Flood Risk & Drainage Assessment Report for the

Proposed

Industrial Development

off

Benner Road, Pinchbeck,

Spalding, Lincolnshire

PE11 3TZ

Prepared for

Neil Brown Engineering Ltd

Issue 01

Jan 2020

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CONTENTS

1.0	DEVELOPMENT SITE AND LOCATION	2
2.0	DEVELOPMENT PROPOSALS	2
3.0	SEQUENTIAL TEST	3
4.0	CLIMATE CHANGE	3
5.0	SITE SPECIFIC FLOOD RISK	4
6.0	FLOOD RISK MITIGATION	6
7.0	SURFACE WATER MANAGEMENT STRATEGY	7
8.0	OCCUPIERS & USERS OF THE DEVELOPMENT	9
9.0	RESIDUAL RISKS	9
10.0	FOUL SEWERAGE	10
11.0	CONCLUSION	10
12.0	APPENDIX 1 SUPPORTING INFORMATION	11

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Issue	:	01
Author	:	G Shuttleworth BSc CEng MICE
Date	:	10th January 2020

1.0 DEVELOPMENT SITE AND LOCATION

1.1. The proposed development is located off Benner Road, Pinchbeck, Spalding, Lincolnshire PE11 3TZ. The OS Grid Reference of the application site is TF 254 250.

1.2. The site is 'L' shaped and covers approximately 0.75 hectares with maximum dimensions of approximately 125m x 95m. The minimum width of the site is 40m

1.3. The site is bounded by Wardentree Lane to the north, Benner Road to the west, an un-named watercourse to the east and further industrial units to the south.

1.4. The site is currently undeveloped but located within an existing industrial estate.

1.5. The site is generally flat with levels varying between 3.05m and 3.50m AOD.

1.6. Drawing 686-002 provided in Appendix 1 illustrates the levels across the site and the key drainage features.

1.7. The site is located approximately 18km inland from The Wash but only 0.75km from the tidal River Welland. Vernatt's Drain is between the site and the tidal River Welland some 0.35km from the site.

1.8. The site is shown in Flood Zone 3 on the Environment Agency's Flood Maps.

2.0 DEVELOPMENT PROPOSALS

2.1. It is proposed to construct three blocks of four industrial units along with associated access roads and parking.

2.2. Details of the proposed development are shown on Drawing 631-003 contained in Appendix 1.

2.3. The maximum lifetime of the development is considered to be 75 years.

2.4. In accordance with Table 2 of the National Planning Practice Guidance (NPPG), the industrial development would be classed as less vulnerable.

2.5. In accordance with Table 3 of NPPG, less vulnerable developments in Flood Zone 3 are acceptable and an Exception Test is not required.

2.6. 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.

2.7. This report also includes a section, which considers how foul sewerage may be provided for the development.

3.0 SEQUENTIAL TEST

3.1. As stated previously the site is in Flood Zone 3 but the vast majority of land around Spalding is also in Flood Zone 3, with large areas at or below sea level, which are vulnerable to failures of the existing raised defences and the impact of climate change.

3.2. Although the site is located in Flood Zone 3, the Flood Hazard Maps produced in the South Holland District Council Strategic Flood Risk Assessment, show that the site is at a relatively low risk of flooding from a breach or overtopping of the defences.

3.3. The site is located within an existing industrial estate and has a similar Flood Hazard Rating to other comparable industrial sites within the area. With reasonably practical flood mitigation measures, the risk of flooding can be minimised.

3.4. Taking into account the above points the site can be considered to have passed the Sequential Test.

4.0 CLIMATE CHANGE

4.1. 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.

4.2. 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%.

4.3. The Environment Agency Flood Maps have not been updated to take account of the revised climate change information. However, it is understood that the South Holland District Council Strategic Flood Risk Assessment does take into account the potential increase in flooding due to increases in sea levels to 2115.

4.4. 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.

4.5. 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.

4.6. 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.

4.7. 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%

4.8. 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.

5.0 SITE SPECIFIC FLOOD RISK

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

a) Flooding from a breach or overtopping of the raised defences of the River Welland
b) Flooding from high water levels in the Vernatt's Drain
c) Flooding from High Water Levels in Scraggs Dyke & Blue Gowt Drain
d) Flooding from infrastructure failure
e) Flooding from groundwater
f) Flooding from failure of the site surface water drainage system.

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

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

5.3. The Flood Risk Maps for Planning show that the site is in Flood Zone 3.

5.4. 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.

5.5. More detailed Flood Information for this site was obtained from the Environment Agency and the information provided is contained in Appendix 1.

5.6. The 1 in 1 year still tidal water level at Fosdyke Bridge is 4.91m AOD. The closest modelled node on the River Welland, provided by the Environment Agency has a 1 in 2 year fluvial flood level of 3.64m AOD.

5.7. From previous work we are aware that the 1 in 2 year fluvial flood level in the River Welland at the closest point to the site is 4.32m AOD, rising to 4.42m for the 1 in 100 year event.

5.8. The above figures do not include any allowance for the rise in fluvial flows or sea levels due to Climate Change.

5.9. Ground levels on the site vary between 3.05 and 3.50m. Therefore, the site is below the 1 in 1 year tide level and the 1 in 2 year fluvial flood level. The site will also be below the daily high tide level occurring twice per day for most of the lunar cycle.

5.10. The site is currently protected from flooding by the raised earth defences of the River Welland.

5.11. The site is potentially at 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.

5.12. Environment Agency has stated that the raised earth flood defences that protect the site are in a fair condition and provide protection from a 1 in 100 year event.

5.13. The Environment Agency advised that for details of any Flood Hazard Mapping reference should be made to the South Holland District Council Strategic Flood Risk Assessment.

5.14. The Flood Hazard Maps in the SFRA show that the residual risk from a breach or overtopping of the defences on the 2115 1 in 100 year fluvial and 1 in 200 year tidal events could result in peak flood depths on the site in two depth ranges 0.25-0.5m and 0.5-1.0m.

5.15. An enlarged extract from the map along with the drawing key and title block is contained in Appendix 1.

5.16. It should be noted that although the some parts of the site are shown to have flood depths between 0.5 and 1.0m, it does not necessarily imply that flood depths up to 1.0m will occur on the site, only that they will be in excess of 0.5m

5.17. The flood depths were considered in conjunction with the surveyed ground levels with the aim of estimating the corresponding flood level at the site. The minimum surveyed level was 3.05m and the maximum was 3.50m. Given the whole of the site is within the depth range 0.25m to 1.0m, the flood level on the site must be between 3.75m and 4.05m.

5.18. We have also considered a grid of LIDAR levels on which we understand were used in the flood depth modelling and used conditional formatting to colour the squares according to flood depth. The flood level which most closely resembles the SFRA plan is 3.75m AOD. The flood depth outlines are slightly different, as we understand that the SFRA modelling uses a larger grid spacing than the 2.0m grid plotted for this site.

5.19. Therefore, it is reasonable to assume the peak flood level is no greater than 3.75m AOD.

Flooding from High Water Levels in the Vernatt's Drain

5.20. Vernatt's Drain is operated and maintained by Welling & Deepings Internal Drainage Board.

5.21. Vernatt's Drain is located approximately 0.35km from the site.

5.22. From the SFRA that the 2115 1 in 100 year fluvial flood level in Vernatt's Drain closest to the site would be 3.85m AOD and the bank levels at this point are 4.25m AOD giving 400mm of freeboard.

5.23. Although there is a risk of flooding from a breach or overtopping of Vernatt's Drain, the potential flood levels would be lower than those for the River Welland considered above.

Flooding from High Water Levels in the Scraggs Dyke and Blue Gowt Drain

5.24. There is a un-named water course flowing north to south along the eastern boundary of the site. The watercourse is culverted under Wardentree Lane. On the northern side of Wardentree Lane, it becomes the Welland and Deepings IDB Scraggs Dyke, which flows north for 350m before it reaches the Welland & Deepings IDB Blue Gowt Drain.

5.25. Although, we do not have any flood level information for Scraggs Dyke and Blue Gowt Drain it is probable that the 1 in 100 year fluvial flood level will remain within the bank levels.

