

**Flood Risk Assessment and
Drainage Report
for the**

**Proposed Residential
Development
off**

**Moulton Road, Cowbit
Lincolnshire**

PE12 5JF

Prepared for

Mr P Smith

January 2017

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CONTENTS

1.0	DEVELOPMENT DESCRIPTION AND LOCATION	2
2.0	ASSESSMENT OF THE FLOOD RISK	3
3.0	CLIMATE CHANGE	5
4.0	DETAILED DEVELOPMENT AND FLOOD RISK MANAGEMENT PROPOSALS	6
5.0	SUSTAINABLE DRAINAGE SYSTEMS	6
6.0	OUTLINE DESIGN OF THE PROPOSED SURFACE WATER DRAINAGE SYSTEM	7
7.0	OFF SITE IMPACTS	9
8.0	RESIDUAL RISKS	9
9.0	FOUL SEWERAGE	9
10.0	CONCLUSIONS	10
11.0	APPENDIX 1 SUPPORTING INFORMATION	11

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Issue : 02
Author : G Shuttleworth
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1.0 DEVELOPMENT DESCRIPTION AND LOCATION

- 1.1. The proposed development is located off Moulton Road, Cowbit, Lincolnshire PE12 6XA. The OS Grid Reference of the application site is TF 267 180. The location of the site is shown on the drawings provided in Appendix 1.
- 1.2. The site covers approximately 0.88 hectares with dimensions of approximately 115m west to east and 70m north to south.
- 1.3. The site is bounded by Moulton Road to the north, the new A16 road to the east, Mill Dyke, an Internal Drainage Board dyke, to the south and existing residential housing to the west.
- 1.4. The site is currently used for agricultural.
- 1.5. The site falls gently from 2.8m AOD in the north west corner to 2.5m AOD in the south east corner.
- 1.6. Drawing 575-001 provided in Appendix 1 illustrates the levels across the site and the key drainage features.
- 1.7. It is proposed to construct up to 17 dwellings with an associated access road.
- 1.8. The site is generally flat located approximately 1.6km from the River Welland but only 600m from the Barrier Bank which is a raised flood defence for the River Welland. The area between the River Welland and the Barrier Bank is functional flood plain known as Cowbit Washlands.
- 1.9. The majority of the site is shown in Flood Zone 1 on the Environment Agency's Flood Maps but the eastern side of the site is shown to be in Flood Zone 2. A copy is provided in Appendix 1.
- 1.10. In accordance with Table 2 of the National Planning Policy Framework (NPPF) Technical Guidance Document the residential development would be classed as more vulnerable.
- 1.11. In accordance with Table 3 of the NPPF Technical Guidance Document more vulnerable developments in Flood Zone 1 and Flood Zone 2 are acceptable.
- 1.12. This Flood Risk & Drainage Assessment Report provides the information required to demonstrate a strategy for dealing with surface water run-off in a sustainable way such that the on and off site impacts are minimal.
- 1.13. This report also includes a section which considers how Foul Sewerage may be provided for the development.

2.0 ASSESSMENT OF THE FLOOD RISK

2.1. The site is at risk of flooding from the following sources

- a) Flooding from a breach of the raised defences of the River Welland
- b) Flooding from high water levels in the Mill Dyke
- c) Flooding from infrastructure failure
- d) Flooding from groundwater
- e) Flooding from failure of the site surface water drainage system.

2.2. Each of the above potential sources of flooding is assessed in more detail as follows

Flooding from a Breach of the Raised Defences on the River Welland

- 2.3. The Environment Agency Flood Risk Maps for Planning show that the majority of the site is in Flood Zone 1, but the eastern side of the site is shown to be in Flood Zones 2. A copy is provided in Appendix 1.
- 2.4. It is understood that the Environment Agency Flood Maps for Planning are based on flooding without the presence of defences and is generally a horizontal projection of the high tide or fluvial flood levels.
- 2.5. It is understood that the River Welland is only tidal as far as Fulney Lock and Marsh Road Sluice downstream of Spalding.
- 2.6. The site is at a potential risk of flooding from either a breach of or overtopping of the defences. With earth defences any prolonged overtopping of the defences will normally lead to a breach.
- 2.7. The Environment Agency has undertaken an extensive amount of modelling to produce detailed Flood Hazard Mapping which considers the flood risk should the existing defences be breached or overtopped.
- 2.8. More detailed Flood Information including Flood Hazard Mapping for this site was requested from the Environment Agency and the information provided is contained in Appendix 1.
- 2.9. Cowbit Washlands is functional flood plain and flooding will extend towards the site as far as the Barrier Bank some 600m from the site.
- 2.10. The March 1947 flooding on the River Welland was contained within the Cowbit Washlands.
- 2.11. From the information provided the 1 in 100 year plus 20% climate change fluvial flood level in the River Welland at the closest point to the site is 4.70m AOD, which is approximately 2.0m higher than ground levels at the site.
- 2.12. However, the Environment Agency Flood Hazard Maps show that the site is not at risk of flooding from a breach of the defences.
- 2.13. It is understood that the breaches modelled by the Environment Agency are breaches of the tidal defences with the closest breach being downstream of Spalding.
- 2.14. The South Holland Strategic Flood Risk Assessment has considered breaches of the fluvial flood embankments. However, as the Cowbit Washlands right hand bank has a crest in excess of 15.0m and has a road on top of it, the risk of breaching was considered negligible.

- 2.15. It is understood that the Environment Agency concur with this view and Flood Hazard Maps for a breach of the Barrier Bank have not been produced.
- 2.16. Therefore the risk of flooding from a breach of the tidal defences or the Barrier Bank is minimal.
- 2.17. The Long Term Flood Risk Information provided on the Gov.uk web-site indicates that the site is at risk of flooding from reservoir failure. It is understood that the reservoir in question is the Cowbit Washlands and the risk of flooding has been considered above.

Flooding from High Water Levels in Mill Dyke

- 2.18. Mill Dyke is located on the southern boundary. It is understood that Mill Dyke flows west to east and eventually discharges to Wheat Mere Drain. Both watercourses are the responsibility of South Holland Internal Drainage Board (SHIDB).
- 2.19. The Surface Water Flood Maps on the Open Government Web-site show that there is no potential for surface water flooding outside the main channel of the dyke.
- 2.20. SHIDB has stated that the 2085, 1 in 100 year plus climate change flood level in Mill Dyke is 1.18m. This level is more than 1.3m lower than the bank level of 2.5m AOD within the site.
- 2.21. Even if the water levels rose considerably, possible due to a blockage, then as the dyke is located within an extensive area of low lying land, a small increase in water level above the bank of the watercourse would need to flood a significant area before the water level could rise significantly.
- 2.22. Therefore, provided the floor levels of the dwellings are set a minimum of 150mm above the bank level of the dyke, the risk of internal flooding from high water levels in the dyke would be minimal.

Flooding from Infrastructure Failure

- 2.23. It is not known if there are any large diameter water or sewage mains in the area.
- 2.24. The Anglian Water Sewer Record Drawings shown that there are four 125mm MDPE foul sewage rising mains, or vacuum pipes that cross the site.
- 2.25. However, provided the floor levels of the proposed buildings are set a minimum of 150mm above adjacent ground levels as required by Building Regulations, and ground levels are graded to the dyke on the southern boundary with no artificial hollows created then the risk of internal flooding would be minimal.

Flooding from Groundwater

- 2.26. The presence of the numerous ditches in the area would indicate that groundwater levels are expected to be close to the ground surface.
- 2.27. Provided the floor levels of the proposed buildings are set a minimum of 150mm above adjacent ground levels as required by Building Regulations, and ground levels are graded to the adjacent ditches with no artificial hollows created then the risk of internal flooding would be minimal.

Flooding from failure of the Site Surface Water Drainage System.

- 2.28. There is a risk of localised flooding from a failure of the surface water drainage system serving the site. The surface water drainage system should be designed to cater for a 1 in 100 year event with an appropriate allowance for climate change.
- 2.29. In addition the floor levels should be set a minimum of 150mm above surrounding site and the gradient across the site is maintained (no hollows created) then the risk of flooding from the site surface water drainage system is low.

3.0 CLIMATE CHANGE

- 3.1. The NPPF web based guidance provides guidance on potential effects of climate change on flooding which is based on information published by the Environment Agency.
- 3.2. The Environment Agency in February 2016 has published updated information on Climate Change. The new guidance advises that for more vulnerable developments in Anglian Region the Flood Risk should be assessed against climate change allowances of 35% and 65% for river flows and increases in peak rainfall intensity of up to 40%.
- 3.3. The Environment Agency Flood Maps have not been updated to take account of the revised climate change information. However, the potential affects of a rise in sea levels may increase the predicted flood depths at the site.
- 3.4. As the majority of the site is in Flood Zone 1 and the floor levels will be set at least 150mm above the surrounding ground levels then the risk of internal flooding due to increases in sea levels or fluvial flood flows due to climate change will be minimal.
- 3.5. Higher peak rainfall intensities may increase the risk of surface water flooding from the surface water drainage systems in the vicinity of the site. Although the frequency of the flooding may increase provided exceedance flow paths are provided then there will be minimal effect on surface water flooding.
- 3.6. The surface water drainage system serving the site will need to be designed such that potential additional flows due to climate change do not cause flooding on this development and do not to contribute to an increased risk of flooding elsewhere in the catchment.
- 3.7. It should be noted that the projected increase peak rainfall intensities do not result in a similar increase in storage volume required i.e. peak intensity may increase by up to 40% but average rainfall will not increase by the same amount.
- 3.8. Previous guidance published by the Environment Agency states that for the period in which peak rainfall intensities may rise by up to 30%, the increase in the volume of run-off will only increase by 20%. Therefore it is reasonable to assume that for a 40% increase in rainfall intensity the increase in volume of run-off will not increase by more than 30%.
- 3.9. It is proposed that the surface water collection and attenuation system for the development site is designed to take into account the potential effects of climate change.

4.0 DETAILED DEVELOPMENT AND FLOOD RISK MANAGEMENT PROPOSALS

Development Proposals

- 4.1. The proposed development involves the construction of up to 17 dwellings along with an associated access road.
- 4.2. Details of the proposed development are shown on a drawing contained in Appendix 1.
- 4.3. An area of land at the eastern side of the site, at the highest flood risk, has been allocated as public open space. Any properties located in this area would have floor levels set at similar levels to the other properties outside Flood Zone 2, effectively raising them out of the zone.
- 4.4. It is also proposed to locate a normally dry attenuation basin within the area of higher flood risk.

5.0 SUSTAINABLE DRAINAGE SYSTEMS

- 5.1. Sustainable Drainage Systems (SuDS) have been considered for this development.
- 5.2. Following the preferred hierarchy of drainage stated in Part H of the Building Regulations and The Suds Manual the following disposal routes have been considered
 - a) Disposal via Infiltration
 - b) Disposal to a Watercourse
 - c) Disposal to Surface Water Sewer
- 5.3. A Desktop Geotechnical Study has been undertaken to assess if the site will be suitable for surface water disposal using infiltration systems.

Desktop Geotechnical Study

- 5.1. From the HR Wallingford Greenfield run-off Calculation Tool available on their web-site the tool identifies the site as having Soil Type 2 on the Winter Rainfall Acceptance Potential (WRAP) Map. Soil Type 2 has relatively good drainage and is generally suitable for infiltration drainage systems. A copy of the Greenfield Run-off Calculation Sheet is provided in Appendix 1.
- 5.2. The British Geological Society web-site was also checked for records of boreholes within the vicinity of the site. There are three boreholes within 300m, 400m and 700m from the centre of the site.
- 5.3. The boreholes generally indicate a soft silty clayey material below the topsoil. Copies of some of the borehole records are presented in Appendix 1.
- 5.4. The presence of the drainage dyke along the southern boundary and elsewhere in the area and the presence of other drainage dykes in the general area indicates that vertical drainage must be restricted.
- 5.5. In the absence of site specific geotechnical investigation reports this Desktop Geotechnical Study concludes that is probable that the site would be unsuitable for surface water disposal via infiltration systems.

Disposal to a Watercourse

- 5.6. Following the hierarchy of Suds, a surface water drainage discharge to an open watercourse is the next preferred option. Therefore it is proposed that the attenuated surface water run-off is discharged to the un-named Dyke on the southern boundary.

6.0 OUTLINE DESIGN OF THE PROPOSED SURFACE WATER DRAINAGE SYSTEM

- 6.1. The proposed layout will create the following artificial surfaces potentially generating surface water run
- a) 1230m² of dwelling roofs
 - b) 650m² of private drives
 - c) 1030m² of adopted roads and footpaths and
 - d) 480m² of shared private drives.
- 6.2. The proportion of the site covered in artificial surfaces is 33%.
- 6.3. There will also be surface water run off from the footpaths around dwelling and away from the access roads which will be drained to the adjacent landscaped areas.
- 6.4. With the proposed development layout, it is proposed that the main access road into the site will be adopted by the highway authority.
- 6.5. A permeable paved access road and road drainage via pit soakaways has been discounted due to the anticipated poor infiltration rates identified in the desktop geo-technical study and the highway authority requirement to have a minimum 1.0m below the base of the road formation or soakaway and the maximum groundwater level.
- 6.6. In the hierarchy of surface water drainage the next option considered for draining the road was a road side swale. A single roadside swale can be provided to provide drainage for the adopted highway. This will be restricted to 600mm deep and have a 450mm maximum water depth.
- 6.7. For dwellings located off the adopted highway it is proposed to discharge the roof water to the swales. However, as the swale is only being provided on one side of the road, pipes under the road will be required. It is proposed that the pipe under the road and the demarcation chamber is adopted by Anglian Water.
- 6.8. In this way the aims of the Water Act 2010 will be met in removing householder responsibility for pipes under adopted highways.
- 6.9. As the pipe under the road will need a reasonable amount of cover and a protective concrete slab it is probable that the downstream end of the pipe will be deeper than the swale.
- 6.10. Therefore it is proposed to install an underdrain in the base of the swale to accept the piped roof water discharges.

