



STRUCTURAL ENGINEERS

[CONSULTING CIVIL & STRUCTURAL ENGINEERS]

**Land North of Chestnut Terrace,
Sutton Bridge,**

Flood Risk Assessment

R - 1886/S - 001

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DESIGN BRIEF

The client requires a flood risk and drainage strategy to accompany the planning application for land North of Chestnut Terrace, Sutton Bridge for a new residential development. The following report provides research into the likelihood of flooding in the area, along with preliminary design proposals to ensure storm water is managed adequately.

INTRODUCTION

This report is a flood risk assessment which has been prepared by SEA Structural Engineers Ltd on behalf of Lincoln Jack Ltd. for a proposed new residential development at land situated north of Chestnut Terrace, Sutton Bridge. The National Grid reference for the site is E547140, N321833. The benefit of this report is limited to our instructing Client.

The objective of this report is to advise interested parties in the development to the potential risk of flooding and management of surface water from a drainage perspective.

This report has been prepared to support an application for full planning permission.

The proposed site is located on Greenfield land towards the north of Sutton Bridge. There are existing residential developments to the south and east, with the west and northern being open greenfield land. Appendix 1 presents the site location plan.



Site location plan. Approximate site boundary outlined in red.

DESCRIPTION AND HISTORY OF THE SITE

With reference to historic maps the site has been undeveloped and can be classified as Greenfield.

Generally the site topography varies from 3.30 to 3.6 and can be considered relatively flat. Appendix 2 presents the topographical survey for the site.

Key features outside the site boundary;

- North – Agricultural land.
- East - Agricultural land and existing residential development
- South - Existing residential development and Sutton Bridge main settlement
- West - Agricultural land

PROPOSED DEVELOPMENT

The proposed development will comprise the construction of 70 new residential dwellings along with all associated infrastructure. Appendix 3 presents the development layout.

GEOLOGY OF SITE

A ground investigation has been completed by AGS Ground Solutions Ltd, ref A1816-2 and shows that the site is underlain by Tidal Flat Deposits over the Ampthill Clay formation.

As part of the ground investigation works infiltration testing was carried out in 2 locations and concludes that due to the potential for higher ground water and poor infiltration rates exhibited, that the site is unlikely to be able to drain to soakaways. Other sources will be explored as part of this report.

FLOOD RISK VULNERABILITY

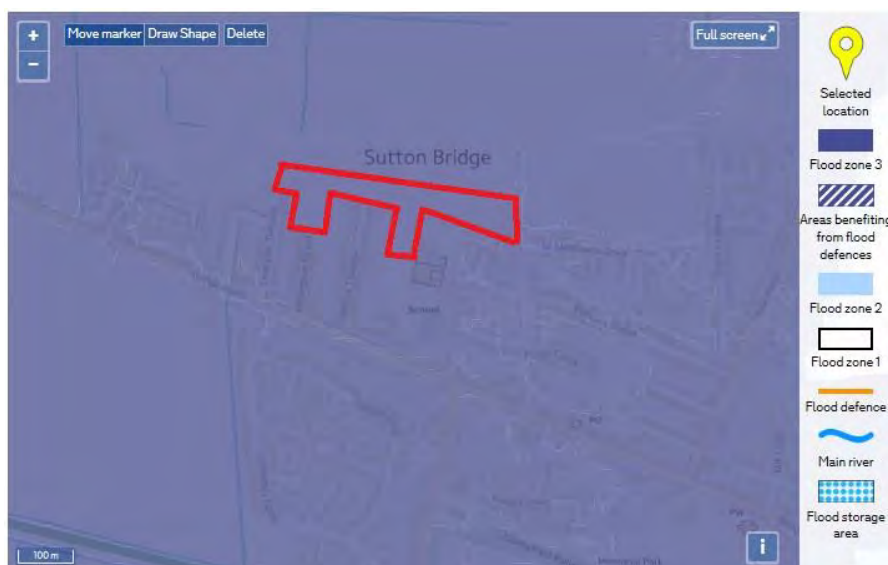
In accordance with the Planning Practise Guidance to the National Planning Policy Framework (NPPF), the development can be classified as more vulnerable. An extract of table 2 of the afore mentioned guidance is presented below

More vulnerable

- Hospitals
- Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels.
- Buildings used for dwelling houses, student halls of residence, drinking establishments, nightclubs and hotels.
- Non-residential uses for health services, nurseries and educational establishments.
- Landfill* and sites used for waste management facilities for hazardous waste.
- Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.

FLOODING FROM RIVERS AND SEA

The Environment Agency determines the flood risk zone from rivers and sea and their data collected is shown below;



Extract from Flood Map for Planning from the Gov.uk website dated 26.01.2019

As can be seen from the above the site is located within flood zone 3, defined as high risk (1% or greater from rivers and 0.5% or greater from the sea in any given year).

The site is shown within the defended area of the South Holland District Council's Strategic Flood Risk Assessment (SHDC SFRA) map and is located in the South Holland Internal Drainage Board district. Based table 3 of the EA flood risk guidance, presented below and a development classification of more vulnerable, a sequential and exception test will be required.

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

Key:

✓ Development is appropriate

✗ Development should not be permitted.

Extract from Table 3 – Flood vulnerability and flood zone 'classification

Sequential Test

The aim of the Sequential Test, as set out in the NPPF, is to ensure that a sequential approach is followed to steer new development to areas with the lowest probability of flooding. The flood zones as defined in the Strategic Flood Risk Assessment for the area provide the basis for applying the Test. The aim is to steer new development to Flood Zone 1 (areas with a low probability of river or sea flooding). Where there are no reasonably available sites in Flood Zone 1, local planning authorities in their decision making should take into account the flood risk vulnerability of land uses and consider reasonably available sites in Flood Zone 2 (areas with a medium probability of river or sea flooding), applying the Exception Test if required. Only where there are no reasonably available sites in Flood Zones 1 or 2 should the suitability of sites in Flood Zone 3 (areas with a high probability of river or sea flooding) be considered, taking into account the flood risk vulnerability of land uses and applying the Exception Test if required.

As can be seen from the flood risk map presented above the whole of the west side of Sutton Bridge is in Flood Zone 3. Therefore, it would be difficult to find a similar site for development within the town boundary that is in a lower flood zone. The South Holland District Council Core Strategy states that there are limited sites outside the town of Spalding available for residential development. Therefore there is a requirement for further land to be brought forward and used for residential development.

We therefore conclude that the sequential test has been passed

Exception Test

As the sequential test has demonstrated that it is not possible for the development to be located in areas with a lower probability of flooding, the Exception Test must be applied, in accordance with EA guidance for this to be passed the following must be provided;

- It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risks, informed by the Strategic Flood Risk Assessment; and
- A site-specific flood risk assessment must demonstrate that the development will be safe for its lifetime taking into account of the vulnerability of its users, without increasing flood risk elsewhere, and where possible will reduce flood risk overall..

The first section will be demonstrated by the supporting Planning Statement and compliance with South Holland District Council's planning policies. This flood risk assessment will demonstrate that the development will be safe for its lifetime and it will not increase flood risk elsewhere.

EA flood Data

To better understand the flood risk from river and seas we have obtained flood level data from the Environment Agency, this data is presented in appendix 4. This shows that there are raised flood defences along the river Nene approximately 1.4km west of the site. They have indicated that that the site is at risk of 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 and assumes that no flood defences exist. Below we have provided a table summarising the data

	Maximum Hazard	Maximum Depth	Maximum Velocity
1 in 200 (0.5%) year in 2006	0.75 and 1.25 (Danger for some)	0.25 – 0.5m	0 – 0.3 m/sec
1 in 1000 (0.1%) year in 2006	0.75 -1.25 (danger for most)	0.5 – 1.0m	0 – 0.3 m/sec
1 in 200 (0.5%) year in 2115	Greater than 2.0 (danger for most)	1.0 – 1.6m	0 – 0.3 m/sec
1 in 1000 year in 2115	Greater than 2.0 (danger for most)	1.0 – 1.6m	0 – 0.3 m/sec

Summary of flood risk from EA data

We have also reviewed the South Holland Strategic Flood Risk Assessment which was updated in 2016. The flood risk maps presented in the SFRA are identical to the maps by the EA and summarised above.

The site is within a defended flood plain, as defined in Appendix 1 of the Environment Agency's "Policy and Practice for the Protection of Flood Plains", which is considered to be passive until such time that a flood greater than the defences can withstand occurs. The likelihood of flooding occurring due to overtopping or failures of the defences is considered to be very low. The site is located approximately 1.4 km from the tidal section of the River Nene, which is maintained by the Environment Agency. The maps supplied by the Environment Agency predict flood depths of up to 1.6m if a breach were to occur in a 1 in 200 year event in 2115. It is also likely that the EA will undertake further bank raising within the next 100 years to ensure that there is a continuing 1 in 200 year defence to Long Sutton and Sutton Bridge.

We have consulted the EA with regards to a proposed mitigation strategy should a breach occur and they have advised the in accordance with the South East Lincs standard advise matrix for a predicted flood depth of 1.0-1.6m that '*Proposals must have a minimum of 2 storeys, with FFL set a minimum of 1m above existing ground level, flood resilient construction to a height 300mm above the predicted flood depth, and demountable defences to 600mm above FFL*'. This development will follow this advice and occupiers of the property will be recommended to register with the Environment Agency's Floodline Warnings Direct Service. We therefore conclude that the risk of flooding from river and sea to be low.

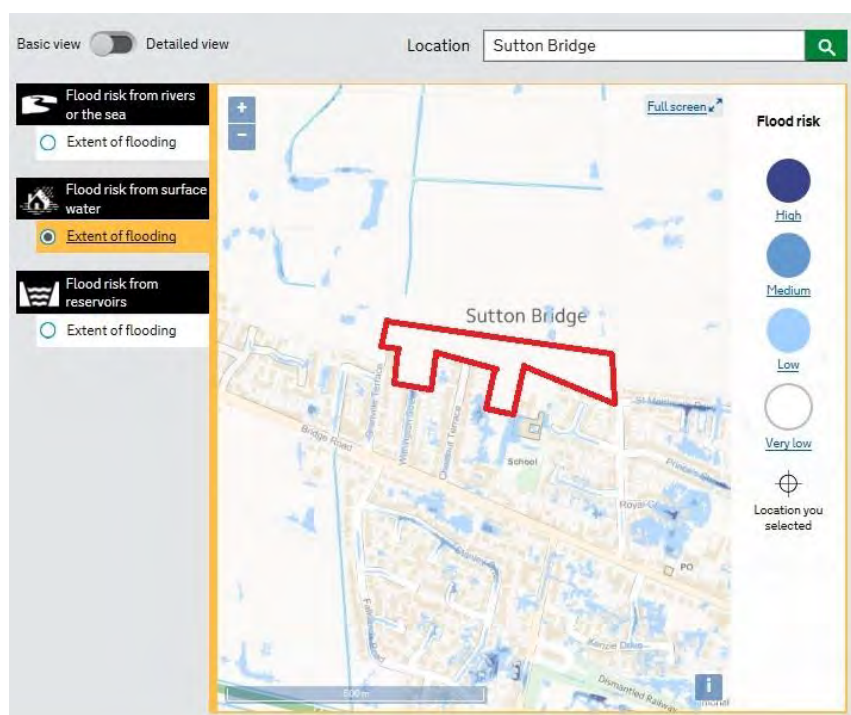
The predications of flood depths used by the Environment agency presented above were produced in 2006. The EA have issued new guidance on the recommend allowances for climate change on predicted sea level rises, fluvial flow and rainfall intensities from February 2016 which will need to be considered in this assessment. The main source of flood risk to this development is tidal; therefore the allowances of sea levels rises will need to be compared. Prior to February 2016 the recommend allowance for sea levels rises for this area from 1990 to 2115 was +1.14m. Updated guidance presented below now indicates an allowance of +1.21m from 1990 to 2115. This represents an increase of 70mm, which is unlikely to have a significant impact on the flood risk maps produced.

<u>Area of England</u>	1990 to 2025	2026 to 2055	2056 to 2085	2086 to 2115	Cumulative rise 1990 to 2115 / metres (m)
East, east midlands, London, south east	4 (140 mm)	8.5 (255 mm)	12 (360 mm)	15 (450 mm)	1.21 m

Extract from table 3 of EA guidance, Flood risk Assessment: Climate change allowances

FLOODING FROM SURFACE WATER

With reference to the EA map 'Flood risk from surface water', extract provided below the site can be seen to have a very low risk of surface water flooding (less than 1in1000).



Extract from flood risk from surface water flooding, gov.uk website, date 26.01.2019

The development is within an area in which local drains/watercourses/ditches are maintained by South Holland IDB who control surface water into the River Nene and the Wash.

This area of Sutton Bridge is within the Westmere catchment and outfalls through the Westmere Sluice into the tidal River Nene during low tides. There are IDB drains to the north west and north east of the development and the levels around these drains are lower than the development site

The channels maintained by South Holland IDB in urban areas are classified as high priority watercourses and as such receive a higher maintenance priority. Should there be a failure of the outfall sluices then the IDB would be informed of the problem by their telemetry system and would take immediate action to deal with this

IDB systems are designed to provide a freeboard of between 600mm and 1000mm to all land in a 1 in 10 year return period rainfall event. This normally provides a standard of service of between 1 in 50 years and 1 in 100 years against flooding. With this and the proposed mitigation strategy of raising FFLS 1m above existing ground levels we therefore conclude that the risk of surface water flooding to the low.

There is a surface water sewer maintained by Anglian water to the east of development and there is a risk of overtopping of water levels within this sewer, however the risk of such an event is considered low.

HISTORIC FLOODING

With reference to the information provided by the EA presented in appendix 4 and an extract below the site has not been subject to historic flooding.



Extract from historic flood map from the EA

MANAGEMENT OF STORM WATER

The site is currently Greenfield with no existing drainage. Therefore Greenfield runoff calculations shall be used to calculate the allowable runoff rate from the site.

It is a requirement of the Building Regulations 2000 (part H) to discharge surface water collected by the new development to one of the following, listed in order of priority;

1. An adequate soakaway or some other adequate infiltration system.
2. A watercourse.
3. A sewer.

As discussed previously a ground investigation from AGS Ground Solution Ltd has indicated that soakaways will not be suitable this development, therefore the use of soakaways had not been considered further.

There is no watercourse located within the development boundary for use of the site surface water.

We have undertaken a pre-development enquiry with Anglian Water, their report is presented in appendix 5. They have indicated that there is a surface water sewer located towards the developments eastern boundary which has capacity to receive the development flows with a restricted discharge of 5l/s. This Sewer is 900mm diameter and outfalls to the north to an existing IDB drain. This has been developed and further information is presented below with regards this.

PROPOSED STORM WATER STRATEGY

The proposals are to drain the site to the Anglian water surface water sewer to the east and attenuate the storm water on site. The design of the attenuation will be for all impermeable areas on the site to accommodate storms up to the 1 in 100 year event and allow for the increase in storm intensities up to 40 % (design life of the development assumed to be greater than 60 years). The sites impermeable areas are presented in appendix 6 and equates to a total area of 16410m², we have increased the impermeable area of the roof and drives by 10% to take into account urban creep.

**Table 2 peak rainfall intensity allowance in small and urban catchments
(use 1961 to 1990 baseline)**

Applies across all of England	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Upper end	10%	20%	40%
Central	5%	10%	20%

The allowable Greenfield runoff rate has been calculated using the HR Wallingford Greenfield runoff rate estimation tool and has been based on the sites total impermeable area of 16,410m². Appendix 7 presents the results of the Greenfield runoff calculations which indicate the Q-bar value to be 2.41l/s.

The greenfield runoff calculated above is likely to require a flow control device with a small aperture which in the long term will become a maintenance issue. We are proposing to restrict the site runoff to 5l/s based on the pre-development enquiry with Anglian Water.

It is proposed to outfall the developments surface water via a new pipe network and outfall into Anglian Waters surface water sewer located east of the development. Attenuation will be in the form of an online detention basin which will provide attenuation for the sites flows for all storm events up to a 1 in 100 year event plus a 40% allowance for climate change. We have modelled the storm water network using Causeway Flow and have calculated that the attenuation volume to be 1055m³. The calculations are presented in appendix 8. An indicative drainage layout is presented in appendix 9.

SUDS

In accordance with South Holland District Council policies for any development larger than 10 dwelling there is a requirement to apply sustainable drainage principles to the development. In accordance with the CIRIA SUDS Manual surface water should be controlled at source and suitably treat any surface water runoff to ensure that water quality is improved. As explained in previous paragraphs the use of soakaways is not possible on this site. Surface water runoff will be controlled on site at a rate of 5l/s as agreed with Anglian Water.

In order to provide adequate surface water treatment all private drives will use tanked permeable paving which will adequately treat water from these areas. All other areas will be treated by the use of an online detention basin which will include a mircopool at the outfall for further treatment. Therefore, the development will provide 2 treatment trains in accordance with the requirement of the SUDS manual.

OVERLAND FLOWS

The proposed development will be designed for a 1 in 100 year event + 40%. There is a risk, although very low, that we could experience a storm event exceeding this return period. During such an event the sites drainage system will become overwhelmed and overland flows are likely. Any overland flows will be directed away from dwellings and towards the site access roads and POS.

MANAGEMENT OF FOUL WATER

Foul water will outfall into existing sewers located within Chestnut Terrace as confirmed in the AW pre-development enquiry.

MAINTAINANCE

It is proposed to offer the main surface water sewers for adoption to Anglian Water. Drains and SUDS located within private areas will remain the responsibility of the householder and the online detention basin will be maintained by an external management company set up on behalf of the householder by the developer. A full maintenance schedule will be provided as part of the detailed design of the scheme following planning permission.

CONCLUSION

Based on the above, and providing the above strategies are adopted, the developed site will not contribute further to flood risk and therefore satisfying the requirements of the National Planning Policies Framework.

REFERENCES

Department for Communities and Local Government (July 2018) - National Planning Policy Framework.

Department for Communities and Local Government (July 2018) - Technical Guidance to the National Planning Policy Framework.

The Building Regulations (2010) - Drainage and Waste Disposal - Approved Document H.

BS EN 752:2008 Drain and sewer systems outside buildings - Hydraulic design and environmental considerations.

BS 8533:2011 Assessing and managing flood risk in development – Code of Practice.

CIRIA Report C635 Designing for exceedance in urban drainage – good practice.

Design and Analysis of Urban Storm Drainage – The Wallingford procedure – Volume 1.

<https://flood-map-for-planning.service.gov.uk>

<http://mapapps.bgs.ac.uk/geologyofbritain/home.html>



STRUCTURAL ENGINEERS

[CONSULTING CIVIL & STRUCTURAL ENGINEERS]

T: 07384 706869

E:enquiries@seaststructuralengineers.co.uk

Client

Lincoln Jack Ltd

Project

Land North of Chestnut Terrace, Sutton Bridge

Title

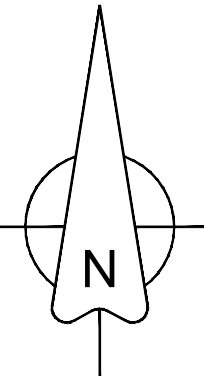
Flood Risk Assessment

Sheet no. 15

Project ref 1886/S/001

Date January 2019

APPENDIX 1 – LOCATION PLAN



Rev.	Date	By	Description
ABDS Ltd architectural consultants Midlands 1-3 Spencer St. Ringstead Northants NN14 4BX Southern Boscarnon Farmhouse St Keverne Cornwall TR12 6NU Tel: 0845 2242967 Email: admin@abdevservices.co.uk 			
PROJECT PROPOSED RESIDENTIAL DEVELOPMENT SUTTON BRIDGE			
DRAWING SITE LOCATION PLAN			
SCALE: 1:1250@A2		DATE: 3.9.2018	
DRAWN BY: ADB		CAD Ref: xxxxxxxxxxxxxx	



STRUCTURAL ENGINEERS

[CONSULTING CIVIL & STRUCTURAL ENGINEERS]

T: 07384 706869

E:enquiries@seastructuralengineers.co.uk

Client

Lincoln Jack Ltd

Project

Land North of Chestnut Terrace, Sutton Bridge

Title

Flood Risk Assessment

Sheet no. 16

Project ref 1886/S/001

Date January 2019

APPENDIX 2 – TOPOGRAPHICAL SURVEY



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[CONSULTING CIVIL & STRUCTURAL ENGINEERS]

T: 07384 706869

E:enquiries@seaststructuralengineers.co.uk

Client

Lincoln Jack Ltd

Project

Land North of Chestnut Terrace, Sutton Bridge

Title

Flood Risk Assessment

Sheet no. 17

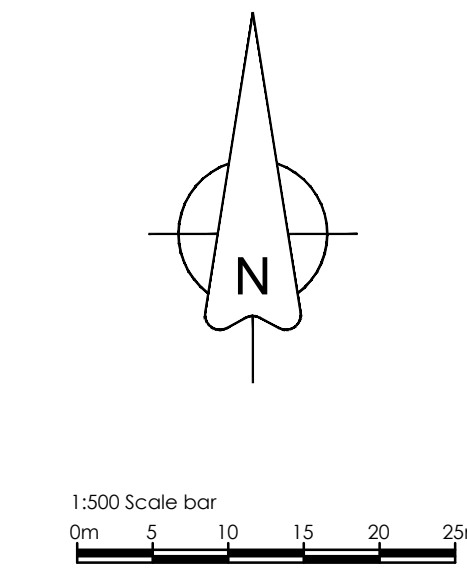
Project ref 1886/S/001

Date January 2019

APPENDIX 3 – PROPOSED LAYOUT



Ordnance Survey (c) Crown Copyright 2018. All rights reserved. Licence number 100022432



No.	Date	By	Description

ABDS Ltd
architectural consultants

Midlands
1-3 Spencer St.
Rugby
Northants
NN14 6BX

Southern
Boscotton Farmhouse
St Kew
Cornwall
TR12 9NU

Tel: 01453 204267
Email: info@abds-services.co.uk

PROJECT
PROPOSED RESIDENTIAL
DEVELOPMENT
SUTTON BRIDGE

ISSUES
PROPOSED BLOCK PLAN

SCALE: 1:500 @ A0 DATE: 10.12.2019
DRAWN BY: ADB CAD Ref: 0000000000



STRUCTURAL ENGINEERS

[CONSULTING CIVIL & STRUCTURAL ENGINEERS]

T: 07384 706869

E:enquiries@seaststructuralengineers.co.uk

Client

Lincoln Jack Ltd

Project

Land North of Chestnut Terrace, Sutton Bridge

Title

Flood Risk Assessment

Sheet no. 18

Project ref 1886/S/001

Date January 2019

APPENDIX 4 – EA FLOOD DATA

.