5.26. This view is supported by the Surface Water Flood Maps published on the government web-site which show surface water flooding contained to within the banks. A copy of the surface water flood map is presented in Appendix 1.

Flooding from Infrastructure Failure

5.27. It is not known if there are any large diameter water mains in the area.

5.28. There are foul and surface water sewers in Benner Road and a foul pumping station on the opposite side of Wardentree Lane to Benner Road.

5.29. Given the topology of the surrounding ground and the presence of the open watercourse on the eastern boundary, provided ground levels are graded to the boundary drains with no artificial hollows created then the risk of internal flooding would be minimal.

Flooding from Groundwater

5.30. There is an open watercourse on the eastern boundary of the site. Water levels were recorded at 1.44m at the northern end of the site and 1.97m along the eastern boundary. It is anticipated that groundwater levels on the site will be similar to that in the open watercourse i.e. 2.0m AOD.

5.31. However, given the topology of the surrounding ground and the presence of the boundary drains provided ground levels are graded to the boundary drains with no artificial hollows created then the risk of internal flooding would be minimal.

Flooding from failure of the Site Surface Water Drainage System.

5.32. 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.

5.33. However, given the topology of the surrounding ground and the presence of the boundary drains provided ground levels are graded to the boundary drains with no artificial hollows created then the risk of internal flooding would be minimal.

6.0 FLOOD RISK MITIGATION

6.1. It is impractical to set the floor levels of the units above the estimated flood level of 3.75m.

6.2. However, it is proposed to set the floor levels as high as practical and to a minimum of 3.45m.

6.3. If practical, internal offices and less resilient areas, should have floor levels set above the flood level 3.75m

6.4. It will be impractical to design industrial buildings to resist the potential flood depths. Therefore, the buildings should be designed for flood resilience so that they can be brought back into service quickly after a flood with minimal damage and repair costs. Flood resilient construction should be used to at least 4.45m.

6.5. This could be achieved by avoiding the use of plaster finishes. Installing floors and walls that can be hosed down and using metal frames kitchen cupboards etc.

6.6. Electrical consumer units should be set above the flood level and sockets should be set as high as possible and fed from above.

7.0 SURFACE WATER MANAGEMENT STRATEGY

7.1. Sustainable Drainage Systems (SuDS) have been considered for this development.

7.2. 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

7.3. 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

7.4. The British Geological Society web-site was checked for records of boreholes within the vicinity of the site. There are four boreholes within 150m of the western boundary of the site,

7.5. The boreholes generally indicate that a clayey layer exists to around 1.5m depth. A sandy gravely layer is present below the clay but the standing ground water level was generally up to the underside of the clay layer.

7.6. Copies of the borehole records are presented in Appendix 1.

7.7. The presence of the watercourse on the eastern boundary also indicates that vertical drainage may be restricted.

7.8. Taking into account the existing borehole records and in the absence of site specific geotechnical investigation reports, it is concluded that the site is unlikely to be suitable for surface water disposal via infiltration systems.

Disposal to a Watercourse

7.9. 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 watercourse running along the eastern boundary of the site.

7.10. Welland & Deepings IDB has been contacted regarding the discharge of surface water. They have stated that their normal maximum discharge is 1.4/l/s/ha but for small sites they would be prepared to accept a discharge of 5.0l/s, subject to the payment of a charge

7.11. They have also stated that they would prefer the point of discharge to be as close to Wardentree Lane as practical. A copy of the correspondence is provided in Appendix 1.

7.12. It should be noted that although we have stated that the watercourse runs along the eastern boundary it does in fact run along the northern boundary for approximately 10m before being piped under Wardentree Lane.

7.13. A discharge opposite the pipe under Wardentree Lane is proposed.

7.14. The gross site area is 0.75ha so the a maximum discharge of 1.05l/s would be required to comply with the IDB's discharge rate of 1.4l/s/ha. It is unlikely that a practical means of restricting the discharge to 1.05 l/s will be achievable and other discharge control devices for flows up to 5.0 l/s should be considered.

7.15. OUTLINE DESIGN OF THE PROPOSED SURFACE WATER DRAINAGE SYSTEM

7.16. Surface water run off will be generated from the following artificial surfaces created by the development.

a) Unit Roofs
b) Access Roads
c) Parking and Loading Bays

7.17. It is proposed that all roads within the site will be privately owned.

Attenuation Required

7.18. Limiting the discharge to the watercourse to a maximum of 5.0 l/s the volume required attenuating from all artificial surfaces for all storms up to and including the 1 in 100 year plus climate change event is estimated at 313m3.

7.19. Calculations are provided in Appendix 1.

Provision of the Required Attenuation Volume

7.20. As previously mentioned the water level in the adjacent water course is between 1.44 and 1.97m and existing ground levels vary between 3.05 and 3.50m.

7.21. The proposed outfall will be at the northern end where the water level is lower.

7.22. Considering the minimum floor level of the units of 3.45m, the access road surface would be at around 3.15m. This equates to around only 1.55m for the hydraulic gradient across the site, the storage depth and cover to the storage units.

7.23. At this stage due to the potential lack of cover and HGV loading, the installation of cellular crates under the access road has not been considered further.

7.24. There would be an opportunity to install cellular crates under the parking bays provided the HGV's could be prevented from driving on the parking areas. The area of the parking bays is 578m2 and with one layer of crates, 0.4m deep could provide 220m3 of the storage required.

7.25. There is a landscaped area to the west of the site, south of the site entrance. A dry attenuation basin could be provided in this location. With 1 in 3 side slopes, 300mm freeboard and 600mm design depth up to 132m3 of attenuation could be provided in this area.

7.26. If an open attenuation basin was not desirable then a similar volume of cellular crate storage could be provided.

7.27. Alternatively, the attenuation volume could be provided in the permeable sub-base under the hardstanding areas. If all the hardstanding areas were used then a depth of 0.45m of permeable sub-base would be required to provide the attenuation.

7.28. In conclusion, the required attenuation volume can be provided in permeable sub-base or cellular crates under the parking bays and a small attenuation basin near the site entrance or a combination of all three.

7.29. The final choice should be made at detailed design stage when more detailed costings and construction phasing are known.

Construction Considerations

7.30. With the use of permeable sub-bases it is essential that it is protected from contamination with mud during construction. It should either, be protected with a asphalt layer, nominally 130mm thick, which is drilled afterwards or the permeable sub-base is only installed after the majority of construction is complete and the risk of contamination has gone. The 130mm asphalt layer is in addition to the depth of permeable sub-base required.

7.31. If a protective asphalt layer is installed it is also essential that some temporary drainage and storage is installed that keeps the permeable sub-base free of contaminated surface water.

7.32. Depending on the structural design of the access roads, the storage volumes provided may need to be tanked to prevent deterioration of the road formation from repeated wetting. If the roads are to be tanked it is likely that service strips will be required to all of the units and this may decrease the area available for permeable sub-base and increase the thickness in the areas where it is provided.

7.33. It is advisable to install an underdrain, either at or below the level of the permeable sub-base. This will assist with drainage and minimise the effect on the formation.

7.34. An illustration of an outline design of a surface water drainage system for the proposed layout is shown on drawing 686/003 provided in Appendix 1.

7.35. The detailed design of the surface water drainage system should follow the principles outlined in this report.

Maintenance

7.36. It is understood that the proposed surface water drainage system will be the collective responsibility of all the units and will be maintained by a management company on behalf of all the owners.

8.0 OCCUPIERS & USERS OF THE DEVELOPMENT

8.1. The proposed development will increase the number of users of the site to between 50-100.

8.2. The land will be occupied full time during the day. It is possible there some units will be staffed at night. There should be no people sleeping on the land.

8.3. The land will normally be protected from flooding by the existing flood defences.

8.4. Should the defences be breached or over topped the land may flood up to depths of up to 0.5m which would result in a low hazard rating.

8.5. Therefore, it can be concluded that the development would be safe for the users over the lifetime of the development.