- 6.11. Depending on the size and shape of the plots and the orientation of the roof slopes other surface drainage features such as channel drains, rain gardens or filter drains may be required to minimise the depth of the pipes under the road and allow connection to the swale underdrain.
- 6.12. The adopted roads would have a longitudinal fall in accordance with the highway authority requirements and a crossfall to the swale.
- 6.13. It is proposed that the two cul-de sacs remain in private ownership and that they are constructed in permeable paving. The roof drainage from the properties served by the private access roads would be discharged to the permeable sub base or to an underdrain.
- 6.14. The permeable sub-base would provide some attenuation storage. At this stage it is not known if the permeable sub-base would need to be tanked to protect the sub grade.
- 6.15. The roadside swales and permeable sub base will provide conveyance and treatment and some attenuation but without flow restriction the discharge to the Dyke could be too high and increase the risk of flooding elsewhere in the catchment.
- 6.16. Therefore it is proposed to provide an attenuation basin which the underdrains can discharge into. A discharge control device would be installed on the piped outlet from the attenuation basin to Mill Dyke. The discharge rate would be agreed with South Holland IDB.
- 6.17. With the proposed layout, limiting the discharge to the watercourse to a maximum of 5.0 l/s the volume required to attenuate all storms up to and including the 1 in 100 year plus climate change event is estimated at 148m³. The attenuation basin shown on the drawings can provide 140m³ at a 600mm nominal depth. Calculations are provided in Appendix 1.
- 6.18. There is also a further 40m³ of storage in the permeable sub base under the private roads and further attenuation will occur in the roadside swales.
- 6.19. Due to the site being relatively flat, to provide adequate gradients across the site, the attenuation designed maximum water level in the attenuation basin will probably be around 1.0m below ground level, which will also provide further emergency attenuation if required.
- 6.20. South Holland IDB have advised that at detailed design stage the surface water drainage system should be designed to operate with the water level in Mill Dyke at the 1 in 100 year plus climate change level.
- 6.21. The attenuation pond would be adopted by either Anglian Water, the Lead Local Flood Authority otherwise a Management Company would need to be set up to undertake the necessary maintenance on behalf of the residents.
- 6.22. It is proposed that the private drives would be constructed in permeable construction. Although we have stated that the stratum is unlikely to be suitable for infiltration systems permeable driveways only require a very low rate of infiltration to operate satisfactorily.

- 6.23. In general terms the 6 hour 1 in 100 year rainfall depth is around 63mm and with a 30 % allowance for climate change this increases to 82mm. A poor infiltration rate of 6mm/hr would reduce the storage required to 46mm. With a permeable sub-base with a 30% void ratio a thickness of only 150mm would be required to provide adequate storage for the 1 in 100 year plus climate change event. 150mm is generally the minimum thickness of sub-base on a driveway for structural requirements and is often greater.
- 6.24. Therefore adopting permeable construction for the private drives should provide satisfactory drainage.
- 6.25. An illustration of the outline design a surface water drainage system for the proposed layout is shown on drawing 575/002 provided in Appendix 1.

7.0 OFF SITE IMPACTS

- 7.1. The flood mitigation measures proposed for this development should not increase the risk of flooding elsewhere in the catchment, therefore there will be no off site impacts.
- 7.2. As the surface water discharge from the site will be collected, attenuated and discharged at a controlled rate there will be no adverse impact on flooding elsewhere in the catchment.

8.0 RESIDUAL RISKS

- 8.1. There are residual risks that more extreme events are experienced than those evaluated in this report. However, the consequences of more extreme events will not be significantly greater than those assessed in this report.

9.0 FOUL SEWERAGE

- 9.1. The Anglian Water Sewer Record Drawings show that there is an existing foul sewer which flows east to west in Moulton Road on the northern boundary of the site.
- 9.2. MH 7001 is located in the vicinity of the proposed location of the access road into the site and would appear to be the most practical connection point.
- 9.3. The AW Sewer Records give a cover level of 3.077m AOD and an Invert Level of 0.883m AOD.
- 9.4. The required sewer length into the site is approximately 120m which at a minimum gradient of 1 in 150 would give an invert level of 1.683m under the adopted highway at the far corner of the site. Existing ground levels are in the order of 2.8m AOD, therefore with the adopted road at existing levels there would be around 900mm cover to the pipe.
- 9.5. Although this is less than the required 1.2m it should be acceptable with a protective concrete slab above. The sewer should also be sufficiently deep to accept flows from the dwellings laid at a minimum gradient of 1 in 80.
- 9.6. At this stage it is reasonable to assume that a gravity connection to the foul sewage system is possible and a pump station should not be required. However, this would be confirmed at detailed design stage.

- 9.7. It is not known if there is sufficient spare capacity in the system but as Anglian Water cannot allocate capacity to proposed developments, further enquiries should be made closer to the time the development is to proceed.
- 9.8. Should additional capacity be required this can be obtained through a Requisition under Section 98 of the Water Act. The Developer would have to pay the additional costs of providing the spare capacity and not connect to the system until the spare capacity is operational.
- 9.9. The AW sewer record drawings show four rising mains, crossing the site. The location of the pipes will need to be determined on site and the development set out to maintain access to the pipes. Alternatively, it may be possible to divert the pipes to an another location on the site and free up more land for development.

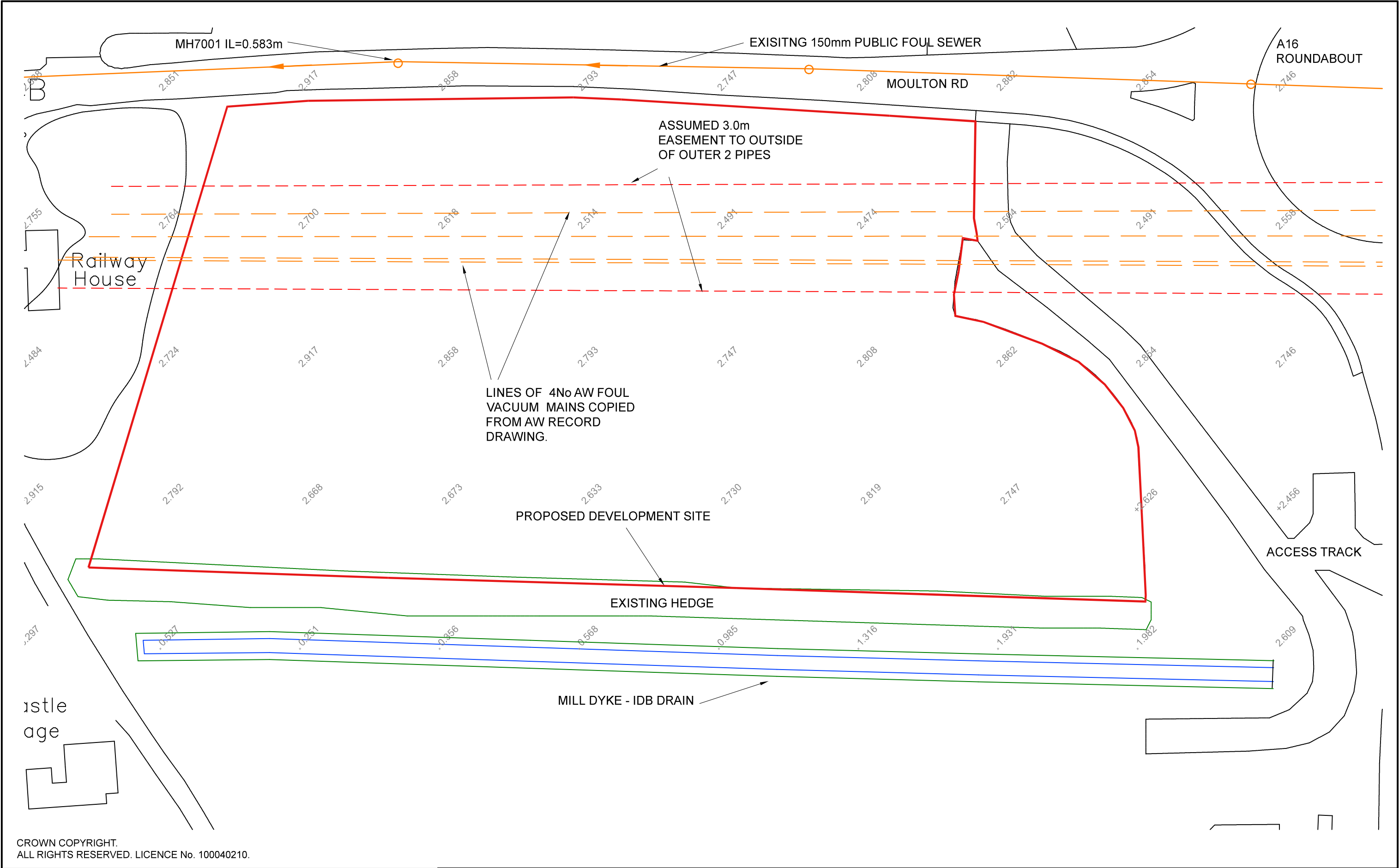
10.0 CONCLUSIONS

- 10.1. The site majority of the site is in Flood Zone 1 and is at a low risk of flooding. For the parts of the site which are shown in Flood Zones 2, the modelling of breaches of the defences shown in the Environment Agency Hazard Maps and the SHDC SFRA show that the floodwaters from a breach should not reach the site.
- 10.2. This report demonstrates that it is practical to install a sustainable surface water drainage system to serve the development such that the risk of flooding elsewhere in the catchment is not increased.
- 10.3. The report also demonstrates that it is relatively straightforward to connect the development to the public foul sewerage system. It is recommended that the location of the vacuum pipes crossing the site is determined before finalising the layout.
- 10.4. Taking into account the above points it is concluded that the proposed development can be considered appropriate in this location.

11.0 APPENDIX 1 SUPPORTING INFORMATION

- a) Environment Agency Flood Map for Planning with Site Location
- b) GSL Drawing 575-001 Existing Levels and Key Drainage Features
- c) Flood Information provided by the Environment Agency.
- d) Gov.uk SW Flood Map
- e) Gov.uk Reservoir Flood Map
- f) Correspondence with South Holland IDB
- g) AW Sewer Record Drawing
- h) RDC Consultancy Proposed Development Layout Drawing
- i) HR Wallingford Greenfield Run-Off Calculations
- j) BGS Borehole Records
- k) SW Calculations
- l) GSL Drawing 575-002 Outline Design of Proposed SW Drainage System





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NOTES 1. DO NOT SCALE FROM THIS DRAWING 2. LEVELS PLOTTED FROM ENVIRONMENT AGENCY LIDAR DATA. 3. POSIITON OF FOUL SEWERS & VACUUM MAINS COPIED FROM AW RECORD DRAWINGS FOR ILLUSTRATION ONLY. REFER TO RECORD DRAWINGS. .						CLIENT MR P SMITH	PROJECT PROPOSED HOUSING DEVELOPMENT AT COWBIT	ENGINEER GS	DRAWN BY GS	APPROVED BY GS	
									SCALE AT A3 1: 500	DATE JAN 17	
							<i>George Shuttleworth Ltd</i> <i>Consulting Engineers</i> 43 Hall Drive Lincoln LN6 7SW Tel: 01522 787710 Email: geo.shuttleworth@btconnect.com	DRAWING TITLE EXISTING SITE LEVELS & FEATURES	THIS DRAWING IS THE COPYRIGHT OF GEORGE SHUTTLEWORTH LTD AND SHALL NOT BE COPIED OR AMENDED WITHOUT THE WRITTEN PERMISSION OF GEORGE SHUTTLEWORTH LTD.		
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	REV			DR	CH	AP			DATE		

George Shuttleworth
geo.shuttleworth@btconnect.com

Our ref: CCN-2016-31742

Date: 4 January 2017

Dear George Shuttleworth,

Provision of Product 3 and 8 for Cowbit, South Holland, PE12 6XA

Thank you for your request of 5 December 2016 to use Environment Agency data, Product 3 in the development of the Flood Risk Assessment (FRA) for the above site. The information is attached.

If you have requested this information to help inform a development proposal, then you should note the detail in the attached advisory text on the use of Environment Agency Information for Flood Risk Assessments.

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 event 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 event with a 0.1% chance of occurring in any year, or the highest recorded historic extent if greater.

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

In Fenland areas, such as Cowbit, this can give a slightly misleading picture in that if there were no flood defences the fens would revert to their natural wetland state, with water spreading out across the whole fens. This flooding would cover large areas of land but to relatively shallow depths and would leave the slightly higher land as isolated dry islands.

Flood defences are, however, present throughout the fenlands and these do reduce the risk of flooding. Whilst our defences are generally in a good condition there is always a chance they can be overtopped or fail during extreme floods. With the water level in the river being above the adjacent ground level a failure of the defence could lead to flooding spreading further than identified on our flood map.

The Flood Map only indicates the extent and likelihood of flooding from rivers or the sea. It should also be remembered that 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 for your area is enclosed. This shows the extent of previous recorded flooding in your area, notably March 1947. It is possible that other flooding

may have occurred that we do not have records for, and other organisations, such as the Local Authority or Internal Drainage Boards, may have records.

Fluvial Flood Data

The fluvial flood data for the model nodes shown on the attached map are set out in the table attached.

This data is taken from the Welland Catchment Model (2007) and are the most up-to-date currently available. We aim to review our models 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 that they are still valid.

Please note that these levels are “in-channel” levels and therefore may not represent the flood level on the floodplain, particularly where the channel is embanked or has raised defences.