Andy Webb
andy@seastructuralengineers.co.uk

Our ref: CCN/2018/110730
Date: 21st December 2018

Dear Andy,

Provision of Flood Risk Information for Withington Street, Sutton Bridge.

Thank you for your request to use our flood risk information in the development of the Flood Risk Assessment (FRA) for the above site. The information is set out below and attached. It is important you read any contextual notes on the maps provided.

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.

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.

Historic Flood Extent Map

A copy of the Historic Flood Extent Map showing the extent of previous recorded flooding in your area is attached. This only covers information we hold and it is possible other flooding may have occurred which other organisations, such as the Local Authority or Internal Drainage Boards, may have records.

Tidal Flood Risk Information

Tidal Defence Information

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

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 2006, which should be used in any consideration of future increases due to climate change.

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.

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 2006 0.5% (1 in 200) chance
- Year 2006 0.1% (1 in 1000) chance
- Year 2115 0.5% (1 in 200) chance
- Year 2115 0.1% (1 in 1000) chance

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 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.

Supporting Information

Please see the Standard Notice or licence for details of permitted use. The Standard Notice can be found at the link below.

<http://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/>

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).

Further information on flood risk can be found on the GOV.UK website at:

<https://www.gov.uk/browse/environment-countryside/flooding-extreme-weather>

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 your Lead Local Flood Authority (ie county council or unitary authority) or, where they exist, the Internal Drainage Board.

Further Contact

I hope we have correctly interpreted your request. If you are not satisfied with our response to your request for information, you can contact us within two calendar months to ask for our decision to be reviewed.

If you have any queries or would like to discuss the content of this letter further please contact Emily Holroyd using the details below.

Yours sincerely,



FOR Alastair Windler

Partnerships and Strategic Overview Team Leader - Welland and Nene

Direct dial 020 302 53535

Direct e-mail PSOWN@environment-agency.gov.uk

Enc.

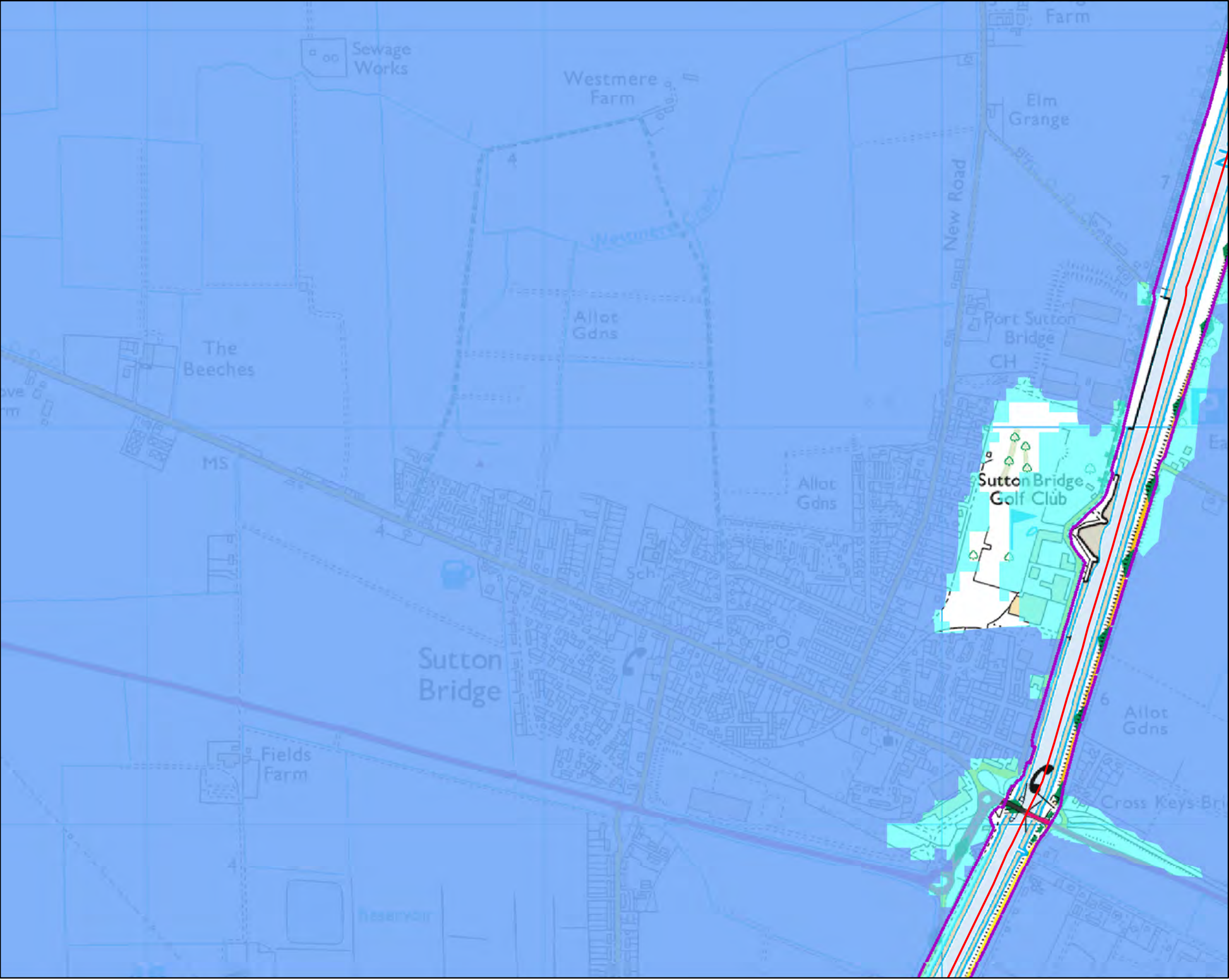
Flood Map

Estimated Tide Levels

Tidal Breach Locations Map

Hazard Mapping – Breaching (4 maps)

Flood Map centred on TF47177 21844 - created December 2018 [Ref: CCN-2018-110730]



Scale 1:10,000



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:

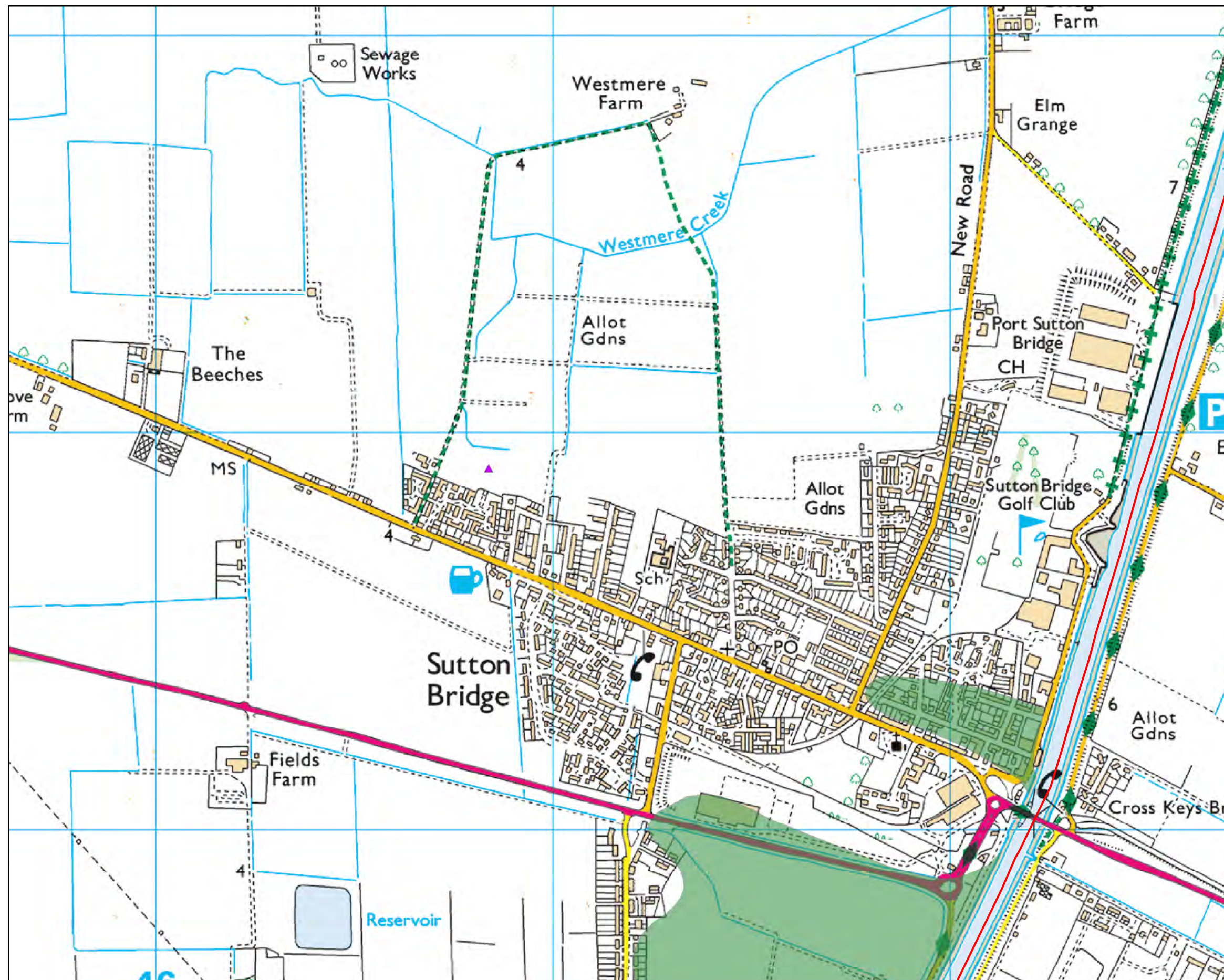
- from the sea by a flood that has a 0.5% (1 in 200) or greater chance of happening each year.
- or from a river by a flood that has a 1% (1 in 100) or greater chance of happening each year.

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

Historic Flood Map centred on TF47177 21844 - created December 2018 [Ref: CCN-2018-110730]



Scale 1:10,000



Legend

- Main River
- January 1978 on the Tidal River Nene

Created by the Partnerships and Strategic Overview Team, Kettering

Lincolnshire & Northamptonshire Area



Tidal Water Levels for the South Humber, East Coast and The Wash

The table below shows still water levels for locations, from the above location map, around the South Humber Estuary, East Coast and The Wash. It is important to note the following:

- The base date for the data is 2014 for the South Humber and 2006 for the East Coast and The Wash.
- The data 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.
- The water level quoted is the ‘Best Estimate’ water level. Depending on the use of the data it may be necessary to carry out sensitivity testing. Upper and Lower 95% confidence bandings are available upon request.
- Levels for other annual chance scenarios are available if required.

Ref	Location	Easting	Northing	Annual Chance (1 in x) of Tide Level					
				metres ODN					
				1	10	50	100	200	1000
HUMBER									
H030	Tetney	535420	403180	3.94	4.29	4.56	4.69	4.82	5.15
H050	Buck Beck	532700	406580	4.03	4.36	4.62	4.74	4.87	5.18
H060	Grimsby	527878	411346	4.10	4.43	4.70	4.82	4.95	5.27
H080	Haborough Marsh	520790	415740	4.26	4.61	4.88	5.01	5.14	5.47
H090	Immingham	519141	417449	4.26	4.61	4.88	5.01	5.14	5.47
H100	South Killingholme	518700	417120	4.41	4.77	5.05	5.18	5.32	5.66
H130	North Killingholme	516530	420000	4.51	4.87	5.15	5.28	5.42	5.77
H150	East Halton	514450	422870	4.59	4.96	5.25	5.39	5.53	5.89
H170	Goxhill	511970	425440	4.67	5.04	5.34	5.47	5.61	5.95
H200	New Holland	508020	424330	4.87	5.26	5.55	5.68	5.81	6.12
H210	Barrow Haven	506380	422620	4.92	5.31	5.60	5.73	5.86	6.17
H220	Ferriby	497550	421150	5.04	5.42	5.67	5.77	5.86	6.04
H230	Winterton	493420	422830	5.14	5.51	5.74	5.83	5.90	6.02
H250	Blacktoft	484247	424190	5.25	5.62	5.83	5.90	5.96	6.04
H270	Goole	474857	422960	5.46	5.85	6.07	6.15	6.21	6.29
East Coast									
~	Great Eau	545500	393800	3.80	4.19	4.46	4.57	4.69	4.96
~	Boygrift	553300	379800	3.84	4.24	4.53	4.65	4.77	5.05
~	Burgh Sluice	555190	358620	4.26	4.45	4.76	4.90	5.03	5.34
Wash									
~	Hobhole	536610	339940	4.82	5.30	5.64	5.78	5.93	6.27
~	Lawyers Sluice	540750	334550	4.84	5.32	5.66	5.80	5.95	6.29
~	West Lighthouse	549150	325750	4.88	5.37	5.71	5.86	6.01	6.35
~	Grand Sluice	532400	344500	4.88	5.33	5.65	5.78	5.93	~
~	Fosdyke Bridge	531700	332200	4.91	5.38	5.71	5.85	5.99	~
~	Marsh Road	526000	324000	5.04	5.44	5.73	5.85	5.98	~
~	Wisbech	546100	310000	4.83	5.25	5.53	5.66	5.78	~
~	Dog In Doublet	527300	299300	3.67	4.00	4.22	4.32	4.42	~



^ Modelled Breach Locations



This map indicates the location of where we have modelled the consequence of breaches 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

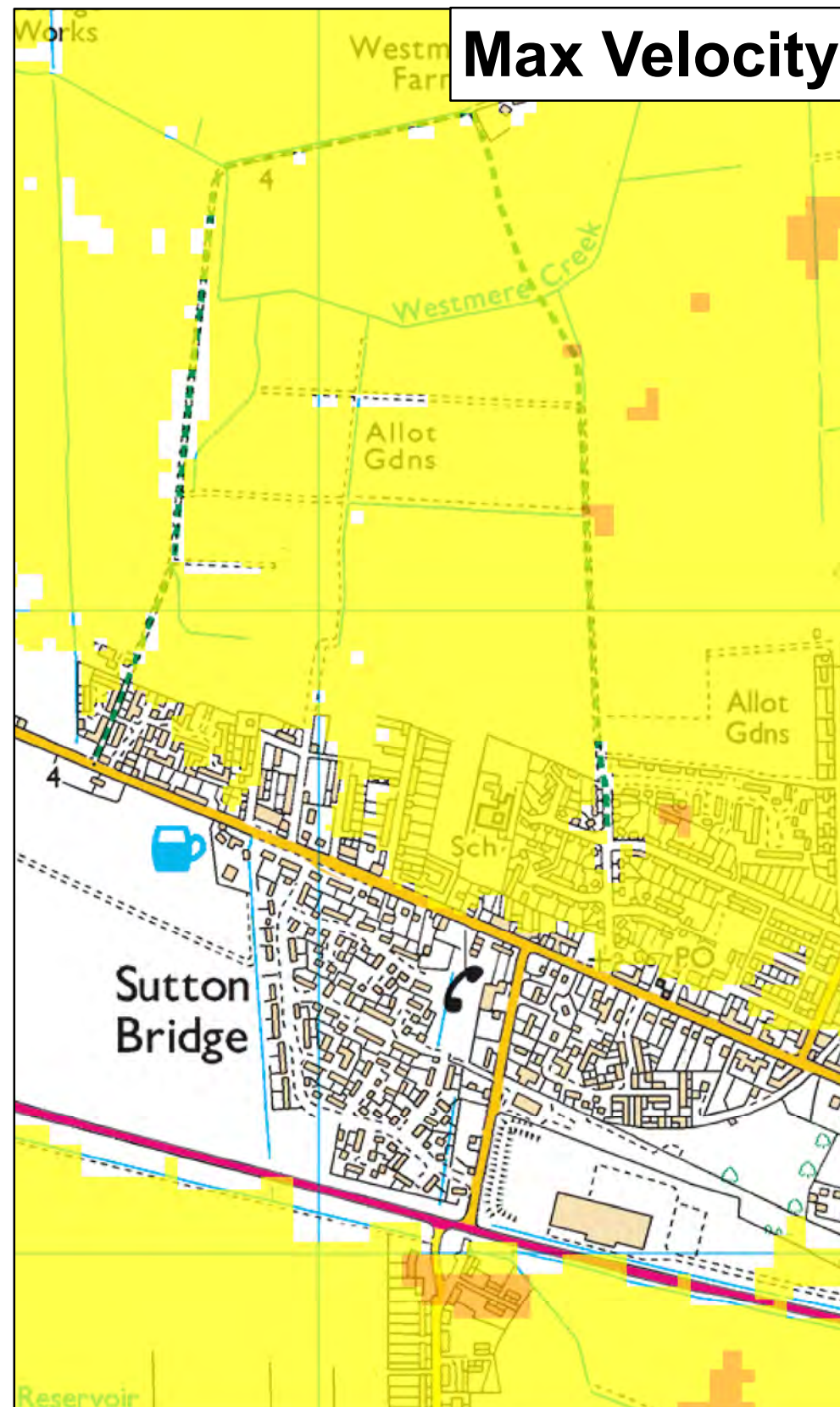
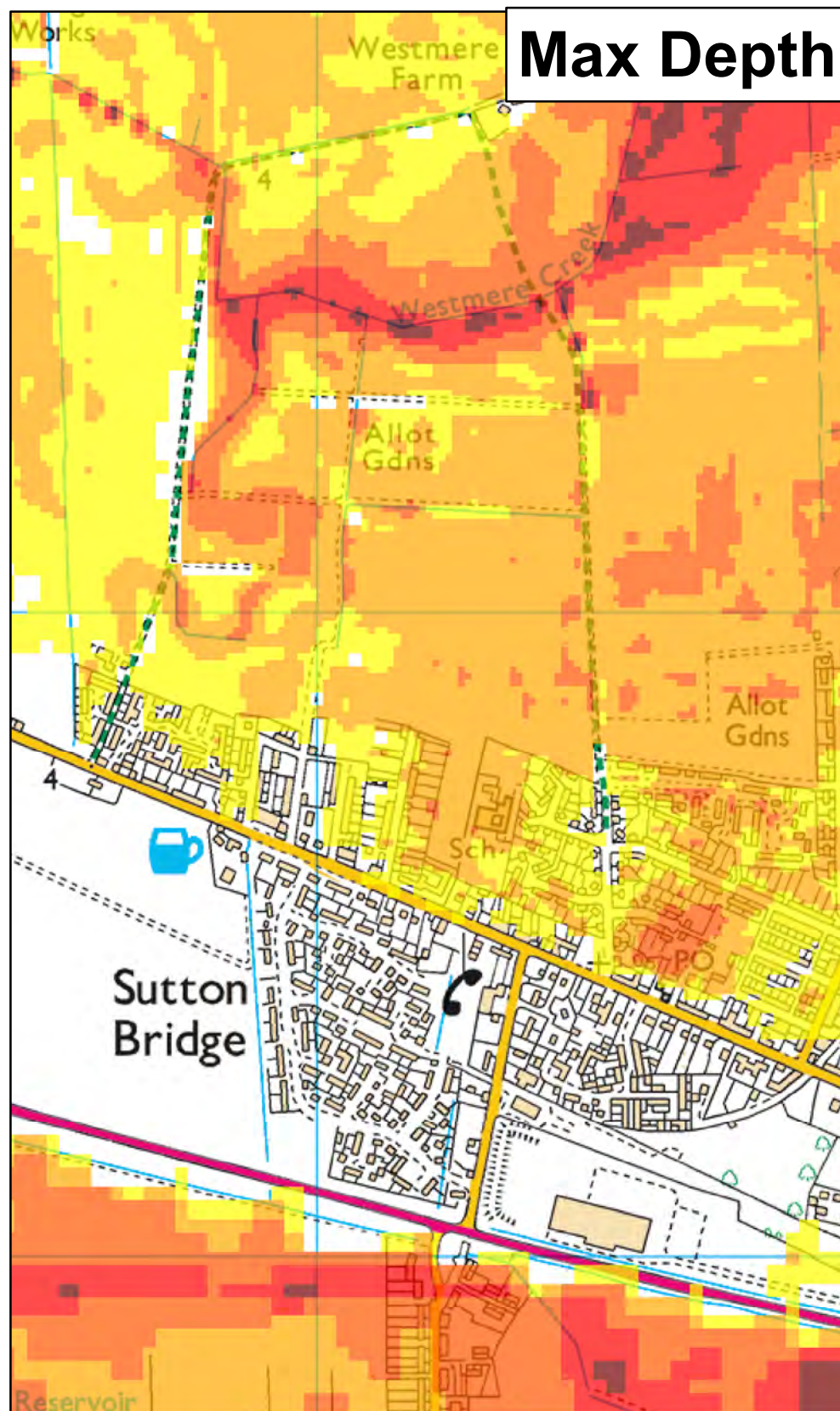
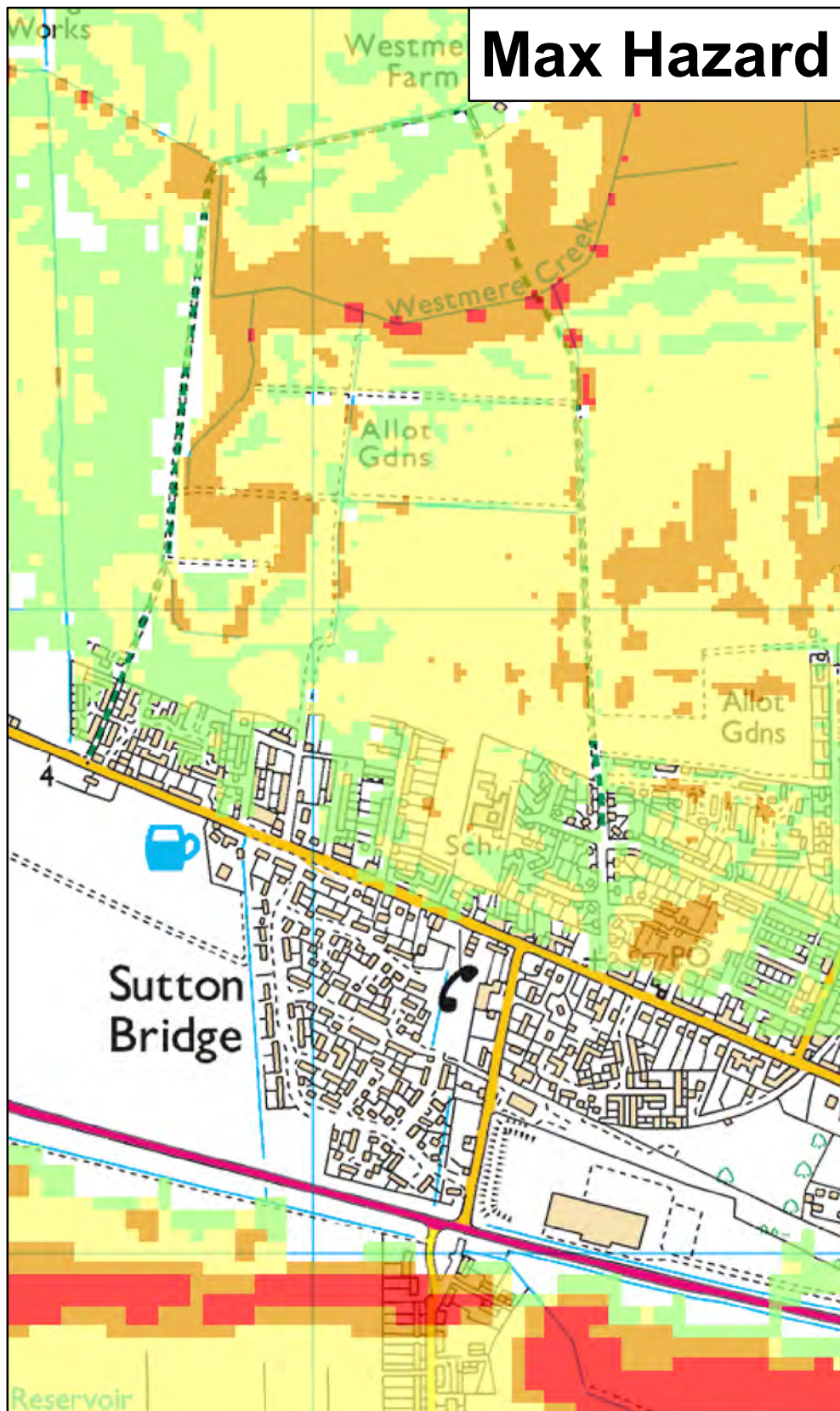