9.0 RESIDUAL RISKS

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

10.0 FOUL SEWERAGE

10.1. A copy of the sewer records has been obtained from Anglian Water and is presented in Appendix 1

10.2. There is a foul sewer located in Benner Road which crosses the entrance to the site. MH4901 is located in the entrance. According to the sewer records the has a depth of 2.71m and should be more than deep enough to accept gravity flows from the development site.

10.3. A Section 106 application will need to be made to Anglian Water for the connection to the foul sewer. It is recommended that the application includes the adoption of the lateral and a demarcation chamber at the boundary.

10.4. With many similar industrial estates connections fro the drainage infrastructure were made into the plots within the industrial estate. Further investigation may reveal an existing sewer connection to MH4901. However, even if a connections exists a Section 106 application for an indirect connection will still be required.

10.5. An outline layout of a proposed foul sewerage system is shown on Drawing 698-003 contained in Appendix 1. The drawing shows an adoptable pumping station located in the open area adjacent to the proposed attenuation basin.

11.0 CONCLUSION

11.1. The site is in Flood Zone 3 but the modelling of breaches of the defences shown in the SFRA show that in the worst case the floodwaters from a breach may flood the site to up to 0.5m.

11.2. In this report the flood depth has converted to an estimated flood level of 3.75m AOD. It is not practical to set the floor levels of the units above this level but they should be set at least 3.45m. Where practical flood resilient construction should be used to 4.45m above floor levels.

11.3. If practical internal offices and less resilient areas should have floor levels set above the flood level 3.75m

11.4. Taking into account the above points the development can be assessed as safe for the lifetime of the development.

11.5. 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. The surface water attenuation required can be provided in permeable sub-base, cellular crates an attenuation basin or a combination of all three.

11.6. This report also demonstrates that it is practical to connect the development to the public foul sewerage system.

11.7. Taking into account the above points it is concluded that the proposed development can be considered appropriate in this location.

12.0 APPENDIX 1 SUPPORTING INFORMATION

a) GSL Drawing 684-002 Existing Levels and Key Drainage Features

b) GSL Drawing 684-003 Proposed Development & Outline of Proposed Drainage

c) Information Provide by the Environment Agency

d) Extract from SFRA 2115 1 in 200 year Residual Risk Flood Depth Map

e) Title Block & Key From SFRA 2115 Residual Risk Flood Depth Map

f) Plot of LIDAR Levels on 2.0m Grid Coloured for 3.75m Flood Level

g) Surface Water Flood Map

h) BGS Borehole Records

i) Correspondence with Welland & Deepings IDB

j) Surface Water Calculations

k) Anglian Water Sewer Record Drawing and Manhole Schedule

N

WELLAND& DEEPINGS IDB
MAINTAINED SCRAGGS DYKE

B1180 WARDENTREE LANE

ASSUMED CULVERT
UNDER ROAD SIZE
UNKNOWN

ASSUMED OUFALL FROM
AW SW SEWER

BENNER ROAD

Kerb

CL3.02

+3.40

3.50+

3.50+

PRIVATE
OPEN
DRAIN

WATER LEVEL
1.44m

EXISTING BUILDING

0.5-1.0m

0.25-0.5m

EXISTING
BUILDING

WATER LEVEL 1.97m

3.40+

EXISTING BUILDING

CL3.05

AW SW
SEWER

AW FOUL
SEWER

+3.19

+3.11

EXTENT OF DEVELOPMENT SITE

+3.05

0.25-0.5m

0.5-1.0m

APPROX LINE OF FLOOD DEPTH
ZONES FROM SFRA FLOOD
DEPTHS MAP

2.94+

CL2.99

MH4901

+3.23

+3.05

CL3.01

CL3.21

CL3.22

CL3.10

CL3.19

CL3.22

+3.05

CL3.15

3.18+

EXISTING BUILDING

NOTES

1. A FULL TOPOGRAPHICAL SURVEY HAS BEEN UNDERTKEN BY AXIS SURVEYS LTD. SELECTED REPRESENTATIVE SPOT LEVELS FROM THE SURVEY ARE SHOWN ON THIS DRAWING TO INDICATE THE GENERAL LEVELS ON THE SITE.

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REV	DESCRIPTION	AP	DATE

CLIENT
NEIL BROWN ENGINEERING LTD

PROJECT
PROPOSED INDUSTRIAL UNITS
OFF BENNER RD, PINCHBECK

DRAWING TITLE
EXISTING SITE LEVELS & KEY
DRAINAGE FEATURES

SCALE AT A3	DATE	APPROVED BY
1:500	JAN 20	GS

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DRG SIZE	DRAWING NO.	REV.
A3	684-002	-

N

WELLAND& DEEPINGS IDB
MAINTAINED SCRAGGS DYKE

B1180 WARDENTREE LANE

NEW ATTENUATED
DISCHARGE TO DYKE

ASSUMED CULVERT
UNDER ROAD SIZE
UNKNOWN

BENNER ROAD

Kerb

CAR PARKING BAYS WITH PERMEABLE SURFACE, SUB-BASE & UNDERDRAIN. DEPTH TO SUIT STRUCTURAL & HYDRAULIC REQUIREMENTS. POTENTIAL TO INSTALL CELLULAR CRATES UNDER CAR PARKING SUBJECT TO STRUCTURAL DESIGN

DISCHARGE CONTROL
CHAMBER

PRIVATE
OPEN
DRAIN

RAMPS TO UNITS TO BE EITHER PERMEABLE OR NORMAL CONSTRUCTION TO MEET STRUCTURAL REQ'S

RAMP
RAMP
RAMP
RAMP

FFL=3.45m

RAINWATER PIPES TO DISCHARGE TO ACCESS RD UNDERDRAIN

EXISTING BUILDING

EXISTING
BUILDING

EXISTING BUILDING

ENTRANCE LEVELS
TO BE GRADED TO
EXISTING

TYPICAL
RD
LEVEL

PERMEABLE ACCESS RD WITH PERMEABLE SUB-BASE & UNDERDRAIN. DEPTH TO SUIT STRUCTURAL & HYDRAULIC REQUIREMENTS

UNDERDRAIN
TO ACCESS RD

+3.15
3.15+
2.94+
3.18+

DEMARCATION CHAMBER

POTENTIAL ATTENUATION BASIN OR CELLULAR CRATE STORAGE

OUTLINE OF
PROPOSED
FOUL
DRAINAGE

FFL=3.45m

RAMPS TO UNITS TO BE EITHER PERMEABLE OR NORMAL CONSTRUCTION TO MEET STRUCTURAL REQ'S

RAINWATER
PIPES TO
DISCHARGE TO
ACCESS RD
UNDERDRAIN

FFL=3.45m

PROPOSED FOUL CONNECTION TO MH4901

EXISTING BUILDING

NOTES

1. THIS DRAWIJNG SHOWS AN OUTLINE DESIGN FOR THE PLANNING APPLICATION STAGE ONLY. FURTHER DETAILED DESIGN REQUIRED FOLLOWING THE DRAINAGE PRINCIPLES OUTLINED ON THIS DRAWING FOR DISCHARGE OF PLANNING CONDITIONS, BUILDING REGULATIONS APPROVAL & CONSTRUCTION.

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REV	DESCRIPTION	AP	DATE

CLIENT
NEIL BROWN ENGINEERING LTD

PROJECT
PROPOSED INDUSTRIAL UNITS
OFF BENNER RD, PINCHBECK

DRAWING TITLE
PROPOSED INDUSTRIAL UNITS &
OUTLINE DRAINAGE DESIGN

SCALE AT A3	DATE	APPROVED BY
1:500	JAN 20	GS

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DRG SIZE	DRAWING NO.	REV.
A3	684-003	-

George Shuttleworth
geo.shuttleworth@btconnect.com

Our ref: CCN/2019/155125

Date: 24 December 2019

Dear George

Provision of Flood Risk Information for Benner Road, Pinchbeck

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.

History of Flooding

With regards to the history of flooding I can advise we do not have any records of flooding in this area. It is possible other flooding may have occurred we do not have records for, and other organisations, such as the Local Authority or Internal Drainage Boards, may have records.

