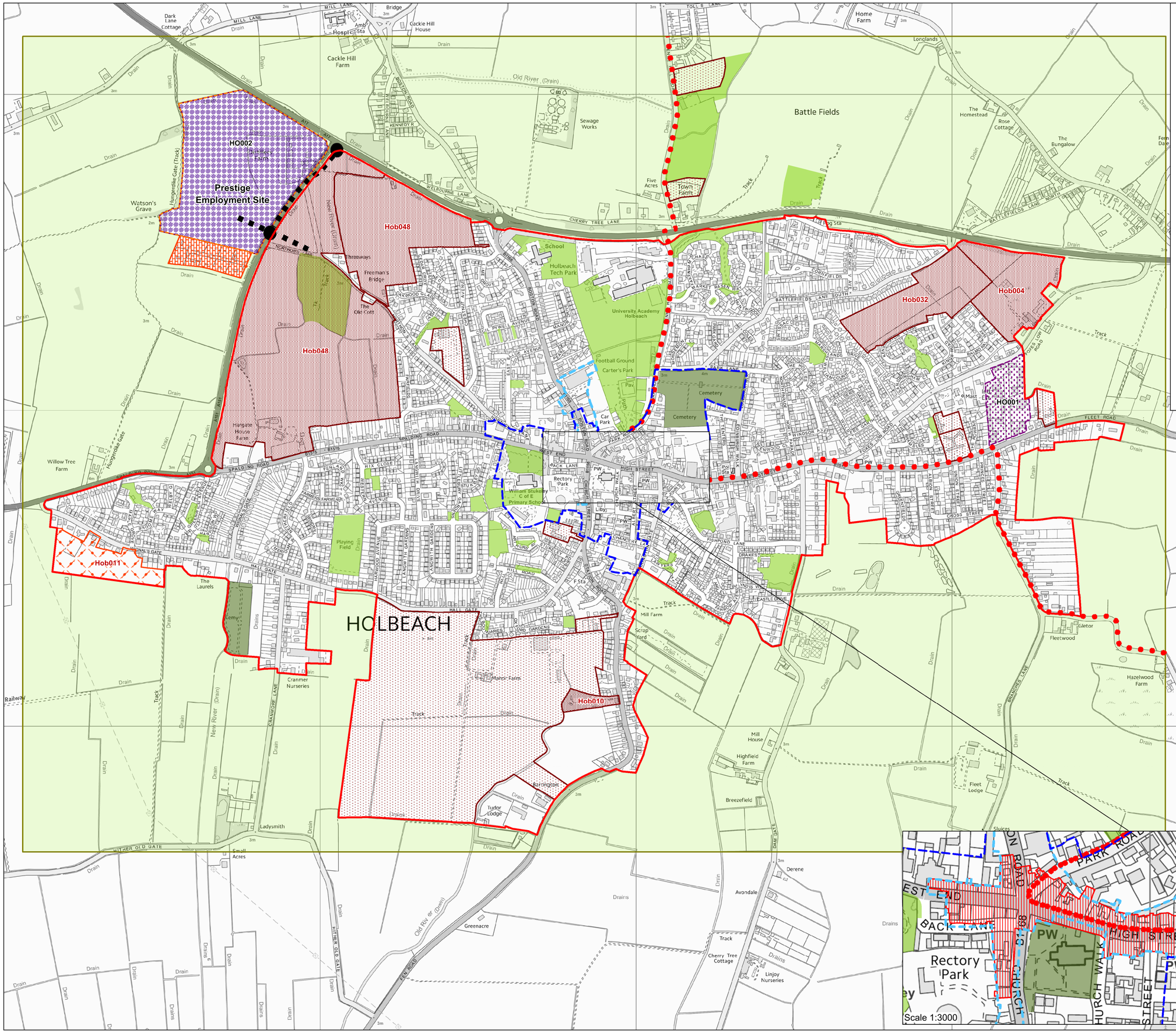
Holbeach

Main Service Centre

Scale 1:8,000 @A2

N

- Inset Map Boundary
- Countryside.....Policy 1,9,19,22,23
- Settlement Boundary.....Policy 1,19,22,23
- Town Centre Boundary.....Policy 24,26,27
- Conservation Area.....Policy 29
- Housing Commitments.....Policy 11
- Housing Allocation.....Policy 11,16
- Housing Reserve Site.....Policy 12
- Existing Residential Gypsy/Traveller Site....Policy 20
- Established Employment Site.....Policy 7
- Proposed Mixed Use Employment Site.....Policy 7
- Prestige Employment Site.....Policy 8
- Primary Shopping Area.....Policy 24
- Recreational Open Space.....Policy 32
- Green Infrastructure.....Policy 32
- Protected Road Line.....Policy 16,33
- Cycle Route.....Policy 33



South East Lincolnshire
Joint Strategic Planning Committee

Ordnance Survey
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Appendix C

RECORD OF BOREHOLE 1, HOLBEACH TF 32 SE 24

BORING: STARTED 15/4/82
BORING: FINISHED 15/4/82

GROUND LEVEL O.D. 3648-2455

HOLE SIZE 150mm dia to 3.0m, 25mm dia probe to 5.1m

SAMPLE OR TEST		CHANGE OF STRATA			
DEPTH	TYPE	LEGEND	DEPTH	O.D. LEVEL	DESCRIPTION
					Site C 065 245
0.3	D1				MADE GROUND - topsoil with brick fragments and gravel.
0.6	D2				
0.8	W1				
0.9	D3		1.0		
1.0-1.15	U(½)1				MADE GROUND - very soft dark grey and brown, organic silty clay with twigs, traces of peat and occasional brick fragments.
1.2	D4				
1.5	D5				
1.8	D6		1.8		
2.5	D7				
3.0	D8				? BDB or TB
3.0-3.3	M(20)				Very soft/soft dark grey slightly organic silty CLAY
3.3-3.6	M(24)				
3.6-3.9	M(31)				
3.9-4.2	M(35)				
4.2-4.5	M(48)				
4.5-4.8	M(43)				
4.8-5.1	M(52)				
			5.1		

REMARKS Water met at 1.0m. It rose to 0.8m within 5 hours of completion.

KEY: D — DISTURBED SAMPLE
B — BULK DISTURBED SAMPLE
W — WATER SAMPLE
U — UNDISTURBED SAMPLE
S ( ) STANDARD PENETRATION TEST
C ( ) CONE PENETRATION TEST
NO. OF BLOWS FOR 300 mm PENETRATION IN BRACKETS
M( ) Mackintosh probe

SOILS ENGINEERING LIMITED PETERBOROUGH

British Geological Survey

HZ 302/85

LINCOLNSHIRE COUNTY COUNCIL MATERIALS LABORATORY

TF 32 NE / 1

TRIAL PIT/BORE HOLE LOG

NGR:- 3607 2554

BH/TP No. 27 **Machine Type** Light Cable Percussion **Dimension of Hole** 200mm **Dimension of Casing** 200mm **Sheet** 1 **of** 2

Site A151 Cherry Lane, Hobeach Subway **Location** - See Plan **Ground Level** - **m AOD**

Remarks (DD) = Drillers Description Head of water maintained from 4.00m Stand pipe installed at 4.50m

British Geological Survey

Date and Time 1986	Depth of Casing (m)	Depth of Water (m)	Sample No.	Sample Type	Sample Depth (m)	Change of Strata: Section	Depth below GL (m)	Reduced Level OD (m)	Thickness of Stratum (m)	Description of Strata	S.P.T. Pen't mm	S.P.T. N	NMC %	Atterberg Limits LL %	Atterberg Limits PL %	Atterberg Limits PI %	Density Bulk ρ kg/m³	Density Dry ρd kg/m³	CBR %	Shear Strength C kN/m²	Shear Strength Ø Degrees	Type of Shear Test	Chemical SO_2 Class	pH	Organic %
29/9							0.10		0.10	Soft light brown slightly sandy SILT (DD)															
			1	D	0.00 - 0.50				0.70	Soft to firm dark brown SILT			17.7												
			2	S	0.50 - 0.95		0.80				300	7	18.3												
									0.30	Soft to firm dark brown SILT with traces of light brown fine sand															
							1.10																		
			3	S	1.00 - 1.45				0.40	Soft to firm brown and light brown SILT with a little fine sand	300	10	22.8	GRADING											
							1.50																		
			4	S	1.50 - 1.95						300	4	30.2												
			5	U100	2.00 - 2.45				1.50	Loose wet brown fine SAND and SILT (becoming saturated at 2.0m)		8 U100	26.4	GRADING			1851	1464							
			6	S	2.60 - 3.05						300	5	31.7										1	8.8	
		3.00	8	W	3.00		3.00																		
			7	S	3.05 - 3.50				3.00	Loose grey/brown slightly silty fine SAND with traces of black fine sand	300	4	29.7	GRADING											
			9	S	3.50 - 3.95						300	6													
			10	S	4.00 - 4.45						300	6													

Scale As Shown

Disturbed Samples
W Ground Water J Jar
D Small Bag S SPT
B Large Bulk

Undisturbed Samples
U100 105 mm diameter
U38 38 mm diameter

Rock Core: 90 Recovery %; 60 RQD %; End of Core Run

Institu Tests
▼ Ground water Level
☐ Core Cutter Density
■ Core Cutter Density/CBR
▽ Sand Bottle Density
▲ CBR P Probe CBR

Symbols
N SPT Blow Count
d Dynamic CBR
S Static CBR

Shear Test Type:
V Shear Vane
SB Shear Box
TX Triaxial

C Cohesive Strength
Ø Internal Friction Angle
C', Ø', Effective Stress Results

HZ 302/85

TF32NE/1

LINCOLNSHIRE COUNTY COUNCIL MATERIALS LABORATORY

TRIAL PIT/BORE HOLE LOG

BH/TP No. 27 **Machine Type** Light Cable Percussion **Dimension of Hole** 200mm **Dimension of Casing** 200mm **Sheet** 2 **of** 2

Site A151 Cherry Lane, Hobeach Subway **Location** See Plan **Ground Level** - **m AOD**

Remarks (DD) = Drillers Description Head of water maintained from 4.00m Stand pipe installed at 4.50m

British Geological Survey

Date and Time 19 86	Depth of Casing (m)	Depth of Water (m)	Sample No.	Sample Type	Sample Depth (m)	Change of Strata Section	Depth below GL (m)	Reduced Level OD (m)	Thickness of Stratum (m)	Description of Strata	S.P.T. Pen't mm	S.P.T. N	NMC %	Atterberg Limits LL %	Atterberg Limits PL %	Atterberg Limits PI %	Density Bulk ρ kg/m³	Density Dry ρd kg/m³	CBR %	Shear Strength C kN/m²	Shear Strength Ø Degrees	Type of Shear Test	Chemical SO_3 Class	Chemical pH	Chemical Organic %
29/9			11	S	4.50 - 4.95					Loose grey/brown slightly silty fine SAND with traces of black fine sand becoming medium dense at 5.00m	300	7													
			12	S	5.00 - 5.45				3.00		300	7		GRADING											
			13	S	5.50 - 5.95						300	8													
	6.00						6.00																		
										Bottom of borehole															

Scale As Shown

Disturbed Samples
W Ground Water J Jar
D Small Bag S SPT
B Large Bulk

Undisturbed Samples
U100 105 mm diameter
U38 38 mm diameter

Rock Core
90 Recovery %
60 RQD %
End of Core Run

Institu Tests
▼ Ground water Level
□ Core Cutter Density
■ Core Cutter Density/CBR
▽ Sand Bottle Density
▲ CBR P Probe CBR

Symbols
N SPT Blow Count
d Dynamic CBR
S Static CBR

Shear Test Type:
V Shear Vane
SB Shear Box
TX Triaxial

C Cohesive Strength
Ø Internal Friction Angle
C', Ø', Effective Stress Results

GROUND LEVEL O.D. TF32SE/17

BORING: FINISHED 27.3.79 362 246

HOLE SIZE 150 mm dia to 9.0 m

SAMPLE OR TEST DEPTH	TYPE	LEGEND	DEPTH	O.D. LEVEL	CHANGE OF STRATA DESCRIPTION
			0.6		MADE GROUND (Concrete followed by hardcore, ashes and soft silty clay).
1.0	B1				
1.0	W1				Very soft dark grey peaty clay with occasional gravel (probably MADE GROUND).
1.65 - 1.95	S(3)				
1.95 - 2.25	S(6)				
			1.8		
2.0 - 2.45	U(4)1				
2.5	D1				Soft grey silty peaty CLAY.
3.5 - 3.95	U(4)2				
4.0	D2				
5.0	D3				
5.0 - 5.45	U(4)3		5.0		
					Interbedded very soft grey silty CLAY and grey fine SAND.
7.0 - 7.45	U(4)4				
7.5	D4				
8.5 - 8.95	U(4)5				
8.5	B2				
			9.0		

?BDB

BDB

REMARKS

1. Groundwater entered the borehole at a depth of 1.0 m. Standing water level on withdrawal of casing on completion of boring 0.6 m.
2. The upper 2.3 m was rebored in an attempt to get an undisturbed sample before 2 m depth. This second sampling attempt failed also.