Fluvial Defence Information

The fluvial defences protecting this site consist of earth embankments. They are in fair condition and provide protection against a flood event with a 1% chance of occurring in any year (1 in 100). We inspect these defences regularly to ensure that any potential defects are identified early.

Modelled Flood Extents

Please find attached a map showing the results of the Welland Catchment Model (2007) for your area. This shows modelled flood extents, taking into account flood defences.

Land Drainage

The information provided is limited to flood risk from the sea and rivers with catchment areas greater than 3km². The property is in an area of extensive land drainage which may pose an additional risk of flooding. Further information should be sought from the South Holland Internal Drainage Board (tel: 01553 819600).

Hazard Mapping – Breaching

Enclosed with this letter is a plan showing the location of the breaches we have modelled, together with two plans showing the maximum values of flood depth, velocity and hazard rating (danger to people) for the following scenarios:

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

Hazard Mapping – Overtopping

Your site is not affected by overtopping.

Further details about the Environment Agency information supplied can be found on the GOV.UK website:

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

If you have requested this information to help inform a development proposal, then you should note the information on GOV.UK on the use of Environment Agency Information for Flood Risk Assessments

<https://www.gov.uk/planning-applications-assessing-flood-risk>
<https://www.gov.uk/government/publications/pre-planning-application-enquiry-form-preliminary-opinion>

Information Warning

Climate change will increase flood risk due to overtopping of defences. Please note that 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 www.gov.uk on 19 February 2016. The appropriate updated climate change allowance should be applied in a Flood Risk Assessment.

Please contact our Partnerships and Strategic Overview Team to discuss how this risk should be considered within your Flood Risk Assessment.

Supporting Information

I hope that we have correctly interpreted your request. 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 that we hold under the Freedom of Information Act 2000 (FOIA) and the associated Environmental Information Regulations 2004 (EIR).

If you are not satisfied with our response to your request for information you can contact us within 2 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 PSO team at the Environment Agency.

Yours faithfully



FOR Ian Cappitt
Partnerships and Strategic Overview Team Leader Lincolnshire

Direct dial 0203 0254 942
Direct fax 01522 785018
Direct e-mail PSOLINCS@environment-agency.gov.uk

Enc.
FRA Advisory Text
Basic FRA Map
Historic Flood Extent Map
Fluvial Flood Data Modelled
Flood Extent Maps
Breach Hazard Maps x2

Awarded to Lincolnshire & Northamptonshire Area



FLOODS
DESTROY
DESIRABLE
BE PREPARED

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

Important

If you have requested this information to help inform a development proposal, then we recommend that you undertake a formal pre-application enquiry using the form available from our website:-

<http://www.environment-agency.gov.uk/research/planning/33580.aspx>

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

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

<http://www.environment-agency.gov.uk/research/planning/82587.aspx>

<http://www.communities.gov.uk/publications/planningandbuilding/nppftechnicalguidance>

<http://www.communities.gov.uk/publications/planningandbuilding/pps25guideupdate>

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

In **Wales**, you should refer to TAN15 for information about what flood consequence assessment is needed for new development in the different flood zones

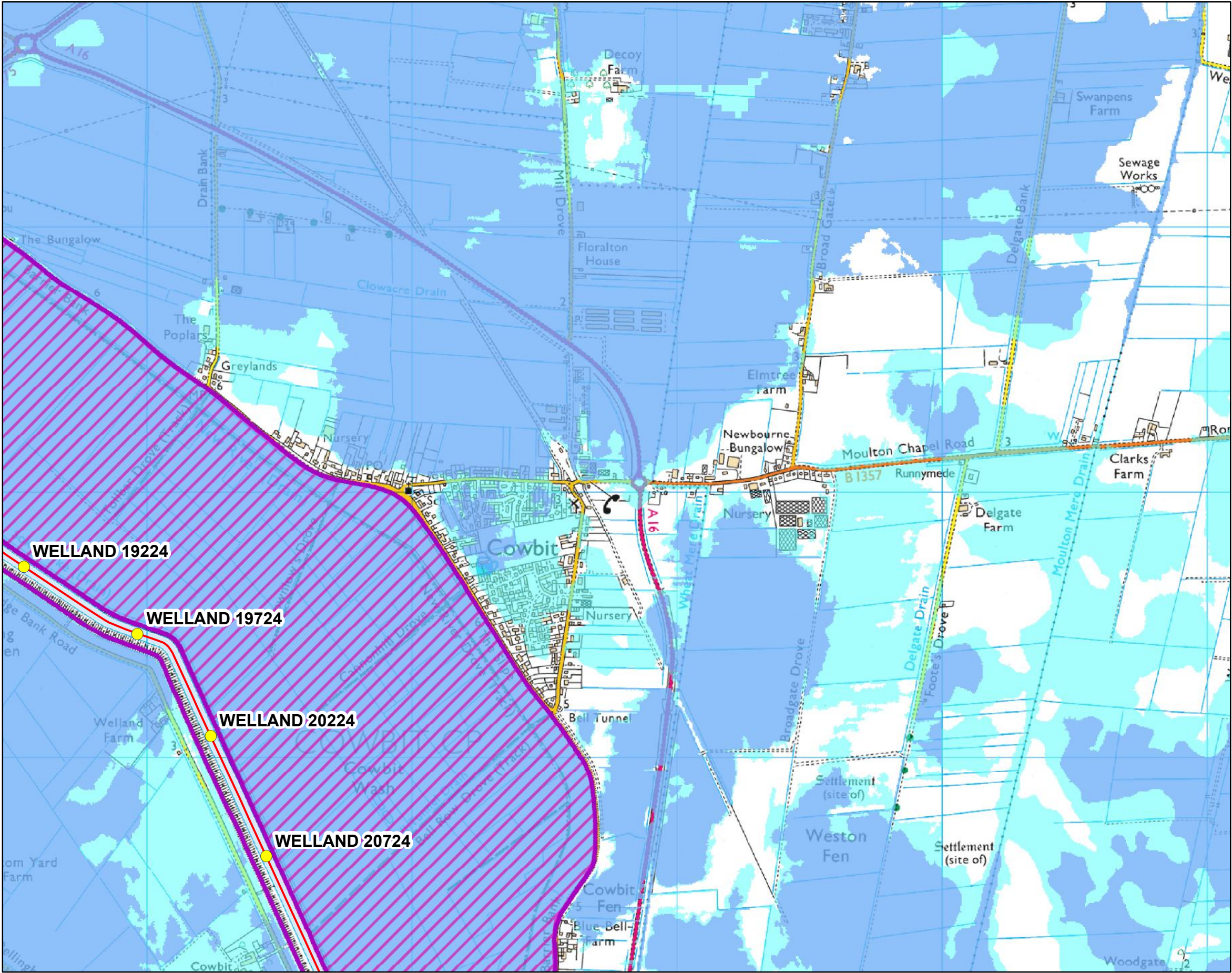
<http://new.wales.gov.uk/splash;jsessionid=8yIGTfGZthmB0t2vhp6hS1GcB1LXvZzB3Ylczf20Xn7LK3zK0nMk!981825250?orig=/topics/planning/policy/tans/tan15/>

You should also consult the Strategic Flood Consequence Assessment if one has been produced by your local planning authority.

In both **England and Wales** you should note that:

1. Information supplied by the Environment Agency may be used to assist in producing a Flood Risk / Consequence Assessment (FRA / FCA) where one is required, but does not constitute such an assessment on its own.
2. This information covers flood risk from main rivers and the sea, and you will need to consider other potential sources of flooding, such as groundwater or overland runoff. The information produced by the local planning authority referred to above may assist here.
3. Where a planning application requires a FRA / FCA and this is not submitted or deficient, the Environment Agency may well raise an objection.
4. For more significant proposals in higher flood risk areas, we would be pleased to discuss details with you ahead of making any planning application, and you should also discuss the matter with your local planning authority.

Basic FRA Map centred on TF2677418019 - created December 2016 [Ref: CCN-2016-31742]



Scale 1:15,000



- Modelled Node
- 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:

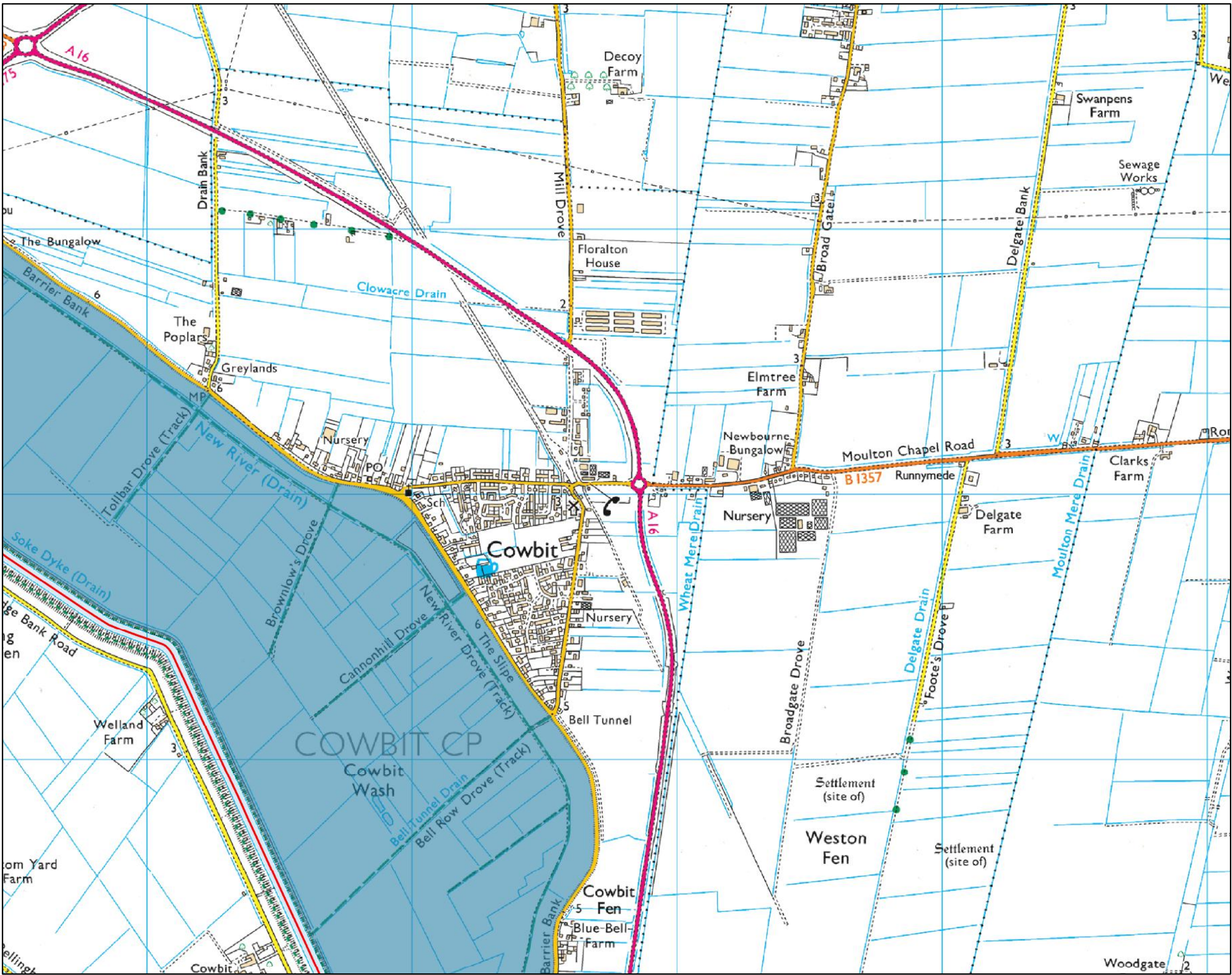
- from the sea by a flood that has a 0.5% (1 in 200) or greater chance of happening each year.
- or from a river by a flood that has a 1% (1 in 100) or greater chance of happening each year.

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, Lincoln

Historic Flood Map centred on TF2677418019 - created December 2016 [Ref: CCN-2016-31742]



Scale 1:15,000



Historic Flooding

- March 1947 on the River Welland near Cowbit
- Main River

Created by the Partnerships and Strategic Overview Team, Lincoln

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

Datasheet [Ref: CCN-2016-31742]

Fluvial Flood Levels (mODN)

The fluvial flood levels for the model nodes shown on the attached map are set out in the table below. They are measured in metres above Ordnance Datum Newlyn (mODN).