Produced by the Partnership and Strategic Overview Team, Lincoln
General Enquiries No: 03708 506 506

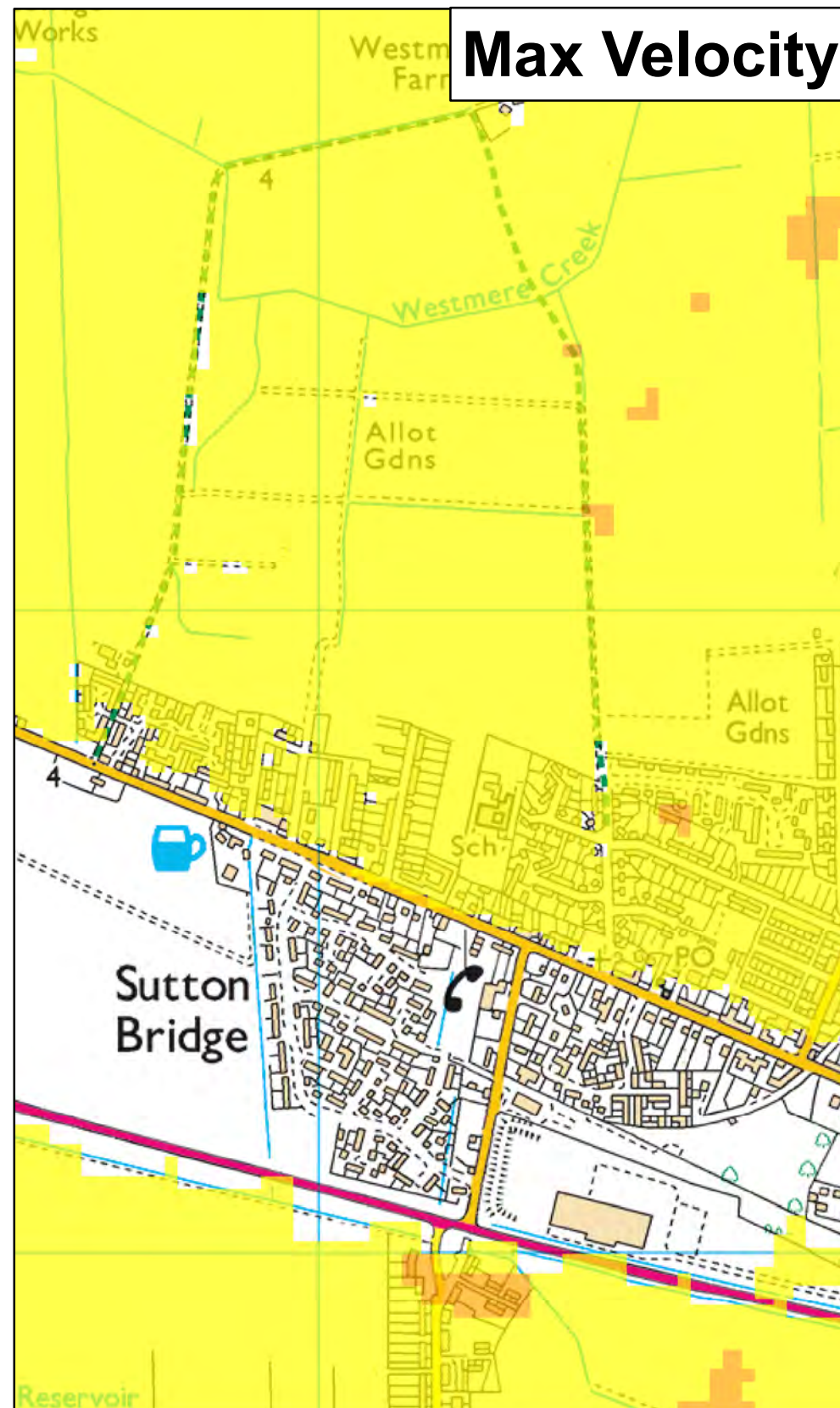
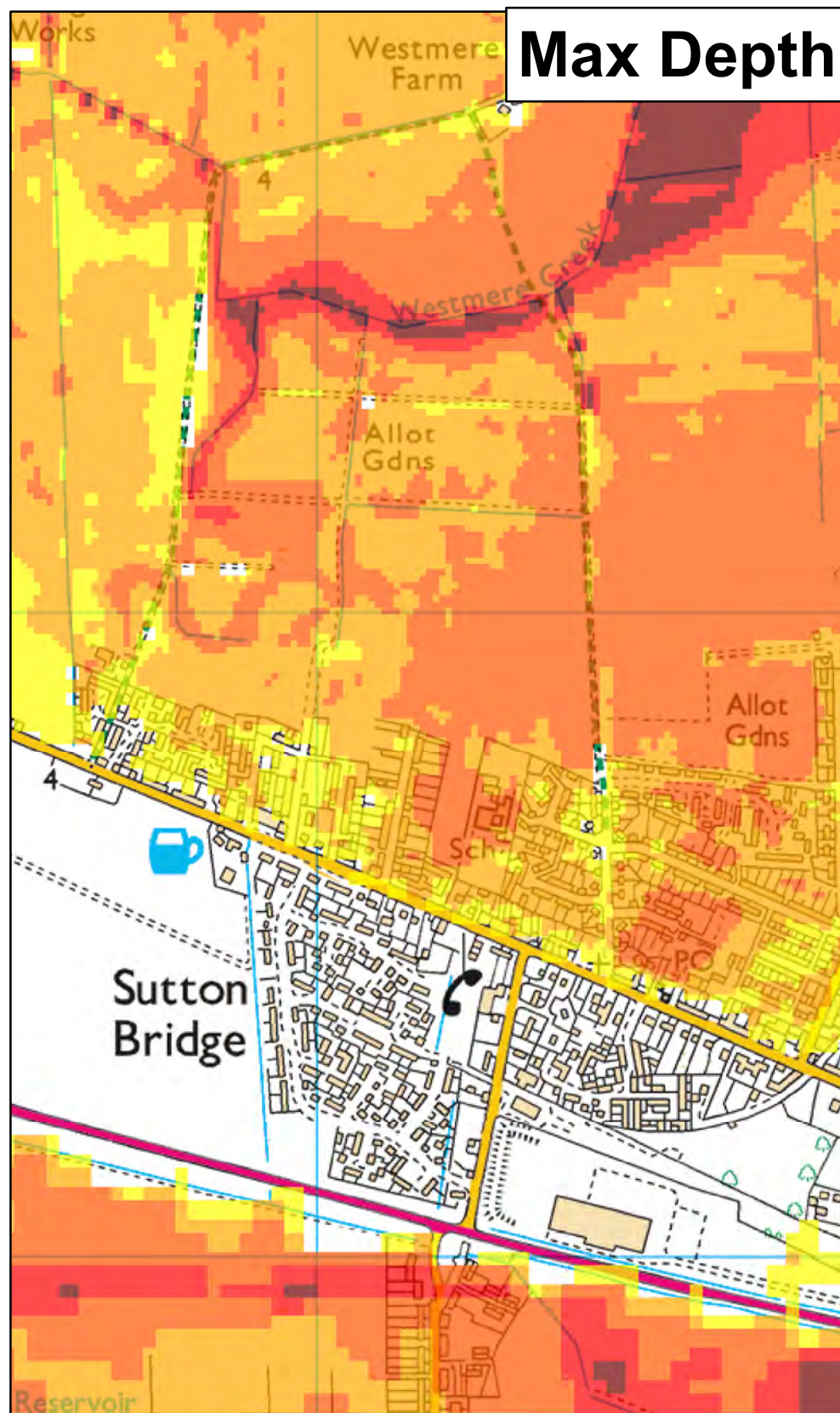
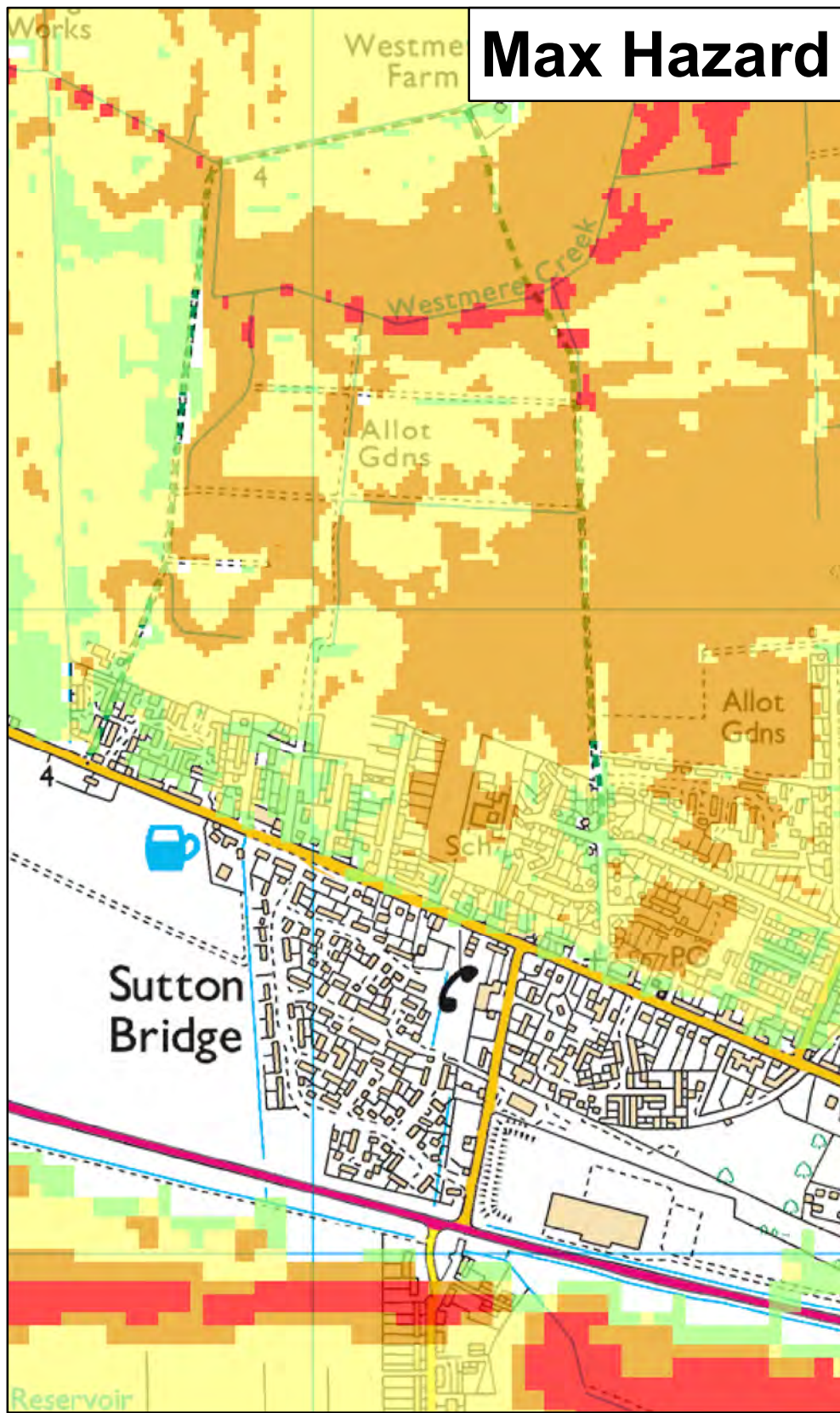
Northern Area Tidal Hazard Mapping