KEY: D — DISTURBED SAMPLE
B — BULK DISTURBED SAMPLE
W — WATER SAMPLE
U — UNDISTURBED SAMPLE

S ( ) STANDARD PENETRATION TEST
C ( ) CONE PENETRATION TEST
NO. OF BLOWS FOR 300 mm PENETRATION IN BRACKETS

SOILS ENGINEERING LIMITED PETERBOROUGH

British Geological Survey

Appendix D

Ground Condition Consultants

Ref: J21-001-R01

Date: 21st January 2021

FAO: Chris Owen-Hughes

Paul Basham Associates
The Bothy, Cams Hall Estate
Fareham, Hampshire
PO16 8UT

Dear Chris,

Re: Targeted Site Investigation – Holbeach, Spalding, Lincolnshire

GCC was commissioned by Paul Basham Associates in January 2021 to undertake a targeted site investigation comprising the installation of groundwater wells and subsequent groundwater monitoring at the site. The location of the site and location of installed monitoring wells are shown on Figure 1.

The British Geological Survey Geology of Britain Viewer (online) shows the site to be underlain by superficial Tidal Flat Deposits (clay and silt) over bedrock Ampthill Clay Formation (mudstone).

5no. windowless sample boreholes were drilled on the 20th January and monitoring wells were installed in all boreholes to depths between 1.6mbgl and 3.1mbgl, comprising unslotted pipe with a bentonite seal around it, followed by slotted pipe to the base of installation with a gravel filter pack and approximately 0.5m of unslotted pipe extending above ground level to be visible to farm machinery. The monitoring well installation depths were limited by blowing silt in the borehole casing.

The ground conditions encountered in the boreholes were as follows:

WS101:

0.0-0.1m Soft brown silty CLAY (Topsoil)

0.1-2.9m Brown very clayey SILT

2.9-5.0m Grey very clayey SILT

Well: 0.72m unslotted, 2.0m slotted

WS102:

0.0-0.2m Soft brown silty CLAY (Topsoil)

0.2-3.2m Brown very clayey SILT

3.2-5.0m Grey very clayey SILT

Well: 0.56m unslotted, 1.0m slotted

WS103:

0.0-0.3m Soft brown silty CLAY (Topsoil)

0.3-3.0m Brown very clayey SILT

Well: 0.47m unslotted, 2.0m slotted

WS104:

0.0-0.2m	Soft brown silty CLAY (Topsoil)
0.2-2.7m	Brown very clayey SILT
2.7-3.5m	Grey very clayey SILT

Well: 1.0m unslotted, 2.0m slotted

WS105:

0.0-0.2m	Soft brown silty CLAY (Topsoil)
0.2-3.1m	Brown very clayey SILT
3.1-3.5m	Grey very clayey SILT

Well: 1.0m unslotted, 2.0m slotted

Groundwater monitoring was undertaken on completion of the site works with groundwater monitored between 0.75mbgl and 1.24mbgl. The full results are shown in Attachment 1.

Due to the shallow groundwater levels encountered & measured in the installed monitoring wells, no falling head testing were carried out.

Soil samples were also recovered from the boreholes for laboratory CBR testing. The results of the testing will be presented in a separate letter.

Yours sincerely

ANTONY PLATT
Director
For Ground Condition Consultants Ltd

RASMUS PALMGREN
Director
For Ground Condition Consultants Ltd

Encl: Figure 1: Location plan
Groundwater monitoring data

Ground Condition Consultants Ltd
10 Waldegrave Close Southampton SO19 9RY
Telephone 07971 450113
ask@groundcc.co.uk www.groundcc.co.uk

client	PAUL BASHAM ASSOCIATES
project	HOLBEACH
title	INVESTIGATION LOCATION PLAN
scale	NTS
drawn by	AP
checked by	RP
date	21 JAN 2021
cad file	J21-001
drawing number	FIGURE 1
rev.	0

GROUND GAS AND GROUNDWATER MONITORING RESULTS

SITE/REF:	Holbeach	
DATE:	20/01/2021	……1... of ……1…
OPERATOR(S):	RP	

Ambient Conditions:	Barometric Pressure (mb)	CH_4 (%v/v)	CO_2 (%v/v)	0_2 (%v/v)	PID (ppm)
Before Monitoring					
After Monitoring					

Atmospheric Pressure Trend:	
Ground Conditions:	
Weather Conditions:	

General Site comments

EQUIPMENT		
Instrument / Model Type	Serial Number	Comments
Dip metre		

Ground Gas Note: "0" readings to be recorded as instrument detection limit

Borehole ID	Time	Flow (l/hr)	Relative Pressure (mb)	Steady CH_4 (%v/v)	CO_2 (%v/v)	O_2 (%v/v)	Peak CH_4 (%v/v)	% of Lower Explosive Limit	CO (ppm)	H_2S (ppm)	Balance (%)	PID (ppm)	Response Zone		Response Strata	Gas screening value CH_4	Gas screening value CO_2
													From (mbgl)	To (mbgl)			

Groundwater

Borehole ID	Standing Water Level (mbgl)	Installation Base Dip (mbgl)	Free Phase LNAPL Thickness (m)	Free Phase DNAPL Thickness (m)	Water Quality Indicators					Well Volume (l)	Purge Volume (l)	Comments (samples)
					Eh	EC	pH	DO	Temp			
WS101	0.79	2.72										
WS102	0.93	1.56										
WS103	0.75	2.47										
WS104	1.08	3.02										
WS105	1.24	3.10										

Well volume (l) = (3.14 x (hole diameter (m)/2)^2 x (base dip (m) - standing water level (m)))x1000 (2l/m in 50mm well)

Gas screening value = gas concentration (%) x gas flow rate (l/hr)

%v/v - Percentage volume by total volume; mbgl - metres below ground level; ppm - parts per million; mb - milibars; l/hr - litres per hour; wv - water vial; gb - 1l glass bottle; pb - 1l plastic bottle

Appendix E

ICP SUDS Mean Annual Flood

Input

Return Period (years)	100	Soil	0.300
Area (ha)	3.875	Urban	0.000
SAAR (mm)	581	Region Number	Region 5

Results	**l/s**
QBAR Rural	5.7
QBAR Urban	5.7
Q100 years	20.2
Q1 year	4.9
Q30 years	13.6
Q100 years	20.2

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ICP SUDS Mean Annual Flood

Input

Return Period (years)	100	Soil	0.300
Area (ha)	1.813	Urban	0.000
SAAR (mm)	581	Region Number	Region 5

Results	**l/s**
QBAR Rural	2.7
QBAR Urban	2.7
Q100 years	9.5
Q1 year	2.3
Q30 years	6.4
Q100 years	9.5

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ICP SUDS Mean Annual Flood

Input

Return Period (years)	100	Soil	0.300
Area (ha)	2.063	Urban	0.000
SAAR (mm)	581	Region Number	Region 5

Results	**l/s**
QBAR Rural	3.0
QBAR Urban	3.0
Q100 years	10.8
Q1 year	2.6
Q30 years	7.3
Q100 years	10.8

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Appendix F

(c) Crown copyright and database rights 2021 Ordnance Survey 100022432 | Date: 08/01/21 | Scale: 1:1000 | Map Centre: 536928,325275 | Data updated: 30/11/20 | Our Ref: 472271 - 2 | Wastewater Plan A1

This plan is provided by Anglian Water pursuant its obligations under the Water Industry Act 1991 sections 198 or 199. It must be used in conjunction with any search results attached. The information on this plan is based on data currently recorded but position must be regarded as approximate. Service pipes, private sewers and drains are generally not shown. Users of this map are strongly advised to commission their own survey of the area shown on the plan before carrying out any works. The actual position of all apparatus MUST be established by trial holes. No liability whatsoever, including liability for negligence, is accepted by Anglian Water for any error or inaccuracy or omission, including the failure to accurately record, or record at all, the location of any water main, discharge pipe, sewer or disposal main or any item of apparatus. This information is valid for the date printed. This plan is produced by Anglian Water Services Limited (c) Crown copyright and database rights 2020 Ordnance Survey 100022432.This map is to be used for the purposes of viewing the location of Anglian Water plant only. Any other uses of the map data or further copies is not permitted. This notice is not intended to exclude or restrict liability for death or personal injury resulting from negligence.

Foul Sewer	Outfall*	Sewage Treatment Works	
Surface Sewer			
Combined Sewer			
Final Effluent	Inlet*	Public Pumping Station	
Rising Main*			
Private Sewer*	Manhole*	Decommissioned Pumping Station	
Decommissioned Sewer*		*(Colour denotes effluent type)	