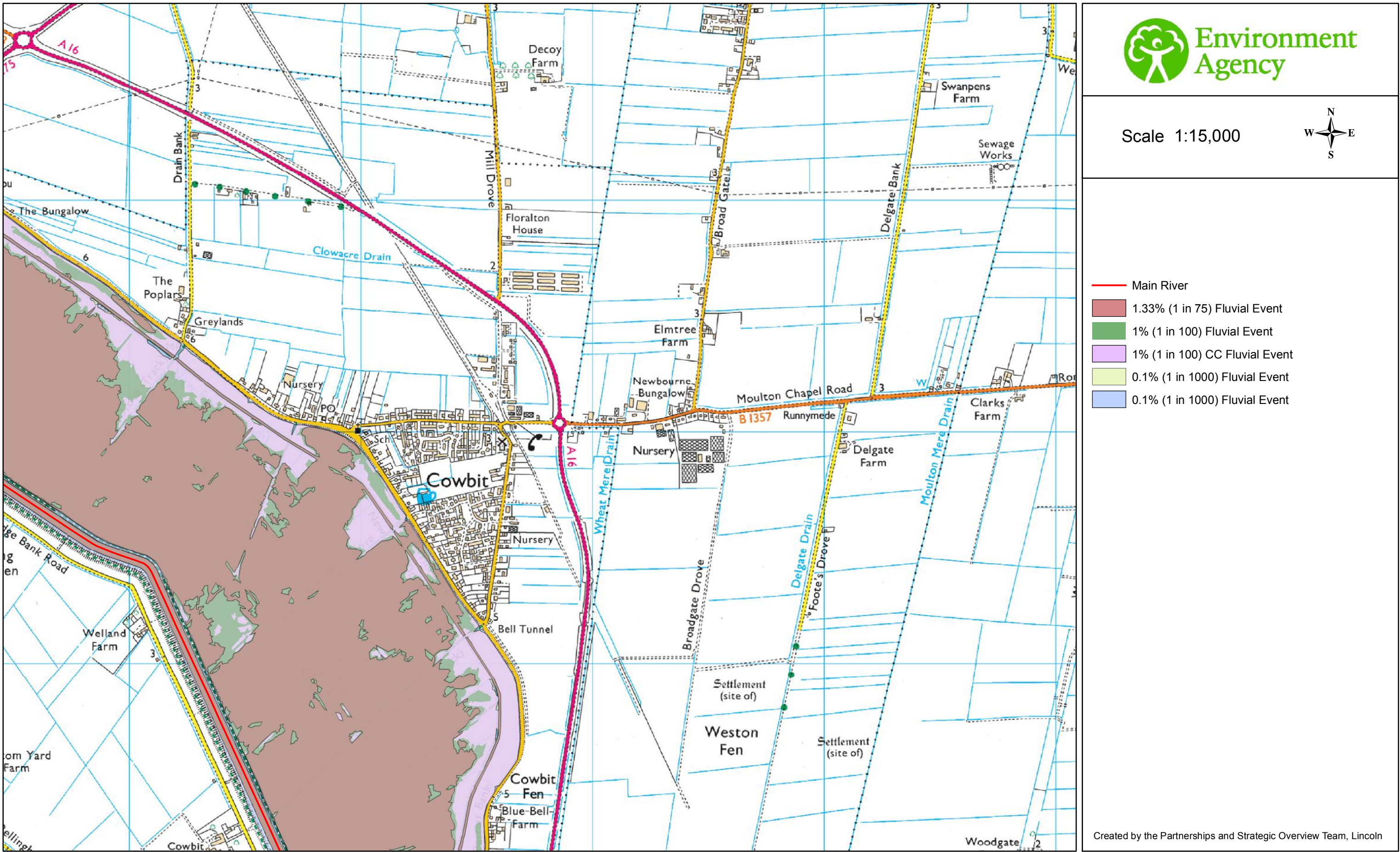
Node Label	Easting	Northing	Annual Exceedance Probability - Maximum Water Levels (mODN)										
			50% (1 in 2)	20% (1 in 5)	10% (1 in 10)	4% (1 in 25)	2% (1 in 50)	1.33% (1 in 75)	1% (1 in 100)	1% (1 in 100) inc 20% Climate Change	0.5% (1 in 200)	0.1% (1 in 1000)	0.1% (1 in 1000) inc 20% Climate Change
WELLAND 19224	524537	317718	4.04	4.34	4.43	4.50	4.54	4.55	4.56	4.68	4.57	4.57	4.68
WELLAND 19724	524966	317465	4.05	4.35	4.45	4.51	4.55	4.57	4.57	4.69	4.59	4.59	4.69
WELLAND 20224	525242	317080	4.05	4.37	4.47	4.53	4.57	4.58	4.59	4.70	4.61	4.61	4.70
WELLAND 20724	525452	316626	4.06	4.39	4.48	4.55	4.59	4.60	4.61	4.72	4.63	4.63	4.72

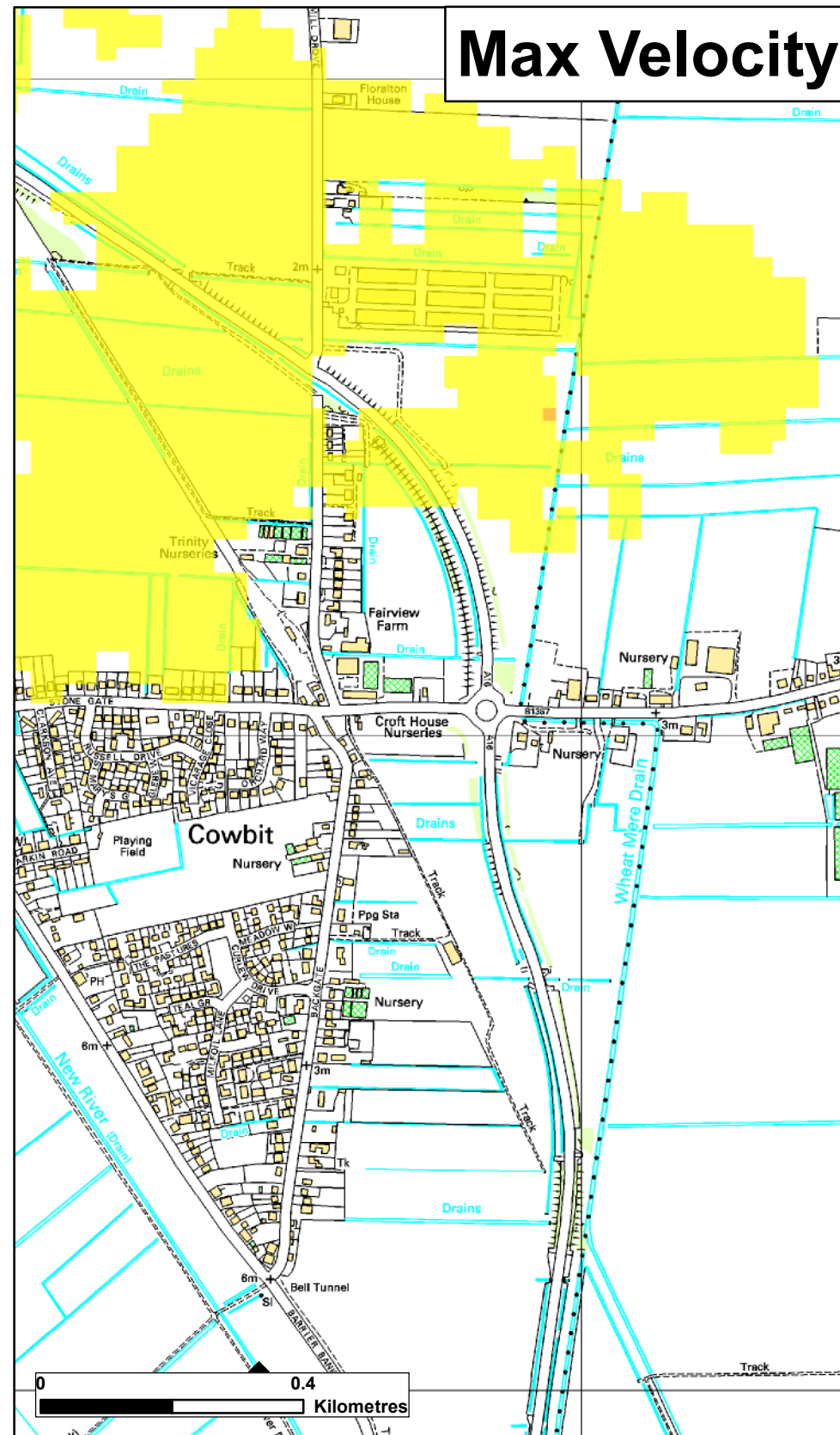
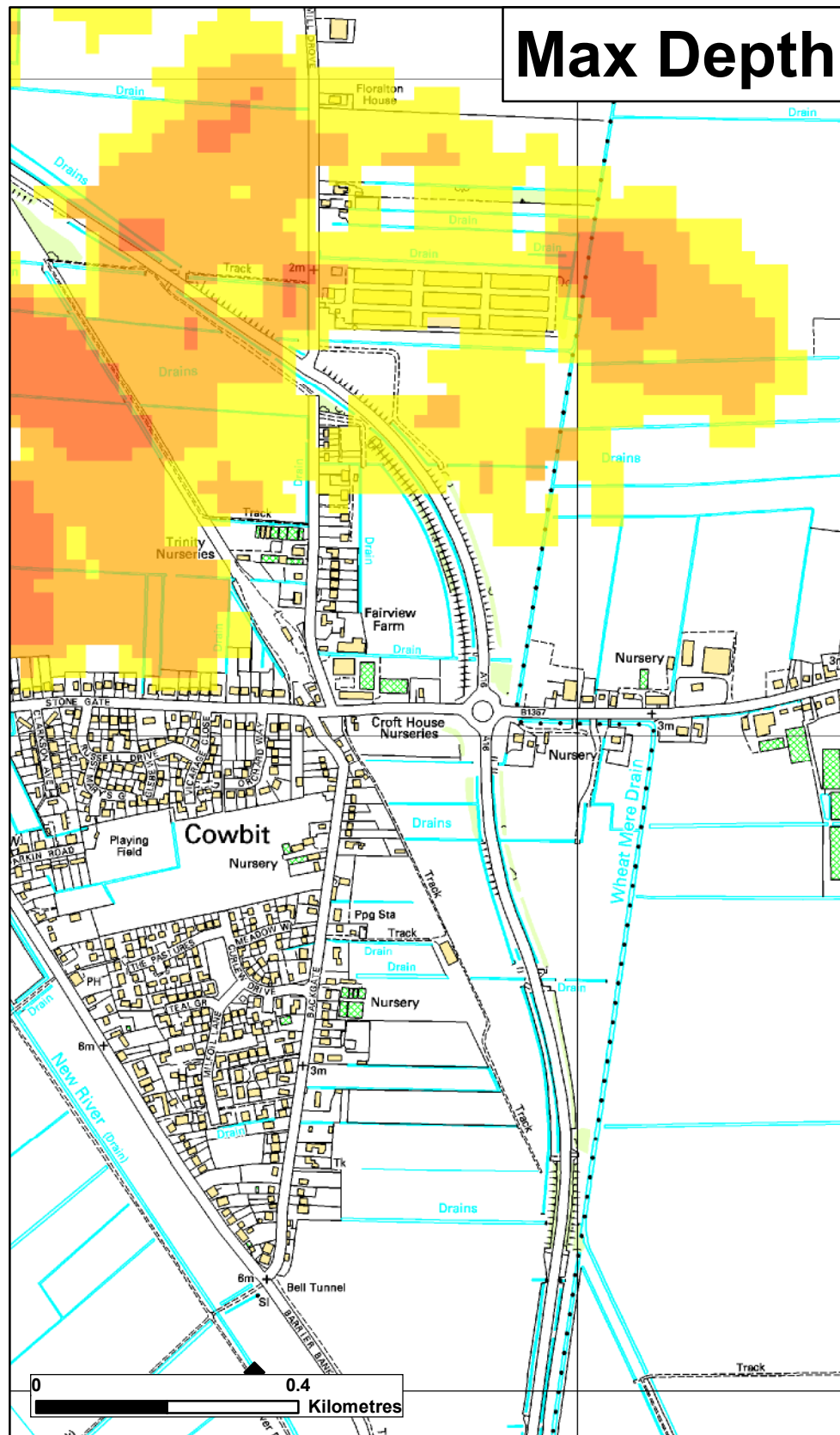
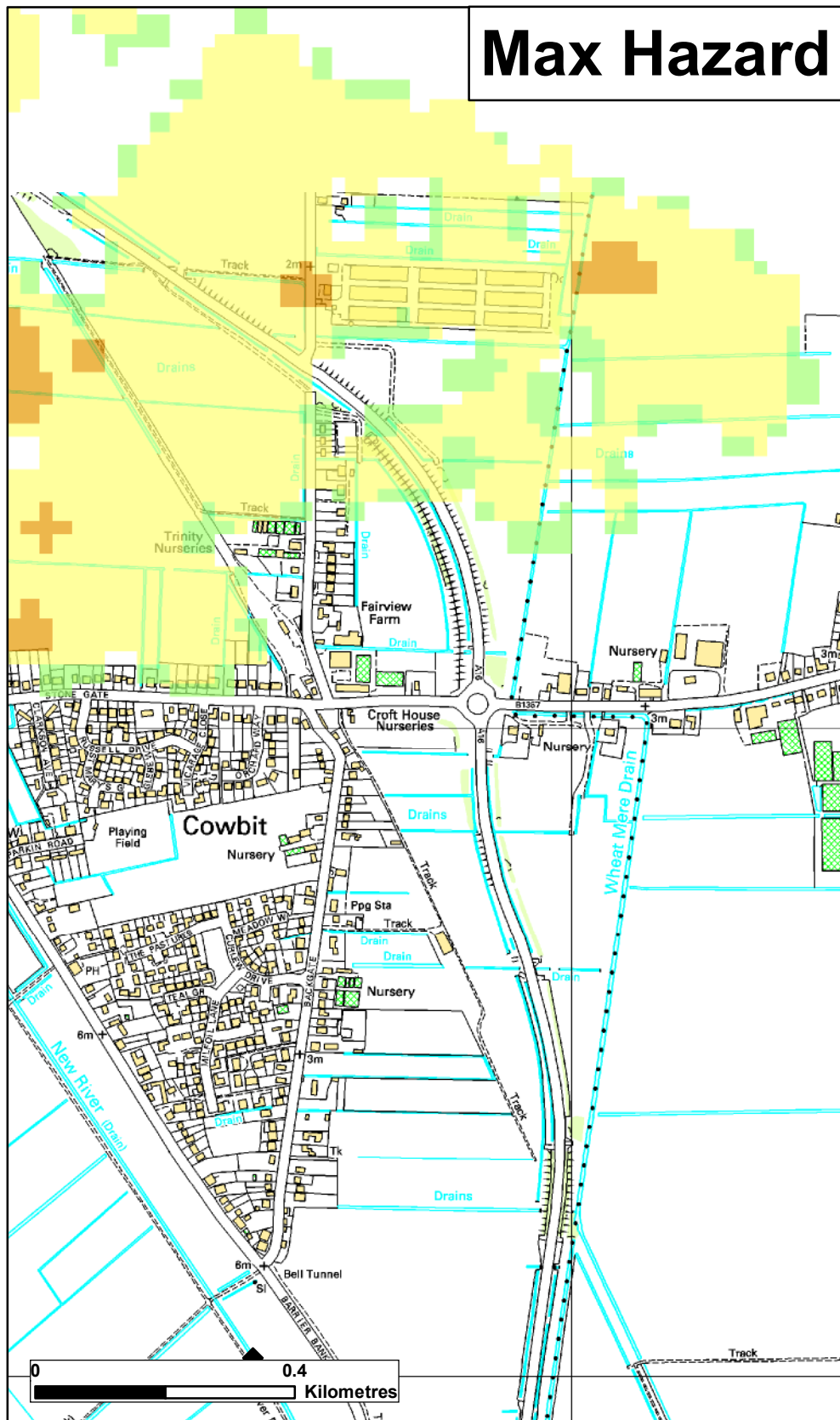
Fluvial Flood Flows (m³/s)

The fluvial flood flows for the model nodes shown on the attached map are set out in the table below. They are measured in metres cubed per second (m³/s).