Location of Modelled Breaches

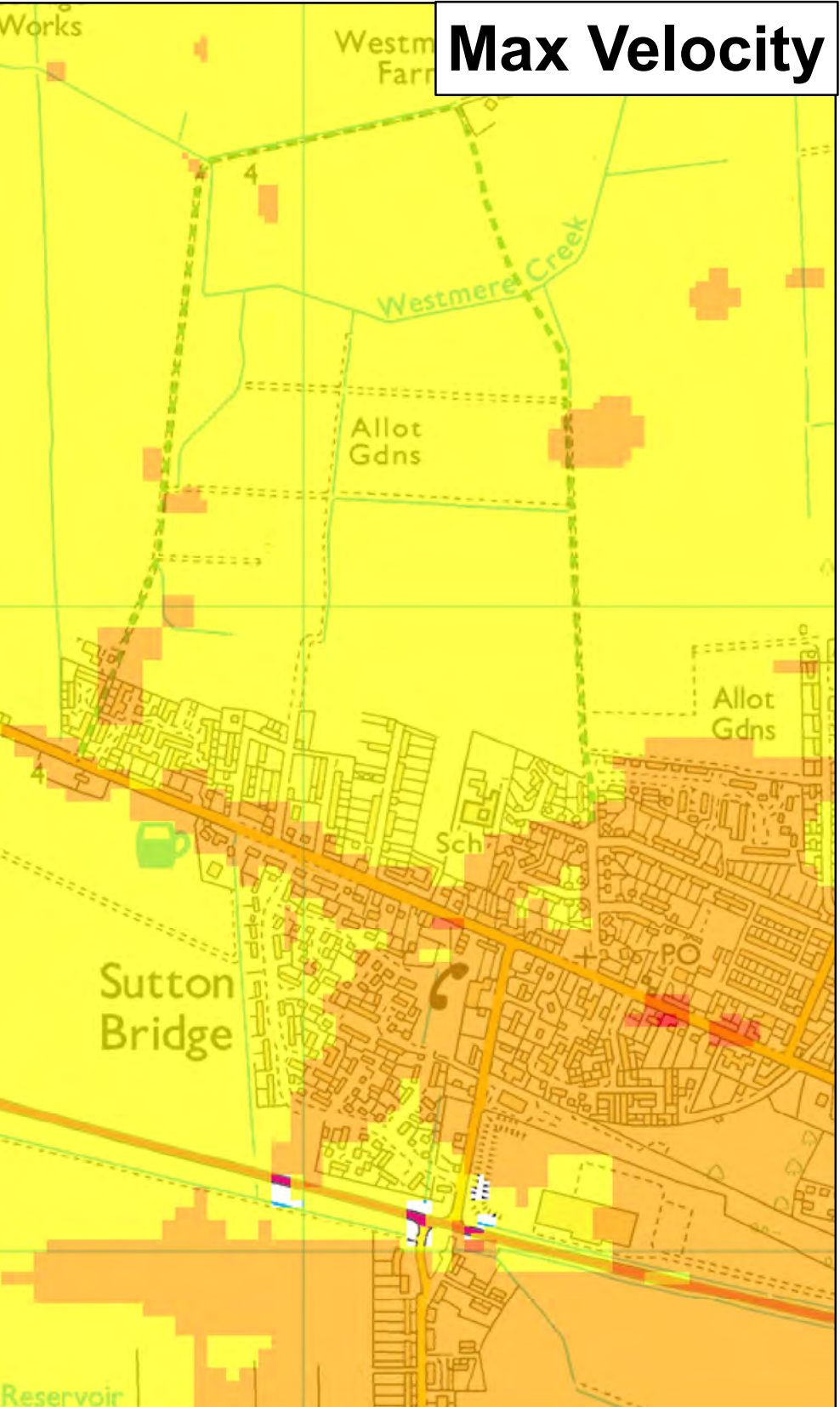
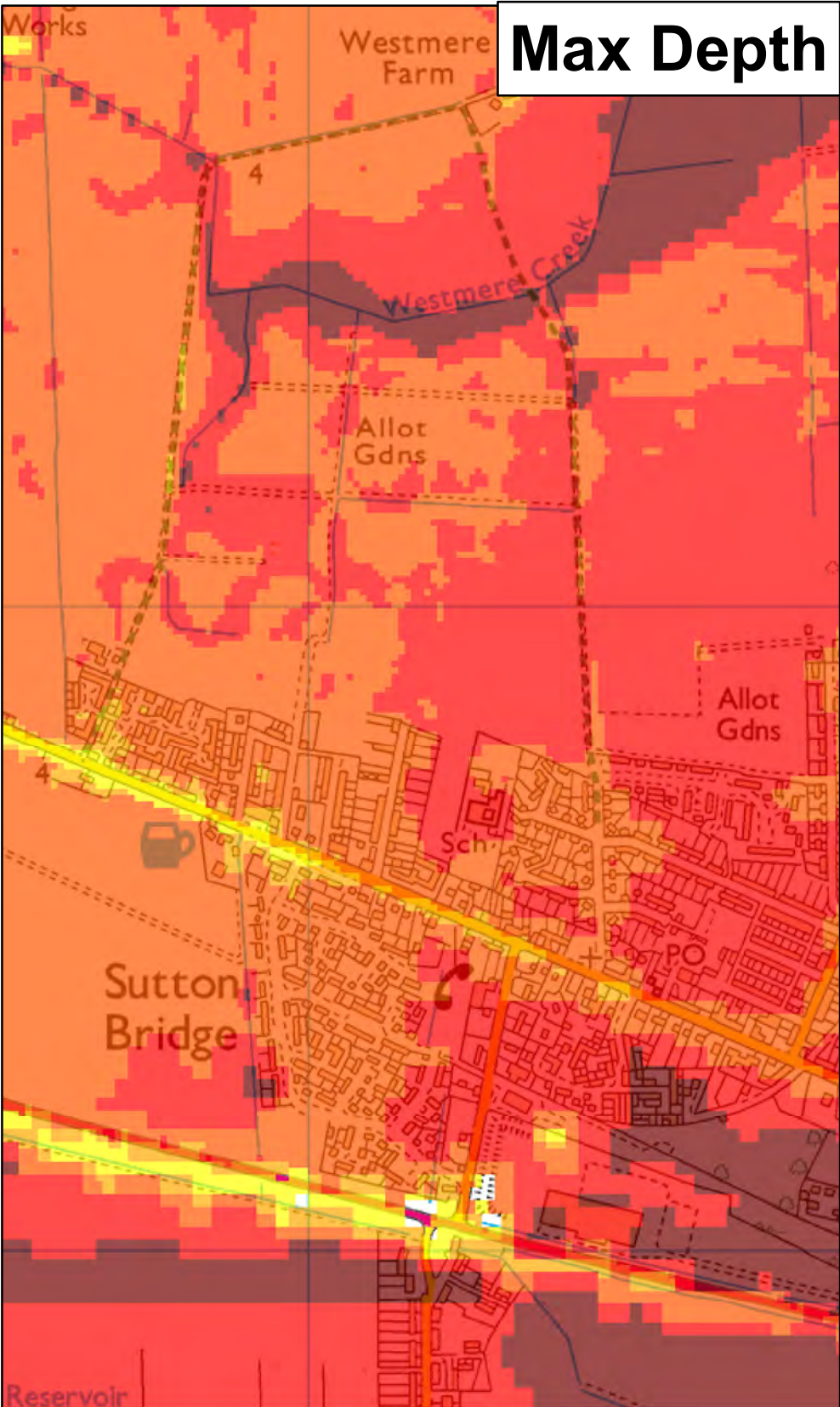
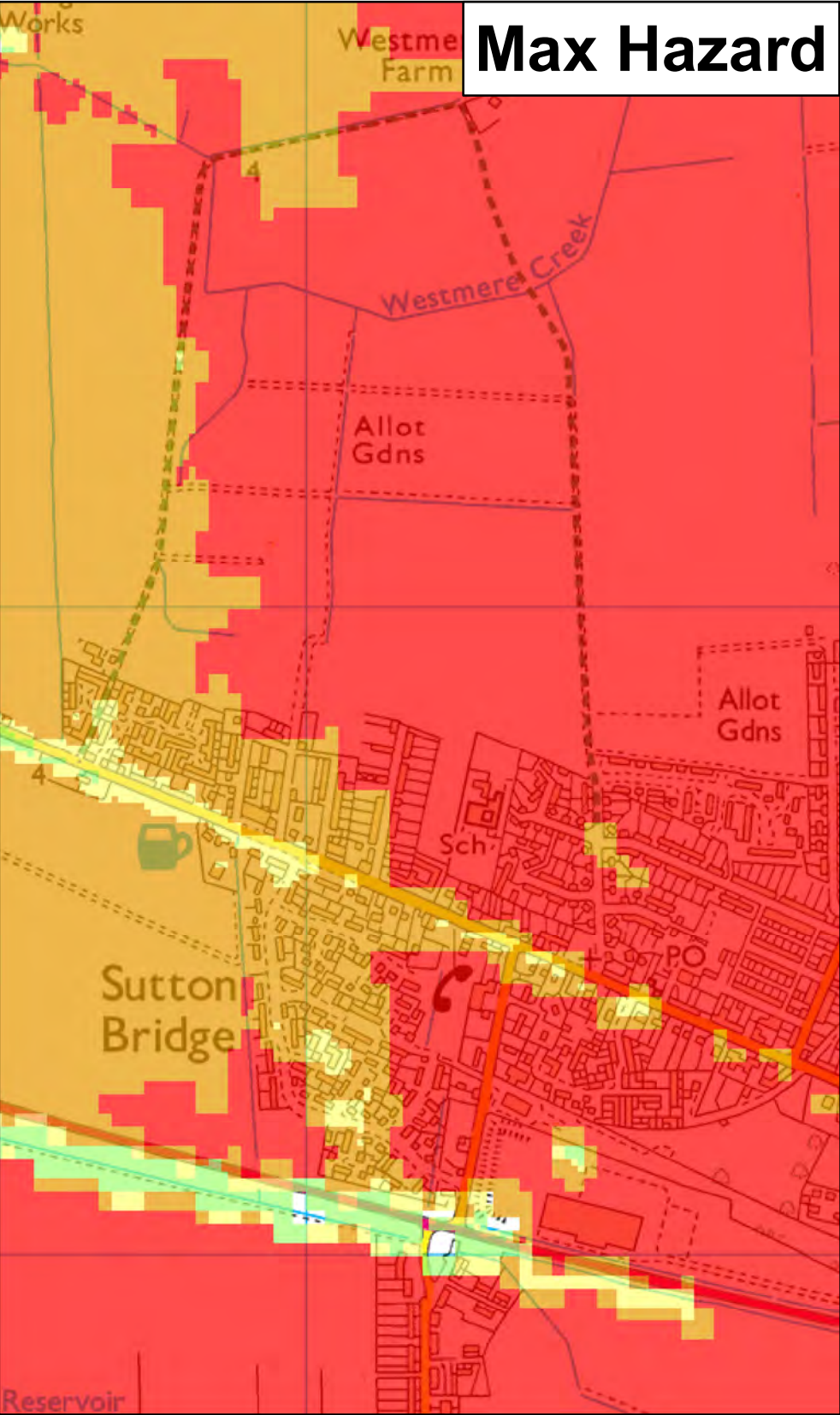
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★ Modelled Breach Locations - see also the accompanying plan "Location of Modelled Breaches"								This map shows the level of flood hazard to people (called a hazard rating) if our flood defences are breached at certain locations, for a range of 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	Max Hazard (Flood Risk to People : FD2320)		Max Depth (m)		Max Velocity (m/s)	
Less than 0.75 (Low Hazard) Between 0.75 and 1.25 (Danger for Some) Between 1.25 and 2.0 (Danger for Most) Greater than 2.0 (Danger for All)		0 - 0.25 0.25 - 0.50 0.50 - 1.0 1.0 - 1.6 1.6 +		0 - 0.3 0.3 - 1.0 1.0 - 1.5 1.5 - 2.5 2.5 +										
Date Printed	December 2018	Scenario year	2006	Scenario Annual Chance	0.5% (1 in 200)	CCN Number	CCN-2018-110730							
Lincolnshire and Northamptonshire Tidal Breaching Hazard Mapping Map Centred on TF 47177 21844 This map is reproduced by permission of Ordnance Survey on behalf of The Controller of Her Majesty's Stationary Office. Crown copyright. All rights reserved. Environment Agency 100026380, 2018. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings.														



★ Modelled Breach Locations - see also the accompanying plan "Location of Modelled Breaches"								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	Max Hazard (Flood Risk to People : FD2320)		Max Depth (m)		Max Velocity (m/s)	
Less than 0.75 (Low Hazard) Between 0.75 and 1.25 (Danger for Some) Between 1.25 and 2.0 (Danger for Most) Greater than 2.0 (Danger for All)		0 - 0.25 0.25 - 0.50 0.50 - 1.0 1.0 - 1.6 1.6 +		0 - 0.3 0.3 - 1.0 1.0 - 1.5 1.5 - 2.5 2.5 +										
Date Printed	December 2018	Scenario year	2006	Scenario Annual Chance	0.1% (1 in 1000)	CCN Number	CCN-2018-110730							
Lincolnshire and Northamptonshire Tidal Breaching Hazard Mapping Map Centred on TF 47177 21844 This map is reproduced by permission of Ordnance Survey on behalf of The Controller of Her Majesty's Stationary Office. Crown copyright. All rights reserved. Environment Agency 100026380, 2018. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings.														



★ **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 December 2018

Scenario year 2115

Scenario Annual Chance 0.5% (1 in 200)

CCN Number CCN-2018-110730

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.

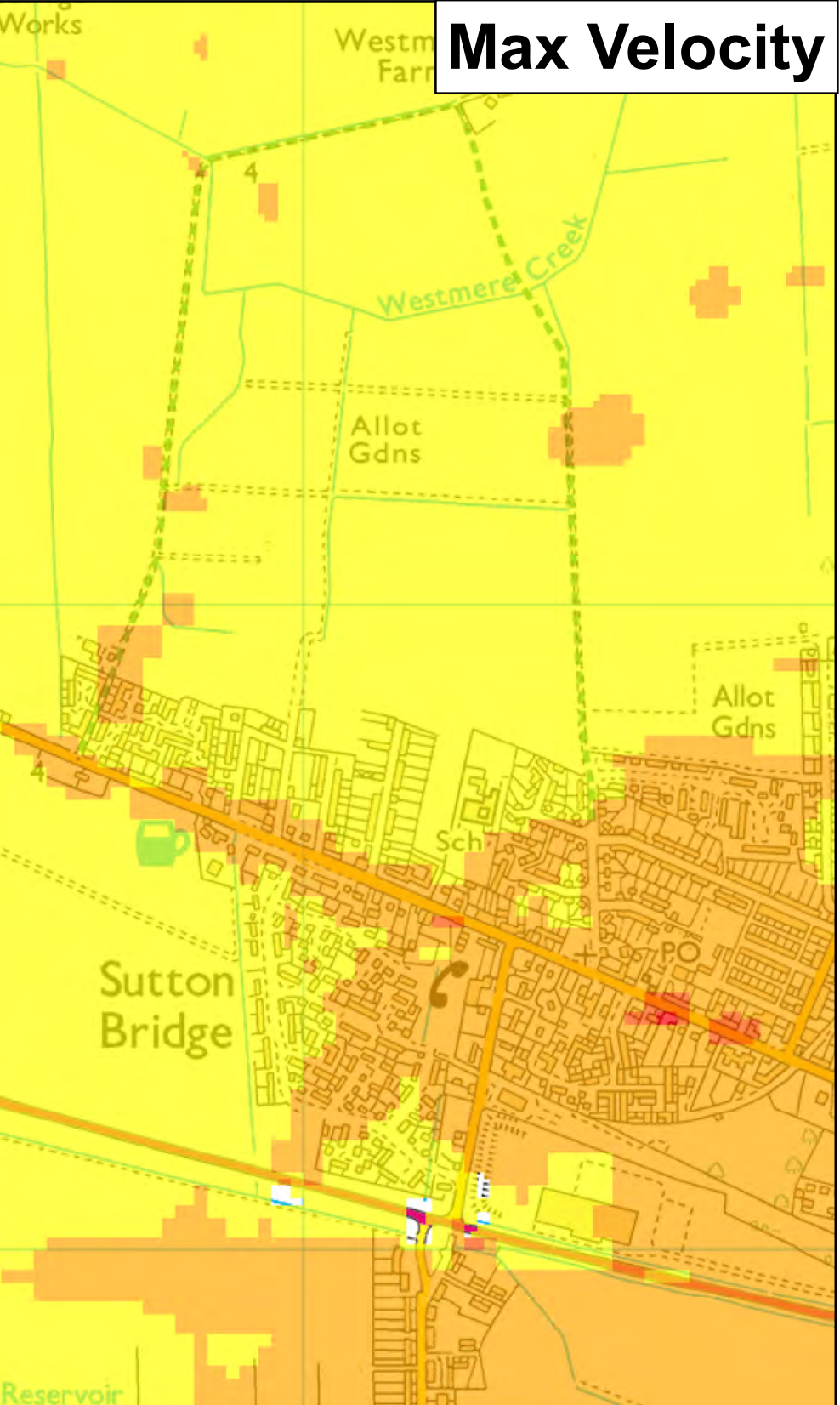
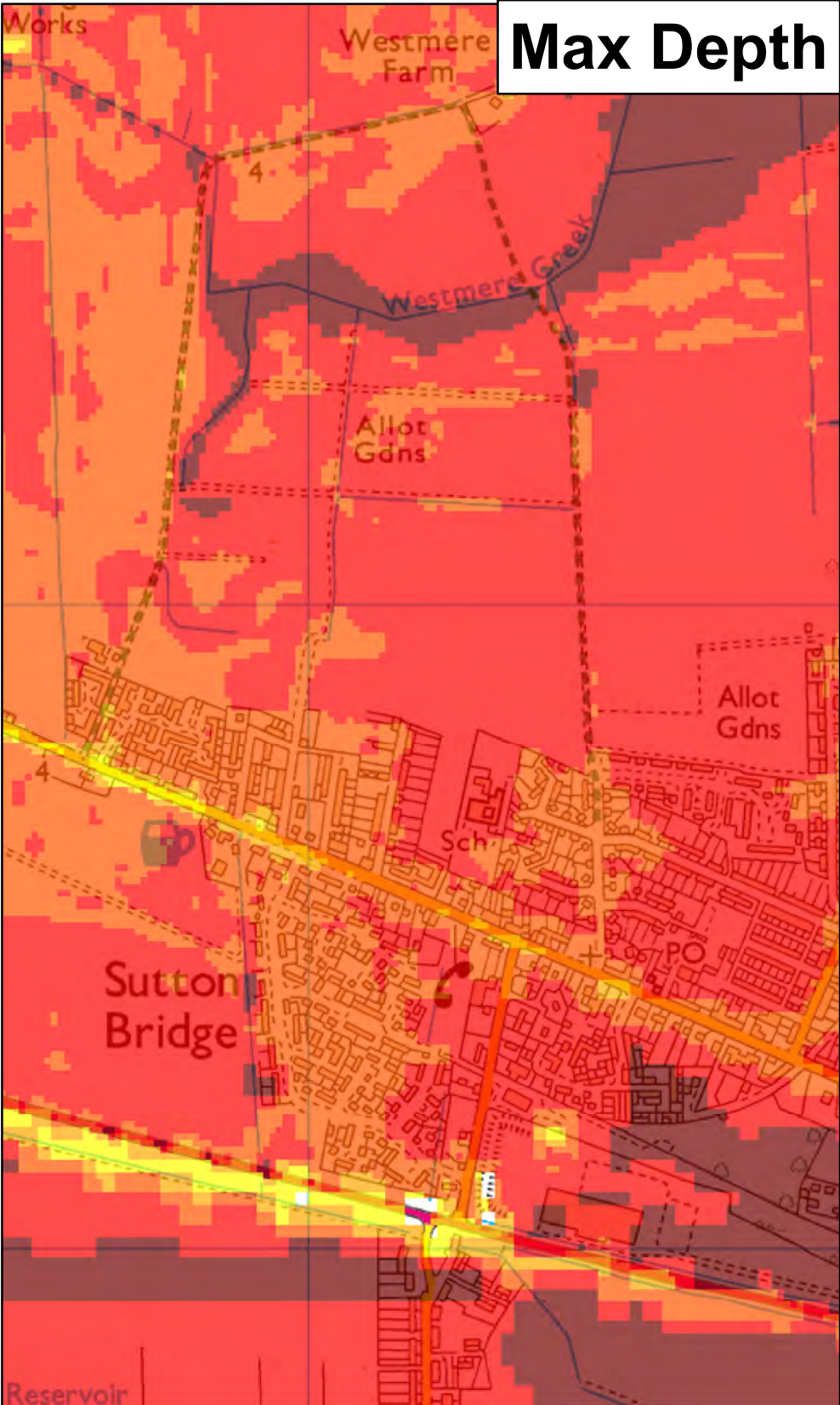
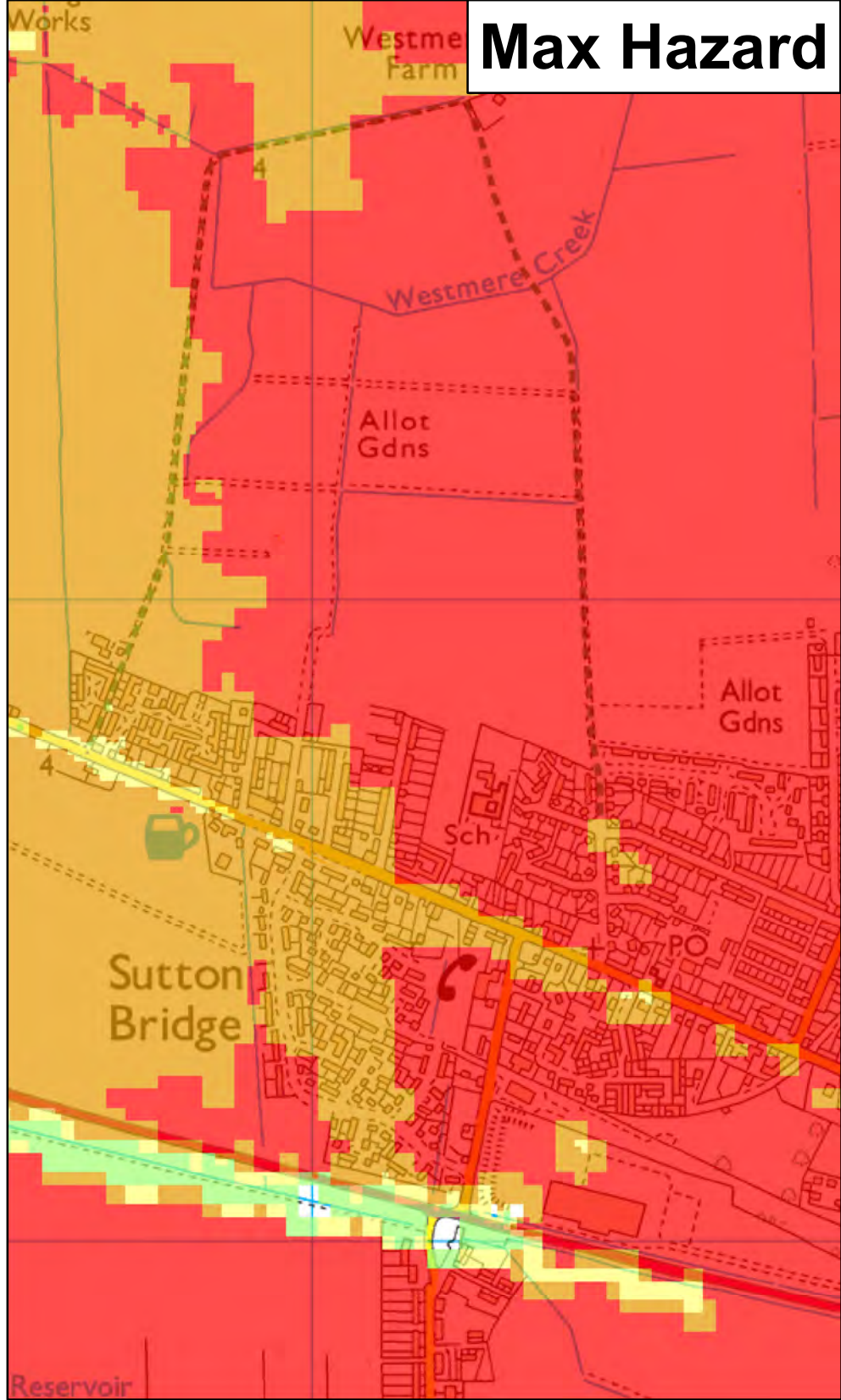
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General Enquiries No: 03708 506 506. Weekday Daytime calls cost 5p plus up to 6p per minute from BT Weekend Unlimited. Mobile and other providers' charges may vary

**Lincolnshire and Northamptonshire
Tidal Breaching Hazard
Mapping**

Map Centred on TF 47177 21844

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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 December 2018

Scenario year 2115

Scenario Annual Chance 0.1% (1 in 1000)

CCN Number CCN-2018-110730

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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APPENDIX 5 – ANGLIAN WATER PRE DEVELOPMENT ENQUIRY

Pre-Planning Assessment Report

WITHINGTON STREET SUTTON BRIDGE

557/903865754/2/0000037

Section 1: Proposed development

Thank you for submitting a pre-planning enquiry. This has been produced for Alan Brown Development Services Ltd. Your reference number is **557/903865754/2/0000037**. If you have any questions upon receipt of this report, please contact the Pre-Development team on 03456 066087 or email planningliaison@anglianwater.co.uk.

The response within this report has been based on the following information which was submitted as part of your application:

List of planned developments	
Type of development	No. Of units
Dwellings	17

The anticipated residential build rate is:

Year	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12
Build rate	17	0	0	0	0	0	0	0	0	0	0	0

Site grid reference no.

TF4722121800

Development type

Greenfield

Planning application status

Approved

The comments contained within this report relate to the public water mains and sewers indicated on our records. Your attention is drawn to the disclaimer in the useful information section of this report.

Section 2: Assets affected

Our records indicate that we have the following types of assets within or overlapping the boundary of your development site as listed in the table below.