c.owenhughes@paulbashamassociates.com

Battlefields Lane

love every drop anglianwater

Manhole Reference	Easting	Northing	Liquid Type	Cover Level	Invert Level	Depth to Invert
0100	537083	325191	F	2.85	0.166	2.684
0101	537051	325176	F	3.08	0.037	3.043
0102	537024	325173	F	3.08	-0.067	3.147
0200	537063	325290	F	3.018	1.652	1.366
0201	537078	325286	F	2.892	0.576	2.316
0202	537081	325264	F	2.297	0.498	1.799
0203	537006	325256	F	-	-	-
0204	537039	325211	F	-	-	-
1001	537172	325055	F	3.6	1.27	2.33
1101	537172	325108	F	3.33	1.61	1.72
1200	537102	325239	F	3.105	0.38	2.725
1201	537107	325224	F	3.001	0.32	2.681
1202	537102	325208	F	2.9	0.26	2.64
1203	537136	325237	F	-	-	-
2000	537298	325019	F	-	-	-
2001	537296	325048	F	-	-	-
5001	536533	325035	F	3.52	2.701	0.819
5002	536585	325036	F	3.658	-1.076	4.734
5003	536530	325040	F	-	-	-
5005	536587	325063	F	-	-0.9	-
5006	536535	325093	F	-	-	-
5007	536528	325076	F	-	-	-
5008	536547	325057	F	-	-	-
5102	536587	325198	F	3.49	0.01	3.48
5103	536597	325138	F	3.538	-0.409	3.947
5104	536518	325141	F	-	-	-
5105	536534	325129	F	-	-	-
5106	536545	325138	F	-	-	-
5107	536560	325138	F	-	-	-
5201	536575	325212	F	3.6	0.12	3.48
5203	536552	325225	F	3.55	0.37	3.18
5204	536555	325277	F	3.43	1.21	2.22
5205	536580	325282	F	3.58	1.44	2.14
5206	536595	325280	F	3.58	1.56	2.02
5402	536534	325450	F	-	-	-
5403	536563	325444	F	-	-	-
5404	536599	325426	F	-	-	-
6001	536606	325087	F	-	-0.727	-
6101	536608	325180	F	3.3	-0.18	3.48
6102	536638	325172	F	3.303	0.18	3.123
6103	536657	325174	F	3.311	0.472	2.839
6104	536679	325176	F	3.297	0.595	2.702
6105	536701	325168	F	3.134	0.718	2.416
6106	536620	325102	F	3.327	1.771	1.556
6107	536663	325112	F	3.466	2.05	1.416
6201	536622	325254	F	3.41	1.83	1.58
6202	536651	325215	F	3.597	2	1.597
6301	536675	325372	F	3.298	0.622	2.676
6303	536604	325364	F	3.295	0.933	2.362
6304	536678	325332	F	3.17	1.722	1.448
6401	536674	325469	F	3.353	0.219	3.134
6402	536673	325424	F	-	-	-
6403	536607	325422	F	-	-	-
7001	536744	325090	F	3.634	1.546	2.088
7002	536773	325026	F	3.47	1.95	1.52
7101	536724	325146	F	3.056	0.877	2.179
7102	536783	325194	F	2.844	1.568	1.276
7103	536786	325173	F	2.973	1.7	1.273
7104	536797	325160	F	3.1	1.814	1.286
7200	536792	325213	F	2.975	1.424	1.551
7301	536727	325374	F	3.35	0.826	2.524
7302	536731	325336	F	3.109	1.134	1.975
7303	536784	325360	F	3.292	2.063	1.229
7304	536752	325344	F	-	1.204	-
7400	536763	325405	F	-	-	-
7401	536757	325413	F	-	-	-
7402	536761	325416	F	-	-	-
8001	536903	325097	F	2.684	-0.091	2.775
8002	536886	325098	F	2.755	0.11	2.645
8003	536838	325099	F	2.8	0.846	1.954
8004	536807	325099	F	2.96	1.423	1.537
8005	536829	325089	F	2.83	1.049	1.781
8006	536835	325063	F	3.001	1.5	1.501
8007	536828	325076	F	2.915	1.25	1.665
8100	536812	325154	F	2.998	1.92	1.078
8101	536852	325169	F	3.201	2.32	0.881
8102	536832	325157	F	2.96	2.09	0.87
8103	536874	325106	F	2.873	0.27	2.603
8104	536859	325109	F	2.973	0.46	2.513
8200	536863	325255	F	2.897	0.887	2.01
8300	536821	325381	F	3.335	2.344	0.991
8401	536892	325448	F	3.508	1.57	1.938
8402	536820	325424	F	3.584	1.25	2.334
8501	536887	325518	F	3.642	1.536	2.106
8502	536825	325528	F	3.612	1.271	2.341
9000	536914	325043	F	2.949	-0.877	3.826
9001	536954	325069	F	2.92	-7.703	10.623
9100	536998	325196	F	2.949	-0.027	2.976
9101	536999	325178	F	3.035	-0.158	3.193
9102	536990	325161	F	2.897	-0.236	3.133
9103	536957	325140	F	2.868	-0.38	3.248
9104	536940	325128	F	2.976	-0.46	3.436
9105	536935	325110	F	2.935	-0.53	3.465
9106	536917	325106	F	2.794	-0.305	3.099
9200	536989	325210	F	2.88	-0.027	2.907
9201	536974	325226	F	3.045	0.053	2.992
9202	536967	325235	F	3.102	0.099	3.003
9203	536955	325259	F	2.96	0.191	2.769
9204	536949	325282	F	2.881	0.282	2.599
9205	536911	325273	F	3.109	0.541	2.568
9300	536946	325309	F	3.102	0.39	2.712
9401	536951	325487	F	3.386	1.844	1.542
9402	536955	325492	F	-	-	-

Manhole Reference	Easting	Northing	Liquid Type	Cover Level	Invert Level	Depth to Invert
9501	536948	325520	F	3.267	1.814	1.453
9502	536955	325533	F	-	-	-
0103	537014	325108	S	-	-	-
0150	537083	325194	S	-	-	-
0151	537052	325179	S	-	-	-
0152	537027	325175	S	-	-	-
0153	537001	325178	S	-	-	-
0154	537000	325196	S	-	-	-
0250	537076	325284	S	-	-	-
0251	537079	325262	S	-	-	-
1050	537175	325097	S	-	-	-
1051	537175	325058	S	-	-	-
1150	537174	325151	S	-	-	-
1250	537101	325238	S	-	-	-
1251	537105	325224	S	-	-	-
1252	537101	325211	S	-	-	-
2150	537222	325181	S	-	-	-
5051	536537	325096	S	-	-	-
5052	536532	325076	S	-	-	-
5053	536547	325060	S	-	-	-
5152	536536	325134	S	-	-	-
5153	536544	325141	S	-	-	-
5154	536562	325141	S	-	-	-
5155	536575	325176	S	-	-	-
5302	536543	325308	S	-	-	-
6305	536617	325327	S	-	-	-
7105	536769	325103	S	-	-	-
7106	536790	325122	S	-	-	-
7150	536781	325198	S	-	-	-
7151	536782	325176	S	-	-	-
7152	536793	325160	S	-	-	-
7250	536792	325215	S	-	-	-
8050	536836	325056	S	-	-	-
8051	536900	325099	S	-	-	-
8052	536889	325099	S	-	-	-
8053	536834	325098	S	-	-	-
8054	536828	325092	S	-	-	-
8055	536825	325077	S	-	-	-
8056	536822	325040	S	-	-	-
8150	536808	325153	S	-	-	-
8151	536836	325155	S	-	-	-
8152	536863	325115	S	-	-	-
8250	536864	325257	S	-	-	-
9002	536934	325061	S	-	-	-
9050	536945	325091	S	-	-	-
9150	536914	325106	S	-	-	-
9151	536936	325111	S	-	-	-
9152	536942	325128	S	-	-	-
9153	536957	325138	S	-	-	-
9154	536990	325157	S	-	-	-
9250	536912	325275	S	-	-	-
9251	536991	325212	S	-	-	-
9252	536969	325236	S	-	-	-
9253	536958	325255	S	-	-	-
9254	536951	325282	S	-	-	-

Manhole Reference	Easting	Northing	Liquid Type	Cover Level	Invert Level	Depth to Invert

Manhole Reference	Easting	Northing	Liquid Type	Cover Level	Invert Level	Depth to Invert

Appendix G

Chris Owen-Hughes
c.owenhughes@paulbashamassociates.com

Our ref: CCN/2020/198662

Date: 13 January 2021

Dear Chris

Provision of Flood Risk Information for Battlefields Lane, Holbeach.

Thank you for your request to use our flood risk information for the above site. The information is set out below and attached. It is important you read any contextual notes on the maps provided.

If you are preparing a Flood Risk Assessment (FRA) for this site, please note this information may not be sufficient by itself to produce an adequate FRA to demonstrate the development is safe over its lifetime. Additional information may be required to carry out an appropriate assessment of all risks, such as the consequences of a breach in defences.

We aim to review our information on a regular basis, so if you are using this data more than twelve months from the date of this letter, please contact us again to check it is still valid.

1. Flood Map

The attached map includes the current Flood Map for your area. The Flood Map indicates the area at risk of flooding, **assuming no flood defences exist**, for a flood with a 0.5% chance of occurring in any year for flooding from the sea, or a 1% chance of occurring for fluvial (river) flooding. It also shows the extent of the Extreme Flood Outline which represents the extent of a flood with a 0.1% chance of occurring in any year, or the highest recorded historic extent if greater.

In some locations, such as around the fens and the large coastal floodplains, showing the area at risk of flooding assuming no defences may give a slightly misleading picture in that if there were no flood defences, water would spread out across these large floodplains. This flooding could cover large areas of land but to relatively shallow depths and could leave pockets of locally slightly higher land as isolated dry islands. It is important to understand the actual risk of the flooding to these dry islands, particularly in the event of defence failure.

The Flood Map also shows the location of formal raised flood defences and flood storage reservoirs. It represents areas at risk of flooding for present day only and does not take account of climate change.

The Flood Map only indicates the extent and likelihood of flooding from rivers or the sea. It should also be remembered flooding may occur from other sources such as surface water sewers, road drainage, etc.

2. History of Flooding

With regards to the history of flooding I can advise we do not have any records of flooding in this area. It is possible recent flooding may have occurred which we are currently investigating, therefore this information may be subject to change. It is possible other flooding may have

occurred which other organisations, such as the Lead Local Flood Authority (ie top tier council), Local Authority or Internal Drainage Board (where they exist), may have records.

3. Schemes in the area

There are no ongoing capital projects to reduce or sustain the current flood risk to this site.

4. Fluvial Flood Risk Information

This site is not considered to be at risk of flooding from main rivers.

The site may be at risk from local ordinary watercourses for which other risk management authorities, such as the Lead Local Flood Authority (ie top tier council) or Internal Drainage Board (where they exist) have responsibility.

5. Tidal Flood Risk Information

5.1 Tidal Defence Information

The existing tidal defences protecting this site consist of earth embankments. They are in fair condition and reduce the risk of flooding (at the defence) to a 0.67% (1 in 150) chance of occurring in any year. We inspect these defences routinely to ensure potential defects are identified.

Refer to paragraph 3.1 for details of any ongoing capital projects to reduce the flood risk to this site.

5.2 Tidal Flood Levels

The attached table shows our current best estimate for extreme tide levels.

Levels for the Humber Estuary have an assessment date of 2014, with others having an assessment date of 2017, which should be used in any consideration of future increases due to climate change.

6. Modelled Hazard Mapping

For certain locations we have carried out modelling to map the maximum values of flood depth, velocity and hazard rating (danger to people) resulting from overtopping and / or breaching of defences at specific locations for a number of scenarios.

At present this information is available along the full coastal / tidal floodplain, except the tidal Witham Haven in Boston (upstream of Hobhole) where only breaching and not overtopping has been modelled and the tidal River Welland upstream of Fosdyke Bridge where neither breaching nor overtopping are available. Hazard mapping is also available for fluvial flood risk in Northampton, Lincoln, Wainfleet and some isolated rural locations.

The number of locations we have this information for is expected to increase in time.

6.1 Hazard Mapping – Breaching

The attached maps show the maximum values of flood depth, velocity and hazard rating (danger to people) resulting from breaching of the defences at specific locations for the scenarios below. For some locations the breach mapping also includes flooding from overtopping if this is expected in that scenario. The location of modelled tidal breaches is shown on a separate attached map.

- Year 2115 0.5% (1 in 200) chance
- Year 2115 0.1% (1 in 1000) chance

Your site is not affected by breaching of the defences for the present day (2006) scenarios.

7. Development Planning

If you would like local guidance on preparing a flood risk assessment for a planning application, please contact our Sustainable Places team at lnplanning@environment-agency.gov.uk. It will help if you mention this data request and attach your site location plan.

We provide free preliminary advice; additional/detailed advice, review of draft FRAs and meetings are chargeable at a rate set to cover our costs, currently £100 (plus VAT) per hour of staff time. Further details are available on our website at https://www.gov.uk/guidance/developers-get-environmental-advice-on-your-planning-proposals.

General advice on flood risk assessment for planning applications can be found on GOV.UK at https://www.gov.uk/guidance/flood-risk-assessment-for-planning-applications

Climate change will increase flood risk due to overtopping of defences. Please note, unless specified otherwise, the climate change data included has an allowance for 20% increase in flow. Updated guidance on how climate change could affect flood risk to new development - 'Flood risk assessments: climate change allowances' was published on GOV.UK in February 2016. The appropriate updated climate change allowance should be applied in a Flood Risk Assessment.

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

8. Data Licence and Other Supporting Information

We respond to requests for recorded information we hold under the Freedom of Information Act 2000 (FOIA) and the associated Environmental Information Regulations 2004 (EIR).

This information is provided in accordance with the Open Government Licence which can be found here: http://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/

Further information on flood risk can be found on the GOV.UK website at:
https://www.gov.uk/browse/environment-countryside/flooding-extreme-weather

9. Other Flood Risk Management Authorities

The information provided with this letter relates to flood risk from main river or the sea. Additional information may be available from other risk management authorities, such as the Lead Local Flood Authority (ie top tier council) or Internal Drainage Board (where they exist).