Fluvial Flood Risk Information

Fluvial Defence Information

The fluvial defences reducing the risk of flooding to this site consist of earth embankments. They are in fair condition and reduce the risk of flooding to a 1% (1 in 100) chance of occuring

in any year. We inspect these defences routinely to ensure potential defects are identified.

Modelled Levels and Flows
Available modelled fluvial flood levels and flows for the model nodes shown on the attached map are set out in the data table attached. This data is taken from the model named on the data table, which is the most up-to-date model currently available.

Please note 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.

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 1% (1 in 100) chance of occurring.

Tidal/Breach 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

Please refer to South Holland District Council's hazard mapping undertaken for their Strategic Flood Risk Assessment (SFRA). Please use the following website for the updated 2016 maps: http://www.southeastlincslocalplan.org/2016-update-of-south-holland-strategic-flood-risk-assessment/

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 Sarah Curl using the details below.

Yours sincerely,

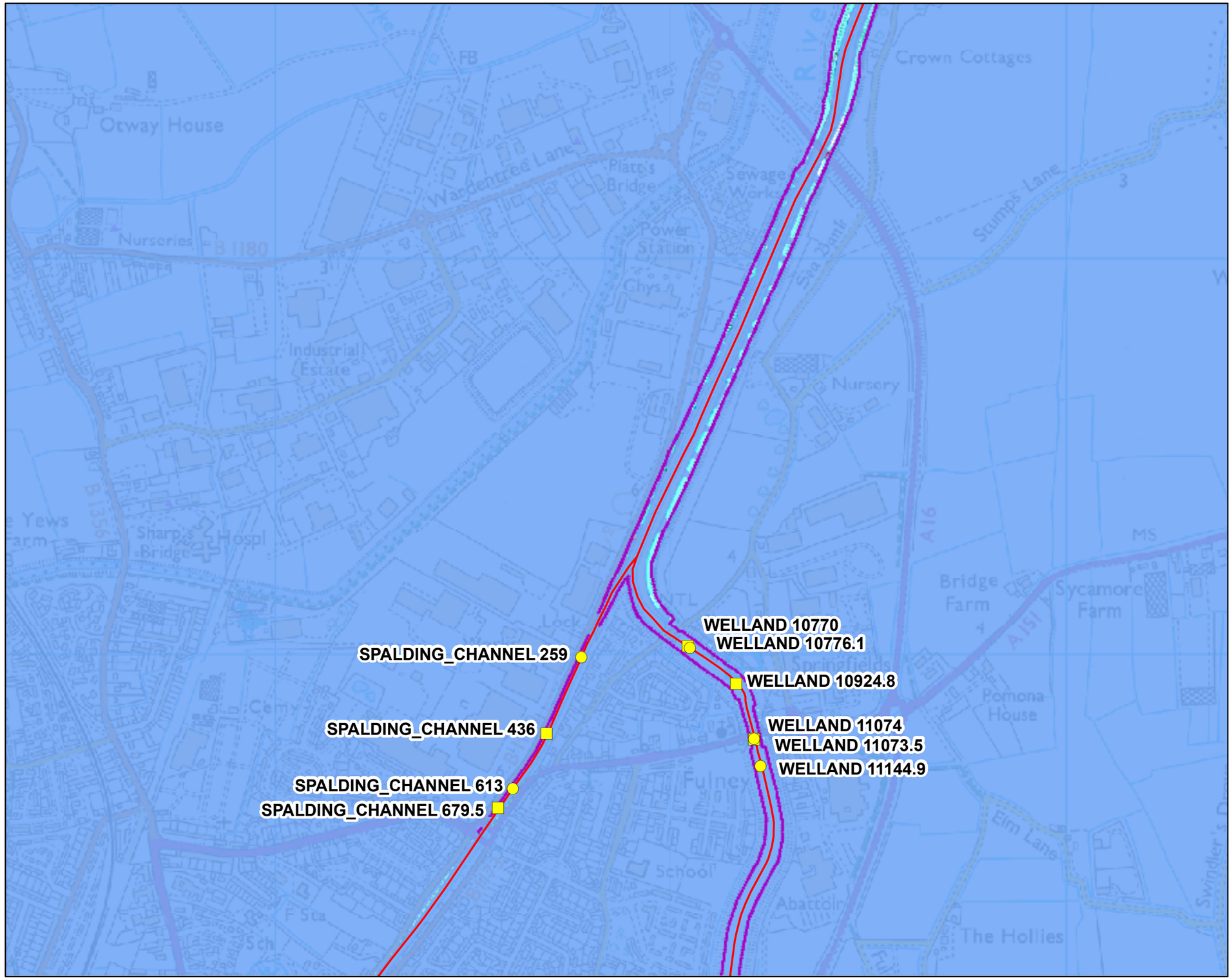


FOR Alastair Windler
Partnerships and Strategic Overview Team Leader - Welland and Nene

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

Enc.
Flood Map
Modelled Fluvial Levels and Flows Data Sheet
Estimated Tide Levels

Flood Map centred on TF 25867 24417 - created December 2019 [Ref: CCN-2019-155125]



Environment Agency

Scale 1:10,000

N

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

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

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

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

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

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

Created by the Partnerships and Strategic Overview Team, Kettering

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

Datasheet [Ref: CCN-2019-155125] Model Name: Welland Model Date: 2016

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).

			Annual Exceedance Probability - Maximum Water Levels (mODN)										
Node Label	**Easting**	**Northing**	**50% (1 in 2)**	**20% (1 in 5)**	**10% (1 in 10)**	**5% (1 in 20)**	**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**
SPALDING_CHANNEL 259	525779	323995	3.70	4.00	4.17	4.45	4.51	4.52	4.52	4.68	4.53	4.56	4.68
SPALDING_CHANNEL 613	525605	323662	3.70	4.00	4.17	4.45	4.51	4.52	4.52	4.68	4.53	4.55	4.68
WELLAND 10776.1	526053	324019	3.64	3.90	4.10	4.36	4.38	4.41	4.43	4.68	4.44	4.45	4.68
WELLAND 11073.5	526216	323788	3.65	3.91	4.10	4.36	4.38	4.41	4.43	4.68	4.44	4.45	4.68
WELLAND 11144.9	526232	323719	3.65	3.91	4.10	4.36	4.39	4.42	4.44	4.68	4.45	4.46	4.68

Fluvial Flood Flows (m^3/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 (m^3/s).

			Annual Exceedance Probability - Maximum Flows (m^3/s)										
Node Label	**Easting**	**Northing**	**50% (1 in 2)**	**20% (1 in 5)**	**10% (1 in 10)**	**5% (1 in 20)**	**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**
SPALDING_CHANNEL 436	525690	323802	0.71	1.06	0.91	1.06	1.03	1.15	1.17	1.65	1.10	1.07	1.93
SPALDING_CHANNEL 679.5	525567	323613	1.30	1.99	1.77	2.06	1.93	2.24	2.31	3.19	2.18	2.06	3.61
WELLAND 10770	526048	324023	74.58	91.64	102.46	116.08	121.43	121.70	123.79	124.12	122.86	123.37	236.17
WELLAND 10924.8	526170	323927	74.06	89.60	100.87	115.72	118.85	119.81	121.38	123.20	120.56	120.49	119.34
WELLAND 11074	526216	323788	73.88	89.28	100.54	115.25	118.58	119.51	123.31	124.59	121.86	124.52	119.07