Additionally, it is highly recommended that you carry out a thorough investigation of your proposed working area to establish whether any unmapped public or private sewers and lateral drains are in existence. We are unable to permit development either over or within the easement strip without our prior consent. The extent of the easement is provided in the table below. Please be aware that the existing water mains/public sewers should be located in highway or open space and not in private gardens. This is to ensure available access for any future maintenance and repair and this should be taken into consideration when planning your site layout.

Water and Used water easement information

Asset type	Pipe size (mm)	Total easement required (m)
Water mains	76	4.50 m either side of the centre line
Water mains	76	4.50 m either side of the centre line
Water mains	76	4.50 m either side of the centre line
Sewer mains	Unknown	3.00 m either side of the centre line
Sewer mains	150	3.00 m either side of the centre line
Sewer mains	Unknown	3.00 m either side of the centre line
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Sewer mains	150	3.00 m either side of the centre line
Sewer mains	150	3.00 m either side of the centre line

If it is not possible to avoid our assets then these may need to be diverted in accordance with Section 185 of the Water Industry Act (1991). You will need to make a formal application if you would like a diversion to be considered.

Due to the private sewer transfer in October 2011 many newly adopted public used water assets and their history are not indicated on our records. You also need to be aware that your development site may contain private water mains, drains or other assets not shown on our records. These are private assets and not the responsibility of Anglian Water but that of the landowner.

Section 3: Water supply

In examining the available capacity for your development site we assess the capacity and costs for two categories of water main. These are:

Strategic:

These are the offsite potable water mains which deliver water within an area to a large number of development sites often across a number of towns. The strategic provision of these water mains enables us to provide of the cheapest solution across a large geographical area.

Local reinforcement:

These are localised reinforcement mains to enable us to provide water to your development site.

On most sites we also have two categories of water mains the Spine Mains and Housing Estate Mains (HEMS). To support your budgeting arrangements we have also examined the estimated cost for delivering the onsite water mains needed for a site of your size.

Water supply network

The water supply to the proposed development site can be provided from the existing mains. Anglian Water cannot reserve capacity and therefore you are recommended to formally apply for a connection at your earliest convenience. Please note that available capacity in our network can be reduced at any time due to increased requirements from existing businesses and houses as well as from new housing and new commercial developments. Your site will benefit from the strategic water main(s) listed below. The strategic scheme(s) has/have been designed to cater for the predicted housing growth in the area. Details of the necessary upgrades can be found in the water infrastructure section of this report and the cost of these works are included in the Zonal charge. The connection point for the site will be at Withington Street & Chestnut Terrace. Currently, there is no expectation that there will be a need for any local reinforcement. However, capacity can be reduced at any time due to an increased demand from existing commercial and residential housing as well as from new developments. You are therefore recommended to formally apply for a connection at your earliest convenience.

Connection point(s)

Connection Point

CP-0129

Address

Withington Street & Chestnut Terrace

National Grid Reference (NGR)

TF4705221760

Water Infrastructure & Costs

In order to supply your site, the following upgrades are required:

Strategic Water Mains	Based on
None	0.699

As a result of the recent charging rules published by Ofwat, our charging regime has changed. Your development site will be required to pay a Zonal charge for each new property connecting to our water supply network that benefits from Full planning permission.

Payment of the Zonal charge must be made before premises are connected to our water supply network. More information on the Zonal charge can be found at <http://www.anglianwater.co.uk/developers/charges>

The Zonal charge consists of two elements. The first is called the 'Fixed Element' which is the same in nature to the Infrastructure charge applied prior to April 2018. The second is called the 'Variable Element' which may vary each financial year.

The elements are combined together to create the 2018/19 Zonal charge for Water:

Fixed Element	£ 370
Variable Element	£ 88.50

In most circumstances zonal charges are raised on a standard basis of one charge per new connection (one for water and one for sewerage). However, if the new connection is to non-household premises, the fixed element is calculated according to the number and type of water fittings in the premises. This is called the "relevant multiplier" method of calculating the charge. Details of the relevant multiplier for each fitting can be found at our web-page: <http://www.anglianwater.co.uk/developers/charges/>

The total Zonal charge payable for your site for Water is:

Zonal charge per new connection - Water	No. Of Units	Total amount payable
£ 458.50	17	£ 7,794.50

The estimated* Onsite Water Mains cost for your site is:

Estimated Onsite Water Mains	
Onsite water mains costs	£ 1,224.00

*A detailed cost breakdown will be provided on receipt of a formal application for a new water main.

In addition, you also have the ability to construct the onsite water mains under a self-lay agreement. In such cases, an Asset Payment is made by Anglian Water following commissioning and adoption of the assets. The Asset Payment is calculated as required in the Water Act 2003. For more information on the self-lay of water mains please see <http://www.anglianwater.co.uk/developers/self-lay>.

You will also need to budget for connection costs. Please note that we offer alternative types of connections depending on your needs and these costs are available in our annual charges booklet, which can be downloaded from <http://www.anglianwater.co.uk/developers/charges>

Section 4: Water recycling services

In examining the used water system we assess the ability for your site to connect to the public sewerage network without causing a detriment to the operation of the system. We also assess the receiving water recycling centre and determine whether the water recycling centre can cope with the increased flow and influent quality arising from your development.

Water recycling centre

The foul drainage from the proposed development is in the catchment of Sutton Bridge Water Recycling Centre, which currently has capacity to treat the flows from your development site. Anglian Water cannot reserve capacity and the available capacity at the water recycling centre can be reduced at any time due to growth, environmental and regulation driven changes.

Used water network

Our assessment has been based on development flows connecting to the nearest foul water sewer of the same size or greater pipe diameter to that required to drain the site. The infrastructure to convey foul water flows to the receiving sewerage network is assumed to be the responsibility of the developer. Conveyance to the connection point is considered as Onsite Work and includes all work carried out upstream from of the point of connection, including making the connection to our existing network. This connection point has been determined in reference to the calculated discharge flow and on this basis, a 150mm internal diameter pipe is required to drain the development site. The nearest practicable connection is to the 150mm diameter sewer at manhole 1801 in Chestnut Terrace at National Grid Reference NGR TF4715521809. The cover level is 3.56m and the invert level is 2.24m. Anglian water has assessed the impact of gravity flows from the planned development to the public foul sewerage network. We can confirm that this is acceptable as the foul sewerage system, at present, has available capacity for your site. Please note that Anglian Water will request a suitably worded condition at planning application stage to ensure this strategy is implemented to mitigate the risk of flooding.

It is assumed that the developer will provide the necessary infrastructure to convey flows from the site to the network. Consequently, this report does not include any costs for the conveyance of flows.

Surface water disposal

The proposed method of surface water drainage submitted is acceptable to Anglian Water, the connection point for the surface water would be to manhole 4751 located in the 900mm foul sewer approximately 185m to the east of the site at NGR TF4744221728 at a rate of 5.00l/s. Our assessment has been based on development flows connecting to the nearest surface water sewer of the same size or greater pipe diameter. The cover level is 3.88m and the invert level is 1.1m. Anglian Water's surface water policy follows the Surface Water hierarchy outlined in Part H of the Building Regulations. Should your needs change then an alternative solution, connection point or flow rate may be required. You are therefore advised to update Anglian Water with any significant changes.

As you may be aware, Anglian Water will consider the adoption of SuDs provided that they meet the criteria outline in our SuDs adoption manual. This can be found on our website at <http://www.anglianwater.co.uk/developers/suds.aspx>. We will adopt features located in public open space that are designed and constructed, in conjunction with the Local Authority and Lead Local Flood Authority (LLFA), to the criteria within our SuDs adoption manual. Specifically, developers must be able to demonstrate:

1. Effective upstream source control,
2. Effective exceedance design, and
3. Effective maintenance schedule demonstrating that the assets can be maintained both now and in the future with adequate access.

If you wish to look at the adoption of any SuDs then an expression of interest form can be found on our website at: <http://www.anglianwater.co.uk/developers/suds.aspx>

The proposed method of surface water disposal is not relevant to Anglian Water; we suggest that you contact the relevant Local Authority, Lead Local Flood Authority, the Environment Agency or the Internal Drainage Board, as appropriate.

Trade Effluent

We note that you do not have any trade effluent requirements. Should this be required in the future you will need our written formal consent. This is in accordance with Section 118 of the Water Industry Act (1991).

Used Water Budget Costs

As a result of the recent charging rules published by Ofwat, our charging regime has changed. Your development site will be required to pay a Zonal charge for each new property connecting to the public sewer that benefits from Full planning permission.

Payment of the Zonal charge must be made before premises are connected to the public sewer. More information on the Zonal charge can be found at <http://www.anglianwater.co.uk/developers/charges>

The Zonal charge consists of two elements. The first is called the 'Fixed Element' which is the same in nature to the Infrastructure charge applied prior to April 2018. The second is called the 'Variable Element' which may vary each financial year.

The elements are combined together to create the 2018/19 Zonal charge for Sewerage:

Fixed Element	£ 370
Variable Element	£ 101

In most circumstances zonal charges are raised on a standard basis of one charge per new connection (one for water and one for sewerage). However, if the new connection is to non-household premises, the fixed element is calculated according to the number and type of water fittings in the premises. This is called the "relevant multiplier" method of calculating the charge. Details of the relevant multiplier for each fitting can be found at our web-page: <http://www.anglianwater.co.uk/developers/charges/>

The total Zonal charge payable for your site for Sewerage is:

Zonal charge per new connection - Sewerage	No. Of Units	Total amount payable
£ 471	17	£ 8,007.00

It has been assumed that the onsite used water network will be provided under a section 104 Water Industry Act application.

It is recommended that you also budget for connection costs. Please note that we offer alternative types of connections depending on your needs and these costs are available at our website.

Section 5: Map of Proposed Connection Points

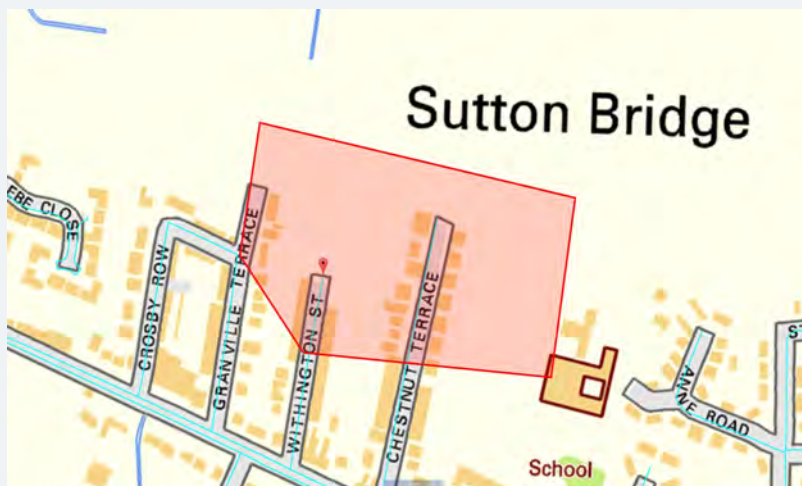


Figure 1: Showing your water point of connection

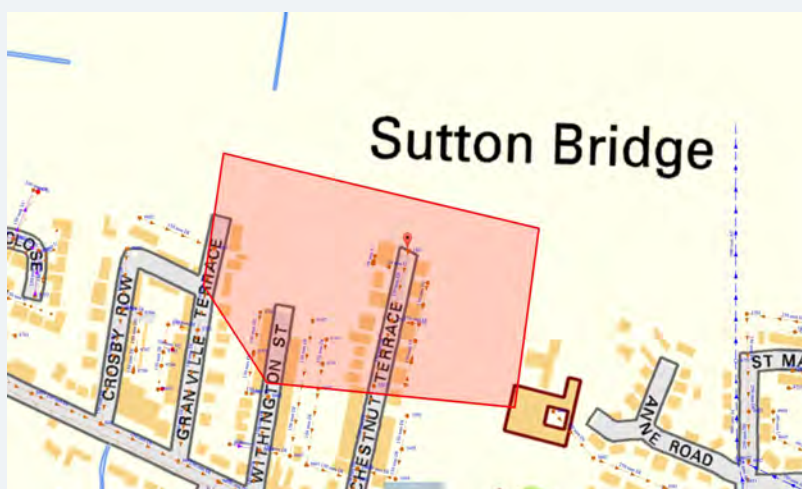


Figure 2: Showing your used water point of connection

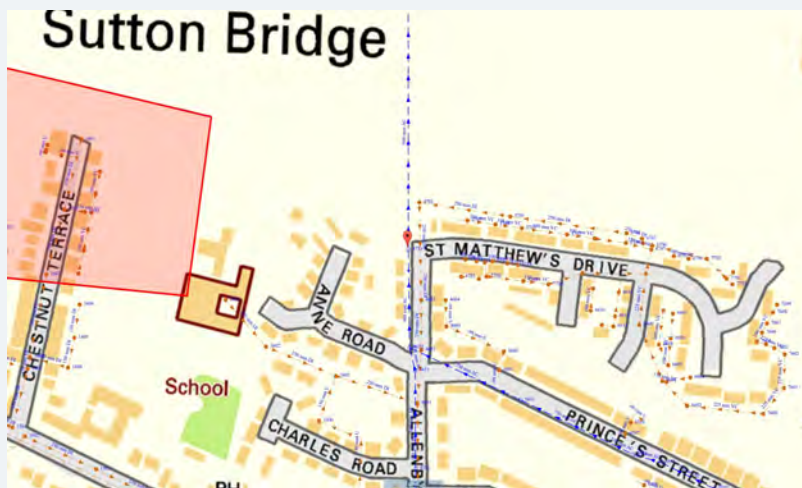


Figure 3: Showing your surface water point of connection

Section 6: Useful Information

Water

Water Industry Act – Key Water Sections:

Section 41:

This provides you with the right to requisition a new water main for domestic purposes to connect your site to the public water network.

Section 45:

This provides you with the right to have a connection for domestic purposes from a building or part of a building to the public water main.

Section 51A - E

This provides you with the right to provide the water main or service connection yourself and for us to vest them into our company.

Section 55:

This applies where you request a supply of water for non domestic purposes.

Section 185:

This provides you with the right to make a reasonable request to have a public water main, sewer or public lateral drain removed or altered, at your expense. Details on how to make an application and the s185 form is available on our website at <http://www.anglianwater.co.uk/developers> or via our Development Services team on 03456 066087.

Details on how you can make a formal application for a new water main, new connection or diversion are available on from our Development Services team on 03456 066087 or via our website at <http://www.anglianwater.co.uk/developers>

If you have any other queries on the rights to requisition or connect your housing to the public water and sewerage infrastructure then please contact our Development Services team at: Developer Services, Anglian Water, PO Box 495, Huntingdon, PE29 6YY or Telephone: 0345 60 66 087 or Email: developerservices@anglianwater.co.uk

Water pressure and flow rate: The water pressure and consistency that we must meet for your site is laid out in the Water Industry Act(1991). This states that we must supply a flow rate of 9 litres per minute at a pressure of 10 metres of head to the external stop tap. If your water pressure requirements exceed this then you will need to provide and maintain any booster requirements to the development site.

Self Lay of Water Mains: A list of accredited Self Lay Organisations can be found at <https://www.lr.org/en/utilities/water-industry-registration-scheme-wirs-wirsae/search/>

Used water

Water Industry Act – Key Used Water Sections:

Section 98:

This provides you with the right to requisition a new public sewer. The new public sewer can be constructed by Anglian Water on your behalf. Alternatively, you can construct the sewer yourself under section 30 of the Anglian Water Authority Act 1977.

Section 102:

This provides you with the right to have an existing sewerage asset vested by us. It is your responsibility to bring the infrastructure to an adoptable condition ahead of the asset being vested.

Section 104:

This provides you with the right to have a design technically vetted and an agreement reached that will see us adopt your assets following their satisfactory construction and connection to the public sewer.

Section 106:

This provides you with the right to have your constructed sewer connected to the public sewer.

Section 185:

This provides you with the right to have a public sewerage asset diverted.

Details on how to make a formal application for a new sewer, new connection or diversion are available on our website at <http://www.anglianwater.co.uk/developers> or via our Development Services team on 03456 066087.

Sustainable drainage systems:

Many existing urban drainage systems can cause problems of flooding, pollution or damage to the environment and are not resilient to climate change in the long term. Therefore our preferred method of surface water disposal is through the use of Sustainable Drainage Systems (SuDS). SuDS are a range of techniques that aim to mimic the way surface water drains in natural systems within urban areas. For more information on SuDS, please visit our website at <http://www.anglianwater.co.uk/developers/suds.aspx>. We also recommend that you contact the Local Authority and Lead Local Flood Authority (LLFA) for the area to discuss your application.

Private sewer transfers:

Sewers and lateral drains connected to the public sewer on the 1 July 2011 transferred into Water Company ownership on the 1 October 2011. This follows the implementation of the Floods and Water Management Act (FWMA). This included sewers and lateral drains that were subject to an existing Section 104 Adoption Agreement and those that were not. There were exemptions and the main non-transferable assets were as follows:

- Surface water sewers and lateral drains that did not discharge to the public sewer, e.g. those that discharged to a watercourse.
- Foul sewers and lateral drains that discharged to a privately owned sewage treatment/collection facility.
- Pumping stations and rising mains will transfer between 1 October 2011 and 1 October 2016.

The implementation of Section 42 of the FWMA will ensure that future private sewers will not be created. It is anticipated that all new sewer applications will need to have an approved section 104 application ahead of a section 106 connection.

Encroachment:

Anglian Water operates a risk based approach to development encroaching close to our used water infrastructure. We assess the issue of encroachment if you are planning to build within 400 metres of a water recycling centre or, within 15 metres to 100 metres of a pumping station. We have more information available on our website at <http://anglianwater.co.uk/developers/encroachment.aspx>

Locating our assets:

Maps detailing the location of our water and used water infrastructure including both underground assets and above ground assets such as pumping stations and recycling centres are available from . All requests from members of the public or non-statutory bodies for maps showing the location of our assets will be subject to an appropriate administrative charge. We have more information on our website at: <http://www.anglianwater.co.uk/developers/our-assets/>

Summary of charges:

A summary of this year's water and used water connection and infrastructure charges can be found at <http://www.anglianwater.co.uk/developers/charges>

Disclaimer:

The information provided in this report is based on data currently held by Anglian Water Services Limited ('Anglian Water') or provided by a third party. Accordingly, the information in this report is provided with no guarantee of accuracy, timeliness, completeness and is without indemnity or warranty of any kind (express or implied).

This report should not be considered in isolation and does not nullify the need for the enquirer to make additional appropriate searches, inspections and enquiries. Anglian Water supports the plan led approach to sustainable development that is set out in the National Planning Policy Framework ('NPPF') and any infrastructure needs identified in this report must be considered in the context of current, adopted and/or emerging local plans. Where local plans are absent, silent or have expired these needs should be considered against the definition of sustainability holistically as set out in the NPPF.

Whilst the information in this report is based on the presumption that proposed development obtains planning permission, nothing in this report confirms that planning permission will be granted or that Anglian Water will be bound to carry out the works/proposals contained within this report.

No liability whatsoever, including liability for negligence is accepted by Anglian Water, or its partners, employees or agents, for any error or omission, or for the results obtained from the use of this report and/or its content. Furthermore in no event will any of those parties be liable to the applicant or any third party for any decision made or action taken as a result of reliance on this report.

This report is valid for the date printed and the enquirer is advised to resubmit their request for an up to date report should there be a delay in submitting any subsequent application for water supply/sewer connection(s).



STRUCTURAL ENGINEERS

[CONSULTING CIVIL & STRUCTURAL ENGINEERS]

T: 07384 706869

E:enquiries@seaststructuralengineers.co.uk

Client

Lincoln Jack Ltd

Project

Land North of Chestnut Terrace, Sutton Bridge

Title

Flood Risk Assessment

Sheet no. 20

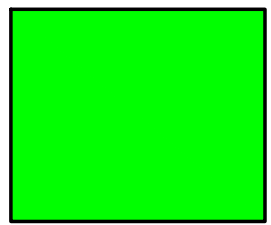
Project ref 1886/S/001

Date January 2019

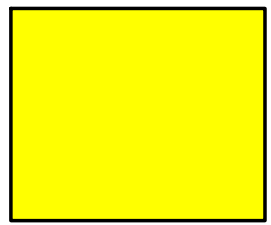
APPENDIX 6 – PROPOSED IMPERMEABLE AREA PLAN



• Drives - 4531m² + 10% for urban creep in the calculations



• Road - 5260m².



• Roof - 5603m² + 10% for urban creep in the calculations

• Total - 16,410m².

GENERAL NOTES

1. All dimensions are in metres unless otherwise stated.
2. All levels are in metres.
3. This drawing is to be read in conjunction with all relevant Engineers and Architect's drawings, Specifications, Reports and Engineering Details.
4. Do not scale from this drawing.