I hope we have correctly interpreted your request. If you have any queries or would like to discuss the content of this letter further please contact James Beckett using the details below.

Yours sincerely,

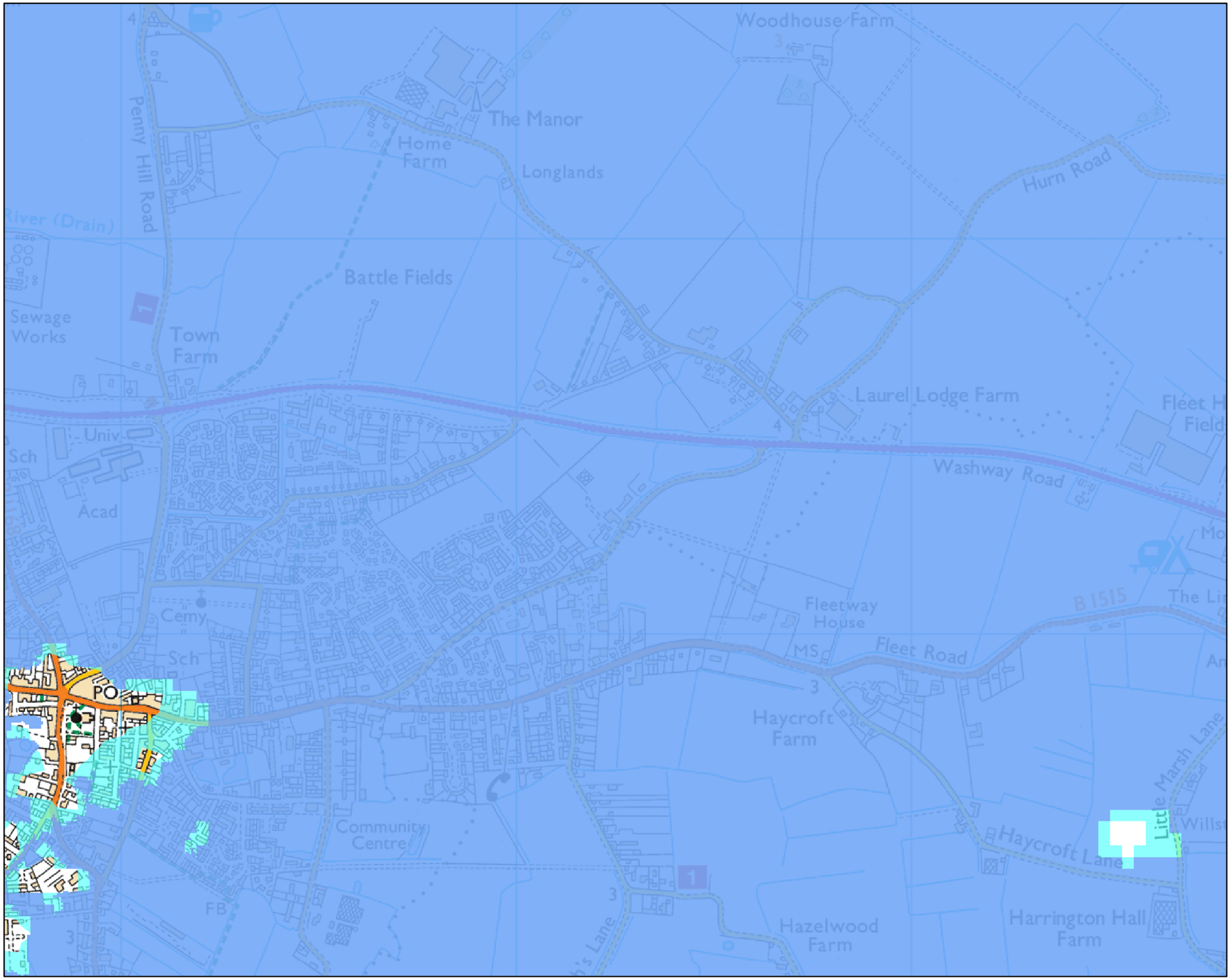
p.p.

Alistair Windler
Partnerships and Strategic Overview Team Leader –Welland and Nene

Direct dial 020 302 53535
Direct e-mail PSOWN@environment-agency.gov.uk

Enc.
Flood Map
Estimated Tide Levels
Tidal Breach Locations Map
Hazard Mapping – Breaching (2 maps)

Flood Map centred on TF 37252 25364 - created January 2021 [Ref: CCN-2020-198662]



Environment Agency

Scale 1:10,000

N

Legend

- Main River
- Raised Defences
- Flood Storage Areas
- Area at Risk of Flooding from Rivers or The Sea
- Extreme Flood Outline

Dark blue shows the area that could be affected by flooding, either from rivers or the sea, if there were no flood defences. This area could be flooded:

- from the sea by a flood that has a 0.5% (1 in 200) or greater chance of happening each year.

- or from a river by a flood that has a 1% (1 in 100) or greater chance of happening each year.

Light blue shows the extent of the Extreme Flood Outline, which represents the extent of a flood event with a 0.1% chance of occurring in any year, or the highest recorded historic extent if greater.

These two colours show the extent of the natural floodplain if there were no flood defences or certain other manmade structures and channel improvements. Sites outside the two extents, but behind raised defences, may be affected by flooding if the defences are overtopped or fail.

Created by the Partnerships and Strategic Overview Team, Kettering

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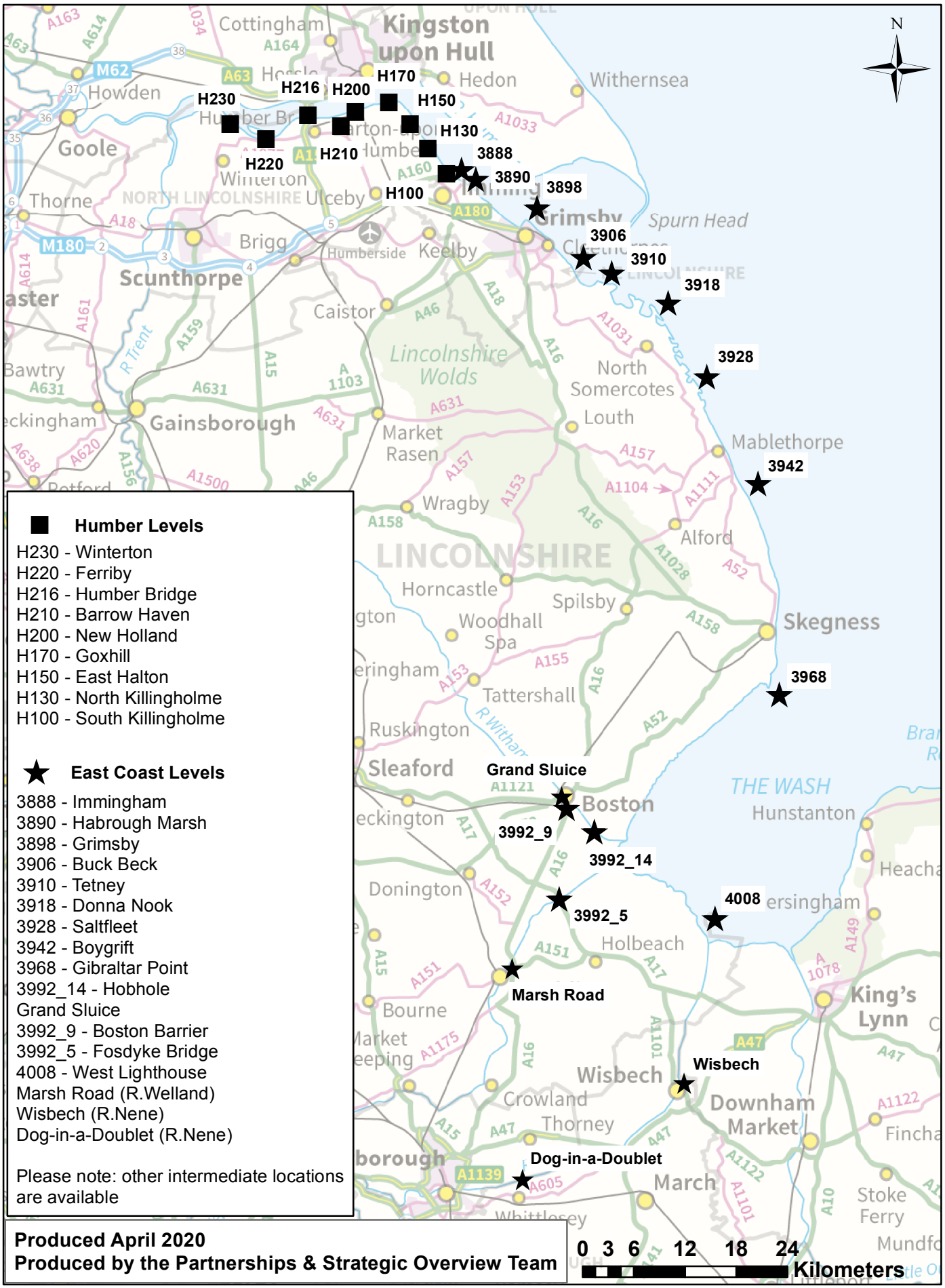
Contact Us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 03708 506 506 (Mon-Fri 8-6). Email: enquiries@environment-agency.gov.uk

Tidal Level Location Map
Lincolnshire & Northamptonshire Area

Environment Agency



Produced April 2020
Produced by the Partnerships & Strategic Overview Team

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Humber Estuary

2014 Interim Water Level Profile

Ref	Location	Easting	Northing	Annual Chance (1 in x) of Tide Level metres ODN																				
				1			10			50			100			200			300			1000		
				Confidence Bound			Confidence Bound			Confidence Bound			Confidence Bound			Confidence Bound			Confidence Bound			Confidence Bound		
				5%	50%	95%	5%	50%	95%	5%	50%	95%	5%	50%	95%	5%	50%	95%	5%	50%	95%	5%	50%	95%
H230	**Winterton**	493420	422830	5.13	5.14	5.15	5.47	5.51	5.56	5.67	5.74	5.82	5.74	5.83	5.92	5.81	5.90	6.00	5.84	5.94	6.03	5.94	6.02	6.06
H220	**Ferriby**	497550	421150	5.03	5.04	5.05	5.38	5.42	5.47	5.59	5.67	5.77	5.67	5.77	5.89	5.74	5.86	6.00	5.78	5.91	6.06	5.91	6.04	6.19
H216	**Humber Bridge**	502478	423914	4.97	4.98	4.99	5.33	5.37	5.42	5.55	5.64	5.74	5.64	5.75	5.88	5.72	5.86	6.02	5.75	5.92	6.10	5.88	6.09	6.31
H210	**Barrow Haven**	506380	422620	4.91	4.92	4.93	5.27	5.31	5.36	5.50	5.60	5.72	5.60	5.73	5.89	5.69	5.86	6.08	5.74	5.94	6.18	5.87	6.17	6.51
H200	**New Holland**	508020	424330	4.86	4.87	4.88	5.21	5.26	5.31	5.45	5.55	5.67	5.55	5.68	5.84	5.64	5.81	6.03	5.68	5.89	6.13	5.82	6.12	6.47
H170	**Goxhill**	511970	425440	4.66	4.67	4.68	5.00	5.04	5.09	5.24	5.34	5.46	5.33	5.47	5.65	5.43	5.61	5.85	5.47	5.69	5.96	5.62	5.95	6.37
H150	**East Halton**	514450	422870	4.58	4.59	4.60	4.91	4.96	5.01	5.15	5.25	5.38	5.25	5.39	5.57	5.34	5.53	5.77	5.39	5.62	5.90	5.54	5.89	6.33
H130	**North Killingholme**	516530	420000	4.50	4.51	4.52	4.82	4.87	4.92	5.05	5.15	5.28	5.15	5.28	5.46	5.24	5.42	5.66	5.29	5.51	5.78	5.43	5.77	6.19
H100	**South Killingholme**	518700	417120	4.41	4.41	4.42	4.72	4.77	4.82	4.95	5.05	5.17	5.05	5.18	5.35	5.14	5.32	5.55	5.18	5.40	5.67	5.33	5.66	6.08
3888	**Immingham***	520440	417625	4.16	4.17	4.19	4.50	4.53	4.62	4.73	4.80	5.00	4.83	4.93	5.19	4.93	5.06	5.41	4.98	5.14	5.55	5.15	5.38	6.01

NOTE:

- The base date for the data is 2014.
- The levels are still water levels. Depending on the use of the data it may be necessary to consider wave heights and / or joint probability analysis of water level and other variables.
- Levels for other annual chance probabilities are available if required.
- The information is due to be updated in mid-2020
- *The levels for Immingham are taken from the 2018 Coastal Flood Boundary dataset.