Tidal Level Location Map
Lincolnshire & Northamptonshire Area



Produced May 2017

Produced by Partnerships & Strategic Overview Team

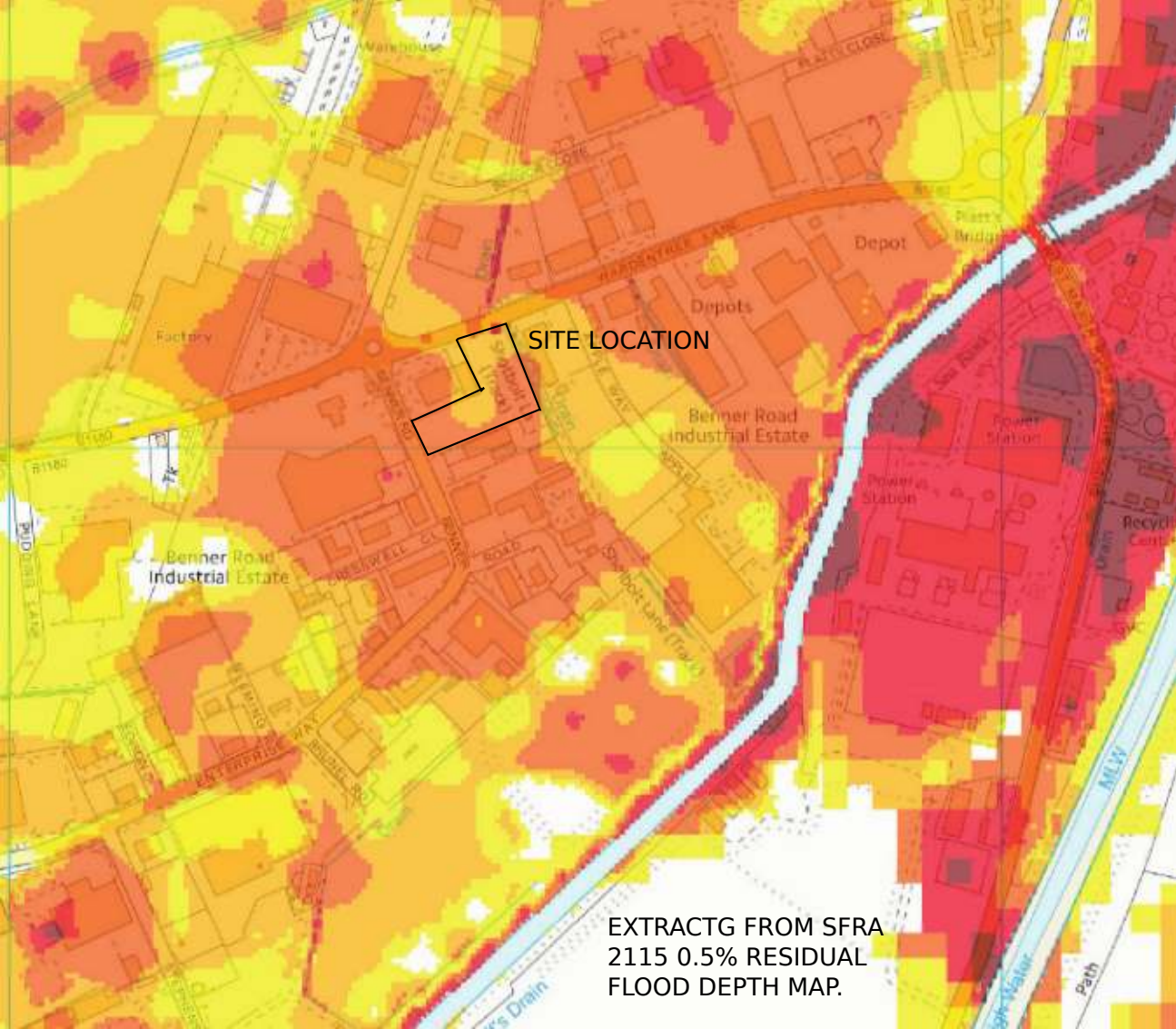
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Tidal Water Levels for the South Humber, East Coast and The Wash

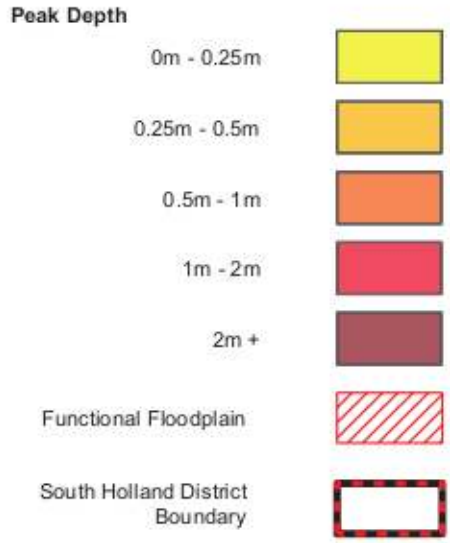
The table below shows still water levels for locations, from the above location map, around the South Humber Estuary, East Coast and The Wash. It is important to note the following:

- 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	~


SITE LOCATION
Depot
Depots
Factory
Benner Road
Industrial Estate
Power
Station
Benner Road
Industrial Estate
MLW
Path
EXTRACTG FROM SFRA
2115 0.5% RESIDUAL
FLOOD DEPTH MAP.

Map Legend



REV	DATE	REMARKS
2	Feb 17	Modelling and Mapping Update
1	Dec 16	Modelling and Mapping Update

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Enhancing Society Together

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SOUTH HOLLAND DISTRICT COUNCIL
COUNCIL OFFICES
PRIORY ROAD
SPALDING
LINCOLNSHIRE
PE11 2XE

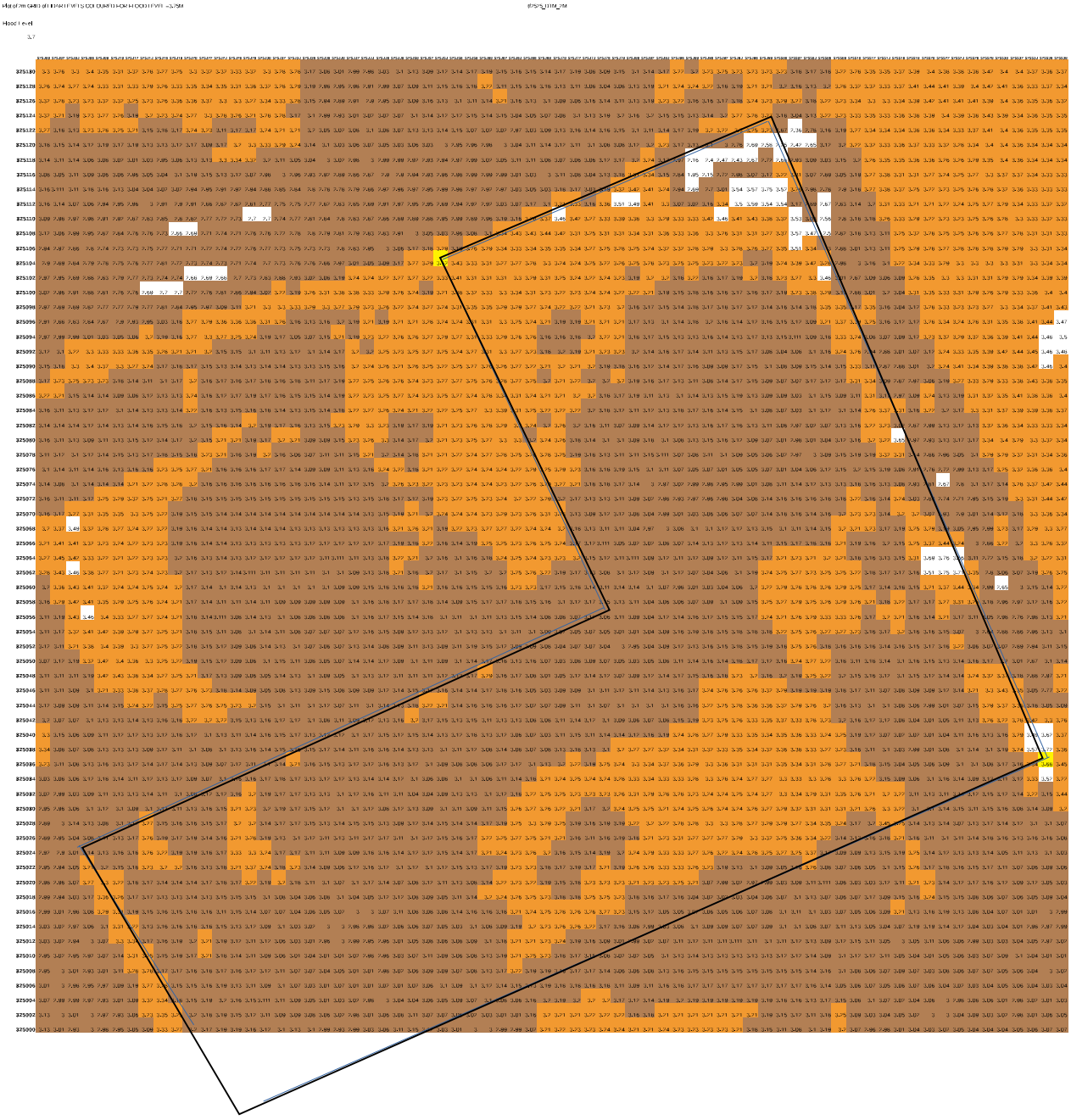
UPDATE OF STRATEGIC FLOOD RISK ASSESSMENT

Residual Peak Depth
Spalding - Year 2115
1% Fluvial / 0.5% Tidal Event Probability