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E:enquiries@seastructuralengineers.co.uk

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Land North of Chestnut Terrace, Sutton Bridge

Title

Flood Risk Assessment

Sheet no. 21

Project ref 1886/S/001

Date January 2019

APPENDIX 7 – GREENFIELD RUNOFF CALCULATIONS

Calculated by: Civils atsea
Site name: Land North of Chestnut Avenue
Site location: Sutton Bridge

Site coordinates
Latitude: 52.77413° N
Longitude: 0.18047° E

This is an estimation of the greenfield runoff rate limits that are needed to meet normal best practice criteria in line with Environment Agency guidance "Preliminary rainfall runoff management for developments", W5-074/A/TR1/1 rev. E (2012) and the SuDS Manual, C753 (Ciria, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Reference: 6520212
Date: 2019-01-27T00:32:51

Methodology

IH124

Site characteristics

Total site area (ha)	1.641
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Methodology

Qbar estimation method	Calculate from SPR and SAAR
SPR estimation method	Calculate from SOIL type

	Default	Edited
SOIL type	2	2
HOST class	---	---
SPR/SPRHOST	0.3	0.3

Hydrological characteristics

	Default	Edited
SAAR (mm)	583	583
Hydrological region	5	5
Growth curve factor: 1 year	0.87	0.87
Growth curve factor: 30 year	2.45	2.45
Growth curve factor: 100 year	3.56	3.56

Notes:

(1) Is $Q_{BAR} < 2.0$ l/s/ha?

Normally limiting discharge rates which are less than 2.0 l/s/ha are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consents are usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set in which case blockage work must be addressed by using appropriate drainage elements

(3) Is $SPR/SPRHOST \leq 0.3$?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite may be a requirement for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited
Qbar (l/s)	2.41	2.41
1 in 1 year (l/s)	2.1	2.1
1 in 30 years (l/s)	5.92	5.92
1 in 100 years (l/s)	8.6	8.6



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T: 07384 706869

E:enquiries@seastructuralengineers.co.uk

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Project

Land North of Chestnut Terrace, Sutton Bridge

Title

Flood Risk Assessment

Sheet no. 22

Project ref 1886/S/001

Date January 2019

APPENDIX 8 – 1in1, 1in30 and 1in100+40% STORM WATER CALCULLATIONS

Rainfall Methodology	FSR
Return Period (years)	2
Additional Flow (%)	0
FSR Region	England and Wales
M5-60 (mm)	20.000
Ratio-R	0.400
CV	0.750
Time of Entry (mins)	4.00
Maximum Time of Concentration (mins)	30.00
Maximum Rainfall (mm/hr)	50.0
Minimum Velocity (m/s)	1.00
Connection Type	Level Soffits
Minimum Backdrop Height (m)	0.000
Preferred Cover Depth (m)	1.200
Include Intermediate Ground	
Enforce best practice design rules	

	Name	Area (ha)	T of E (mins)	Add Inflow (l/s)	Cover Level (m)	Node Type	Manhole Type	Diameter (mm)	Width (mm)	Easting (m)	Northing (m)	Depth (m)	Notes
	S1	0.092	4.00		3.800	Manhole	Adoptable	1500				1.672	
	S2	0.092	4.00		3.800	Manhole	Adoptable	1500				1.726	
	S3	0.092	4.00		3.800	Manhole	Adoptable	1500				1.824	
	S4	0.092	4.00		3.800	Manhole	Adoptable	1500				2.002	
	S5	0.092	4.00		3.800	Manhole	Adoptable	1500				1.650	
	S6	0.092	4.00		3.800	Manhole	Adoptable	1500				1.694	
	S7	0.092	4.00		3.800	Manhole	Adoptable	1500				1.766	
	S8	0.092	4.00		3.800	Manhole	Adoptable	1500				1.809	
	S9	0.092	4.00		3.800	Manhole	Adoptable	1500				1.872	
	S10	0.092	4.00		3.800	Manhole	Adoptable	1500				1.947	
	S11	0.092	4.00		3.800	Manhole	Adoptable	1500				2.197	
	S12	0.092	4.00		3.800	Manhole	Adoptable	1500				2.279	
	S13	0.092	4.00		3.800	Manhole	Adoptable	1500				2.355	
	S14				3.500	Manhole	Adoptable	600				2.103	
	S15	0.092	4.00		3.800	Manhole	Adoptable	1500				1.500	
	S16	0.092	4.00		3.800	Manhole	Adoptable	1500				1.500	
	S17	0.092	4.00		3.800	Manhole	Adoptable	1500				1.709	
	S18				3.500	Manhole	Adoptable	600				2.181	
	S19	0.092	4.00		3.500	Manhole	Adoptable	600				2.202	
	S20	0.077	4.00		3.700	Manhole	Adoptable	1500				2.415	
	S21				3.600	Manhole	Adoptable	2400				2.450	
	S22				3.800	Manhole	Adoptable	1800				2.700	

	Name	US Node	DS Node	Length (m)	ks (mm) / n	Velocity Equation	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	Link Type	T of C (mins)	Rain (mm/hr)	Con Offset (m)	Min DS IL (m)	Lateral Area (ha)	Lateral Ins Point (%)	Lateral T of E (mins)
?	1.000	S1	S3	76.068	0.600	Colebrook-White	2.128	1.976	0.152	500.0	600	Circular	5.17	50.0					
?	2.000	S2	S3	49.158	0.600	Colebrook-White	2.074	1.976	0.098	500.0	600	Circular	4.76	50.0					
	1.001	S3	S4	88.948	0.600	Colebrook-White	1.976	1.798	0.178	500.0	600	Circular	6.54	50.0					
	1.002	S4	S11	97.264	0.600	Colebrook-White	1.798	1.603	0.195	500.0	600	Circular	8.04	50.0					
	3.000	S5	S6	11.073	0.600	Colebrook-White	2.150	2.106	0.044	250.0	450	Circular	4.14	50.0					
	3.001	S6	S7	17.937	0.600	Colebrook-White	2.106	2.034	0.072	250.0	450	Circular	4.38	50.0					
	3.002	S7	S8	10.841	0.600	Colebrook-White	2.034	1.991	0.043	250.0	450	Circular	4.52	50.0					
	3.003	S8	S9	15.630	0.600	Colebrook-White	1.991	1.928	0.063	250.0	450	Circular	4.72	50.0					
	3.004	S9	S10	18.651	0.600	Colebrook-White	1.928	1.853	0.075	250.0	450	Circular	4.96	50.0					
	3.005	S10	S11	19.059	0.600	Colebrook-White	1.853	1.753	0.100	190.6	450	Circular	5.18	50.0					
	1.003	S11	S12	40.772	0.600	Colebrook-White	1.603	1.521	0.082	500.0	600	Circular	8.67	50.0					
	1.004	S12	S13	38.220	0.600	Colebrook-White	1.521	1.445	0.076	500.0	600	Circular	9.26	50.0					
	1.005	S13	S14	24.182	0.600	Colebrook-White	1.445	1.397	0.048	500.0	600	Circular	9.63	50.0					
	1.006	S14	S19	49.553	0.600	Colebrook-White	1.397	1.298	0.099	500.0	600	Circular	10.39	49.3					
	4.000	S15	S17	38.867	0.600	Colebrook-White	2.300	2.091	0.209	186.0	300	Circular	4.56	50.0					
?	5.000	S16	S17	52.139	0.600	Colebrook-White	2.300	2.091	0.209	250.0	300	Circular	4.88	50.0					
	4.001	S17	S18	16.488	0.600	Colebrook-White	2.091	1.619	0.472	34.9	300	Circular	4.98	50.0					
	4.002	S18	S19	10.505	0.600	Colebrook-White	1.319	1.298	0.021	500.0	600	Circular	5.14	50.0					
	1.007	S19	S20	6.613	0.600	Colebrook-White	1.298	1.285	0.013	500.0	600	Circular	10.49	49.0					
	1.008	S20	S21	67.570	0.600	Colebrook-White	1.285	1.150	0.135	500.0	600	Circular	11.54	46.5					
	1.009	S21	S22	7.129	0.600	Colebrook-White	1.150	1.100	0.050	142.6	600	Circular	11.59	46.4					

	Name	US Node	DS Node	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Minimum Depth (m)	Maximum Depth (m)	Σ Area (ha)	Σ Add Inflow (ha)	Pro Depth (mm)	Pro Velocity (m/s)	Notes
?	1.000	S1	S3	1.082	305.9	12.5	1.072	1.224	1.072	1.224	0.092	0.0	82	0.542	Upstream Depth is less than the specified minimum
?	2.000	S2	S3	1.082	305.9	12.5	1.126	1.224	1.126	1.224	0.092	0.0	82	0.542	Upstream Depth is less than the specified minimum
	1.001	S3	S4	1.082	305.9	37.4	1.224	1.402	1.224	1.402	0.276	0.0	140	0.743	
	1.002	S4	S11	1.082	305.9	49.9	1.402	1.597	1.402	1.597	0.368	0.0	163	0.806	
	3.000	S5	S6	1.281	203.7	12.5	1.200	1.244	1.200	1.244	0.092	0.0	74	0.718	
	3.001	S6	S7	1.281	203.7	24.9	1.244	1.316	1.244	1.316	0.184	0.0	105	0.877	
	3.002	S7	S8	1.281	203.7	37.4	1.316	1.359	1.316	1.359	0.276	0.0	130	0.984	
	3.003	S8	S9	1.281	203.7	49.9	1.359	1.422	1.359	1.422	0.368	0.0	151	1.065	
	3.004	S9	S10	1.281	203.7	62.3	1.422	1.497	1.422	1.497	0.460	0.0	170	1.131	
	3.005	S10	S11	1.469	233.6	74.8	1.497	1.597	1.497	1.597	0.552	0.0	174	1.313	
	1.003	S11	S12	1.082	305.9	137.2	1.597	1.679	1.597	1.679	1.012	0.0	282	1.054	
	1.004	S12	S13	1.082	305.9	149.6	1.679	1.755	1.679	1.755	1.104	0.0	296	1.076	
	1.005	S13	S14	1.082	305.9	162.1	1.755	1.503	1.503	1.755	1.196	0.0	311	1.097	
	1.006	S14	S19	1.082	305.9	159.7	1.503	1.602	1.503	1.602	1.196	0.0	308	1.093	
	4.000	S15	S17	1.149	81.2	12.5	1.200	1.409	1.200	1.409	0.092	0.0	79	0.837	
?	5.000	S16	S17	0.990	70.0	12.5	1.200	1.409	1.200	1.409	0.092	0.0	85	0.752	Velocity is less than the specified minimum
	4.001	S17	S18	2.669	188.6	37.4	1.409	1.581	1.409	1.581	0.276	0.0	90	2.092	
	4.002	S18	S19	1.082	305.9	37.4	1.581	1.602	1.581	1.602	0.276	0.0	140	0.743	
	1.007	S19	S20	1.082	305.9	207.7	1.602	1.815	1.602	1.815	1.564	0.0	364	1.159	
	1.008	S20	S21	1.082	305.9	207.0	1.815	1.850	1.815	1.850	1.641	0.0	362	1.158	
	1.009	S21	S22	2.037	576.0	206.4	1.850	2.100	1.850	2.100	1.641	0.0	248	1.876	

Link Name	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)	US Node Name	Dia (mm)	Width (mm)	Node Type	MH Type	DS Node Name	Dia (mm)	Width (mm)	Node Type	MH Type
1.000	76.068	500.0	600	Circular	3.800	2.128	1.072	3.800	1.976	1.224	S1	1500		Manhole	Adoptable	S3	1500		Manhole	Adoptable
2.000	49.158	500.0	600	Circular	3.800	2.074	1.126	3.800	1.976	1.224	S2	1500		Manhole	Adoptable	S3	1500		Manhole	Adoptable
1.001	88.948	500.0	600	Circular	3.800	1.976	1.224	3.800	1.798	1.402	S3	1500		Manhole	Adoptable	S4	1500		Manhole	Adoptable
1.002	97.264	500.0	600	Circular	3.800	1.798	1.402	3.800	1.603	1.597	S4	1500		Manhole	Adoptable	S11	1500		Manhole	Adoptable
3.000	11.073	250.0	450	Circular	3.800	2.150	1.200	3.800	2.106	1.244	S5	1500		Manhole	Adoptable	S6	1500		Manhole	Adoptable
3.001	17.937	250.0	450	Circular	3.800	2.106	1.244	3.800	2.034	1.316	S6	1500		Manhole	Adoptable	S7	1500		Manhole	Adoptable
3.002	10.841	250.0	450	Circular	3.800	2.034	1.316	3.800	1.991	1.359	S7	1500		Manhole	Adoptable	S8	1500		Manhole	Adoptable
3.003	15.630	250.0	450	Circular	3.800	1.991	1.359	3.800	1.928	1.422	S8	1500		Manhole	Adoptable	S9	1500		Manhole	Adoptable
3.004	18.651	250.0	450	Circular	3.800	1.928	1.422	3.800	1.853	1.497	S9	1500		Manhole	Adoptable	S10	1500		Manhole	Adoptable
3.005	19.059	190.6	450	Circular	3.800	1.853	1.497	3.800	1.753	1.597	S10	1500		Manhole	Adoptable	S11	1500		Manhole	Adoptable
1.003	40.772	500.0	600	Circular	3.800	1.603	1.597	3.800	1.521	1.679	S11	1500		Manhole	Adoptable	S12	1500		Manhole	Adoptable
1.004	38.220	500.0	600	Circular	3.800	1.521	1.679	3.800	1.445	1.755	S12	1500		Manhole	Adoptable	S13	1500		Manhole	Adoptable
1.005	24.182	500.0	600	Circular	3.800	1.445	1.755	3.500	1.397	1.503	S13	1500		Manhole	Adoptable	S14	600		Manhole	Adoptable
1.006	49.553	500.0	600	Circular	3.500	1.397	1.503	3.500	1.298	1.602	S14	600		Manhole	Adoptable	S19	600		Manhole	Adoptable
4.000	38.867	186.0	300	Circular	3.800	2.300	1.200	3.800	2.091	1.409	S15	1500		Manhole	Adoptable	S17	1500		Manhole	Adoptable
5.000	52.139	250.0	300	Circular	3.800	2.300	1.200	3.800	2.091	1.409	S16	1500		Manhole	Adoptable	S17	1500		Manhole	Adoptable
4.001	16.488	34.9	300	Circular	3.800	2.091	1.409	3.500	1.619	1.581	S17	1500		Manhole	Adoptable	S18	600		Manhole	Adoptable
4.002	10.505	500.0	600	Circular	3.500	1.319	1.581	3.500	1.298	1.602	S18	600		Manhole	Adoptable	S19	600		Manhole	Adoptable
1.007	6.613	500.0	600	Circular	3.500	1.298	1.602	3.700	1.285	1.815	S19	600		Manhole	Adoptable	S20	1500		Manhole	Adoptable
1.008	67.570	500.0	600	Circular	3.700	1.285	1.815	3.600	1.150	1.850	S20	1500		Manhole	Adoptable	S21	2400		Manhole	Adoptable
1.009	7.129	142.6	600	Circular	3.600	1.150	1.850	3.800	1.100	2.100	S21	2400		Manhole	Adoptable	S22	1800		Manhole	Adoptable

Rainfall Methodology	FSR		Return Period (years)	Climate Change (%)
FSR Region	England and Wales		1	0
M5-60 (mm)	20.000			
Ratio-R	0.400			
Summer CV	0.750			
Winter CV	0.840			
Analysis Speed	Detailed			
Skip Steady State	x			
Drain Down Time (mins)	240			
Additional Storage (m³/ha)	20.0			
Storm Durations (mins)	15			
	30			
	60			
	120			
	180			
	240			
	360			
	480			
	600			
	720			
	960			
	1440			
	2160			
	2880			
	4320			
	5760			
	7200			
	8640			
	10080			
Check Discharge Rate(s)	x			
1 year (l/s)				
30 year (l/s)				

100 year (l/s)				
Check Discharge Volume	x			
100 year 360 minute (m³)				

Hydro-Brake®												
Node	Flap Valve	Online / Offline	Replaces Downstream Link	Loop to Node	Invert Level (m)	Design Depth (m)	Design Flow (l/s)	Objective	Sump Available	Product Number	Min Outlet Diameter (m)	Min Node Diameter (mm)
S21	x	Online	x		1.150	1.650	5.0	(HE) Minimise upstream storage		CTL-SHE-0096-5000-1650-5000	0.150	1200

Depth/Area/Inf Area									
Node	Base Inf Coefficient (m/hr)	Side Inf Coefficient (m/hr)	Safety Factor	Porosity	Invert Level (m)	Time to half empty (mins)	Depth (m)	Area (m ²)	Inf. Area (m ²)
S19	0.00000	0.00000	2.0	1.00	1.298	0	0.000	690.0	0.0
							1.502	690.0	0.0
							1.503	0.0	0.0

Node Size	
Node Losses	
Link Size	
Minimum Diameter (mm)	150
Link Length	
Maximum Length (m)	100.000
Coordinates	
Accuracy (m)	1.000
Crossings	
Cover Depth	
Minimum Cover Depth (m)	
Maximum Cover Depth (m)	3.000
Backdrops	
Minimum Backdrop Height (m)	
Maximum Backdrop Height (m)	1.500
Full Bore Velocity	
Minimum Full Bore Velocity (m/s)	
Maximum Full Bore Velocity (m/s)	3.000
Proportional Velocity	
Return Period (years)	
Minimum Proportional Velocity (m/s)	0.750
Maximum Proportional Velocity (m/s)	3.000
Surcharged Depth	
Return Period (years)	
Maximum Surcharged Depth (m)	0.100
Flooding	
Return Period (years)	30
Discharge Rates	
1 year (l/s)	
30 year (l/s)	
100 year (l/s)	
Discharge Volume	

100 year 360 minute (m³)	
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Results for 1 year Critical Storm Duration. Lowest mass balance: 99.78%															
Event	US Node ID	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status	Link ID	DS Node ID	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	S1	10	2.210	0.082	13.7	0.2347	0.0000	OK	1.000	S3	12.8	0.402	0.042	2.6716	
15 minute winter	S2	10	2.158	0.084	13.7	0.2369	0.0000	OK	2.000	S3	13.3	0.430	0.044	1.7283	
15 minute winter	S3	11	2.111	0.135	39.8	0.3753	0.0000	OK	1.001	S4	34.8	0.718	0.114	4.3168	
15 minute winter	S4	13	1.940	0.142	44.9	0.3806	0.0000	OK	1.002	S11	39.3	0.468	0.129	8.6267	
15 minute winter	S5	10	2.237	0.087	13.7	0.2512	0.0000	OK	3.000	S6	13.6	0.507	0.067	0.3025	
15 minute winter	S6	10	2.224	0.118	27.3	0.3372	0.0000	OK	3.001	S7	27.1	0.644	0.133	0.7591	
15 minute winter	S7	10	2.196	0.162	40.8	0.4560	0.0000	OK	3.002	S8	40.2	0.731	0.197	0.5965	
15 minute winter	S8	10	2.170	0.179	53.9	0.4972	0.0000	OK	3.003	S9	53.1	0.858	0.261	0.9681	
15 minute winter	S9	10	2.122	0.194	66.8	0.5332	0.0000	OK	3.004	S10	65.6	1.014	0.322	1.2105	
15 minute winter	S10	11	2.046	0.193	79.3	0.5221	0.0000	OK	3.005	S11	78.9	1.289	0.338	1.1670	
15 minute winter	S11	12	1.880	0.277	123.9	0.7227	0.0000	OK	1.003	S12	117.5	0.898	0.384	5.3430	
15 minute winter	S12	12	1.811	0.290	126.0	0.7462	0.0000	OK	1.004	S13	123.2	0.904	0.403	5.2392	
15 minute winter	S13	12	1.743	0.298	131.7	0.7583	0.0000	OK	1.005	S14	131.9	0.997	0.431	3.2465	
15 minute winter	S14	12	1.677	0.280	131.9	0.0793	0.0000	OK	1.006	S19	135.9	2.068	0.444	3.5375	
15 minute summer	S15	10	2.383	0.083	13.7	0.2480	0.0000	OK	4.000	S17	13.8	0.760	0.170	0.7075	
15 minute summer	S16	10	2.389	0.089	13.7	0.2660	0.0000	OK	5.000	S17	13.7	0.719	0.195	0.9913	
15 minute winter	S17	10	2.191	0.100	41.1	0.2858	0.0000	OK	4.001	S18	40.2	2.046	0.213	0.3243	
15 minute summer	S18	9	1.607	0.288	40.0	0.0814	0.0000	OK	4.002	S19	41.8	1.641	0.137	0.7069	
480 minute winter	S19	456	1.593	0.295	27.1	203.5840	0.0000	OK	1.007	S20	4.8	0.377	0.016	0.9357	
480 minute winter	S20	456	1.593	0.308	6.0	0.7396	0.0000	OK	1.008	S21	5.3	0.168	0.017	12.4389	
480 minute winter	S21	456	1.592	0.442	5.3	2.0019	0.0000	OK	1.009	S22	4.6	0.609	0.008	0.0542	161.4
480 minute winter	S22	456	1.138	0.038	4.6	0.0000	0.0000	OK							

Rainfall Methodology	FSR
Return Period (years)	2
Additional Flow (%)	0
FSR Region	England and Wales
M5-60 (mm)	20.000
Ratio-R	0.400
CV	0.750
Time of Entry (mins)	4.00
Maximum Time of Concentration (mins)	30.00
Maximum Rainfall (mm/hr)	50.0
Minimum Velocity (m/s)	1.00
Connection Type	Level Soffits
Minimum Backdrop Height (m)	0.000
Preferred Cover Depth (m)	1.200
Include Intermediate Ground	
Enforce best practice design rules	