Customer services line: 03708 506 506
Calls to 03 numbers cost the same as calls to standard geographic numbers
(i.e. numbers beginning with 01 or 02)

Email: enquiries@environment-agency.gov.uk
www.gov.uk/environment-agency

East Coast and Wash: Immingham to the West Lighthouse

2018 Coastal Flood Boundary Extreme Sea Levels

CFB Ref	Location	Easting	Northing	Annual Chance (1 in x) of Tide Level in metres ODN																				
				1			10			50			100			200			300			1000		
				Confidence Bound			Confidence Bound			Confidence Bound			Confidence Bound			Confidence Bound			Confidence Bound			Confidence Bound		
				2.5%	50%	97.5%	2.5%	50%	97.5%	2.5%	50%	97.5%	2.5%	50%	97.5%	2.5%	50%	97.5%	2.5%	50%	97.5%	2.5%	50%	97.5%
3888	**Immingham**	520440	417625	4.16	4.17	4.19	4.50	4.53	4.62	4.73	4.80	5.00	4.83	4.93	5.19	4.93	5.06	5.41	4.98	5.14	5.55	5.15	5.38	6.01
3890	**Haborough Marsh**	522100	416512	4.14	4.15	4.17	4.48	4.51	4.60	4.70	4.77	4.97	4.80	4.90	5.16	4.90	5.03	5.38	4.94	5.10	5.51	5.11	5.34	5.97
3898	**Grimsby**	529295	413162	3.98	3.99	4.01	4.31	4.34	4.43	4.53	4.60	4.80	4.61	4.71	4.97	4.71	4.84	5.19	4.74	4.90	5.31	4.88	5.11	5.74
3906	**Buck Beck**	534709	407369	3.87	3.88	3.90	4.19	4.23	4.31	4.41	4.50	4.68	4.50	4.61	4.86	4.61	4.75	5.10	4.64	4.82	5.22	4.80	5.05	5.66
3910	**Tetney**	538035	405537	3.85	3.86	3.89	4.17	4.22	4.30	4.40	4.50	4.67	4.49	4.61	4.86	4.60	4.75	5.10	4.63	4.82	5.21	4.80	5.06	5.66
3918	**Donna Nook**	544641	401997	3.82	3.83	3.86	4.14	4.19	4.27	4.38	4.48	4.65	4.47	4.60	4.85	4.58	4.74	5.10	4.63	4.82	5.22	4.81	5.08	5.68
3928	**Saltfleet**	549131	393360	3.78	3.79	3.82	4.11	4.16	4.26	4.36	4.46	4.64	4.47	4.59	4.86	4.57	4.74	5.11	4.63	4.83	5.25	4.83	5.11	5.74
3942	**Boygrift**	555131	380860	3.72	3.74	3.77	4.06	4.11	4.22	4.33	4.43	4.65	4.43	4.57	4.87	4.56	4.73	5.13	4.62	4.83	5.28	4.85	5.15	5.82
3968	**Gibraltar Point**	557652	356181	4.16	4.17	4.20	4.51	4.56	4.67	4.76	4.85	5.08	4.85	4.97	5.27	4.94	5.10	5.49	4.99	5.18	5.63	5.14	5.41	6.09
3992_14	**Hobhole**	535990	340116	4.96	4.97	5.01	5.40	5.44	5.56	5.66	5.76	5.98	5.78	5.90	6.20	5.88	6.04	6.44	5.92	6.11	6.57	6.03	6.31	6.99
	Grand Sluice*	532366	344510	4.93	4.94	4.98	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3
3992_9	**Boston Barrier**	532754	342852	4.93	4.94	4.98	5.41	5.45	5.57	5.73	5.83	6.05	5.85	5.97	6.27	5.93	6.09	6.49	5.94	6.13	6.59	5.98	6.26	6.94
3992_5	**Fosdyke Bridge**	531886	332234	4.87	4.88	4.92	5.31	5.35	5.47	5.58	5.68	5.90	5.71	5.83	6.13	5.82	5.98	6.38	5.87	6.06	6.52	6.01	6.29	6.97
4008	**West Lighthouse**	550094	329971	4.87	4.88	4.91	5.21	5.26	5.37	5.46	5.56	5.78	5.56	5.68	5.98	5.66	5.82	6.21	5.71	5.90	6.35	5.86	6.14	6.81
-	**Marsh Road**	525988	324065	-	5.04	-	-	5.44	-	-	5.73	-	-	5.85	-	-	5.98	-	-	-	-	-	-	-
-	**Wisbech**	546110	309940	-	4.83	-	-	5.25	-	-	5.53	-	-	5.66	-	-	5.78	-	-	-	-	-	-	-
-	**Dog-in-a-Doublet**	527200	299287	-	3.67	-	-	4.00	-	-	4.22	-	-	4.32	-	-	4.42	-	-	-	-	-	-	-

See next page for notes

East Coast and Wash: Immingham to the West Lighthouse

2018 Coastal Flood Boundary Extreme Sea Levels

NOTES:

The following notes apply to all CFB sites (ie all on table excluding Marsh Road, Wisbech, Dog-in-a-Doublet)

- The base date for the data is 2017.
- The levels are still water levels. Depending on the use of the data it may be necessary to consider wave heights and / or joint probability analysis of water level and other variables.
- Levels for other annual chance probabilities are available if required.
- For additional information relating to the 2018 Coastal Flood Boundary Extreme Sea Levels or to access the full dataset for the above sites or intermediate locations refer to the Defra Metadata Catalogue at https://deframetadata.com/geonetwork/srv/eng/catalog.search#/metadata/84a5c7c0-d465-11e4-b0bd-f0def148f590

The following notes apply to all Marsh Road, Wisbech, Dog-in-a-Doublet

- The base date for the data is 2006
- The levels are still water levels. Depending on the use of the data it may be necessary to consider wave heights and / or joint probability analysis of water level and other variables.
- Levels for other annual chance probabilities are available if required.
- These levels will be updated as their respective tidal river models are updated.

The following notes apply to Grand Sluice

- The data is based on CFB 2018 data for Boston Barrier site, capped at 5.3mAOD to reflect use of the barrier.
- The base date for the data is 2017
- The levels are still water levels. Depending on the use of the data it may be necessary to consider wave heights and / or joint probability analysis of water level and other variables.
- For additional information relating to the 2018 Coastal Flood Boundary Extreme Sea Levels or to access the full dataset for the above sites or intermediate locations refer to the Defra Metadata Catalogue at https://deframetadata.com/geonetwork/srv/eng/catalog.search#/metadata/84a5c7c0-d465-11e4-b0bd-f0def148f590

^ **Modelled Breach Locations**

0 3.5 7 14 Kilometres

This map indicates the location of where we have modelled the consequence of breaches in the defences along the coastline and tidal rivers. We have mapped the the maximum values of Hazard Rating (Danger to People), Depth and Velocity.

We have not assumed that all breaches occur at the same time, but have modelled each breach individually and overlaid the results to find the maximum values.

Our modelling only considers the consequences of a breach, it does not make any assumption about the likelihood of a breach occurring. Our defences generally provide a good standard of flood defence but a risk of breaching remains.

Please contact the Environment Agency for information on how these maps are used in the management of flood risk.

General Enquiries No: 03708 506 506.
Weekday daytime calls cost 5p plus up to 6ppm from BT Weekend Unlimited. Mobile and other providers charges may vary

Environment Agency

Produced by the Partnership and Strategic Overview Team, Lincoln
General Enquiries No: 03708 506 506

Northern Area Tidal Hazard Mapping

Location of Modelled Breaches

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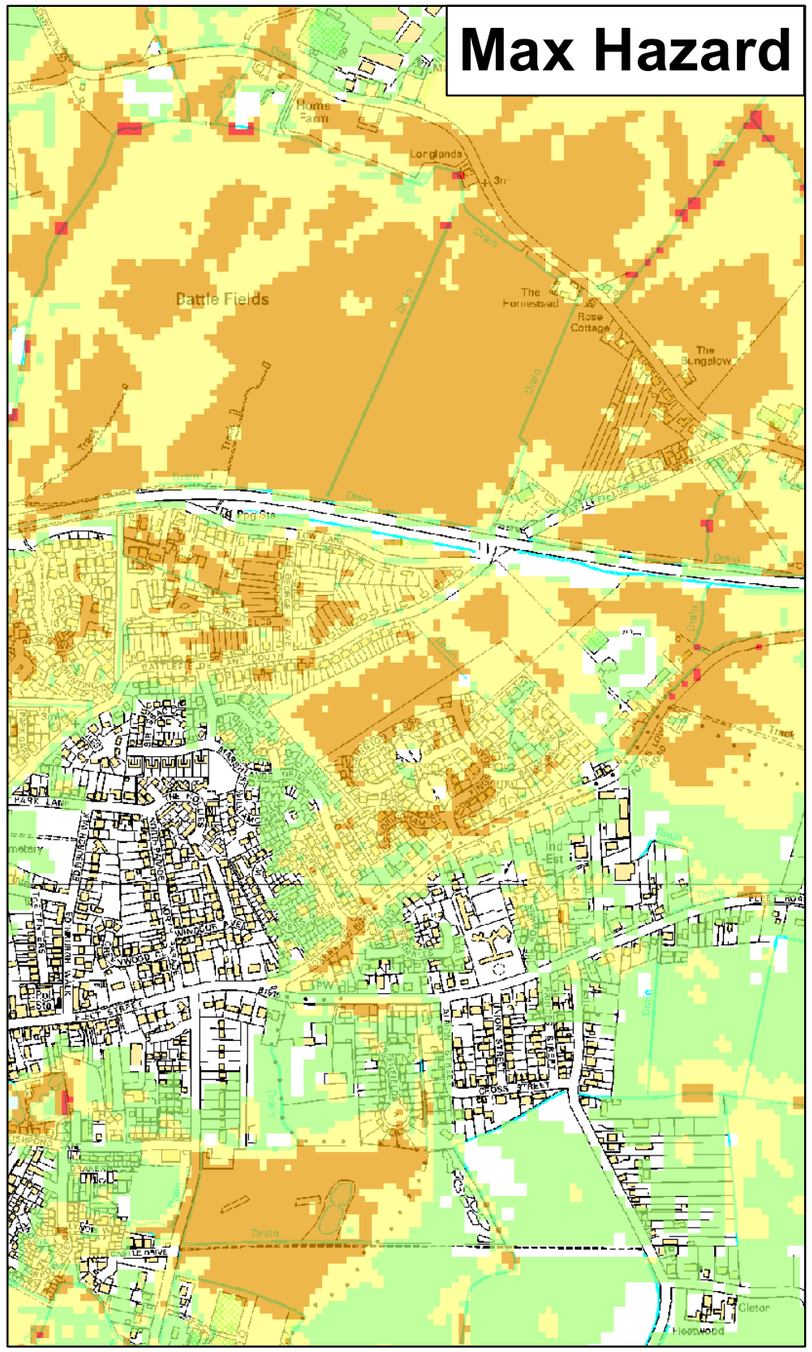

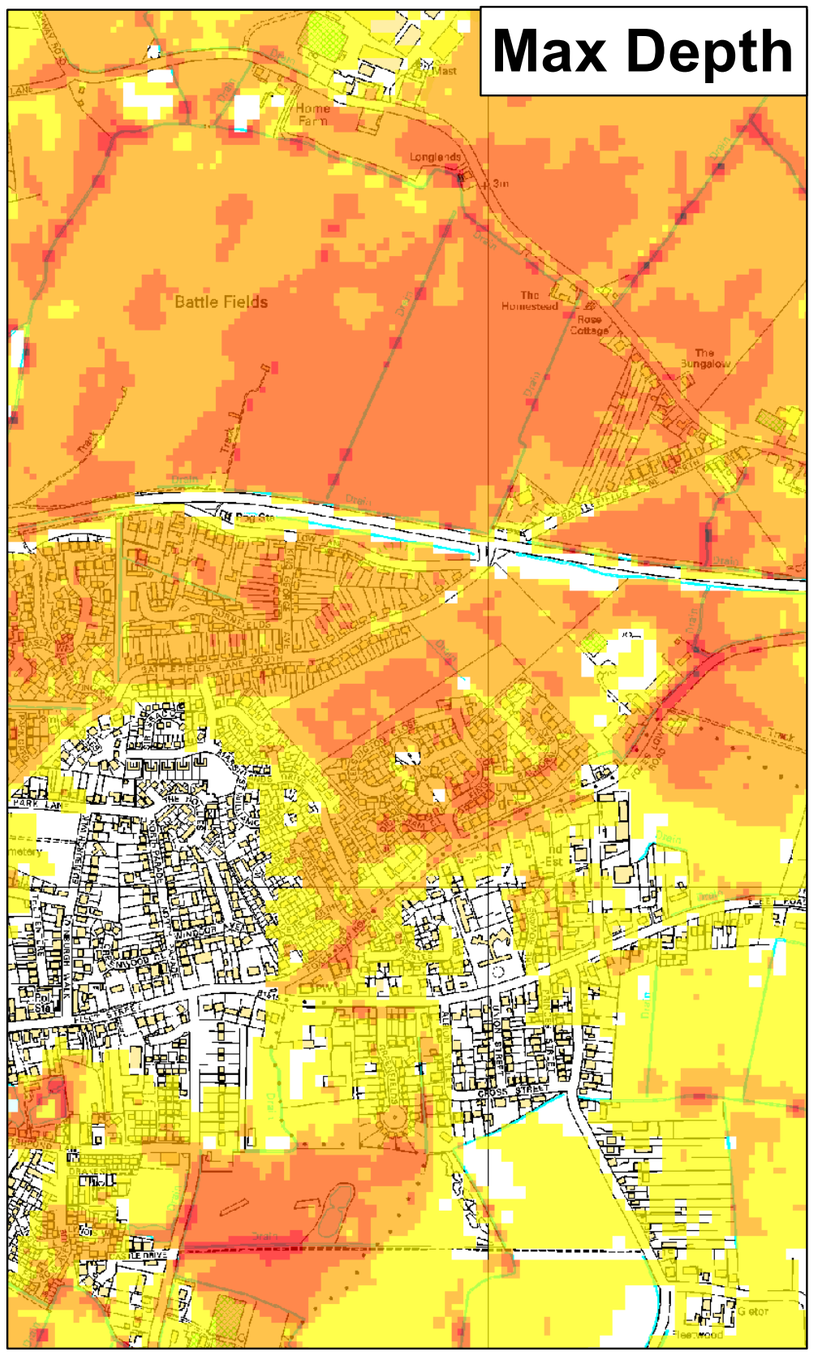

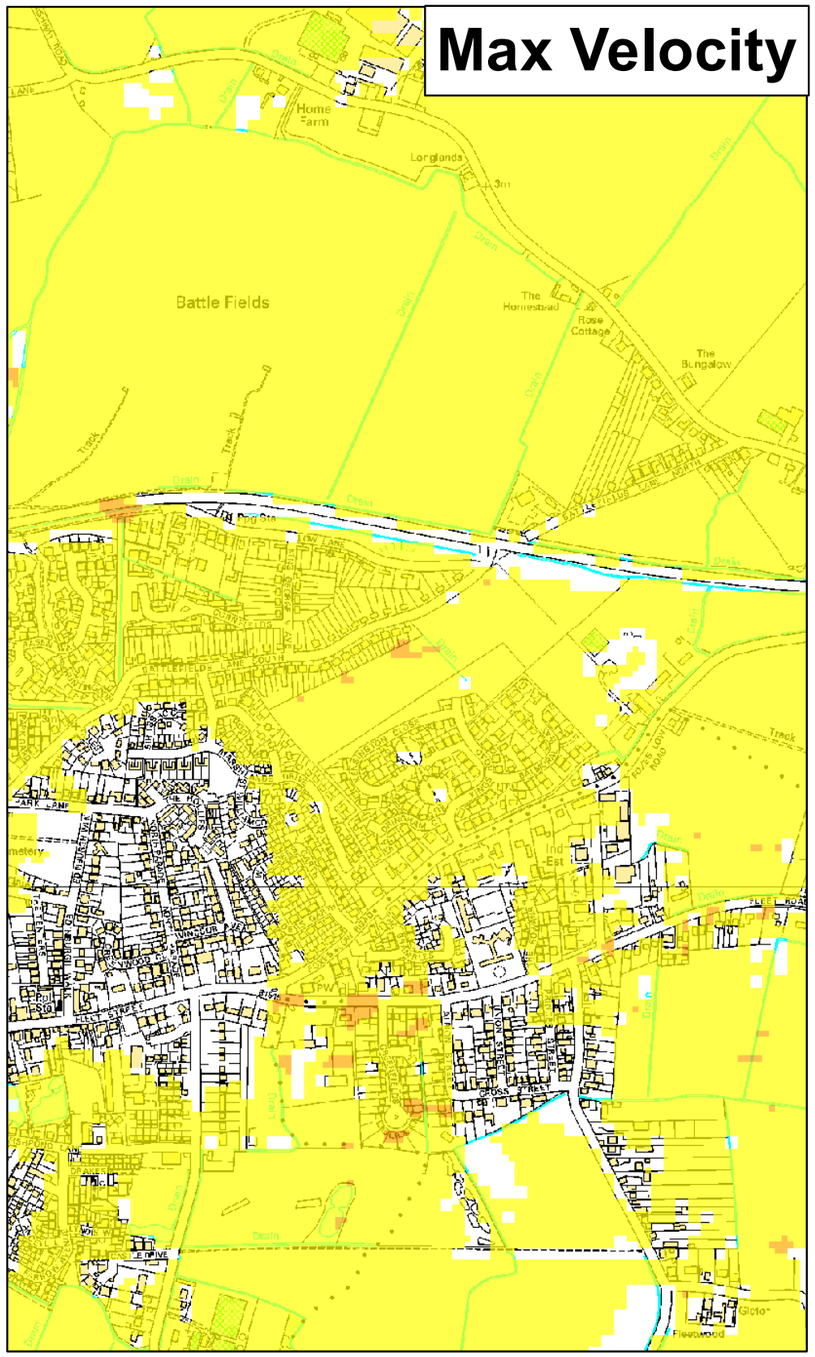

★ **Modelled Breach Locations** - see also the accompanying plan "Location of Modelled Breaches"

Max Hazard (Flood Risk to People : FD2320)	Max Depth (m)	Max Velocity (m/s)
Less than 0.75 (Low Hazard)	0 - 0.25	0 - 0.3
Between 0.75 and 1.25 (Danger for Some)	0.25 - 0.50	0.3 - 1.0
Between 1.25 and 2.0 (Danger for Most)	0.50 - 1.0	1.0 - 1.5
Greater than 2.0 (Danger for All)	1.0 - 1.6	1.5 - 2.5
	1.6 +	2.5 +

Date Printed	January 2021	Scenario year	2115	Scenario Annual Chance	0.5% (1 in 200)	CCN Number	CCN-2020-198573

This map shows the level of flood hazard to people (called a hazard rating) if our flood defences are breached at certain locations, for a range of scenarios. The hazard rating depends on the depth and velocity of floodwater, and maximum values of these are also mapped.

The map is based on computer modelling of simulated breaches at specific locations. Each breach has been modelled individually and the results combined to create this map. Multiple breaches, other combinations of breaches, different sized tidal surges or flood flows may all give different results.

The map only considers the consequences of a breach, it does not make any assumption about the likelihood of a breach occurring. The likelihood of a breach occurring will depend on a number of different factors, including the construction and condition of the defences in the area. A breach is less likely where defences are of a good standard, but a risk of breaching remains.

General Enquiries No: 03708 506 506. Weekday Daytime calls cost 5p plus up to 6p per minute from BT Weekend Unlimited. Mobile and other providers' charges may vary

Environment Agency

Lincolnshire and Northamptonshire Tidal Breaching Hazard Mapping

Map Centred on TF 36867 25334

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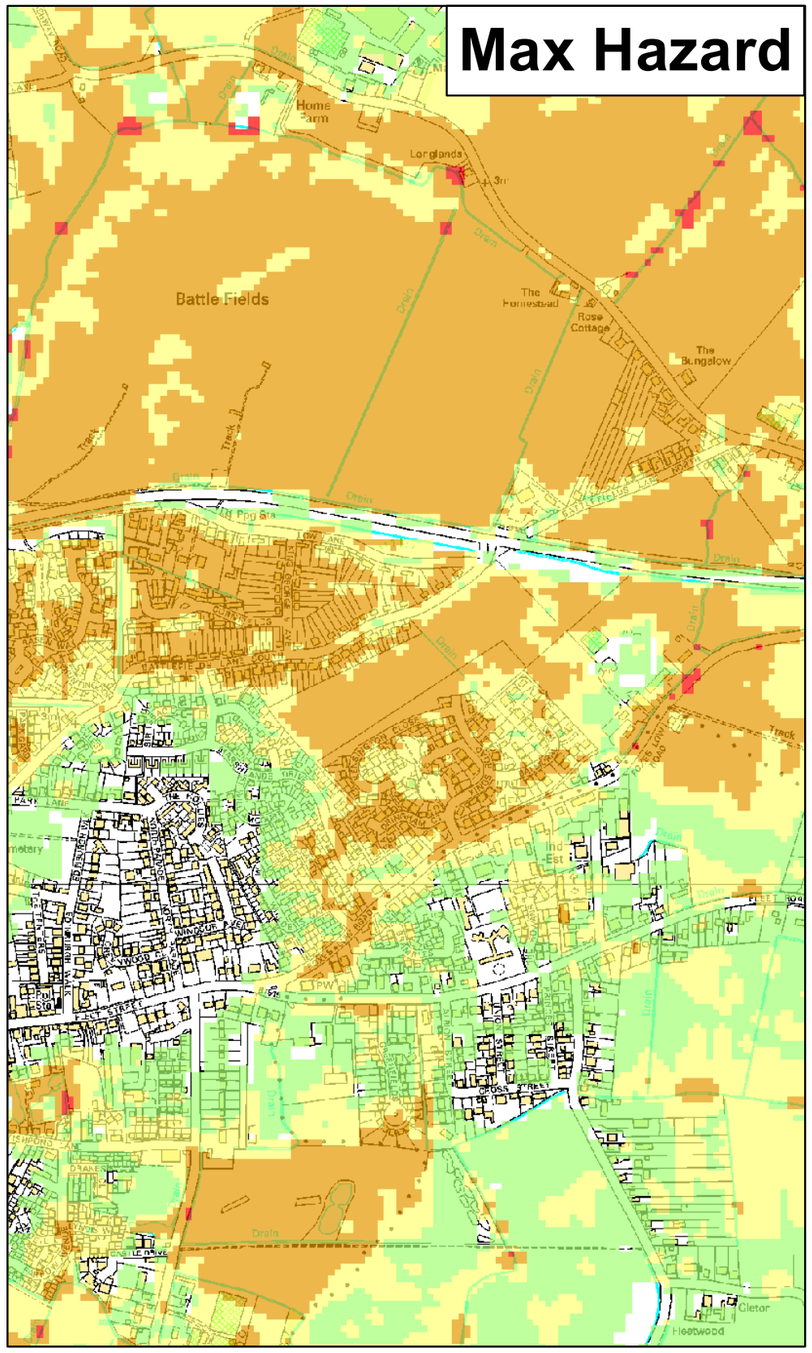

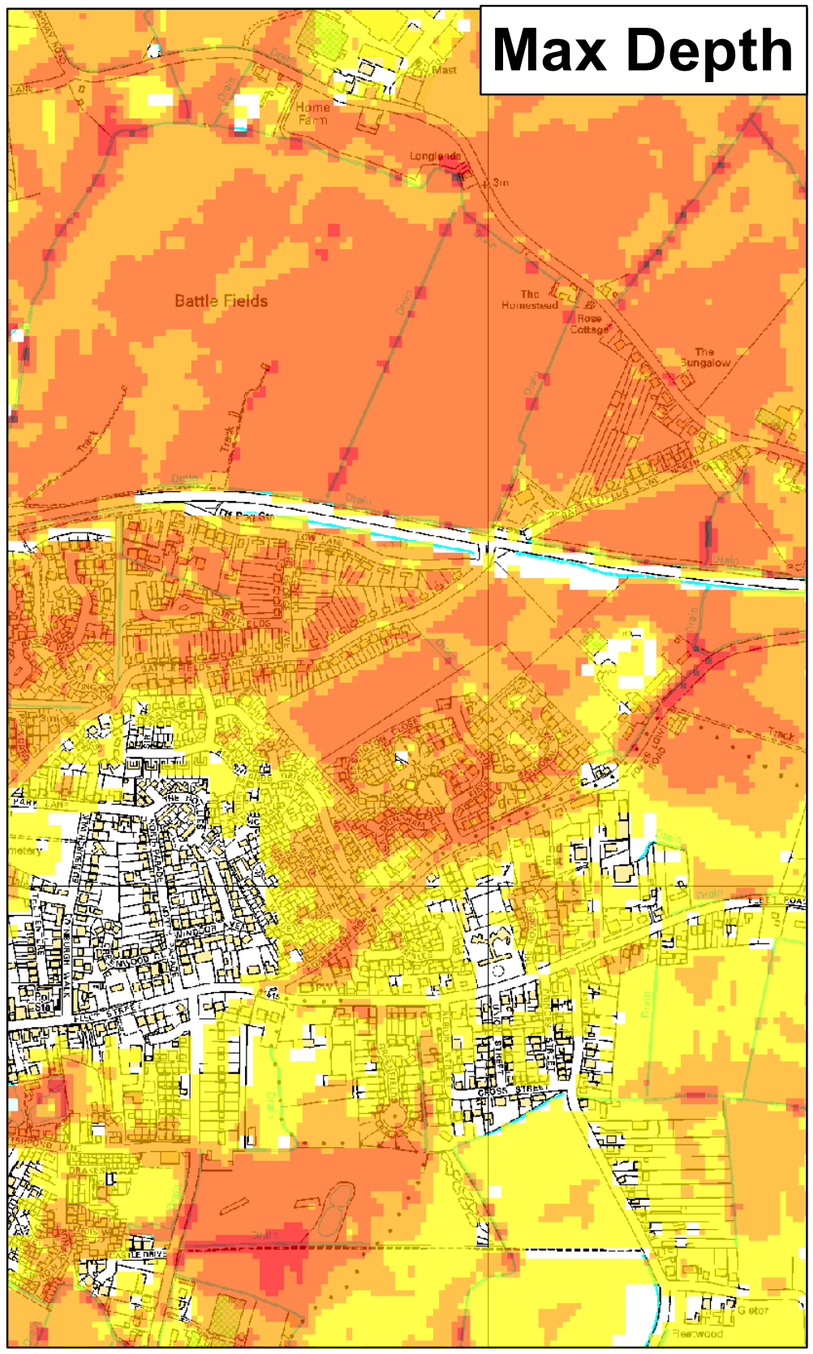

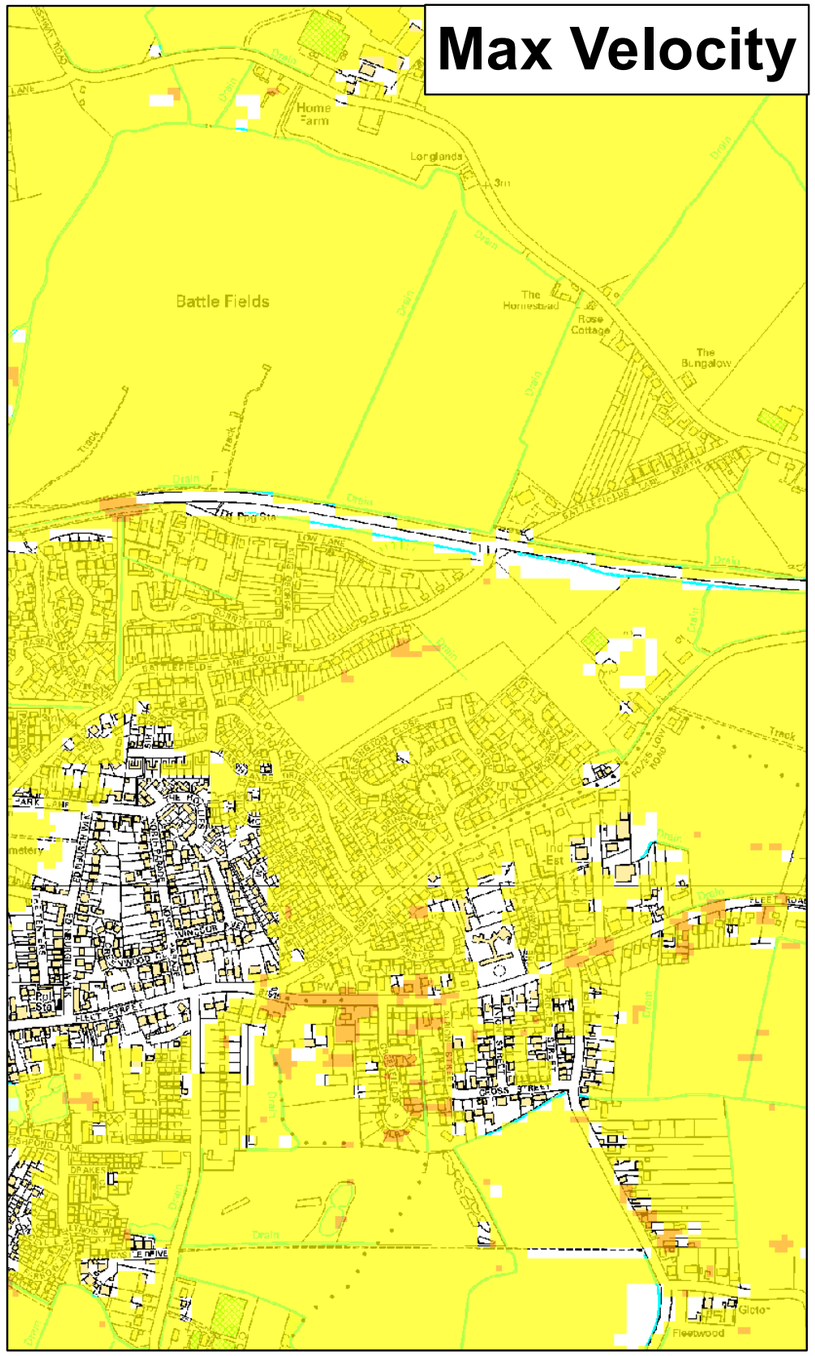

★ **Modelled Breach Locations** - see also the accompanying plan "Location of Modelled Breaches"

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Between 0.75 and 1.25 (Danger for Some)	0.25 - 0.50	0.3 - 1.0
Between 1.25 and 2.0 (Danger for Most)	0.50 - 1.0	1.0 - 1.5
Greater than 2.0 (Danger for All)	1.0 - 1.6	1.5 - 2.5
	1.6 +	2.5 +

Date Printed	January 2021	Scenario year	2115	Scenario Annual Chance	0.1% (1 in 1000)	CCN Number	CCN-2020-198573

This map shows the level of flood hazard to people (called a hazard rating) if our flood defences are breached at certain locations, for a range of scenarios. The hazard rating depends on the depth and velocity of floodwater, and maximum values of these are also mapped.

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General Enquiries No: 03708 506 506. Weekday Daytime calls cost 5p plus up to 6p per minute from BT Weekend Unlimited. Mobile and other providers' charges may vary

Environment Agency

Lincolnshire and Northamptonshire Tidal Breaching Hazard Mapping

Map Centred on TF 36867 25334

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Appendix H

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Surface Network 2

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	18.700	Add Flow / Climate Change (%)	0
Ratio R	0.400	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Surface Network 2

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.000	8-12	0.000	16-20	0.000	24-28	1.450
4-8	0.000	12-16	0.000	20-24	0.046	28-32	0.317

Total Area Contributing (ha) = 1.813

Total Pipe Volume (m³) = 9.100

Network Design Table for Surface Network 2

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	171.645	0.000	0.0	1.813	5.00	0.0	0.600	o	225	Pipe/Conduit	
1.001	5.517	0.055	100.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.002	24.299	0.243	100.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.003	27.397	1.229	22.3	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	28.33	3.500	1.813	0.0	0.0	0.0	0.12	4.9«	245.5
1.001	50.00	28.40	3.500	1.813	0.0	0.0	0.0	1.31	52.0«	245.5
1.002	50.00	28.71	3.445	1.813	0.0	0.0	0.0	1.31	52.0«	245.5
1.003	50.00	28.87	3.202	1.813	0.0	0.0	0.0	2.78	110.7«	245.5

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Manhole Schedules for Surface Network 2

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	PN	Pipe Out Invert Level (m)	Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)	Backdrop (mm)
S10	4.100	0.600	Open Manhole	1200	1.000	3.500	225				
S11	4.100	0.600	Open Manhole	1050	1.001	3.500	225	1.000	3.500	225	
S12	4.100	0.655	Open Manhole	1200	1.002	3.445	225	1.001	3.445	225	
S13	4.100	0.898	Open Manhole	1200	1.003	3.202	225	1.002	3.202	225	
S14	4.100	2.127	Open Manhole	0		OUTFALL		1.003	1.973	225	

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
S10	537121.713	325408.775	537121.713	325408.775	Required	
S11	536978.454	325314.229	536978.454	325314.229	Required	
S12	536973.130	325312.784	536973.130	325312.784	Required	
S13	536949.635	325306.584	536949.635	325306.584	Required	
S14	536949.670	325279.187			No Entry	

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PIPELINE SCHEDULES for Surface Network 2

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.000	o	225	S10	4.100	3.500	0.375	Open Manhole	1200
1.001	o	225	S11	4.100	3.500	0.375	Open Manhole	1050
1.002	o	225	S12	4.100	3.445	0.430	Open Manhole	1200
1.003	o	225	S13	4.100	3.202	0.673	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.000	171.645	0.0	S11	4.100	3.500	0.375	Open Manhole	1050
1.001	5.517	100.0	S12	4.100	3.445	0.430	Open Manhole	1200
1.002	24.299	100.0	S13	4.100	3.202	0.673	Open Manhole	1200
1.003	27.397	22.3	S14	4.100	1.973	1.902	Open Manhole	0

Free Flowing Outfall Details for Surface Network 2

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.003	S14	4.100	1.973	0.000	0	0

Simulation Criteria for Surface Network 2

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.700	Storm Duration (mins)	30
Ratio R	0.400		

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Online Controls for Surface Network 2

Hydro-Brake® Optimum Manhole: S13, DS/PN: 1.003, Volume (m³): 1.9

Unit Reference	MD-SHE-0081-2700-0800-2700
Design Head (m)	0.800
Design Flow (l/s)	2.7
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	81
Invert Level (m)	3.202
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	0.800	2.7
Flush-Flo™	0.238	2.7
Kick-Flo®	0.512	2.2
Mean Flow over Head Range	-	2.3

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**
0.100	2.4	1.200	3.2	3.000	5.0	7.000	7.4
0.200	2.7	1.400	3.5	3.500	5.3	7.500	7.7
0.300	2.7	1.600	3.7	4.000	5.7	8.000	7.9
0.400	2.6	1.800	3.9	4.500	6.0	8.500	8.1
0.500	2.3	2.000	4.1	5.000	6.3	9.000	8.4
0.600	2.4	2.200	4.3	5.500	6.6	9.500	8.6
0.800	2.7	2.400	4.5	6.000	6.9		
1.000	3.0	2.600	4.6	6.500	7.2		

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Storage Structures for Surface Network 2

Tank or Pond Manhole: S10, DS/PN: 1.000

Invert Level (m) 3.500

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	3179.8	0.201	3500.8	0.401	3822.9	0.501	3984.8
0.101	3340.7	0.301	3661.5	0.500	3983.2		

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Summary of Critical Results by Maximum Level (Rank 1) for Surface Network 2

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Storage Structures 1
Number of Online Controls 1 Number of Time/Area Diagrams 0
Number of Offline Controls 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.400
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 18.700 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status ON
DVD Status OFF
Inertia Status OFF

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 1, 30, 100
Climate Change (%) 40, 40, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	S10	2880 Winter	100	+40%	30/180 Winter				3.942
1.001	S11	2880 Winter	100	+40%	30/240 Winter				3.932
1.002	S12	2880 Winter	100	+40%	30/60 Winter				3.930
1.003	S13	2880 Winter	100	+40%	1/180 Winter				3.924

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	S10	0.217	0.000	0.21			3.4	FLOOD RISK	
1.001	S11	0.207	0.000	0.10			3.3	FLOOD RISK	
1.002	S12	0.260	0.000	0.07			3.1	FLOOD RISK	
1.003	S13	0.497	0.000	0.03			2.7	FLOOD RISK	

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STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Surface Network 1

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	18.700	Add Flow / Climate Change (%)	0
Ratio R	0.400	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Surface Network 1

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.000	4-8	0.000	8-12	1.049	12-16	1.014

Total Area Contributing (ha) = 2.063

Total Pipe Volume (m³) = 7.051

Network Design Table for Surface Network 1

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	56.262	0.000	0.0	2.063	5.00	0.0	0.600	o	225	Pipe/Conduit	
1.001	7.707	0.564	13.7	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.002	61.178	0.408	150.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.003	52.199	0.348	150.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	12.65	3.500	2.063	0.0	0.0	0.0	0.12	4.9«	279.4
1.001	50.00	12.68	3.500	2.063	0.0	0.0	0.0	3.56	141.5«	279.4
1.002	50.00	13.64	2.936	2.063	0.0	0.0	0.0	1.07	42.4«	279.4
1.003	50.00	14.46	2.528	2.063	0.0	0.0	0.0	1.07	42.4«	279.4

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Manhole Schedules for Surface Network 1

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	PN	Pipe Out Invert Level (m)	Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)	Backdrop (mm)
S1	4.100	0.600	Open Manhole	1200	1.000	3.500	225				
S2	4.100	0.600	Open Manhole	1050	1.001	3.500	225	1.000	3.500	225	
S3	4.100	1.164	Open Manhole	1200	1.002	2.936	225	1.001	2.936	225	
S4	4.100	1.572	Open Manhole	1200	1.003	2.528	225	1.002	2.528	225	
S5	4.100	1.920	Open Manhole	0		OUTFALL		1.003	2.180	225	

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
S1	536844.601	325305.731	536844.601	325305.731	Required	
S2	536790.774	325289.357	536790.774	325289.357	Required	
S3	536783.162	325290.561	536783.162	325290.561	Required	
S4	536732.708	325255.961	536732.708	325255.961	Required	
S5	536689.417	325226.794			No Entry	

Free Flowing Outfall Details for Surface Network 1

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.003	S5	4.100	2.180	0.000	0	0

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Simulation Criteria for Surface Network 1

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.700	Storm Duration (mins)	30
Ratio R	0.400		

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Online Controls for Surface Network 1

Hydro-Brake® Optimum Manhole: S3, DS/PN: 1.002, Volume (m³): 1.6

Unit Reference	MD-SHE-0081-3000-1064-3000
Design Head (m)	1.064
Design Flow (l/s)	3.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	81
Invert Level (m)	2.936
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.064	3.0
Flush-Flo™	0.320	3.0
Kick-Flo®	0.660	2.4
Mean Flow over Head Range	-	2.6

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.4	1.200	3.2	3.000	4.8	7.000	7.2
0.200	2.9	1.400	3.4	3.500	5.2	7.500	7.5
0.300	3.0	1.600	3.6	4.000	5.5	8.000	7.7
0.400	3.0	1.800	3.8	4.500	5.9	8.500	7.9
0.500	2.9	2.000	4.0	5.000	6.2	9.000	8.1
0.600	2.7	2.200	4.2	5.500	6.4	9.500	8.4
0.800	2.6	2.400	4.4	6.000	6.7		
1.000	2.9	2.600	4.5	6.500	7.0		

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Storage Structures for Surface Network 1

Tank or Pond Manhole: S1, DS/PN: 1.000

Invert Level (m) 3.500

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	3496.7	0.201	3639.7	0.401	3785.2	0.501	3858.8
0.101	3567.9	0.301	3712.1	0.500	3858.1		

Volume Summary (Static)

Length Calculations based on Centre-Centre

Pipe Number	USMH Name	Storage Structure Volume (m³)	Total Volume (m³)
1.000	S1	2223.794	2223.794
1.001	S2	0.000	0.000
1.002	S3	0.000	0.000
1.003	S4	0.000	0.000
Total		2223.794	2223.794

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Summary of Critical Results by Maximum Level (Rank 1) for Surface Network 1

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Storage Structures 1
Number of Online Controls 1 Number of Time/Area Diagrams 0
Number of Offline Controls 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.400
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 18.700 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status ON
DVD Status OFF
Inertia Status OFF

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 1, 30, 100
Climate Change (%) 40, 40, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	S1	2880 Winter	100	+40%	30/120 Winter				3.982
1.001	S2	2880 Winter	100	+40%	30/180 Summer				3.987
1.002	S3	2880 Winter	100	+40%	1/60 Summer				3.985
1.003	S4	2880 Winter	100	+40%					2.568

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	S1	0.257	0.000	0.27		4.2	FLOOD RISK	
1.001	S2	0.262	0.000	0.04		4.0	FLOOD RISK	
1.002	S3	0.824	0.000	0.07		3.0	FLOOD RISK	
1.003	S4	-0.185	0.000	0.07		3.0	OK	

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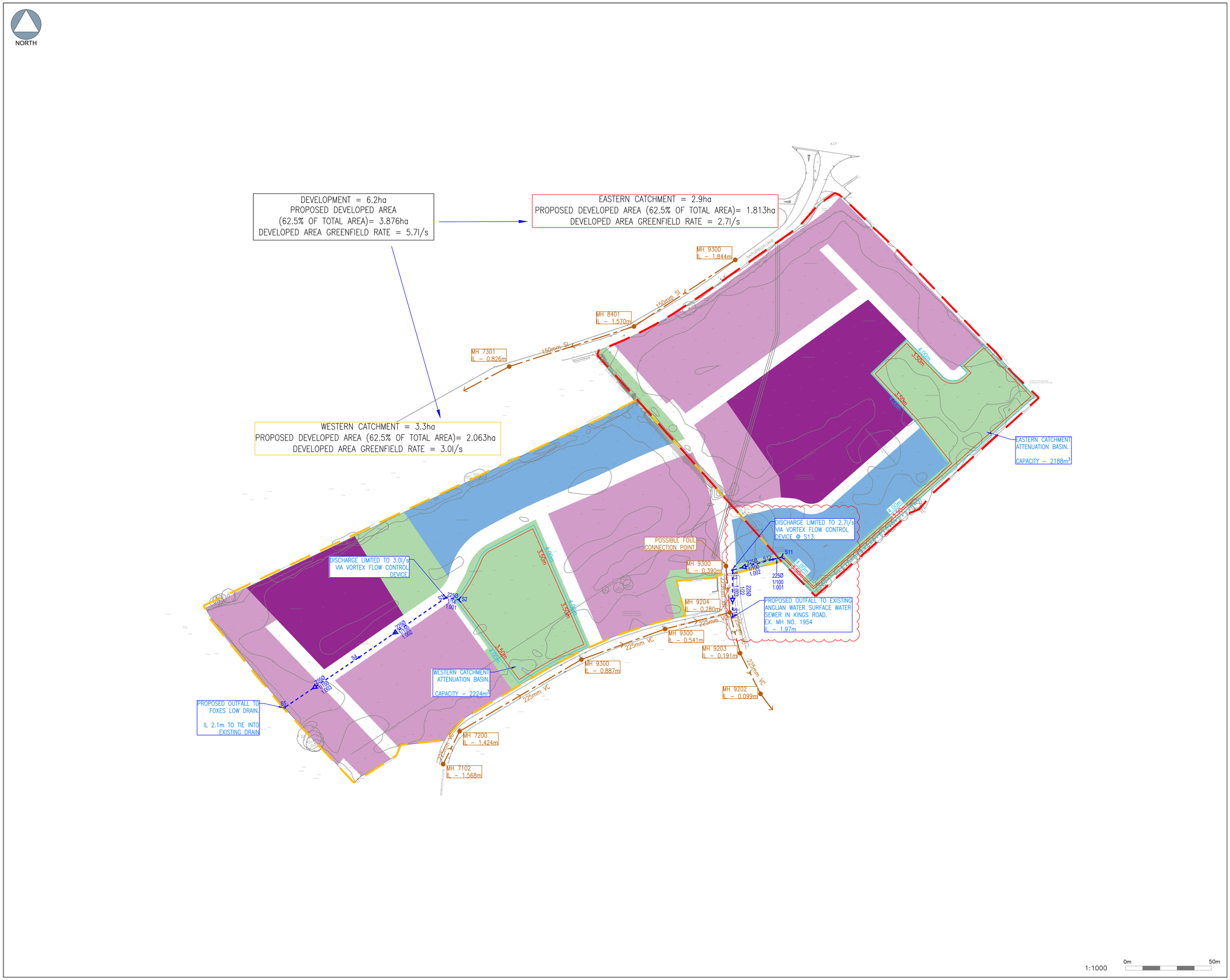
Appendix I



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- HIGH DENSITY 40–45 DPH: FLATS AND TERRACES
- 2–3 BED SEMI DETACHED UNITS 30 DPH
- 3–4 BED SEMI DETACHED AND DETACHED UNITS WITH SPACIOUS FRONTAGE 25 DPH
- PUBLIC OPEN SPACE
- ADOPTED ANGLIAN WATER FOUL SEWERS

PRELIMINARY

DRAWING/DESIGN IS STILL 'IN DEVELOPMENT' YOU ARE ADVISED TO MAKE DUE ALLOWANCE

Rev	Description	Date	By	Chkd
B	SW east catchment outfall amendment	15/12/2021	AJS	JC
A	Drawing revised following masterplan update	27/01/2021	COH	RJW

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Client: CICERO ESTATES

Project Name: BATTLEFIELDS LANE SOUTH, HOLBEACH
OUTLINE PLANNING APPLICATION

Title: DRAINAGE STRATEGY

Project Phase: PRELIMINARY

Checked By	Checked Date	Drawn By	Drawn Date
AJS	22/01/2021	COH	22/01/2021

Client Drawing No.	Scale	
-	1:1000	(AT A1 SIZE)

PBA Drawing No.	Revision
087.5011.501	B