DATE OF ISSUE: Feb 2017 REV NO: 2

SCALE: 1 : 15,000 @ A1

MAP NO:



PLOT OF LIDAR LEVELS ON 2m GRID WITH FLOOD LEVEL SET AT 3.75m

Basic view Detailed view

Location Enter a place or postcode in England

Flood risk from rivers or the sea

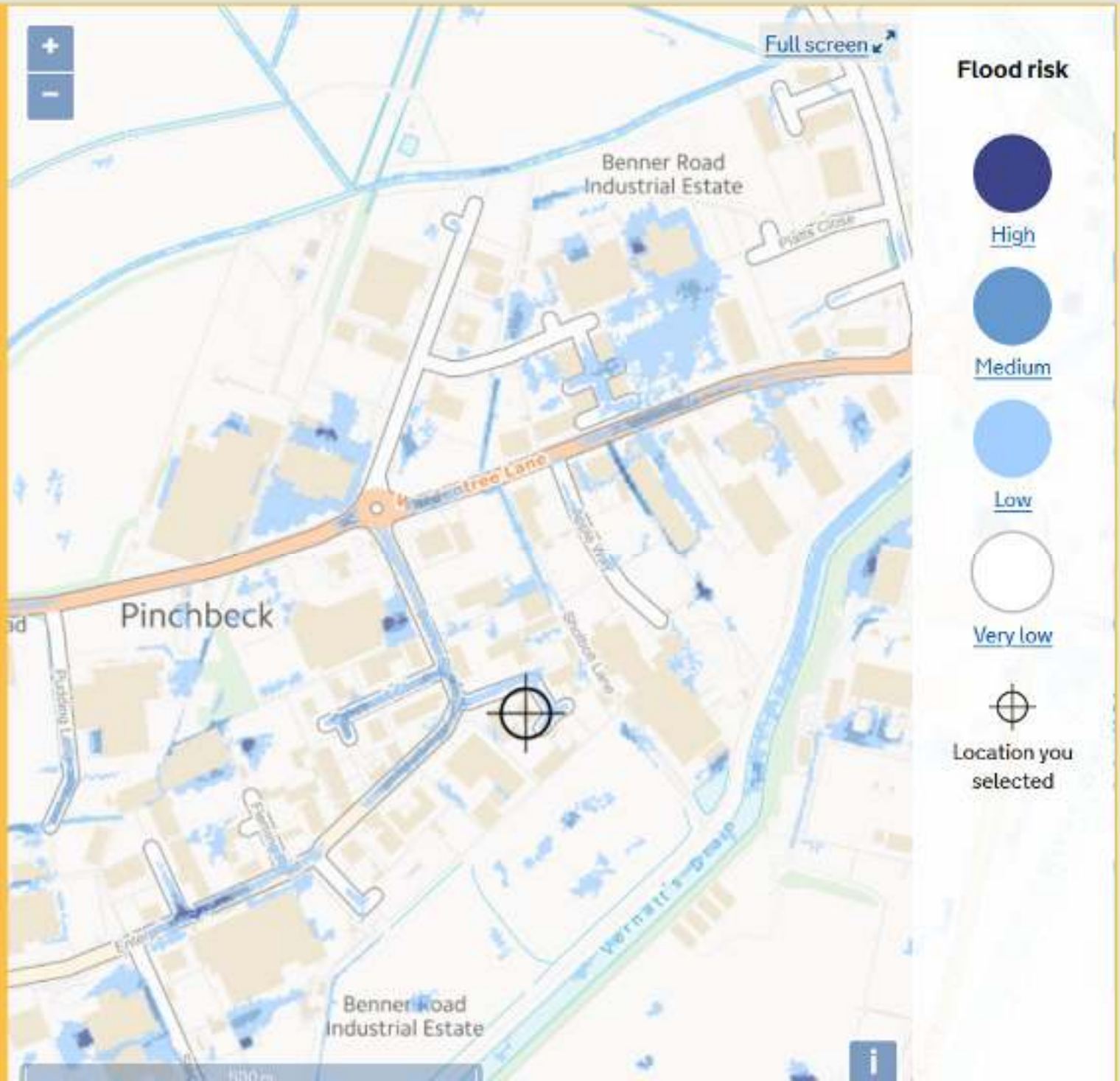
- Extent of flooding

Flood risk from surface water

- Extent of flooding

Flood risk from reservoirs

- Extent of flooding



Somerville House
St Johns Road, Meadowfield
Durham, DH7 8TZ
TEL: 0191 375 5808
FAX: 0191 378 3762
E-Mail: enquiries@dunelm.co.uk

Job No. : C10430 **Equipment:** Jcb Type
Site Name : Wm. Morrision - Spalding

Record of Trial Pit TP2

Easting		Start date	11/04/2000
Northing		End date	11/04/2000
Ground level		Backfill date	11/04/2000
Final depth	3.20	Page	1 of 1

Samples & Testing

Water	Cu kN/m2	Depths From	Depths To	Type	Legend	Depth (Thickness)	Strata Descriptions	Level	Inst/ Back fill
						(0.20) 0.20	MADE GROUND - Grass overlying brown sandy soil.		
		0.40	0.60	B		(0.50) 0.70	MADE GROUND - Medium brown very sandy sandy clay with some fragments of brick, metal and plastic.		
						(0.75) 1.45	Generally firm to stiff medium brown very sandy CLAY. With high silt content and occasional cobbles/stones. Odour of fuel noted around 1.40m.		
		1.70	1.90	B		(1.45) 2.90	Virually moist light grey/occasionally dark grey very sandy SILT/CLAY, with bands of clayey sand. Odour of fuel throughout		
		3.00	3.20	B		(0.30) 3.20	Virually moist dark grey very sandy SILT/CLAY, with bands of clayey sand. Slight odour of fuel		
							End of Trial Pit		

General remarks

Slight collapse of trial pit below 2.30m.

Trial pit moist although no actual water ingress/strike.

© Dunelm Windows (c) 1998 ME Associates

Somerville House
St Johns Road, Meadowfield
Durham, DH7 8TZ
TEL: 0191 375 5000
FAX: 0191 378 3362
E-Mail: enquiries@dunelm.co.uk

Job No. : C10430 **Equipment:** Jcb Type
Site Name : Wm. Morrision - Spalding

Record of Trial Pit TP1

Easting		Start date	11/04/2000
Northing		End date	11/04/2000
Ground level		Backfill date	11/04/2000
Final depth	3.00	Page	1 of 1

Samples & Testing

Water	Cu kN/m2	Depths From	Depths To	Type	Legend	Depth (Thickness)	Strata Descriptions	Level	Inst/ Back fill
						(0.10) 0.10	MADE GROUND - Grass overlying brown soil with occasional brick fragments.		
		0.30	0.50	B		(0.50)	MADE GROUND - Medium brown/occasionally dark brown sandy sand with occasional cobbles, bricks and clay intrusions.		
						0.60			
	118.00	0.90				(0.60)	Stiff medium brown/grey mottled sandy CLAY. With high silt content.		
						1.20			
						(1.30)	Medium to dark brown/orange/grey very moist very silty SAND. With occasional clayey intrusions/lenses.		
		2.50	2.70	B		2.50			
						(0.50)	Dark brown/dark grey sandy SILT. With occasional high clay content.		
						3.00	End of Trial Pit		

General remarks

Water ingress at 2.60m Collapse of trial pit below 1.20m.