Node Label	Easting	Northing	Annual Exceedance Probability - Maximum Flows (m³/s)										
			50% (1 in 2)	20% (1 in 5)	10% (1 in 10)	4% (1 in 25)	2% (1 in 50)	1.33% (1 in 75)	1% (1 in 100)	1% (1 in 100) inc 20% Climate Change	0.5% (1 in 200)	0.1% (1 in 1000)	0.1% (1 in 1000) inc 20% Climate Change
WELLAND 19224	524537	317718	59.16	76.22	81.93	87.94	92.55	93.43	94.15	95.07	95.28	95.45	95.41
WELLAND 19724	524966	317465	58.82	75.98	81.75	88.00	92.57	93.44	94.15	95.06	95.28	95.44	95.41
WELLAND 20224	525242	317080	58.47	75.75	81.58	88.06	92.59	93.45	94.15	95.06	95.28	95.44	95.40
WELLAND 20724	525452	316626	58.40	75.53	81.42	88.12	92.61	93.46	94.15	95.05	95.27	95.45	95.40

Modelled Flood Extents (with defences) centred on TF2677418019 - created December 2016
[Ref: CCN-2016-31742]



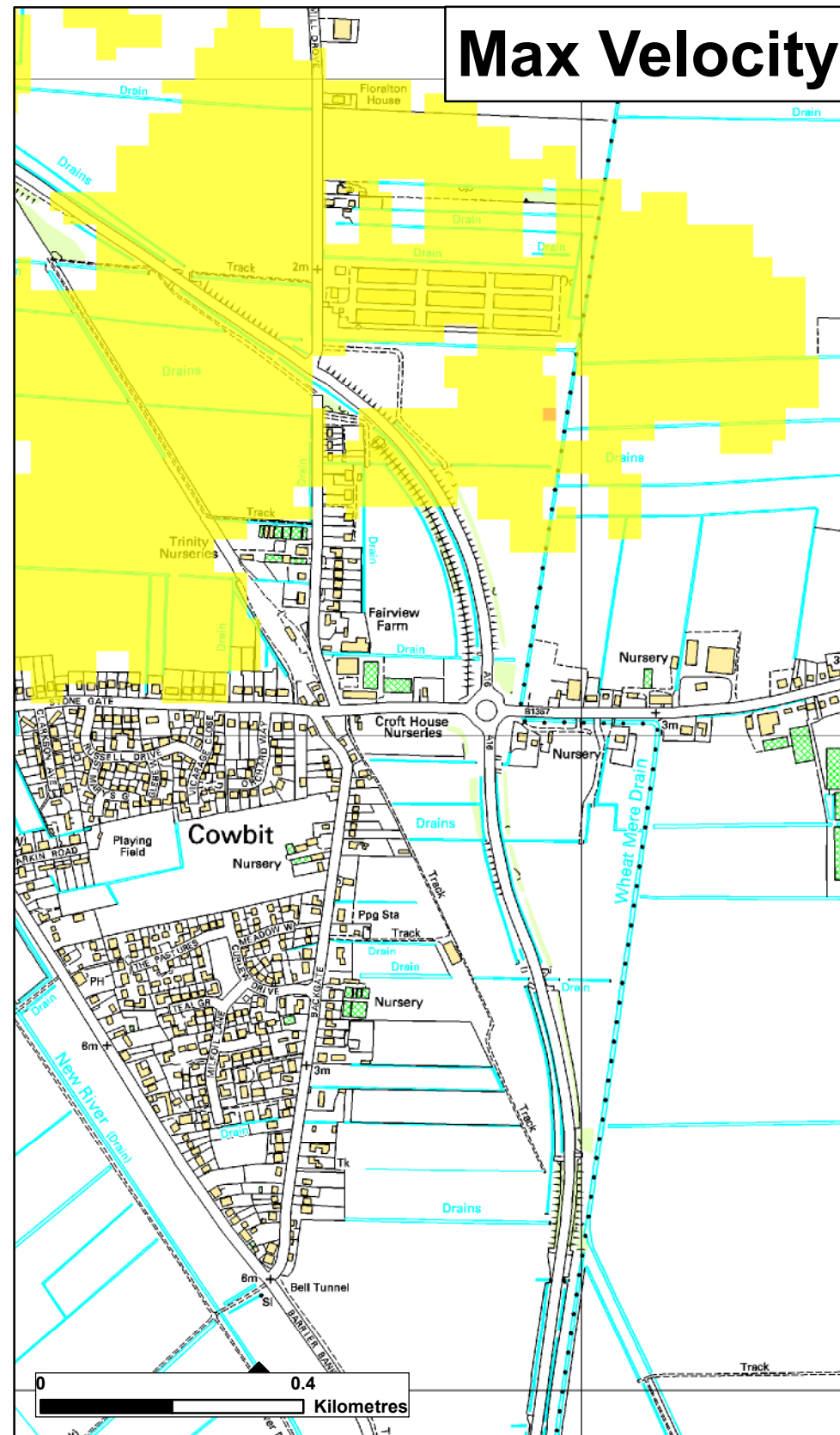
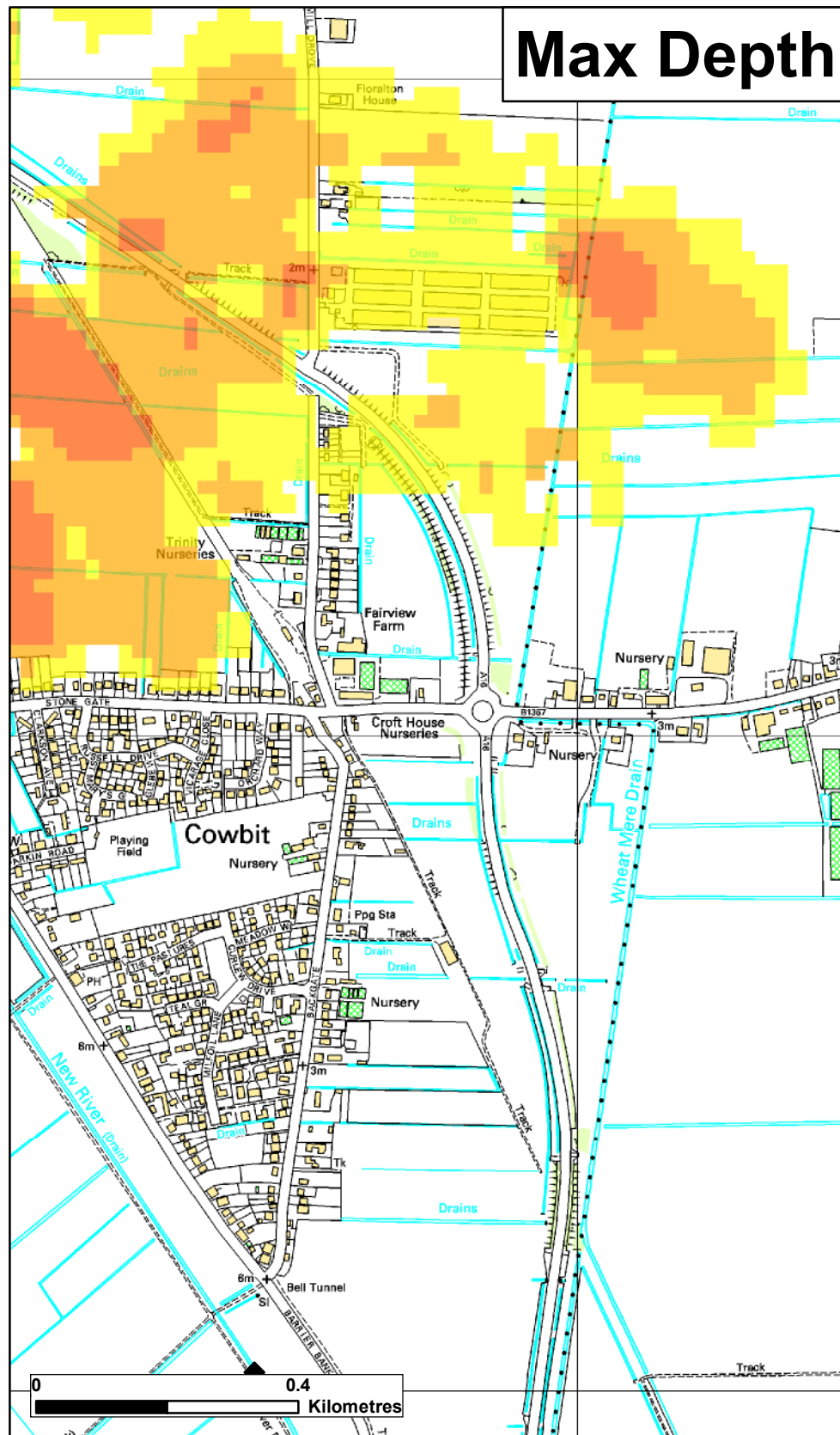
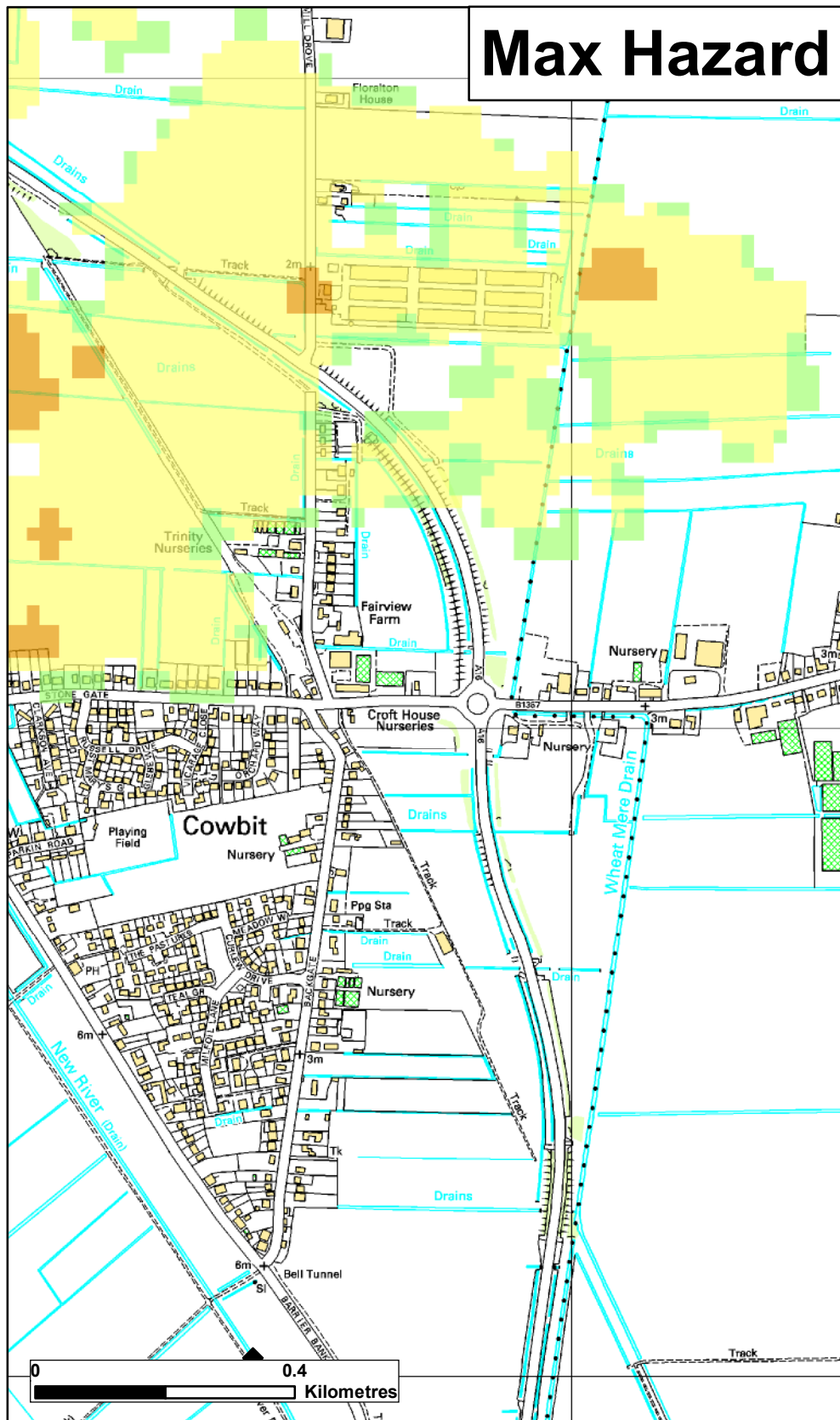