	Name	Area (ha)	T of E (mins)	Add Inflow (l/s)	Cover Level (m)	Node Type	Manhole Type	Diameter (mm)	Width (mm)	Easting (m)	Northing (m)	Depth (m)	Notes
	S1	0.092	4.00		3.800	Manhole	Adoptable	1500				1.672	
	S2	0.092	4.00		3.800	Manhole	Adoptable	1500				1.726	
	S3	0.092	4.00		3.800	Manhole	Adoptable	1500				1.824	
	S4	0.092	4.00		3.800	Manhole	Adoptable	1500				2.002	
	S5	0.092	4.00		3.800	Manhole	Adoptable	1500				1.650	
	S6	0.092	4.00		3.800	Manhole	Adoptable	1500				1.694	
	S7	0.092	4.00		3.800	Manhole	Adoptable	1500				1.766	
	S8	0.092	4.00		3.800	Manhole	Adoptable	1500				1.809	
	S9	0.092	4.00		3.800	Manhole	Adoptable	1500				1.872	
	S10	0.092	4.00		3.800	Manhole	Adoptable	1500				1.947	
	S11	0.092	4.00		3.800	Manhole	Adoptable	1500				2.197	
	S12	0.092	4.00		3.800	Manhole	Adoptable	1500				2.279	
	S13	0.092	4.00		3.800	Manhole	Adoptable	1500				2.355	
	S14				3.500	Manhole	Adoptable	600				2.103	
	S15	0.092	4.00		3.800	Manhole	Adoptable	1500				1.500	
	S16	0.092	4.00		3.800	Manhole	Adoptable	1500				1.500	
	S17	0.092	4.00		3.800	Manhole	Adoptable	1500				1.709	
	S18				3.500	Manhole	Adoptable	600				2.181	
	S19	0.092	4.00		3.500	Manhole	Adoptable	600				2.202	
	S20	0.077	4.00		3.700	Manhole	Adoptable	1500				2.415	
	S21				3.600	Manhole	Adoptable	2400				2.450	
	S22				3.800	Manhole	Adoptable	1800				2.700	

	Name	US Node	DS Node	Length (m)	ks (mm) / n	Velocity Equation	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	Link Type	T of C (mins)	Rain (mm/hr)	Con Offset (m)	Min DS IL (m)	Lateral Area (ha)	Lateral Ins Point (%)	Lateral T of E (mins)
?	1.000	S1	S3	76.068	0.600	Colebrook-White	2.128	1.976	0.152	500.0	600	Circular	5.17	50.0					
?	2.000	S2	S3	49.158	0.600	Colebrook-White	2.074	1.976	0.098	500.0	600	Circular	4.76	50.0					
	1.001	S3	S4	88.948	0.600	Colebrook-White	1.976	1.798	0.178	500.0	600	Circular	6.54	50.0					
	1.002	S4	S11	97.264	0.600	Colebrook-White	1.798	1.603	0.195	500.0	600	Circular	8.04	50.0					
	3.000	S5	S6	11.073	0.600	Colebrook-White	2.150	2.106	0.044	250.0	450	Circular	4.14	50.0					
	3.001	S6	S7	17.937	0.600	Colebrook-White	2.106	2.034	0.072	250.0	450	Circular	4.38	50.0					
	3.002	S7	S8	10.841	0.600	Colebrook-White	2.034	1.991	0.043	250.0	450	Circular	4.52	50.0					
	3.003	S8	S9	15.630	0.600	Colebrook-White	1.991	1.928	0.063	250.0	450	Circular	4.72	50.0					
	3.004	S9	S10	18.651	0.600	Colebrook-White	1.928	1.853	0.075	250.0	450	Circular	4.96	50.0					
	3.005	S10	S11	19.059	0.600	Colebrook-White	1.853	1.753	0.100	190.6	450	Circular	5.18	50.0					
	1.003	S11	S12	40.772	0.600	Colebrook-White	1.603	1.521	0.082	500.0	600	Circular	8.67	50.0					
	1.004	S12	S13	38.220	0.600	Colebrook-White	1.521	1.445	0.076	500.0	600	Circular	9.26	50.0					
	1.005	S13	S14	24.182	0.600	Colebrook-White	1.445	1.397	0.048	500.0	600	Circular	9.63	50.0					
	1.006	S14	S19	49.553	0.600	Colebrook-White	1.397	1.298	0.099	500.0	600	Circular	10.39	49.3					
	4.000	S15	S17	38.867	0.600	Colebrook-White	2.300	2.091	0.209	186.0	300	Circular	4.56	50.0					
?	5.000	S16	S17	52.139	0.600	Colebrook-White	2.300	2.091	0.209	250.0	300	Circular	4.88	50.0					
	4.001	S17	S18	16.488	0.600	Colebrook-White	2.091	1.619	0.472	34.9	300	Circular	4.98	50.0					
	4.002	S18	S19	10.505	0.600	Colebrook-White	1.319	1.298	0.021	500.0	600	Circular	5.14	50.0					
	1.007	S19	S20	6.613	0.600	Colebrook-White	1.298	1.285	0.013	500.0	600	Circular	10.49	49.0					
	1.008	S20	S21	67.570	0.600	Colebrook-White	1.285	1.150	0.135	500.0	600	Circular	11.54	46.5					
	1.009	S21	S22	7.129	0.600	Colebrook-White	1.150	1.100	0.050	142.6	600	Circular	11.59	46.4					

	Name	US Node	DS Node	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Minimum Depth (m)	Maximum Depth (m)	Σ Area (ha)	Σ Add Inflow (ha)	Pro Depth (mm)	Pro Velocity (m/s)	Notes
?	1.000	S1	S3	1.082	305.9	12.5	1.072	1.224	1.072	1.224	0.092	0.0	82	0.542	Upstream Depth is less than the specified minimum
?	2.000	S2	S3	1.082	305.9	12.5	1.126	1.224	1.126	1.224	0.092	0.0	82	0.542	Upstream Depth is less than the specified minimum
	1.001	S3	S4	1.082	305.9	37.4	1.224	1.402	1.224	1.402	0.276	0.0	140	0.743	
	1.002	S4	S11	1.082	305.9	49.9	1.402	1.597	1.402	1.597	0.368	0.0	163	0.806	
	3.000	S5	S6	1.281	203.7	12.5	1.200	1.244	1.200	1.244	0.092	0.0	74	0.718	
	3.001	S6	S7	1.281	203.7	24.9	1.244	1.316	1.244	1.316	0.184	0.0	105	0.877	
	3.002	S7	S8	1.281	203.7	37.4	1.316	1.359	1.316	1.359	0.276	0.0	130	0.984	
	3.003	S8	S9	1.281	203.7	49.9	1.359	1.422	1.359	1.422	0.368	0.0	151	1.065	
	3.004	S9	S10	1.281	203.7	62.3	1.422	1.497	1.422	1.497	0.460	0.0	170	1.131	
	3.005	S10	S11	1.469	233.6	74.8	1.497	1.597	1.497	1.597	0.552	0.0	174	1.313	
	1.003	S11	S12	1.082	305.9	137.2	1.597	1.679	1.597	1.679	1.012	0.0	282	1.054	
	1.004	S12	S13	1.082	305.9	149.6	1.679	1.755	1.679	1.755	1.104	0.0	296	1.076	
	1.005	S13	S14	1.082	305.9	162.1	1.755	1.503	1.503	1.755	1.196	0.0	311	1.097	
	1.006	S14	S19	1.082	305.9	159.7	1.503	1.602	1.503	1.602	1.196	0.0	308	1.093	
	4.000	S15	S17	1.149	81.2	12.5	1.200	1.409	1.200	1.409	0.092	0.0	79	0.837	
?	5.000	S16	S17	0.990	70.0	12.5	1.200	1.409	1.200	1.409	0.092	0.0	85	0.752	Velocity is less than the specified minimum
	4.001	S17	S18	2.669	188.6	37.4	1.409	1.581	1.409	1.581	0.276	0.0	90	2.092	
	4.002	S18	S19	1.082	305.9	37.4	1.581	1.602	1.581	1.602	0.276	0.0	140	0.743	
	1.007	S19	S20	1.082	305.9	207.7	1.602	1.815	1.602	1.815	1.564	0.0	364	1.159	
	1.008	S20	S21	1.082	305.9	207.0	1.815	1.850	1.815	1.850	1.641	0.0	362	1.158	
	1.009	S21	S22	2.037	576.0	206.4	1.850	2.100	1.850	2.100	1.641	0.0	248	1.876	

Link Name	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)	US Node Name	Dia (mm)	Width (mm)	Node Type	MH Type	DS Node Name	Dia (mm)	Width (mm)	Node Type	MH Type
1.000	76.068	500.0	600	Circular	3.800	2.128	1.072	3.800	1.976	1.224	S1	1500		Manhole	Adoptable	S3	1500		Manhole	Adoptable
2.000	49.158	500.0	600	Circular	3.800	2.074	1.126	3.800	1.976	1.224	S2	1500		Manhole	Adoptable	S3	1500		Manhole	Adoptable
1.001	88.948	500.0	600	Circular	3.800	1.976	1.224	3.800	1.798	1.402	S3	1500		Manhole	Adoptable	S4	1500		Manhole	Adoptable
1.002	97.264	500.0	600	Circular	3.800	1.798	1.402	3.800	1.603	1.597	S4	1500		Manhole	Adoptable	S11	1500		Manhole	Adoptable
3.000	11.073	250.0	450	Circular	3.800	2.150	1.200	3.800	2.106	1.244	S5	1500		Manhole	Adoptable	S6	1500		Manhole	Adoptable
3.001	17.937	250.0	450	Circular	3.800	2.106	1.244	3.800	2.034	1.316	S6	1500		Manhole	Adoptable	S7	1500		Manhole	Adoptable
3.002	10.841	250.0	450	Circular	3.800	2.034	1.316	3.800	1.991	1.359	S7	1500		Manhole	Adoptable	S8	1500		Manhole	Adoptable
3.003	15.630	250.0	450	Circular	3.800	1.991	1.359	3.800	1.928	1.422	S8	1500		Manhole	Adoptable	S9	1500		Manhole	Adoptable
3.004	18.651	250.0	450	Circular	3.800	1.928	1.422	3.800	1.853	1.497	S9	1500		Manhole	Adoptable	S10	1500		Manhole	Adoptable
3.005	19.059	190.6	450	Circular	3.800	1.853	1.497	3.800	1.753	1.597	S10	1500		Manhole	Adoptable	S11	1500		Manhole	Adoptable
1.003	40.772	500.0	600	Circular	3.800	1.603	1.597	3.800	1.521	1.679	S11	1500		Manhole	Adoptable	S12	1500		Manhole	Adoptable
1.004	38.220	500.0	600	Circular	3.800	1.521	1.679	3.800	1.445	1.755	S12	1500		Manhole	Adoptable	S13	1500		Manhole	Adoptable
1.005	24.182	500.0	600	Circular	3.800	1.445	1.755	3.500	1.397	1.503	S13	1500		Manhole	Adoptable	S14	600		Manhole	Adoptable
1.006	49.553	500.0	600	Circular	3.500	1.397	1.503	3.500	1.298	1.602	S14	600		Manhole	Adoptable	S19	600		Manhole	Adoptable
4.000	38.867	186.0	300	Circular	3.800	2.300	1.200	3.800	2.091	1.409	S15	1500		Manhole	Adoptable	S17	1500		Manhole	Adoptable
5.000	52.139	250.0	300	Circular	3.800	2.300	1.200	3.800	2.091	1.409	S16	1500		Manhole	Adoptable	S17	1500		Manhole	Adoptable
4.001	16.488	34.9	300	Circular	3.800	2.091	1.409	3.500	1.619	1.581	S17	1500		Manhole	Adoptable	S18	600		Manhole	Adoptable
4.002	10.505	500.0	600	Circular	3.500	1.319	1.581	3.500	1.298	1.602	S18	600		Manhole	Adoptable	S19	600		Manhole	Adoptable
1.007	6.613	500.0	600	Circular	3.500	1.298	1.602	3.700	1.285	1.815	S19	600		Manhole	Adoptable	S20	1500		Manhole	Adoptable
1.008	67.570	500.0	600	Circular	3.700	1.285	1.815	3.600	1.150	1.850	S20	1500		Manhole	Adoptable	S21	2400		Manhole	Adoptable
1.009	7.129	142.6	600	Circular	3.600	1.150	1.850	3.800	1.100	2.100	S21	2400		Manhole	Adoptable	S22	1800		Manhole	Adoptable

Rainfall Methodology	FSR		Return Period (years)	Climate Change (%)
FSR Region	England and Wales		30	0
M5-60 (mm)	20.000			
Ratio-R	0.400			
Summer CV	0.750			
Winter CV	0.840			
Analysis Speed	Detailed			
Skip Steady State	x			
Drain Down Time (mins)	240			
Additional Storage (m³/ha)	20.0			
Storm Durations (mins)	15			
	30			
	60			
	120			
	180			
	240			
	360			
	480			
	600			
	720			
	960			
	1440			
	2160			
	2880			
	4320			
	5760			
	7200			
	8640			
	10080			
Check Discharge Rate(s)	x			
1 year (l/s)				
30 year (l/s)				

100 year (l/s)				
Check Discharge Volume	x			
100 year 360 minute (m³)				

Hydro-Brake®												
Node	Flap Valve	Online / Offline	Replaces Downstream Link	Loop to Node	Invert Level (m)	Design Depth (m)	Design Flow (l/s)	Objective	Sump Available	Product Number	Min Outlet Diameter (m)	Min Node Diameter (mm)
S21	x	Online	x		1.150	1.650	5.0(HE)	Minimise upstream storage		CTL-SHE-0096-5000-1650-5000	0.150	1200

Depth/Area/Inf Area									
Node	Base Inf Coefficient (m/hr)	Side Inf Coefficient (m/hr)	Safety Factor	Porosity	Invert Level (m)	Time to half empty (mins)	Depth (m)	Area (m ²)	Inf. Area (m ²)
S19	0.00000	0.00000	2.0	1.00	1.298	60	0.000	690.0	0.0
							1.502	690.0	0.0
							1.503	0.0	0.0

Node Size	
Node Losses	
Link Size	
Minimum Diameter (mm)	150
Link Length	
Maximum Length (m)	100.000
Coordinates	
Accuracy (m)	1.000
Crossings	
Cover Depth	
Minimum Cover Depth (m)	
Maximum Cover Depth (m)	3.000
Backdrops	
Minimum Backdrop Height (m)	
Maximum Backdrop Height (m)	1.500
Full Bore Velocity	
Minimum Full Bore Velocity (m/s)	
Maximum Full Bore Velocity (m/s)	3.000
Proportional Velocity	
Return Period (years)	
Minimum Proportional Velocity (m/s)	0.750
Maximum Proportional Velocity (m/s)	3.000
Surcharged Depth	
Return Period (years)	
Maximum Surcharged Depth (m)	0.100
Flooding	
Return Period (years)	30
Discharge Rates	
1 year (l/s)	
30 year (l/s)	
100 year (l/s)	
Discharge Volume	

100 year 360 minute (m³)	
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Results for 30 year Critical Storm Duration. Lowest mass balance: 99.89%															
Event	US Node ID	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status	Link ID	DS Node ID	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	S1	10	2.257	0.129	33.7	0.3701	0.0000	OK	1.000	S3	32.5	0.496	0.106	5.1728	
15 minute winter	S2	11	2.208	0.134	33.7	0.3794	0.0000	OK	2.000	S3	32.1	0.517	0.105	3.4353	
15 minute winter	S3	11	2.195	0.219	98.3	0.6078	0.0000	OK	1.001	S4	91.5	0.845	0.299	11.7188	
15 minute winter	S4	12	2.155	0.357	120.2	0.9597	0.0000	OK	1.002	S11	110.2	0.608	0.360	20.9909	
15 minute winter	S5	10	2.361	0.211	33.7	0.6080	0.0000	OK	3.000	S6	32.0	0.525	0.157	0.9074	
15 minute winter	S6	10	2.357	0.251	65.6	0.7167	0.0000	OK	3.001	S7	62.6	0.667	0.307	1.8643	
15 minute winter	S7	10	2.345	0.311	96.3	0.8738	0.0000	OK	3.002	S8	93.4	0.773	0.459	1.3123	
15 minute winter	S8	10	2.323	0.332	127.1	0.9231	0.0000	OK	3.003	S9	124.6	0.968	0.612	2.0131	
15 minute winter	S9	11	2.279	0.351	158.3	0.9662	0.0000	OK	3.004	S10	155.4	1.197	0.763	2.4723	
15 minute winter	S10	11	2.203	0.350	189.0	0.9494	0.0000	OK	3.005	S11	184.6	1.554	0.790	2.5186	
15 minute winter	S11	12	2.116	0.513	278.3	1.3371	0.0000	OK	1.003	S12	270.1	1.062	0.883	10.4397	
960 minute winter	S12	930	2.056	0.535	24.0	1.3767	0.0000	OK	1.004	S13	23.2	0.569	0.076	10.4501	
960 minute winter	S13	930	2.056	0.611	25.2	1.5559	0.0000	SURCHARGED	1.005	S14	24.4	0.579	0.080	6.8115	
960 minute winter	S14	930	2.056	0.659	24.4	0.1864	0.0000	SURCHARGED	1.006	S19	23.6	0.654	0.077	13.9580	
15 minute summer	S15	10	2.435	0.135	33.7	0.4035	0.0000	OK	4.000	S17	34.0	0.928	0.419	1.4242	
15 minute summer	S16	10	2.446	0.146	33.7	0.4372	0.0000	OK	5.000	S17	33.9	0.884	0.485	1.9979	
15 minute winter	S17	10	2.266	0.175	101.5	0.4974	0.0000	OK	4.001	S18	100.3	2.538	0.532	0.6518	
960 minute winter	S18	930	2.056	0.737	6.0	0.2085	0.0000	SURCHARGED	4.002	S19	5.8	0.453	0.019	2.9590	
960 minute winter	S19	930	2.056	0.758	31.3	523.6243	0.0000	SURCHARGED	1.007	S20	4.8	0.373	0.016	1.8627	
960 minute winter	S20	930	2.056	0.771	6.3	1.8534	0.0000	SURCHARGED	1.008	S21	5.4	0.166	0.018	19.0329	
960 minute winter	S21	930	2.056	0.906	5.4	4.0970	0.0000	SURCHARGED	1.009	S22	4.6	0.609	0.008	0.0542	260.8
15 minute winter	S22	31	1.138	0.038	4.6	0.0000	0.0000	OK							

Rainfall Methodology	FSR
Return Period (years)	2
Additional Flow (%)	0
FSR Region	England and Wales
M5-60 (mm)	20.000
Ratio-R	0.400
CV	0.750
Time of Entry (mins)	4.00
Maximum Time of Concentration (mins)	30.00
Maximum Rainfall (mm/hr)	50.0
Minimum Velocity (m/s)	1.00
Connection Type	Level Soffits
Minimum Backdrop Height (m)	0.000
Preferred Cover Depth (m)	1.200
Include Intermediate Ground	
Enforce best practice design rules	

	Name	Area (ha)	T of E (mins)	Add Inflow (l/s)	Cover Level (m)	Node Type	Manhole Type	Diameter (mm)	Width (mm)	Easting (m)	Northing (m)	Depth (m)	Notes
	S1	0.092	4.00		3.800	Manhole	Adoptable	1500				1.672	
	S2	0.092	4.00		3.800	Manhole	Adoptable	1500				1.726	
	S3	0.092	4.00		3.800	Manhole	Adoptable	1500				1.824	
	S4	0.092	4.00		3.800	Manhole	Adoptable	1500				2.002	
	S5	0.092	4.00		3.800	Manhole	Adoptable	1500				1.650	
	S6	0.092	4.00		3.800	Manhole	Adoptable	1500				1.694	
	S7	0.092	4.00		3.800	Manhole	Adoptable	1500				1.766	
	S8	0.092	4.00		3.800	Manhole	Adoptable	1500				1.809	
	S9	0.092	4.00		3.800	Manhole	Adoptable	1500				1.872	
	S10	0.092	4.00		3.800	Manhole	Adoptable	1500				1.947	
	S11	0.092	4.00		3.800	Manhole	Adoptable	1500				2.197	
	S12	0.092	4.00		3.800	Manhole	Adoptable	1500				2.279	
	S13	0.092	4.00		3.800	Manhole	Adoptable	1500				2.355	
	S14				3.500	Manhole	Adoptable	600				2.103	
	S15	0.092	4.00		3.800	Manhole	Adoptable	1500				1.500	
	S16	0.092	4.00		3.800	Manhole	Adoptable	1500				1.500	
	S17	0.092	4.00		3.800	Manhole	Adoptable	1500				1.709	
	S18				3.500	Manhole	Adoptable	600				2.181	
	S19	0.092	4.00		3.500	Manhole	Adoptable	600				2.202	
	S20	0.077	4.00		3.700	Manhole	Adoptable	1500				2.415	
	S21				3.600	Manhole	Adoptable	2400				2.450	
	S22				3.800	Manhole	Adoptable	1800				2.700	

	Name	US Node	DS Node	Length (m)	ks (mm) / n	Velocity Equation	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	Link Type	T of C (mins)	Rain (mm/hr)	Con Offset (m)	Min DS IL (m)	Lateral Area (ha)	Lateral Ins Point (%)	Lateral T of E (mins)
?	1.000	S1	S3	76.068	0.600	Colebrook-White	2.128	1.976	0.152	500.0	600	Circular	5.17	50.0					
?	2.000	S2	S3	49.158	0.600	Colebrook-White	2.074	1.976	0.098	500.0	600	Circular	4.76	50.0					
	1.001	S3	S4	88.948	0.600	Colebrook-White	1.976	1.798	0.178	500.0	600	Circular	6.54	50.0					
	1.002	S4	S11	97.264	0.600	Colebrook-White	1.798	1.603	0.195	500.0	600	Circular	8.04	50.0					
	3.000	S5	S6	11.073	0.600	Colebrook-White	2.150	2.106	0.044	250.0	450	Circular	4.14	50.0					
	3.001	S6	S7	17.937	0.600	Colebrook-White	2.106	2.034	0.072	250.0	450	Circular	4.38	50.0					
	3.002	S7	S8	10.841	0.600	Colebrook-White	2.034	1.991	0.043	250.0	450	Circular	4.52	50.0					
	3.003	S8	S9	15.630	0.600	Colebrook-White	1.991	1.928	0.063	250.0	450	Circular	4.72	50.0					
	3.004	S9	S10	18.651	0.600	Colebrook-White	1.928	1.853	0.075	250.0	450	Circular	4.96	50.0					
	3.005	S10	S11	19.059	0.600	Colebrook-White	1.853	1.753	0.100	190.6	450	Circular	5.18	50.0					
	1.003	S11	S12	40.772	0.600	Colebrook-White	1.603	1.521	0.082	500.0	600	Circular	8.67	50.0					
	1.004	S12	S13	38.220	0.600	Colebrook-White	1.521	1.445	0.076	500.0	600	Circular	9.26	50.0					
	1.005	S13	S14	24.182	0.600	Colebrook-White	1.445	1.397	0.048	500.0	600	Circular	9.63	50.0					
	1.006	S14	S19	49.553	0.600	Colebrook-White	1.397	1.298	0.099	500.0	600	Circular	10.39	49.3					
	4.000	S15	S17	38.867	0.600	Colebrook-White	2.300	2.091	0.209	186.0	300	Circular	4.56	50.0					
?	5.000	S16	S17	52.139	0.600	Colebrook-White	2.300	2.091	0.209	250.0	300	Circular	4.88	50.0					
	4.001	S17	S18	16.488	0.600	Colebrook-White	2.091	1.619	0.472	34.9	300	Circular	4.98	50.0					
	4.002	S18	S19	10.505	0.600	Colebrook-White	1.319	1.298	0.021	500.0	600	Circular	5.14	50.0					
	1.007	S19	S20	6.613	0.600	Colebrook-White	1.298	1.285	0.013	500.0	600	Circular	10.49	49.0					
	1.008	S20	S21	67.570	0.600	Colebrook-White	1.285	1.150	0.135	500.0	600	Circular	11.54	46.5					
	1.009	S21	S22	7.129	0.600	Colebrook-White	1.150	1.100	0.050	142.6	600	Circular	11.59	46.4					

	Name	US Node	DS Node	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Minimum Depth (m)	Maximum Depth (m)	Σ Area (ha)	Σ Add Inflow (ha)	Pro Depth (mm)	Pro Velocity (m/s)	Notes
?	1.000	S1	S3	1.082	305.9	12.5	1.072	1.224	1.072	1.224	0.092	0.0	82	0.542	Upstream Depth is less than the specified minimum
?	2.000	S2	S3	1.082	305.9	12.5	1.126	1.224	1.126	1.224	0.092	0.0	82	0.542	Upstream Depth is less than the specified minimum
	1.001	S3	S4	1.082	305.9	37.4	1.224	1.402	1.224	1.402	0.276	0.0	140	0.743	
	1.002	S4	S11	1.082	305.9	49.9	1.402	1.597	1.402	1.597	0.368	0.0	163	0.806	
	3.000	S5	S6	1.281	203.7	12.5	1.200	1.244	1.200	1.244	0.092	0.0	74	0.718	
	3.001	S6	S7	1.281	203.7	24.9	1.244	1.316	1.244	1.316	0.184	0.0	105	0.877	
	3.002	S7	S8	1.281	203.7	37.4	1.316	1.359	1.316	1.359	0.276	0.0	130	0.984	
	3.003	S8	S9	1.281	203.7	49.9	1.359	1.422	1.359	1.422	0.368	0.0	151	1.065	
	3.004	S9	S10	1.281	203.7	62.3	1.422	1.497	1.422	1.497	0.460	0.0	170	1.131	
	3.005	S10	S11	1.469	233.6	74.8	1.497	1.597	1.497	1.597	0.552	0.0	174	1.313	
	1.003	S11	S12	1.082	305.9	137.2	1.597	1.679	1.597	1.679	1.012	0.0	282	1.054	
	1.004	S12	S13	1.082	305.9	149.6	1.679	1.755	1.679	1.755	1.104	0.0	296	1.076	
	1.005	S13	S14	1.082	305.9	162.1	1.755	1.503	1.503	1.755	1.196	0.0	311	1.097	
	1.006	S14	S19	1.082	305.9	159.7	1.503	1.602	1.503	1.602	1.196	0.0	308	1.093	
	4.000	S15	S17	1.149	81.2	12.5	1.200	1.409	1.200	1.409	0.092	0.0	79	0.837	
?	5.000	S16	S17	0.990	70.0	12.5	1.200	1.409	1.200	1.409	0.092	0.0	85	0.752	Velocity is less than the specified minimum
	4.001	S17	S18	2.669	188.6	37.4	1.409	1.581	1.409	1.581	0.276	0.0	90	2.092	
	4.002	S18	S19	1.082	305.9	37.4	1.581	1.602	1.581	1.602	0.276	0.0	140	0.743	
	1.007	S19	S20	1.082	305.9	207.7	1.602	1.815	1.602	1.815	1.564	0.0	364	1.159	
	1.008	S20	S21	1.082	305.9	207.0	1.815	1.850	1.815	1.850	1.641	0.0	362	1.158	
	1.009	S21	S22	2.037	576.0	206.4	1.850	2.100	1.850	2.100	1.641	0.0	248	1.876	

Link Name	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)	US Node Name	Dia (mm)	Width (mm)	Node Type	MH Type	DS Node Name	Dia (mm)	Width (mm)	Node Type	MH Type
1.000	76.068	500.0	600	Circular	3.800	2.128	1.072	3.800	1.976	1.224	S1	1500		Manhole	Adoptable	S3	1500		Manhole	Adoptable
2.000	49.158	500.0	600	Circular	3.800	2.074	1.126	3.800	1.976	1.224	S2	1500		Manhole	Adoptable	S3	1500		Manhole	Adoptable
1.001	88.948	500.0	600	Circular	3.800	1.976	1.224	3.800	1.798	1.402	S3	1500		Manhole	Adoptable	S4	1500		Manhole	Adoptable
1.002	97.264	500.0	600	Circular	3.800	1.798	1.402	3.800	1.603	1.597	S4	1500		Manhole	Adoptable	S11	1500		Manhole	Adoptable
3.000	11.073	250.0	450	Circular	3.800	2.150	1.200	3.800	2.106	1.244	S5	1500		Manhole	Adoptable	S6	1500		Manhole	Adoptable
3.001	17.937	250.0	450	Circular	3.800	2.106	1.244	3.800	2.034	1.316	S6	1500		Manhole	Adoptable	S7	1500		Manhole	Adoptable
3.002	10.841	250.0	450	Circular	3.800	2.034	1.316	3.800	1.991	1.359	S7	1500		Manhole	Adoptable	S8	1500		Manhole	Adoptable
3.003	15.630	250.0	450	Circular	3.800	1.991	1.359	3.800	1.928	1.422	S8	1500		Manhole	Adoptable	S9	1500		Manhole	Adoptable
3.004	18.651	250.0	450	Circular	3.800	1.928	1.422	3.800	1.853	1.497	S9	1500		Manhole	Adoptable	S10	1500		Manhole	Adoptable
3.005	19.059	190.6	450	Circular	3.800	1.853	1.497	3.800	1.753	1.597	S10	1500		Manhole	Adoptable	S11	1500		Manhole	Adoptable
1.003	40.772	500.0	600	Circular	3.800	1.603	1.597	3.800	1.521	1.679	S11	1500		Manhole	Adoptable	S12	1500		Manhole	Adoptable
1.004	38.220	500.0	600	Circular	3.800	1.521	1.679	3.800	1.445	1.755	S12	1500		Manhole	Adoptable	S13	1500		Manhole	Adoptable
1.005	24.182	500.0	600	Circular	3.800	1.445	1.755	3.500	1.397	1.503	S13	1500		Manhole	Adoptable	S14	600		Manhole	Adoptable
1.006	49.553	500.0	600	Circular	3.500	1.397	1.503	3.500	1.298	1.602	S14	600		Manhole	Adoptable	S19	600		Manhole	Adoptable
4.000	38.867	186.0	300	Circular	3.800	2.300	1.200	3.800	2.091	1.409	S15	1500		Manhole	Adoptable	S17	1500		Manhole	Adoptable
5.000	52.139	250.0	300	Circular	3.800	2.300	1.200	3.800	2.091	1.409	S16	1500		Manhole	Adoptable	S17	1500		Manhole	Adoptable
4.001	16.488	34.9	300	Circular	3.800	2.091	1.409	3.500	1.619	1.581	S17	1500		Manhole	Adoptable	S18	600		Manhole	Adoptable
4.002	10.505	500.0	600	Circular	3.500	1.319	1.581	3.500	1.298	1.602	S18	600		Manhole	Adoptable	S19	600		Manhole	Adoptable
1.007	6.613	500.0	600	Circular	3.500	1.298	1.602	3.700	1.285	1.815	S19	600		Manhole	Adoptable	S20	1500		Manhole	Adoptable
1.008	67.570	500.0	600	Circular	3.700	1.285	1.815	3.600	1.150	1.850	S20	1500		Manhole	Adoptable	S21	2400		Manhole	Adoptable
1.009	7.129	142.6	600	Circular	3.600	1.150	1.850	3.800	1.100	2.100	S21	2400		Manhole	Adoptable	S22	1800		Manhole	Adoptable

Rainfall Methodology	FSR		Return Period (years)	Climate Change (%)
FSR Region	England and Wales		100	40
M5-60 (mm)	20.000			
Ratio-R	0.400			
Summer CV	0.750			
Winter CV	0.840			
Analysis Speed	Detailed			
Skip Steady State	x			
Drain Down Time (mins)	240			
Additional Storage (m³/ha)	20.0			
Storm Durations (mins)	15			
	30			
	60			
	120			
	180			
	240			
	360			
	480			
	600			
	720			
	960			
	1440			
	2160			
	2880			
	4320			
	5760			
	7200			
	8640			
	10080			
Check Discharge Rate(s)	x			
1 year (l/s)				
30 year (l/s)				

100 year (l/s)				
Check Discharge Volume	x			
100 year 360 minute (m³)				

Hydro-Brake®												
Node	Flap Valve	Online / Offline	Replaces Downstream Link	Loop to Node	Invert Level (m)	Design Depth (m)	Design Flow (l/s)	Objective	Sump Available	Product Number	Min Outlet Diameter (m)	Min Node Diameter (mm)
S21	x	Online	x		1.150	1.650	5.0(HE)	Minimise upstream storage		CTL-SHE-0096-5000-1650-5000	0.150	1200

Depth/Area/Inf Area									
Node	Base Inf Coefficient (m/hr)	Side Inf Coefficient (m/hr)	Safety Factor	Porosity	Invert Level (m)	Time to half empty (mins)	Depth (m)	Area (m ²)	Inf. Area (m ²)
S19	0.00000	0.00000	2.0	1.00	1.298		0.000	690.0	0.0
							1.502	690.0	0.0
							1.503	0.0	0.0

Node Size	
Node Losses	
Link Size	
Minimum Diameter (mm)	150
Link Length	
Maximum Length (m)	100.000
Coordinates	
Accuracy (m)	1.000
Crossings	
Cover Depth	
Minimum Cover Depth (m)	
Maximum Cover Depth (m)	3.000
Backdrops	
Minimum Backdrop Height (m)	
Maximum Backdrop Height (m)	1.500
Full Bore Velocity	
Minimum Full Bore Velocity (m/s)	
Maximum Full Bore Velocity (m/s)	3.000
Proportional Velocity	
Return Period (years)	
Minimum Proportional Velocity (m/s)	0.750
Maximum Proportional Velocity (m/s)	3.000
Surcharged Depth	
Return Period (years)	
Maximum Surcharged Depth (m)	0.100
Flooding	
Return Period (years)	30
Discharge Rates	
1 year (l/s)	
30 year (l/s)	
100 year (l/s)	
Discharge Volume	

100 year 360 minute (m³)	
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Results for 100 year +40% Critical Storm Duration. Lowest mass balance: 99.64%

Event	US Node ID	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status	Link ID	DS Node ID	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
1440 minute winter	S1	1410	2.785	0.657	2.6	1.8856	0.0000	SURCHARGED	1.000	S3	2.6	0.222	0.008	21.4266	
1440 minute winter	S2	1410	2.785	0.711	2.6	2.0156	0.0000	SURCHARGED	2.000	S3	2.6	0.222	0.008	13.8467	
1440 minute winter	S3	1410	2.785	0.809	7.8	2.2471	0.0000	SURCHARGED	1.001	S4	7.8	0.421	0.025	25.0546	
1440 minute winter	S4	1410	2.785	0.987	10.4	2.6524	0.0000	SURCHARGED	1.002	S11	9.5	0.306	0.031	27.3971	
15 minute winter	S5	11	3.219	1.069	61.2	3.0821	0.0000	SURCHARGED	3.000	S6	52.4	0.520	0.257	1.7544	
15 minute winter	S6	11	3.208	1.102	107.7	3.1453	0.0000	SURCHARGED	3.001	S7	104.9	0.669	0.515	2.8420	
15 minute winter	S7	11	3.165	1.131	157.1	3.1770	0.0000	SURCHARGED	3.002	S8	159.3	1.006	0.782	1.7177	
15 minute winter	S8	11	3.103	1.112	211.5	3.0957	0.0000	SURCHARGED	3.003	S9	215.5	1.360	1.058	2.4765	
15 minute winter	S9	11	2.971	1.043	267.7	2.8675	0.0000	SURCHARGED	3.004	S10	274.4	1.732	1.347	2.9551	
15 minute summer	S10	11	2.786	0.933	301.2	2.5303	0.0000	SURCHARGED	3.005	S11	293.5	1.852	1.256	3.0198	
1440 minute winter	S11	1410	2.785	1.182	26.2	3.0804	0.0000	SURCHARGED	1.003	S12	24.1	0.562	0.079	11.4845	
1440 minute winter	S12	1410	2.785	1.264	26.5	3.2560	0.0000	SURCHARGED	1.004	S13	25.4	0.516	0.083	10.7657	
1440 minute winter	S13	1410	2.785	1.340	27.8	3.4155	0.0000	SURCHARGED	1.005	S14	26.8	0.503	0.088	6.8115	
1440 minute winter	S14	1410	2.785	1.388	26.8	0.3929	0.0000	SURCHARGED	1.006	S19	26.2	0.682	0.086	13.9580	
1440 minute winter	S15	1410	2.785	0.485	2.6	1.4534	0.0000	SURCHARGED	4.000	S17	2.6	0.486	0.032	2.7370	
1440 minute winter	S16	1410	2.785	0.485	2.6	1.4534	0.0000	SURCHARGED	5.000	S17	2.6	0.463	0.037	3.6716	
1440 minute winter	S17	1410	2.785	0.694	7.8	1.9750	0.0000	SURCHARGED	4.001	S18	7.8	1.153	0.041	1.1611	
1440 minute winter	S18	1410	2.785	1.466	7.8	0.4150	0.0000	SURCHARGED	4.002	S19	7.7	0.503	0.025	2.9590	
1440 minute winter	S19	1410	2.785	1.487	36.5	1027.9970	0.0000	SURCHARGED	1.007	S20	4.9	0.345	0.016	1.8627	
1440 minute winter	S20	1410	2.785	1.500	6.0	3.6085	0.0000	SURCHARGED	1.008	S21	5.3	0.144	0.017	19.0329	
1440 minute winter	S21	1410	2.785	1.635	5.3	7.3985	0.0000	SURCHARGED	1.009	S22	4.9	0.620	0.009	0.0567	423.9
1440 minute winter	S22	1410	1.139	0.039	4.9	0.0000	0.0000	OK							



STRUCTURAL ENGINEERS

[CONSULTING CIVIL & STRUCTURAL ENGINEERS]

T: 07384 706869

E:enquiries@seaststructuralengineers.co.uk

Client

Lincoln Jack Ltd

Project

Land North of Chestnut Terrace, Sutton Bridge

Title

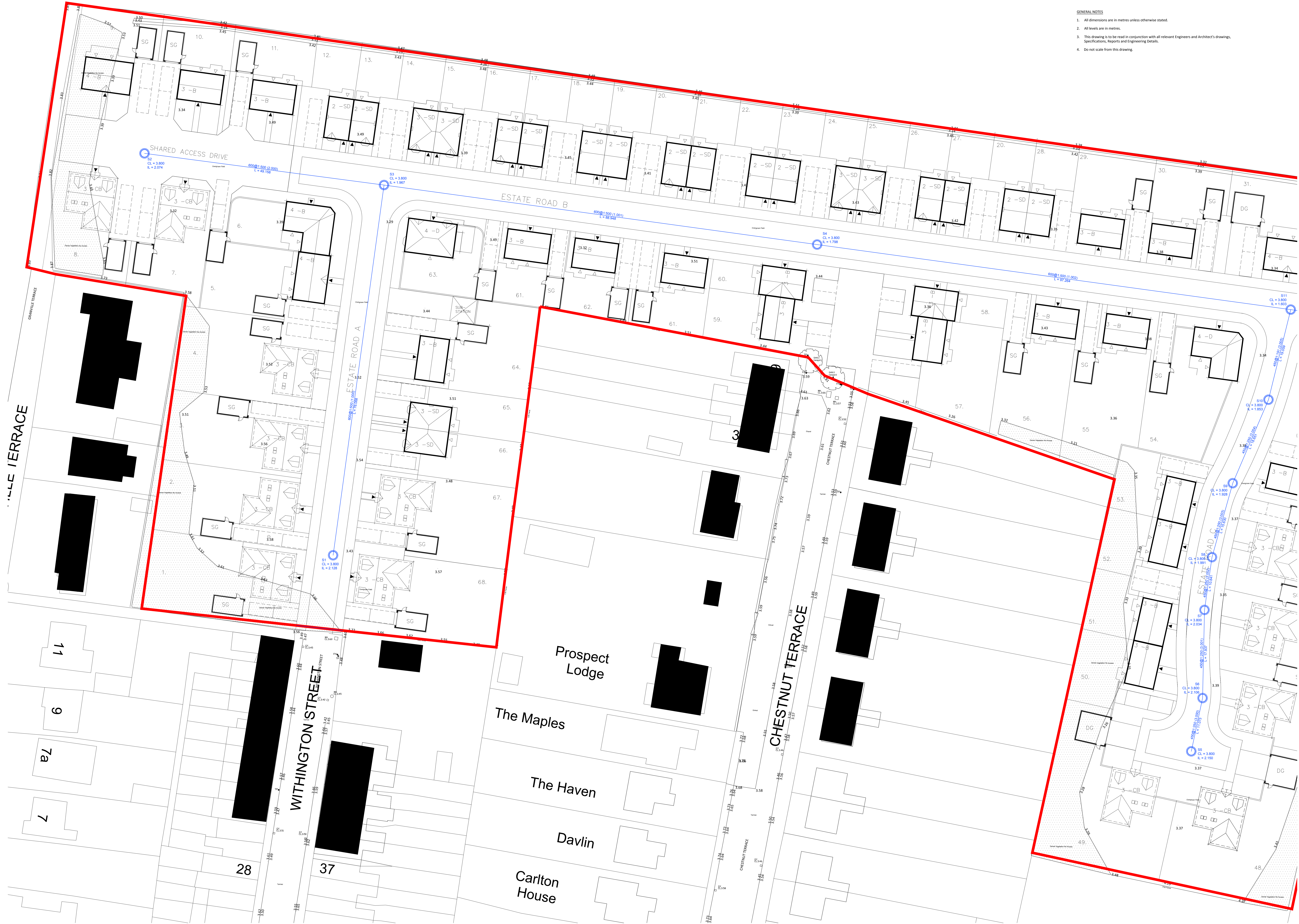
Flood Risk Assessment

Sheet no. 23

Project ref 1886/S/001

Date January 2019

APPENDIX 9 – PROPOSED DRAINAGE LAYOUT



- GENERAL NOTES
1. All dimensions are in metres unless otherwise stated.
 2. All levels are in metres.
 3. This drawing is to be read in conjunction with all relevant Engineers and Architect's drawings, Specifications, Reports and Engineering Details.
 4. Do not scale from this drawing.

PRELIMINARY DRAWING ONLY
This drawing is an indicative storm water drainage layout and should only be used for the planning application and relevant consultations.

- Drawing Key
- Proposed storm drainage run
 - Proposed storm PCC MH 1500Ø
 - Existing Anglian Water Chamber

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