SIS for Windows (c) 1990 MZ Associates

BORING: STARTED 3.11.77 TF 22146
BORING: FINISHED 3.11.77 257 210
GROUND LEVEL O.D. TF 22146 HOLE SIZE 150 mm x 200 TO 6.00 m

SAMPLE OR TEST		CHANGE OF STRATA			
DEPTH	TYPE	LEGEND	DEPTH	O.D. LEVEL	DESCRIPTION
.50	D1		0.7		TOPSOIL.
1.00 - 1.45	U(A)1				Firm grey and brown mottled silty sandy CLAY.
1.50	D2		1.9		
2.65 - 2.95	S(21)		2.8		Medium dense brown clayey silty fine SAND.
3.00	D3				
3.50	W1				Medium dense grey/brown silty fine SAND. Slightly clayey with organic traces in the upper horizons.
4.15 - 4.45	S(17)				
4.50	D4				
5.65 - 5.95	S(29)		6.0		
6.00	D5				

REMARKS Groundwater entered the borehole at a depth of 3.5 m.
Standing water level on completion of boring 1.8 m.

KEY: D — DISTURBED SAMPLE
B — BULK DISTURBED SAMPLE
W — WATER SAMPLE
U — UNDISTURBED SAMPLE
a { } STANDARD PENETRATION TEST
c { } CONE PENETRATION TEST
NO. OF BLOWS FOR 300 mm PENETRATION IN BRACKETS

SOILS ENGINEERING LIMITED, PETERBOROUGH

GROUND LEVEL O.D. TF22NE/2A

COMPLETED 3.11.77

HOLE SIZE 150 mm x DIA TO 6.00 m

SAMPLE OR TEST		CHANGE OF STRATA			
DEPTH	TYPE	LEGEND	DEPTH	O.D. LEVEL	DESCRIPTION
			0.5		TOPSOIL.
0.50	D1				Firm brown slightly laminated silty sandy CLAY with thin grey bands and layers of fine brown sand.
1.00 - 1.45	U(4)1				
			1.8		
1.50	D2				Loose to medium dense brown silty fine SAND.
2.65 - 2.95	S(12)		2.75		
3.00	D3				Medium dense grey/brown silty fine SAND.
3.50	W1				
4.15 - 4.45	S(20)				
4.50	D4				
5.65 - 5.95	S(32)		6.0		
6.00	D5				

REMARKS Groundwater entered the borehole at a depth of 3.5 m.
Standing water level on completion 3.8 m.

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

SOILS ENGINEERING LIMITED PETERBOROUGH

Subject: RE: FW: Surface Water Drainage in Pinchbeck
From: Craig Shinkin <Craig@wellandidb.org.uk>
Date: 24/12/2019, 11:32
To: George Shuttleworth <geo.shuttleworth@btconnect.com>

HI George,

Thank you for the information and plan provided.

I can say that our comments on any planning application would be very similar to this:

Given the site areas provided a Development Contribution of approximately £5,660 would be payable in advance to the Board to allow the provision of discharging surface water ultimately into the Board's system. Also an application would need to be made in advance to the Board for consent to discharge surface water. This would be subject to the payment of the correct application fee and agreement of technical details.

Any discharge outfall should be located as near to the Board's system as possible with a suitable headwall being installed and the outfall invert should be sited as high as possible to minimise the duration of being submerged during times of higher water levels. The maintenance of the private dyke should also be proven to the Board in advance.

Please find attached a plan showing Board drains and pipelines in this area.

Kind Regards,

From: George Shuttleworth [mailto:geo.shuttleworth@btconnect.com]
Sent: 20 December 2019 11:50
To: Craig Shinkin <Craig@wellandidb.org.uk>
Subject: Re: FW: Surface Water Drainage in Pinchbeck

Craig,

Attached is a block/location plan which is the initial layout and may change but only slightly. I have worked out the impermeable areas shown on the drawing and they are

Building Roofs = 2570m2, Roads and Hardstanding Areas 2360m2 giving a total of 4930m2. The total site area = 7500m2 giving a 66% percentage impermeable.

The above areas are subject to change as the design is finalised but they should not change by much.

I trust this helps

Regards

George Shuttleworth
for George Shuttleworth Ltd.
Tel 01522 787710 or 07940 927285
http://www.georgeshuttleworthltd.co.uk

On 20/12/2019 11:31, Craig Shinkin wrote:

> Good Morning George,
>
> Thank you for your email below.
>
> We would need to see a location plan and a block plan detailing the total site area, the total

proposed impermeable area and the surface water discharge outfall location.

If you could provide those in due course we would be grateful and then be able to give you a more complete response.

Kind Regards,

From: Debra Thornalley
Sent: 20 December 2019 09:03
To: Craig Shinkin <Craig@wellandidb.org.uk>
Subject: FW: Surface Water Drainage in Pinchbeck

From: George Shuttleworth [mailto:geo.shuttleworth@btconnect.com]
Sent: 19 December 2019 17:29
To: info <info@wellandidb.org.uk>
Subject: Surface Water Drainage in Pinchbeck

Good Afternoon,

We are working for a developer who is looking to build some industrial units on vacant ground off Benner Road, Pinchbeck. To the eastern boundary of the site, between the site and Shotbolt Lane, there is what I understand is a riparian drain which is piped under Wardentree Lane, where on the northern side it becomes an IDB maintained drain discharging to Blue Gowt Drain.

The proposal is to discharge surface water to this drain attenuated to 5.0 l/s. Although, this is greater than 1.4 l/s/ha it is the minimum practical size for a hydro-brake.

Would the above proposal be acceptable to the Board.

Whilst, writing, do you have any information on historic flooding in the area and what the normal and max recorded levels are in Blue Gowt Drain?

If you have any queries please do not hesitate to contact me
--
Regards
George Shuttleworth
for George Shuttleworth Ltd.
Tel 01522 787710 or 07940 927285
http://www.georgeshuttleworthltd.co.uk

Debra Thornalley
Finance & Ratings Officer

ARTIFICIAL AREAS

Building Roofs			
Northern Block	1	840	840
Southern Blocks	2	864	1728
			2568
Car Parking Bays			578
Loading Bays	6	80	480
Access Road			1300
Total Artificial Surfaces			4926
Total Site Area			7500
PIMP (% Impermeable)			66

George Shuttleworth Ltd
Consulting Engineers
www.george shuttleworthltd.co.uk

Ref No: 684
Project: Benner Rd Pinchbeck
Date: 10/01/2020
Engineer: GS

ATTENUATION & DISCHARGE TO DYKE- ALL ARTIFICIAL SURFACES

Calculation of Rain Profiles

M5-60	20							
r	0.4							
D (mins)	15	30	60	120	240	360	720	1440
Z1	0.64	0.81	1	1.21	1.4	1.62	1.8	2.2
M5-D	12.8	16.2	20.0	24.2	28.0	32.4	36.0	44.0
Z2(100)	1.94	1.99	2.03	2.02	2.01	1.95	1.92	1.86
Z2(30)	1.50	1.52	1.53	1.54	1.53	1.51	1.49	1.45
Z2(2)	0.80	0.80	0.81	0.82	0.83	0.83	0.84	0.85
Z2(1)	0.62	0.62	0.64	0.65	0.67	0.68	0.69	0.71
MT-D(100)	24.83	32.24	40.60	48.88	56.28	63.18	69.12	81.84
MT-D(30)	19.20	24.62	30.60	37.15	42.84	48.92	53.64	63.80
MT-D(2)	10.24	12.96	16.20	19.84	23.24	26.89	30.24	37.40
MT-D(1)	7.87	10.04	12.70	15.73	18.76	22.03	24.84	31.24
I(100)	99.33	64.48	40.60	24.44	14.07	10.53	5.76	3.41
I(30)	76.80	49.25	30.60	18.57	10.71	8.15	4.47	2.66
I(2)	40.96	25.92	16.20	9.92	5.81	4.48	2.52	1.56
I(1)	31.49	20.09	12.70	7.87	4.69	3.67	2.07	1.30