★ Modelled Breach Locations - see also the accompanying plan "Location of Modelled Breaches"							
Max Hazard (Flood Risk to People : FD2320)		Max Depth (m)		Max Velocity (m/s)		This map shows the level of flood hazard to people (called a hazard rating) if our flood defences are breached at certain 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.	
- 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 2016	Scenario year	2115	Scenario Annual Chance	0.5% (1 in 200)	CCN Number	CCN-2016-31742
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 2677418019

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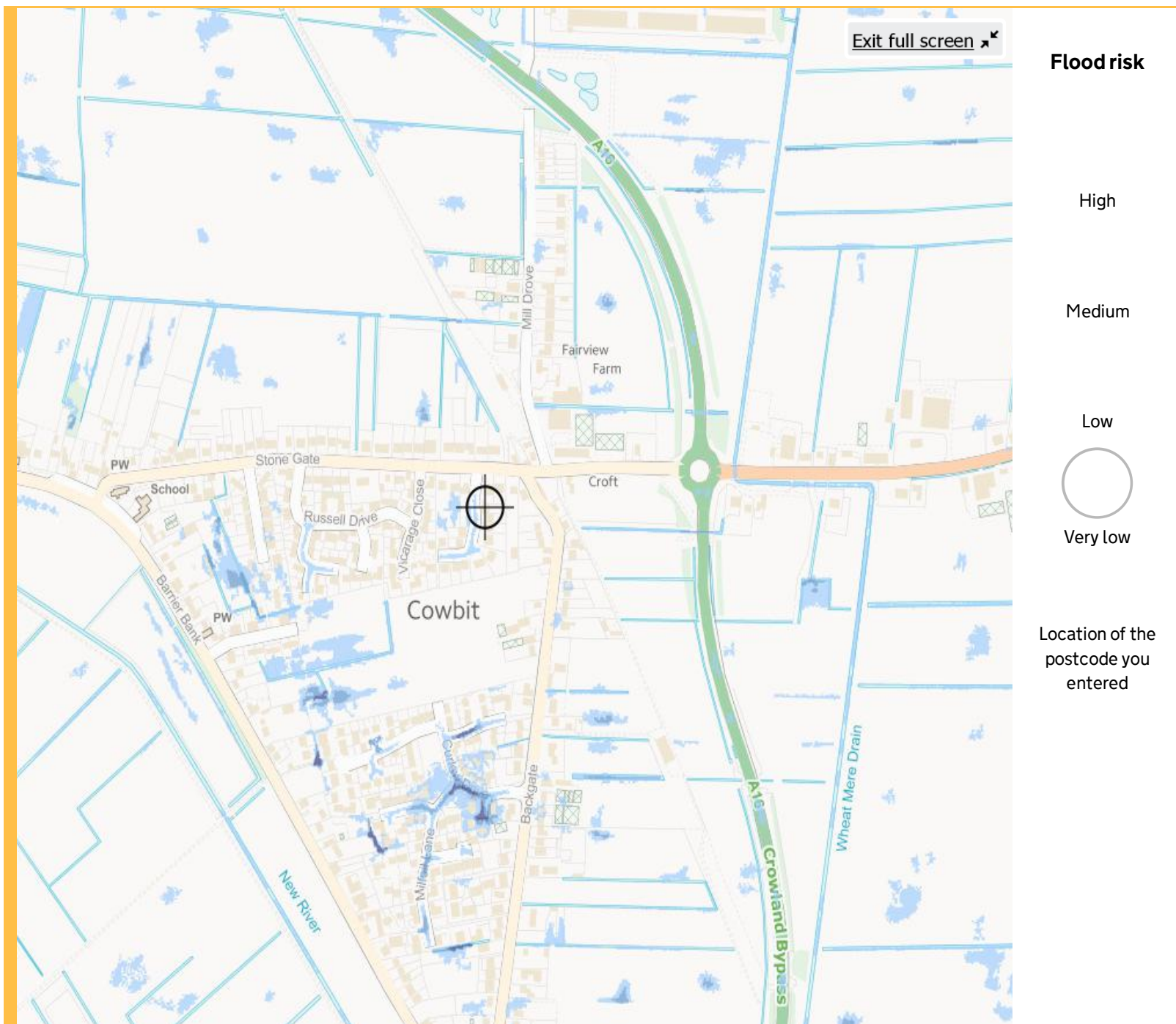


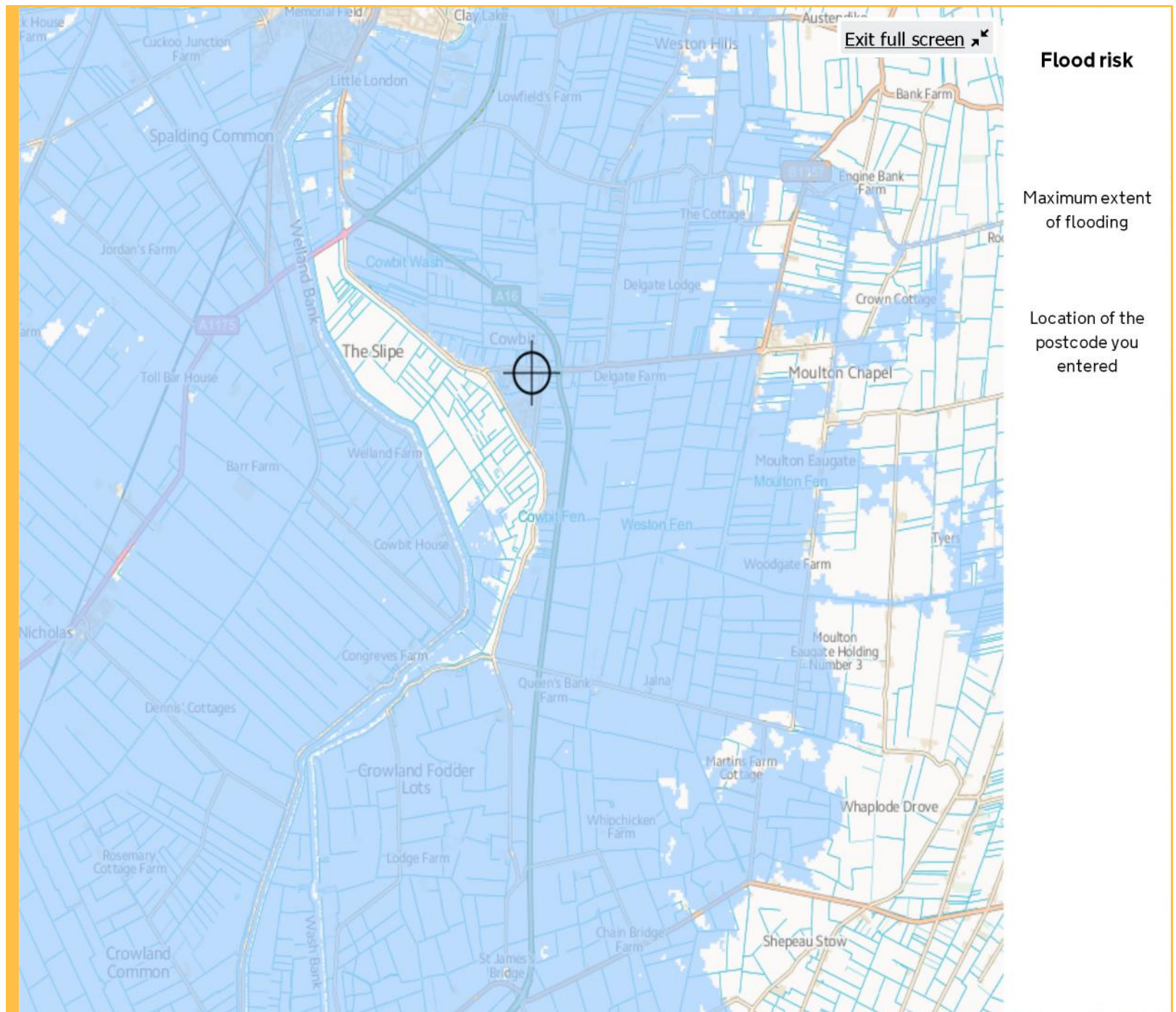
★ Modelled Breach Locations - see also the accompanying plan "Location of Modelled Breaches"							
Max Hazard (Flood Risk to People : FD2320)		Max Depth (m)		Max Velocity (m/s)		This map shows the level of flood hazard to people (called a hazard rating) if our flood defences are breached at certain 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.	
- 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 2016	Scenario year	2115	Scenario Annual Chance	0.1% (1 in 1000)	CCN Number	CCN-2016-31742
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 2677418019

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Subject: RE: Proposed Development off Moulton Chapel Road, Cowbit
From: Karl Vines <Karl@wlma.org.uk>
Date: 04/01/2017 15:34
To: George Shuttleworth <geo.shuttleworth@btconnect.com>
CC: Dominic Morris <Dominic@wlma.org.uk>

George

Thank you for your enquiry.

Am I right in thinking that the watercourse to the south of the site to which you intend to discharge is the Board maintained Mill Dyke, or does the site not extend quite that far. If it is, then Byelaw consent will be required from the Board for anything within 9m of the watercourse and the Board would seek a dedicated access strip to be provided as part of any consent.

I understand the issues regarding the feasibility of reducing the discharge rate down to the green field run-off rate of 1.4l/s/ha on smaller sites such as this. However, it would be desirable to get as close to greenfield rate as possible, and the flow rate through a 5/l/s hydrobrake using the maximum heads achievable on the site should be looked at to see how this compares. The discharge of water to any watercourse will not only require the consent of the Board but will also incur a Surface Water Development Contribution Fee from the Board. The discharge condition should also be taken in to account when looking at flows from the site and the volume of on-site storage required. For guidance, the 1 in 100 year plus climate change (2085) water level in the Wheatmere Drain and Mill Dyke is 1.18m ODN. This level is taken from the Board's modelling undertaken in 2010, and therefore the climate change scenario may not meet current standards.

If you wish to discuss further, please do not hesitate in giving me a call.

Regards

Karl Vines

District Engineer, South Holland IDB

dd: +44 (0)1406 421708 | **m:** +44 (0)7960 710929 | **f:** +44 (0)1406 426501 | **e:** karl@wlma.org.uk

Water Management Alliance

Kettlewell House, Austin Fields Industrial Estate, King's Lynn, Norfolk, [PE30 1PH](#), UK

t: +44 (0)1553 819600 | **f:** +44 (0)1553 819639 | **e:** info@wlma.org.uk | www.wlma.org.uk

Consisting of:

[Broads Drainage Board](#), [East Suffolk Drainage Board](#), [King's Lynn Drainage Board](#)
[Norfolk Rivers Drainage Board](#) and [South Holland Drainage Board](#)

Defenders of the Lowland Environment

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With our commitment to ISO 14001, please consider the environment before printing this e-mail.

From: George Shuttleworth [mailto:geo.shuttleworth@btconnect.com]

Sent: 04 January 2017 12:00

To: Karl Vines <Karl@wlma.org.uk>

Subject: Proposed Development off Moulton Chapel Road, Cowbit

Karl,

We are working for a developer who is looking to put a residential development on a site off Moulton Chapel Road, Cowbit. A location plan is attached. We are preparing a Flood Risk and Drainage Report to accompany the planning application.

For surface water drainage we are looking to have an attenuated discharge to the dyke running along the southern boundary of the site. We understand that this flows west to east under the new A16 and discharges to your Wheat Mere Drain. Would this be acceptable to your Board. We are aware that you will be a consultee on the planning application in due course but it is usually better if we have asked the question beforehand. Normally we would look to attenuate to 1.4 l/s/ha but in this instance with the site being only 1.25 ha it will be difficult to have a

discharge control device that would be suitable for adoption below 5.0 l/s. Therefore we would propose to attenuate to 5.0l/s. Would this be acceptable?.

For the Flood Risk part of our report we consider the flood risk from the Dyke and Wheat Mere Drain to be low but if you have any historic flood information or maximum water levels in Wheat Mere Drain I would be grateful if you would let me have the information so I can include it in the report.

Any help would be appreciated.

--

Regards

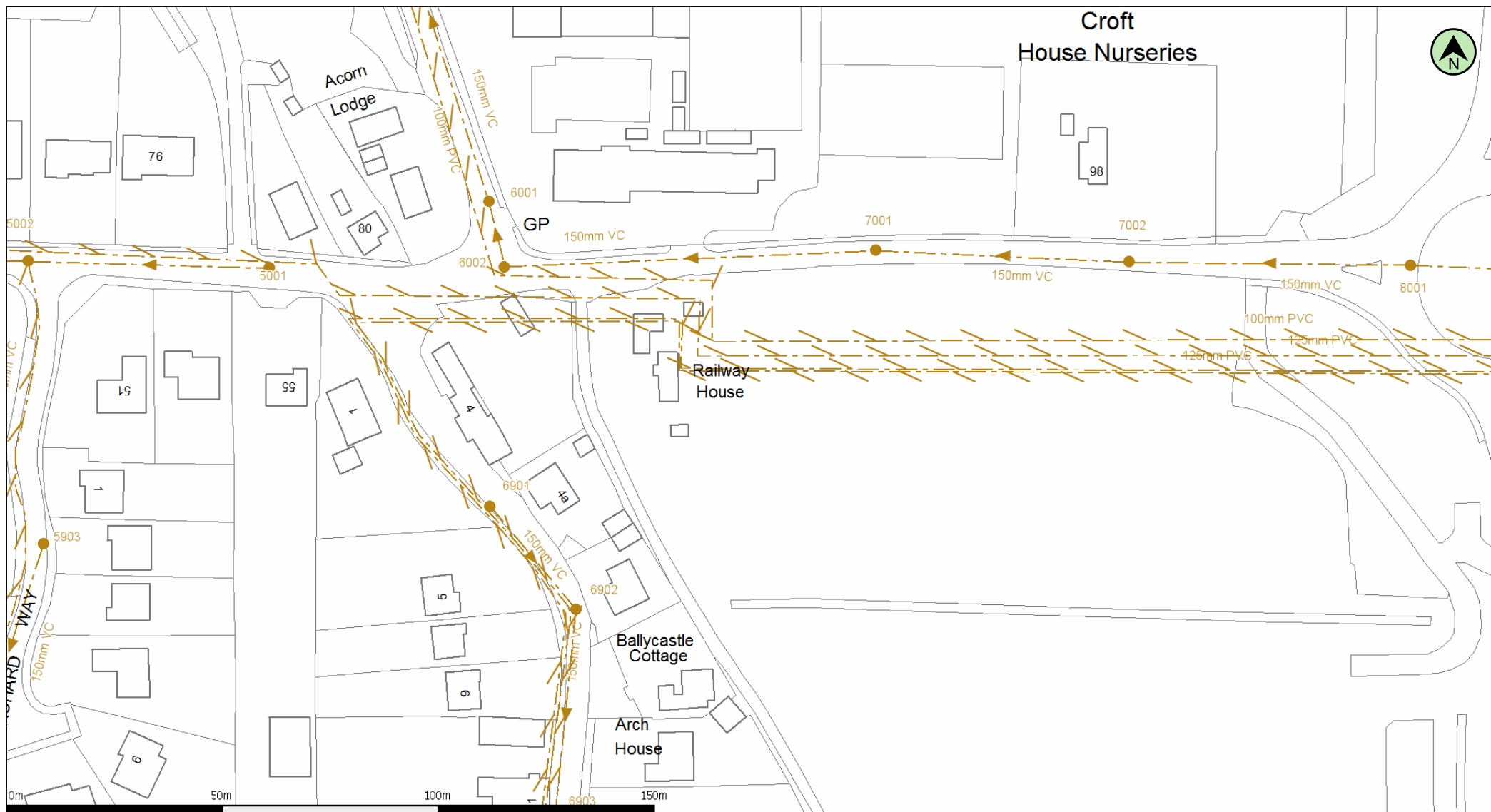
George Shuttleworth

for George Shuttleworth Ltd.

Tel 01522 787710 or 07940 927285

<http://www.georgeshuttleworthltd.co.uk>

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Date: 19/12/16

Scale: 1:1250

Map Centre: 526683,318006

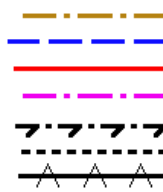
Data updated: 24/10/16

Our Ref: 208134 - 1

Wastewater Plan A4

This plan is provided by Anglian Water pursuant to its obligations under the Water Industry Act 1991 sections 198 or 199. It must be used in conjunction with any search results attached. The information on this plan is based on data currently recorded but position must be regarded as approximate. Service pipes, private sewers and drains are generally not shown. Users of this map are strongly advised to commission their own survey of the area shown on the plan before carrying out any works. The actual position of all apparatus MUST be established by trial holes. No liability whatsoever, including liability for negligence, is accepted by Anglian Water for any error or inaccuracy or omission, including the failure to accurately record, or record at all, the location of any water main, discharge pipe, sewer or disposal main or any item of apparatus. This information is valid for the date printed. This plan is produced by Anglian Water Services Limited (c) Crown copyright and database rights 2016 Ordnance Survey 100022432. This map is to be used for the purposes of viewing the location of Anglian Water plant only. Any other uses of the map data or further copies is not permitted. This notice is not intended to exclude or restrict liability for death or personal injury resulting from negligence.

Foul Sewer
Surface Sewer
Combined Sewer
Final Effluent
Rising Main
(Colour denotes effluent type)
Private Sewer
(Colour denotes effluent type)
Decommissioned Sewer
(Colour denotes effluent type)



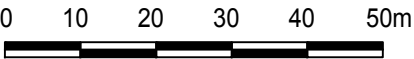
Outfall
(Colour denotes effluent type)
Inlet
(Colour denotes effluent type)
Manhole
(Colour denotes effluent type)
Sewage Treatment Works
Pumping Station



geo.shuttleworth@btconnect.com

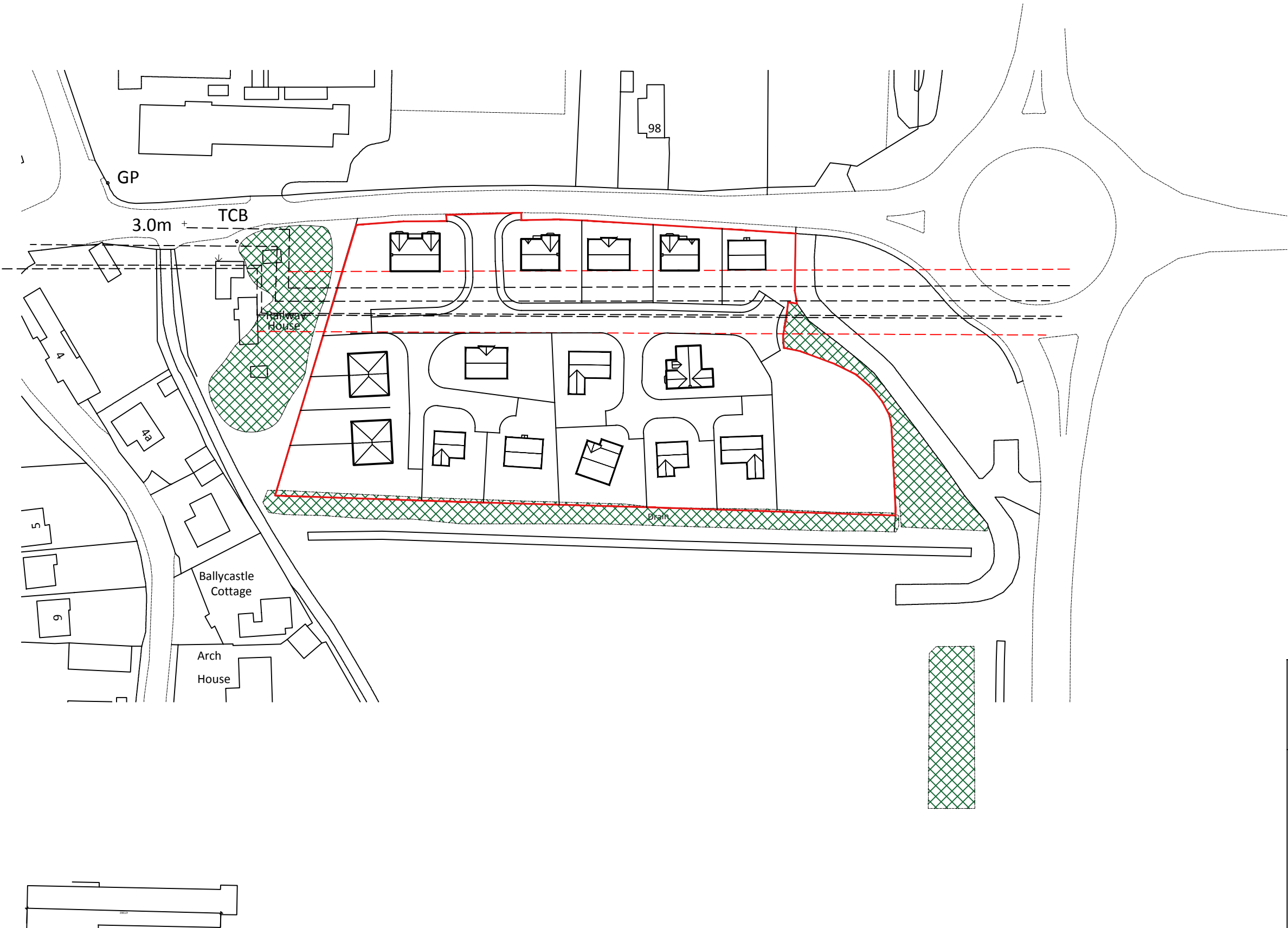
Cowbit

love every drop
anglianwater



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PLANNING PERMISSION ONLY



A	MD	Underground Services shown, Revised layout	4.1.16
Rev.	By	Notes	Date
rdc Robert Doughty Consultancy 32 High Street, Helpringham Sleaford, Lincolnshire NG34 0RA Tel: 01529 421646 Fax: 01529 421358 Email: admin@rdc-landplan.co.uk Web: www.rdc-landplan.co.uk			
Client: Mr P Smith			
Project: Land South off Moulton Chapel Rd. Cowbit			
Drawing title: Indicative Site Layout			
Drawing No. 1207-2_SP01	Rev. A	Drawn MD	
Scale 1:1000 @ A3	Date 29/09/16	Checked LMS	

Greenfield runoff estimation for sites

Site name: Moulton Rd
Site location: Cowbit

Site coordinates
Latitude: 52.74428° N
Longitude: 0.1236° W

Reference: gcruj1vcxymj / 1
Date: 19 Dec 2016

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 CIRIA SUDS Manual (2007). It is not to be used for detailed design of drainage systems. It is recommended that every drainage scheme uses hydraulic modelling software to finalise volume requirements and design details before drawings are produced.

Site characteristics

Total site area	1	ha
Significant public open space	0	ha
Area positively drained	1	ha

Methodology

Greenfield runoff method	IH124
Qbar estimation method	Calculate from SPR and SAAR
SPR estimation method	Calculate from SOIL type
SOIL type	2
HOST class	N/A
SPR	0.30

Hydrological characteristics

	Default	Edited	
SAAR	557	557	mm
M5-60 Rainfall Depth	20	20	mm
'r' Ratio M5-60/M5-2 day	0.4	0.4	
FEH/FSR conversion factor	0.79	0.79	
Hydrological region	5	5	
Growth curve factor: 1 year	0.87	0.87	
Growth curve factor: 10 year	1.65	1.65	
Growth curve factor: 30 year	2.45	2.45	
Growth curve factor: 100 year	3.56	3.56	

Greenfield runoff rates

	Default	Edited	
Qbar	1.39	1.39	l/s
1 in 1 year	1.21	1.21	l/s
1 in 30 years	3.42	3.42	l/s
1 in 100 years	4.97	4.97	l/s

Please note that a minimum flow of 5 l/s applies to any site

Site name: Moulton Rd
Site location: Cowbit

Site coordinates
Latitude: 52.74428° N
Longitude: 0.1236° W

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 CIRIA SUDS Manual (2007). It is not to be used for detailed design of drainage systems. It is recommended that every drainage scheme uses hydraulic modelling software to finalise volume requirements and design details before drawings are produced.

Reference: gcruj1vcxymj / 1
Date: 19 Dec 2016

Site characteristics

Total site area	1	ha
Significant public open space	0	ha
Area positively drained	1	ha

Methodology

Greenfield runoff method	FEH	
Qmed estimation method	Calculate from BFI and SAAR	
BFI and SPR estimation method	Calculate from dominant HOST	
HOST class	N/A	
BFI / BFIHOST	0.00	
Qmed	N/A	l/s
Qbar / Qmed Conversion Factor	N/A	

Hydrological characteristics

	Default	Edited	
SAAR	557	557	mm
M5-60 Rainfall Depth	20	20	mm
'r' Ratio M5-60/M5-2 day	0.4	0.4	
FEH/FSR conversion factor	0.79	0.79	
Hydrological region	5	5	
Growth curve factor: 1 year	0.87	0.87	
Growth curve factor: 10 year	1.65	1.65	
Growth curve factor: 30 year	2.45	2.45	
Growth curve factor: 100 year	3.56	3.56	

Greenfield runoff rates

	Default	Edited	
Qbar	---	---	l/s
1 in 1 year	---	---	l/s
1 in 30 years	---	---	l/s
1 in 100 years	---	---	l/s

Please note that a minimum flow of 5 l/s applies to any site

6-in or 1:10 000 Map Registration No.

TF/21 NE/5

National Grid Reference

C5 Combust

2656 1820

For whom made Spalding Rural District Council

Town or Village Cowbit County Lincoln

Exact site (reference to a fixed point on 1-in or 1:50 000 Map:

1-in or 1:50 000
New Series Map No.

Enter 'C' if
Confidential

144

British Geological Survey

Purpose for which made Proving sequence

Ground level at ^{shaft}bore relative to O.D. 2.3 m. If not ground level give O.D. of beginning of ^{shaft}bore _____ m.

Made by Pre-Piling Surveys Date of sinking 1972

Information from Report _____ Examined by _____

British Geological Survey

British Geological Survey

British Geological Survey

Specimen Numbers and Additional Notes

British Geological Survey

[illegible]

TF/21 NE/4

National Grid Reference

C4 Combust

For whom made Spalding Rural District Council

2661 1760

British Geological Survey

Town or Village Cowbit County Lincoln

1-in or 1:50 000
New Series Map No.

Enter 'C' if
Confidential

Exact site (reference to a fixed point on 1-in or 1:50 000 Map:

144

British Geological Survey

Geological Survey British Geological Survey
Purpose for which made Proving Sequence

Ground level at shaft
bore relative to O.D. 2.2 m. If not ground level give O.D. of beginning of shaft
bore _____ m.

Made by Pre-Piling Surveys Date of sinking 1971

Information from Report Examined by _____

British Geological Survey

Geological Classification

Description of Strata

Thickness
metres

Depth
metres

Topsoil

0.4

0.4

+0.9 → Brown clayey silty fine sand with traces of topsoil

0.9

1.3

Very soft grey silty clay with traces
of peat

5.7

7.0

6-in or 1:10 000 Map Registration No.

National Grid Reference

British Geological Survey
2740 1811

1-in or 1:50 000
New Series Map No.

Enter 'C' if
Confidential

144

Name and Number of Shaft or Borehole .

C6 Low bit

British Geological Survey

British Geological Survey

For whom made Salding Rural District Council

Town or Village Lowbit County Lucas

Exact site (reference to a fixed point on 1-in or 1:50 000 Map:

British Geological Survey

British Geological Survey

Purpose for which made Proving Sequence

Ground level at ^{shaft} ~~bore~~ relative to O.D. 3.0 m. If not ground level give O.D. of beginning of ^{shaft} ~~bore~~ m.

Made by Pre-Piling Surveys Date of sinking 1971

Information from Report

Examined by _____

British Geological Survey

Specimen Numbers and Additional Notes

British Geological Survey

[illegible]

Location	House Roof	Garage Roof	Drive	Total
Plot 1	112	0	30	142
Plot 2	77	0	31	108
Plot 3	80	0	32	112
Plot 4	77	0	33	110
Plot 5	66	0	34	100
Plot 6	90	0	35	125
Plot 7	80	0	36	116
Plot 8	70	0	37	107
Plot 9	52	0	39	91
Plot 10	52	0	40	92
Plot 11	52	0	41	93
Plot 12	52	0	42	94
Plot 13	65	0	43	108
Plot 14	70	0	44	114
Plot 15	80	0	45	125
Plot 16	65	0	46	111
Plot 17	90	0	47	137
				1885
	1230	0	655	1885

Adopted Roads and Footpaths	1028
Shared Private Access Roads	478
Total Artificial Area	2912.6
Total Site Area	8900
% Impermeable Area (PIMP)	32.7
Exc Private Drives	2735.6

ATTENUATION & DISCHARGE TO DITCH

Calculation of Rain Profiles

M5-60 20
r 0.4

D (mins)	15	30	60	120	240	360	480	720	1440
Z1	0.64	0.81	1	1.21	1.4	1.62	1.76	1.8	2.2
M5-D	12.8	16.2	20.0	24.2	28.0	32.4	35.2	36.0	44.0
Z2(100)	1.94	1.99	2.03	2.02	2.01	1.95	1.93	1.92	1.86
Z2(30)	1.50	1.52	1.53	1.54	1.53	1.51	1.50	1.49	1.45
Z2(2)	0.80	0.80	0.81	0.82	0.83	0.83	0.84	0.84	0.85
Z2(1)	0.62	0.62	0.64	0.65	0.67	0.68	0.68	0.69	0.71
MT-D(100)	24.83	32.24	40.60	48.88	56.28	63.18	67.94	69.12	81.84
MT-D(30)	19.20	24.62	30.60	37.15	42.84	48.92	52.80	53.64	63.80
MT-D(2)	10.24	12.96	16.20	19.84	23.24	26.89	29.57	30.24	37.40
MT-D(1)	7.87	10.04	12.70	15.73	18.76	22.03	23.94	24.84	31.24
I(100)	99.33	64.48	40.60	24.44	14.07	10.53	8.49	5.76	3.41
I(30)	76.80	49.25	30.60	18.57	10.71	8.15	6.60	4.47	2.66
I(2)	40.96	25.92	16.20	9.92	5.81	4.48	3.70	2.52	1.56
I(1)	31.49	20.09	12.70	7.87	4.69	3.67	2.99	2.07	1.30

Note: Intensity I() limited to 100mm/hr

Calculation of Flows and Volumes

Contributing Impermeable Area = 2736 m2

Climate Change of 30%

Flows (l/s) = $2.78 \times I \times A(\text{ha}) \times \text{Global warming}$

Storm	15	30	60	120	240	360	480	720	1440
1 in 100 yr	98.20	63.74	40.14	24.16	13.91	10.41	8.40	5.69	3.37
1 in 30 yr	75.93	48.69	30.25	18.36	10.59	8.06	6.53	4.42	2.63
2 in 30 yr	40.49	25.63	16.02	9.81	5.74	4.43	3.65	2.49	1.54
1 in 1 yr	31.13	19.86	12.56	7.78	4.64	3.63	2.96	2.05	1.29

Volume (m3) = $C_v \times A(\text{ha}) \times I \times D/60$ $C_v = 1.00$

Storm	15	30	60	120	240	360	480	720	1440
1 in 100 yr	88.31	114.65	144.38	173.85	200.15	224.69	241.60	245.81	291.05
1 in 30 yr	68.28	87.57	108.82	132.11	152.35	173.99	187.77	190.76	226.89
1 in 2 yr	36.42	46.09	57.61	70.57	82.65	95.64	105.15	107.54	133.00
1 in 1 yr	28.00	35.72	45.16	55.94	66.72	78.35	85.12	88.34	111.10

Initial Estimate of Balancing Volume Required

For Peak Discharge of 5.00 l/s Av'ge Disch Factor = 0.85 Average Discharge = 4.25 l/s

Storm	15	30	60	120	240	360	480	720	1440
1 in 100 yr	84.48	107.00	129.08	143.25	138.95	132.89	119.20	62.21	0.00
1 in 30 yr	64.46	79.92	93.52	101.51	91.15	82.19	65.37	7.16	0.00
1 in 2 yr	32.59	38.44	42.31	39.97	21.45	3.84	0.00	0.00	0.00
1 in 1 yr	24.17	28.07	29.86	25.34	5.52	0.00	0.00	0.00	0.00

		Depth (m)	Area (m2)	Sq Dims
Storage required for 1 in 30 yr storm	102 m3	0.6	169	13
Storage required for 1 in 100 yr storm	143 m3	0.6	239	15

Soil Infiltration Rate	6	mm/hr
	0.000002	m/s
Connected Impermeable Area	0	
Area of Perm Sub-base	30	
Impermeable Area	30	m2
Hydr Loading Rate	1.00	
Total rainfall (10 Year)		
M5-60	20	
r	0.4	
Min Sub-base Depth	0.15	m
Void Ratio	0.3	
Storage Vol in Sub-base	1.35	m3
a50	32	m2
Percolation Outflow	0.00005	m3/s
	0.1	l/s
	190	l/hr
Total Outflow	0.00005	m3/s

1 in 10 year STORM EVENT

D		15	30	60	120	240	360	480	720	1440
Z1		0.63	0.8	1	1.21	1.4	1.62	1.76	2	2.2
M5-D		12.6	16	20	24.2	28	32.4	35.2	40	44
Z2		1.23	1.24	1.24	1.23	1.23	1.21	1.21	1.2	1.18
M10-Dmin		15.498	19.84	24.8	29.766	34.44	39.204	42.592	48	51.92

D		15	30	60	120	240	360	480	720	1440
I	m3	0	1	1	1	1	1	1	1	2
Outflow	m3	0.0	0.1	0.2	0.4	0.8	1.1	1.5	2.3	4.6
S	m3	0.4	0.5	0.6	0.5	0.3	0.0	0.0	0.0	0.0
Time to Empty to 50%	hrs	1.1	1.3	1.5	1.4	0.7	0.1	0.0	0.0	0.0
Volume Check		OK	OK	OK	OK	OK	OK	OK	OK	OK

1 in 30 year STORM EVENT

D		15	30	60	120	240	360	480	720	1440
Z1		0.63	0.8	1	1.21	1.4	1.62	1.76	2	2.2
M5-D		12.6	16	20	24.2	28	32.4	35.2	40	44
Z2		1.5	1.52	1.54	1.53	1.53	1.49	1.49	1.47	1.45
M30-Dmin		18.9	24.32	30.8	37.026	42.84	48.276	52.448	58.8	63.8

D		15	30	60	120	240	360	480	720	1440
I	m3	1	1	1	1	1	1	2	2	2
Outflow	m3	0.0	0.1	0.2	0.4	0.8	1.1	1.5	2.3	4.6
S	m3	0.5	0.6	0.7	0.7	0.5	0.3	0.1	0.0	0.0
Time to Empty to 50%	hrs	1.4	1.7	1.9	1.9	1.4	0.8	0.1	0.0	0.0
Volume Check		OK	OK	OK	OK	OK	OK	OK	OK	OK

1 in 100 year STORM EVENT

Climate Change Volumetric Allowance

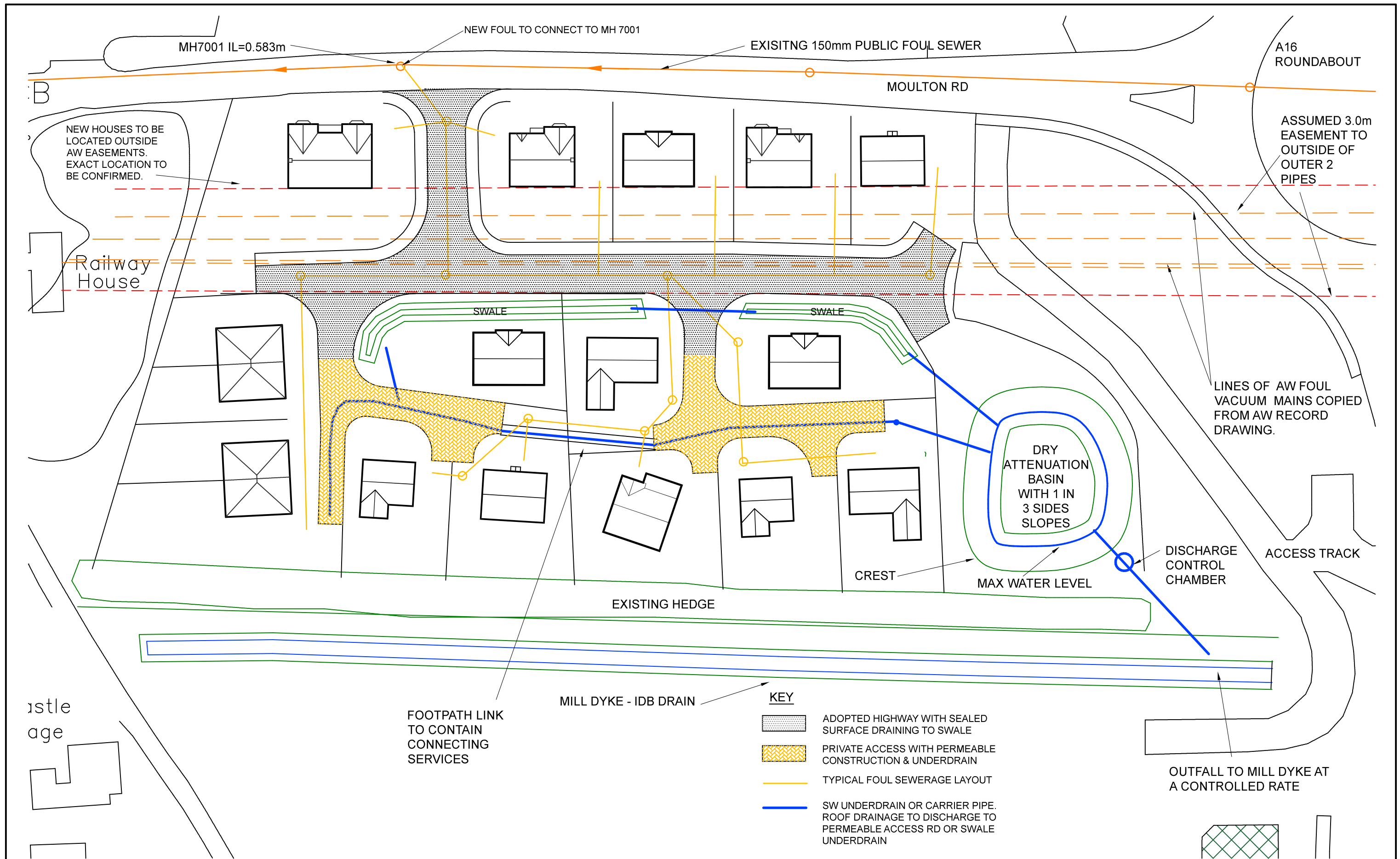
30.00%

D		15	30	60	120	240	360	480	720	1440
Z1		0.63	0.8	1	1.21	1.4	1.62	1.76	2	2.2
M5-D		12.6	16	20	24.2	28	32.4	35.2	40	44
Z2		1.94	1.99	2.03	2.02	2.01	1.95	1.93	1.92	1.86
M100-Dmin inc CC		31.78	41.39	52.78	63.55	73.16	82.13	88.32	99.84	106.39

D		15	30	60	120	240	360	480	720	1440
I	m3	1	1	2	2	2	2	3	3	3
Outflow	m3	0.0	0.1	0.2	0.4	0.8	1.1	1.5	2.3	4.6
S	m3	0.9	1.1	1.39	1.53	1.4	1.3	1.1	0.7	0.0
Time to Empty to 50%	hrs	2.4	3.0	3.7	4.0	3.8	3.5	3.0	1.9	0.0
Volume Check		OK	OK	FAIL	FAIL	FAIL	OK	OK	OK	OK

Although there are three failures above. The additional volume is only 0.18m3 which represents 6mm standing on the drive and ignores the volume in the sand laying course and the gaps in the blocks and therefore at outline design stage is deemed acceptable

	Easting	Northing	Easting	Northing	Distance	Description
Site Centre	526732	317957				
Borehole 1	526560	318200	-172	243	298	Soft Clay under 0.3m of topsoil
Borehole 2	526610	317600	-122	-357	377	0.4m topsoil, 0.9m of silty/sandy material over 5.0m of soft clay
Borehole 3	527400	318110	668	153	685	0.3m of topsoil over soft silty clay



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								DRAWING TITLE OUTLINE DESIGN OF PROPOSED DRAINAGE	DRG SIZE A3	DRAWING NO. 575-002	
	REV			DR	CH	AP	DATE				