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

Calculation of Flows and Volumes

Contributing Impermeable Area = 4926 m2
Climate Change of 30%
Flows (l/s) = 2.78 x I x A(ha) x Global warming

Storm	15	30	60	120	240	360	720	1440
1 in 100 yr	176.83	114.78	72.28	43.51	25.05	18.75	10.25	6.07
1 in 30 yr	136.72	87.67	54.48	33.07	19.07	14.52	7.96	4.73
2 in 30 yr	72.92	46.14	28.84	17.66	10.34	7.98	4.49	2.77
1 in 1 yr	56.06	35.76	22.61	14.00	8.35	6.54	3.69	2.32

Volume (m3) = Cv x A(ha) x I x D/60 Cv= 1.00

Storm	15	30	60	120	240	360	720	1440
1 in 100 yr	159.02	206.45	259.99	313.04	360.41	404.59	442.63	524.09
1 in 30 yr	122.95	157.69	195.96	237.88	274.34	313.30	343.50	408.56
1 in 2 yr	65.57	82.99	103.74	127.08	148.82	172.21	193.65	239.50
1 in 1 yr	50.41	64.32	81.33	100.73	120.14	141.09	159.07	200.05

Initial Estimate of Balancing Volume Required

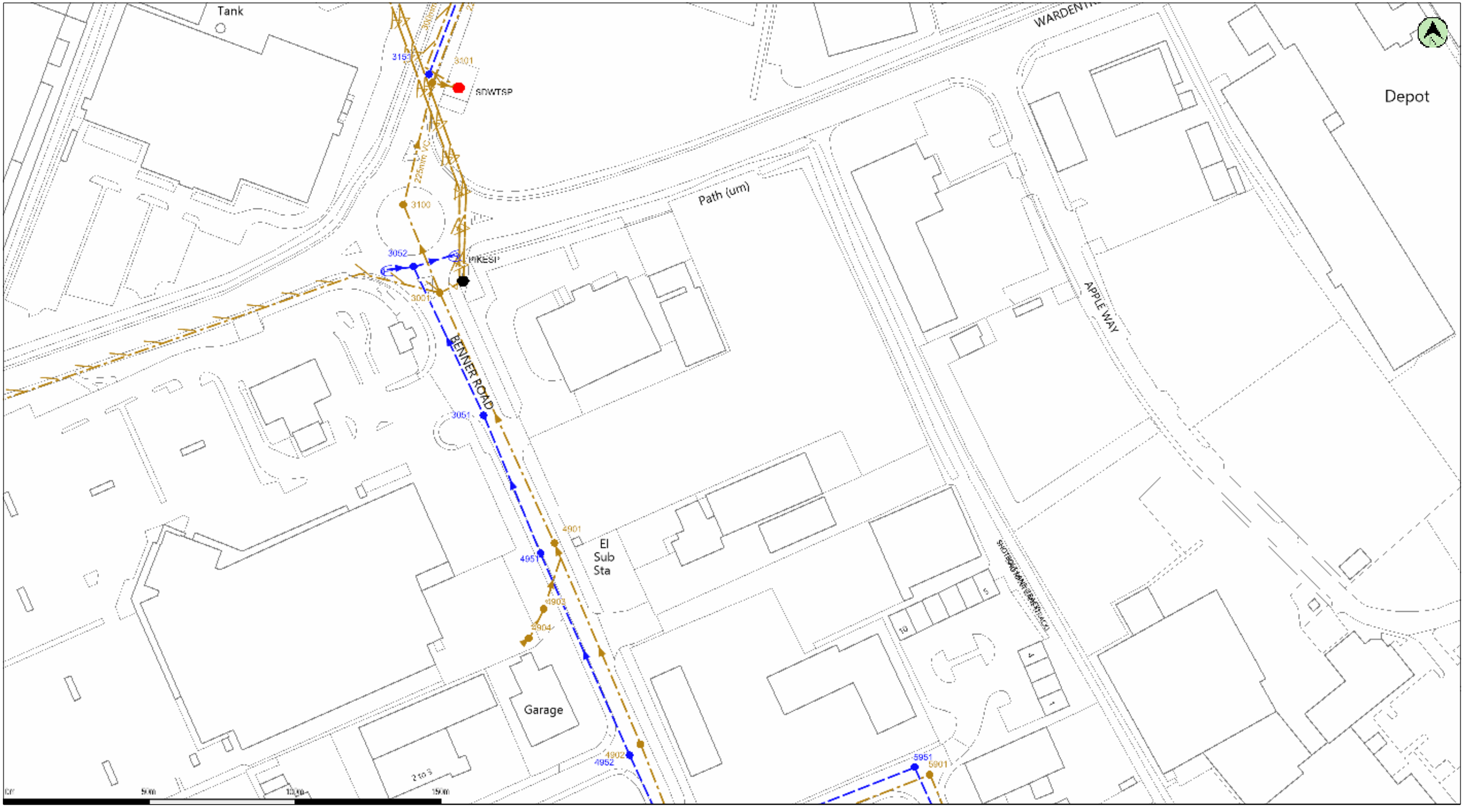
For Peak Discharge of 5.00 l/s Av Discharge Factor= 0.85 Av Qout = **4.25** l/s

Storm	15	30	60	120	240	360	720	1440
1 in 100 yr	155.19	198.80	244.69	282.44	299.21	312.79	259.03	156.89
1 in 30 yr	119.13	150.04	180.66	207.28	213.14	221.50	159.90	41.36
1 in 2 yr	61.75	75.34	88.44	96.48	87.62	80.41	10.05	0.00
1 in 1 yr	46.59	56.67	66.03	70.13	58.94	49.29	0.00	0.00

Storage required for 1 in 30 yr storm **221** m3
Storage required for 1 in 100 yr storm **313** m3

OPTIONS FOR PROVIDING ATTENUATION VOLUME REQUIRED

Attenuation Volume required				313	m3
Option 1 – All Permeable Sub-base					
Area Available, Access Rd, Parking & Ramps				2358	m2
Depth Required at 0.3 void Ratio				0.442	m
Option 2 – All Permeable Sub-base except ramps					
Area Available, Access Rd, Parking				1878	m2
Depth Required at 0.3 void Ratio				0.555	m
Option 3 Cellular Crates to Parking Bays					
Crate Depth	0.4	m	Void Ration	0.95	
Volume Under Parking Bays				220	m3
Additional Volume Under Access Rad				93	m3
Depth of Permeable Sub-base Required under Access Road				0.239	m
Option 4 – Attenuation Basin With 1 in 3 side slopes and 300mm freeboard					
Area at max depth				274	m2
Base Area				167	m2
Depth				0.6	m
Volume Available				132.3	m3
Depth of Permeable Pavement req under access road				0.463	m
Option 5 – Cellular Crates in place of open attenuation basin					
Area Available, Access Rd, Parking				274	m2
Crate Depth	0.4	m	Void Ration	0.95	
Volume Available				104.12	m3



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- Foul Sewer
- Surface Sewer
- Combined Sewer
- Final Effluent
- Rising Main*
- Private Sewer*
- Decommissioned Sewer*
- Outfall*
- Inlet*
- Manhole*
- Sewage Treatment Works
- Public Pumping Station
- Decommissioned Pumping Station

*(Colour denotes effluent type)

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Benner Rd

love every drop anglianwater

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert
3001	F	3.06	-0.03	3.09
3100	F	-	-	-
3101	F	-	-	-
4901	F	3.09	0.379	2.711
4902	F	3.08	0.695	2.385
4903	F	-	-	-
4904	F	-	-	-
5901	F	3.139	1.449	1.69
3051	S	3.11	1.29	1.82
3052	S	3.18	1.21	1.97
3151	S	-	-	-
4951	S	3.041	1.361	1.68
4952	S	3.082	1.412	1.67
5951	S	3.06	1.79	1.27

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert