SURFACE WATER DRAINAGE STRATEGY

Job No. 20630

Proposed Residential Development
Land between Wildfields Road and Hall Road
Clenchwarton
Norfolk

For Ian H Bix Associates Ltd

February 2016

civil • structural • environmental • surveying

cost effective engineering solutions

plandescil
consulting engineers

REPORT CONTROL SHEET

Client: Ian H Bix Associates Ltd **Job No.:** 20630

Project Name: Proposed Residential Development
Land between Wildfields Road and Hall Road
Clenchwarton
Norfolk

Issue		
First Issue	February 2016	**Report Prepared and Reviewed by:** Sally Hare B.Sc (Hons) CSci, MIEnvSc, MCIWEM Senior Environmental Consultant
		Report Authorised by: p.p. Eur Ing J R Riley B.Sc (Hons), C.Eng., MICE., C.WEM MCIWEM Director

CONDITIONS OF INVESTIGATION AND REPORTING

This report and its findings should be considered in relation to the terms of the brief and objectives agreed between Plandescil Ltd and the Client.

Plandescil Ltd are only able to work with information available at the time the Surface Water Drainage Strategy is carried out which have been applied to the Surface Water Drainage Strategy in accordance with current best practice. Plandescil Ltd cannot be held responsible for any subsequent flooding to the development or surrounding area.

The details contained in this report are based upon information provided by others and upon the assumption that all relevant information has been provided by those parties from whom it has been requested and that such information is accurate. Information obtained by Plandescil Ltd has not been independently verified by Plandescil Ltd, unless otherwise stated in the report.

This report was prepared and provided for the sole and specific use of the client. Plandescil Ltd shall not be responsible for any use of the report or its contents for any other purpose. Copies of the report to other parties for information should be copied in full but Plandescil Ltd shall extend no professional liability or warranty to other parties in this connection without written consent. The copyright of this report and other plans and documents prepared by Plandescil Ltd are owned by them.

CONTENTS

	REPORT CONTROL SHEET	**i**
	CONDITIONS OF INVESTIGATION AND REPORTING	**i**
1.0	**INTRODUCTION**	**3**
1.1	Background Information	3
1.2	Objectives	3
2.0	**SITE DESCRIPTION**	**3-9**
2.1	Location	3
2.2	Existing Site Layout	3-4
2.3	Proposed Development	4
2.4	Hydrology, Catchment & Flood Risk	4-5
2.5	Geology	5-6
2.6	Groundwater	6-7
2.7	Surface Water Flood Risk	7
2.8	Surface Water Runoff from the Existing Site	8
2.9	Surface Water Runoff from the Proposed Development	8-9
3.0	**SURFACE WATER DRAINAGE STRATEGY**	**9-15**
3.1	Surface Water Drainage	9-14
3.2	Future Maintenance	14
3.3	Water Quality	14-15
3.4	Impact Downstream	15
4.0	**SUMMARY**	**15**
5.0	**REFERENCES**	**15-16**

DRAWINGS APPENDIX

Drawing No. 20630/800 - Site Location Plan
Drawing No. 20630/001 - Topographical Survey
Drawing No. 20630/003 - Proposed Site Plan
Drawing No. 20630/803 - Environment Agency Flood Map (Fluvial & Tidal)
Drawing No. 20630/810 - Environment Agency Surface Water Flooding Map
Drawing No. 20630/811 - Environment Agency Surface Water Depth Map – High Chance of Occurrence
Drawing No. 20630/812 - Environment Agency Surface Water Depth Map – Medium Chance of Occurrence
Drawing No. 20630/813 - Environment Agency Surface Water Depth Map – Low Chance of Occurrence
Drawing No. 20630/814 - Environment Agency Surface Water Velocity Map – High Chance of Occurrence
Drawing No. 20630/815 - Environment Agency Surface Water Velocity Map – Medium Chance of Occurrence

Drawing No. 20630/816 - Environment Agency Surface Water Velocity Map – Low Chance of Occurrence

APPENDIX A
Groundsure Geoinsight Report

APPENDIX B
Greenfield Runoff Rates
Micro Drainage Design Simulations for the Proposed Surface Water Drainage System
Predicted Surface Water Runoff Rates from the Proposed Development Prior to Mitigation

APPENDIX C
Surface Water Maintenance Schedule

APPENDIX D
SuDS Checklist for Outline Applications

APPENDIX E
British Geological Society Borehole Location Map
BGS Borehole Record TF51NE17
BGS Borehole Record TF51NE19
BGS Borehole Record TF51NE22

1.0 INTRODUCTION

1.1 Background Information

This Surface Water Drainage Strategy was prepared by Plandescil Ltd on behalf of Ian H Bix Associates Ltd in February 2016, to accompany an outline planning application (planning reference 15/01315/OM) for a proposed residential development on the land between Wildfields Road and Hall Road, Clenchwarton, Norfolk.

1.2 Objectives

This report has been prepared to provide details on the surface water drainage strategy for the proposed development. This has been required by the Borough Council of King's Lynn and West Norfolk as the development is classified as a major application as the site area exceeds 0.5ha. The proposed development of the greenfield site will occupy 0.215 ha of hardstanding, including 0.110 ha utilising porous construction techniques. The development will not increase impermeable areas by more than 0.25 ha as such the application is not considered to have a significant impact on the sites surface water drainage[19].

This assessment has been prepared in accordance with the requirements of the National Planning Policy Framework, Planning Policy Guidance, Flood Risk & Coastal Change Guidance (NPPF, FR&CCG)[2], the regional requirements of the Lead Local Flood Authority (LLFA) and the local Strategic Flood Risk Assessment (SFRA). A variety of public, published and site-specific information sources have been consulted in the compilation of this report, a list of these sources can be found in Section 5.0, References.

A SuDS Checklist for Outline Applications has been completed for the site and is included in **Appendix D**, the checklist has been based upon Breckland Council's SuDS Checklist for Outline Applications[19]. Whilst the site does not fall within the catchment of Breckland Council, the requirements of this form are considered applicable to all Local Authorities.

2.0 SITE DESCRIPTION

2.1 Location

The proposed site is located in the settlement of Clenchwarton, to the south Wildfields Roads and west of Hall Road. The site has an OS Pathfinder Grid Reference of TF 58783 20941[6], refer to Drawing No. 20630/800 in the **Drawings Appendix** for the Site Location Plan. The proposed site is located in the Borough Council of King's Lynn and West Norfolk administration area and is within the Environment Agency's Cambridgeshire and Bedfordshire area[7].

2.2 Existing Site Layout

The existing site comprises of a workshop on the southern boundary, the remaining site is undeveloped, as shown on Drawing No. 20630/001 in the **Drawings Appendix**. The site is accessible via an existing access off Hall Road.

A topographical survey has been carried out of the existing site to determine the existing site levels, refer to Drawing No. 20630/001. The site levels relate to a GPS derived datum, control was established using Ordnance Survey National GPS OSGB32(36), translated from ETRS89 using OSGM02 and OSTN02 models. All levels within this report refer to ground levels above ordnance datum (AOD) unless otherwise noted. Ground levels vary across the site from 1.71m to 2.49m AOD.

The site is situated at the extent of Clenchwarton village, where residential dwellings are located to the south and east. To the west and north is agricultural land. The land is bound by Hall Road to the east and Wildfields Road to the north.

2.3 Proposed Development

The proposed development is for ten residential dwellings, refer to Drawing No. 20630/003 in the **Drawings Appendix** detailing the proposed site layout. The site will be accessible from Hall Road.

2.4 Hydrology, Catchment & Flood Risk

No surface water bodies are located on-site.

The site is located in King's Lynn Internal Drainage Board's (IDB) catchment and is located in King's Lynn IDB's sub catchment of West Lynn.

Drainage ditches are located on the western, northern and eastern boundaries of the site. The drainage ditches on the western and eastern boundaries flow north, into the northern ditch. The ditch is then culverted under the road and appears on the northern side of Wildfields Road and continues north along Hall Road. The ditch then outfalls into the IDB Linford Close Drain (IDB ref DRN140G0505), that flows south-east.

To establish the drainage catchment the site is located in, the Flood Estimation Handbook Web Service[17], the catchment is shown in **Figure 1** below.

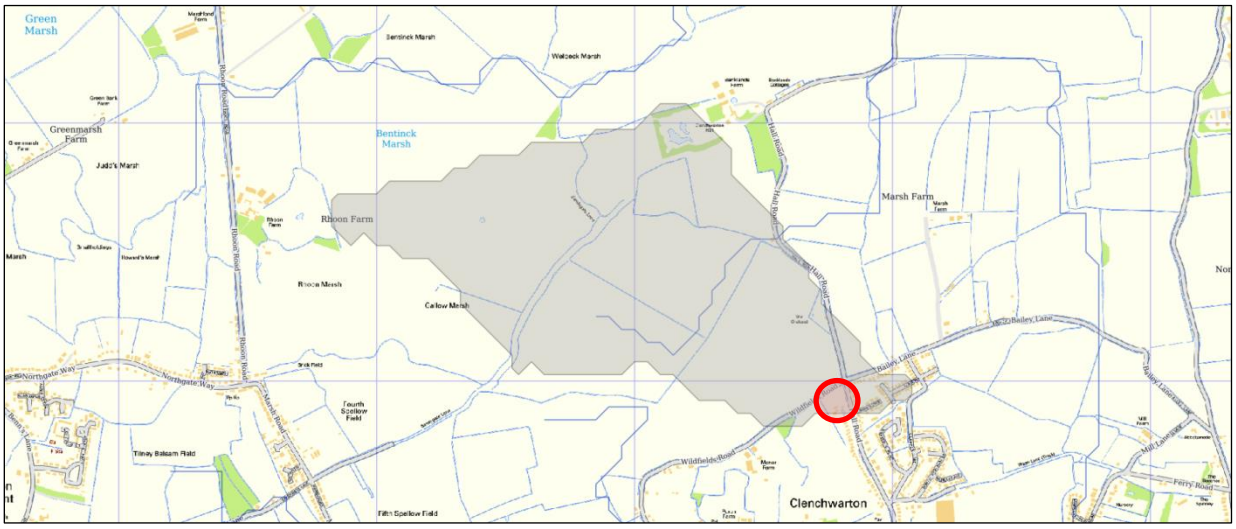


Figure 1. The catchment of the drainage network (the red circle denotes the site).

No Environment Agency maintained rivers are in close proximity to the site. The site is within the Anglian River Basin District and the Environment Agency's Management and Operational Catchment of North West Norfolk[18].

The Environment Agency's Flood Map[7] indicates that the site is located in an area of flood risk as the proposed development is located within Flood Zone 3 and is benefiting from flood defences, refer to Drawing No. 20630/803 in the **Drawings Appendix**. For further details on flood risk refer to the Flood Risk Assessment prepared by Geoff Beel Consultancy in August 2015[21].

2.5 Geology

The British Geological Survey's (BGS), digital geological map[8] identifies that the site is underlain by Tidal Flat Deposits (Clay and Silt) Superficial Deposits. The Kimmeridge Clay Formation (Mudstone) Bedrock is located at depth. This is consistent with the findings of the Groundsure GeoInsight report[20] in **Appendix A.** No borehole records are located within 250m of the site boundary.

The Groundsure GeoInsight report[20] details that the Superficial Deposits have an intergranular flow type with very low to low permeability. The bedrock has a fractured flow type with very low to low permeability. The Flood Estimation Handbook Web Service[17] details that the BGS classify the hydrogeology underlying the site to be '*rocks with essentially no groundwater*'.

The Groundsure GeoInsight report[20] does not indicate the presence of any Artificial/Made Ground on-site.

Groundsure GeoInsight report[20] has been consulted to review the natural ground subsidence on-site, these are summarised in **Table 1** below, the report details the maximum hazard rating of natural subsidence to be moderate.

Natural Ground Subsidence	On-site
Shrink-Swell Clay	**Low** Ground conditions predominantly medium plasticity. Do not plant trees with high soil moisture demands near to buildings. For new build, consideration should be given to advice published by the National House Building Council (NHBC) and the Building Research Establishment (BRE). There is a possible increase in construction cost to reduce potential shrink swell problems.
Landslides	**Very Low** Slope instability problems are unlikely to be present. No special actions required to avoid problems due to landslides. No special ground investigation required, and increased construction costs or increased financial risks are unlikely due to potential problems with landslides.
Ground Dissolution Soluble Rocks	**Negligible** Soluble rocks are present, but unlikely to cause problems except under exceptional conditions. No special actions required to avoid problems due to soluble rocks. No special ground investigation required, and increased construction costs or increased financial risks are unlikely due to potential problems with soluble rocks.

Natural Ground Subsidence	On-site
Compressible Deposits	**Moderate** Significant potential for compressibility problems. Do not drain, load or de-water ground near the property without technical advice. For new build, consider possibility of compressible ground in ground investigation, construction and building design. Consider effects of groundwater changes. Extra construction costs are likely.
Collapsible Deposits	**Negligible** No indicators for collapsible deposits identified. No actions required to avoid problems due to collapsible deposits. No special ground investigation required, or increased construction costs or increased financial risk due to potential problems with collapsible deposits.
Running Sands	**Moderate** Significant potential for running sand problems with relatively small changes in ground conditions. Avoid large amounts of water entering the ground (for example through pipe leakage or soakaways). Do not dig (deep) holes into saturated ground near the property without technical advice. For new build, consider the consequences of soil and groundwater conditions during and after construction.

Table 1. Natural ground subsidence.

2.6 Groundwater

No detailed BGS Hydrogeological Maps[9] are available for the site. To determine an approximate groundwater level, BGS borehole records were reviewed to obtain details on the groundwater level within the area. BGS Borehole Records[8] did not identify any boreholes immediately surrounding the site, however a number were identified along the A17 highway to the south. Three boreholes with records of groundwater observations have been reviewed to obtain details on the groundwater within the area, the findings of these are detailed in **Table 2** below.

Borehole	Approx. distance from site	Approx. ground level (m) AOD	Depth of borehole	Date	Depth of Groundwater (m)	
					BGL	AOD
TF51NE17	1690m south-west	2.76m	10.50m	December 1974	Seepage at 1.20m	Seepage at 1.59m
TF51NE18	1690m south-east	3.58m	15.30m	December 1974	1.37m	2.21m
TF51NE22	1850m south-east	3.41m	15.00m	December 1974	1.30m	2.11m

Table 2. Depth of groundwater observed within the BGS Borehole Records[8]

BGS boreholes records indicate the groundwater to be located at approximately 1.59m – 2.20m AOD, suggesting the groundwater to be close to the surface.

For further details on the BGS borehole logs and their locations refer to **Appendix E.**

The Environment Agency's Groundwater Maps[7] identifies the site is not located in a Groundwater Source Protection Zone.

The Environment Agency's Groundwater Maps[7] identifies the Tidal Flat Superficial Deposits and Kimmeridge Clay Bedrock to both be classified as an Unproductive Strata. The unproductive strata are rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow.

2.7 Surface Water Flood Risk

The Environment Agency's Surface Water Flooding Maps[7] indicates the site to be at low to very low risk of surface water flooding. The majority of the site is located in an area of very low risk of surface water flooding, a limited area of low risk is identified in the centre and in two areas on the eastern boundary. Refer to Drawing No. 20630/810 in the **Drawings Appendix** detailing the surface water flood risk.

The Environment Agency defines risk as follows;

High Risk: This area has a chance of flooding of greater than 1 in 30 in any one given year (i.e., a 3.3% AEP annual exceedance probability (AEP) of flooding).

Medium Risk: This area has a chance of flooding of between 1 in 100 in any one given year (i.e., a 1.0% AEP) and 1 in 30 in any one given year (i.e., a 3.3% AEP).

Low Risk: This area has a chance of flooding of between 1 in 1000 in any one given year (i.e., a 0.1% AEP) and 1 in 100 in any one given year (i.e., a 1.0% AEP).

Very Low Risk: This area has a chance of flooding of less than 1 in 1000 in any one given year (i.e., a 0.1% AEP of flooding).

During the highest chance of occurrence surface water flood event (3.3% or greater AEP) and the medium chance of occurrence surface water flood event (between 1.0% and 3.3% AEP), no surface water flooding is shown on site. Refer to Drawing No. 20630/811, 812, 814 and 815 in the **Drawings Appendix** detailing the highest and medium chance of occurrence surface water flood event.

During the lowest chance of occurrence surface water flood event (between 0.1 % and 1.0% AEP), the majority of the site is located in an area of very low risk of surface water flooding. A limited area of surface water flooding is identified in the centre of the site and in two areas on the eastern boundary. The depth of the surface water is shown to be less than 300mm and have a velocity of less than 0.25m/s. Refer to Drawing No. 20630/813 and 816 in the **Drawings Appendix** detailing the lowest chance of occurrence surface water flood event.

During all three scenarios dry access and egress is possible along Hall Road. As commonly experienced, some minor flooding is noted along the line of the existing ditches, but is not shown to extend on-site.

2.8 Surface Water Runoff from the Existing Site

The proposed site for the residential development is currently greenfield, except for an existing workshop on the southern boundary. Surface water runoff from the workshop currently discharges to the adjacent ditch.

Table 3 below details the existing runoff rates for the site including the greenfield runoff rates from the undeveloped area of site and the brownfield runoff rates from the existing workshop, providing a total rate of runoff during each specified event.

The greenfield rates have been calculated based upon the area that will be made impermeable excluding the existing shed (0.202 ha) and were calculated using the IH 124 Method. The results have been linearly interpolated using the ratio of the development size to 50 ha. Refer to **Appendix B** for the greenfield runoff rates.

To determine the existing runoff rates from the shed, the system was been modelled using the Modified Rational Method, refer to **Appendix B** for surface water runoff rate calculations.

		QBAR (l/s)	1 in 1 year event (l/s)	1 in 30 year event (l/s)	1 in 100 year event (l/s)
Existing Runoff Rates	Greenfield Runoff Rate	0.3	0.3	0.7	1.1
	Brownfield Runoff Rates	n/a	1.7	4.2	7.0
	Total Runoff Rates	**0.3**	**2.0**	**4.9**	**8.1**

Table 3. Existing Runoff Rates from the site.

2.9 Surface Water Runoff from the Proposed Development

The proposed residential development will create a hardstanding area of 0.215 ha. **Table 4** below details the distribution of the proposed hardstanding areas as shown on Drawing No. 20630/003 in the **Drawings Appendix**.

Proposed Hardstanding Area	Surface Area (ha)
Proposed Roof Areas	0.105 ha
Proposed Permeable Private Drive Areas	0.110 ha
Total Hardstanding Area	**0.215 ha**

Table 4. Distribution of proposed hardstanding areas on-site.

The proposal will result in an increased amount of surface water runoff discharging from the site prior to mitigation. **Table 5** below details the predicted amount of surface water runoff from the proposed hardstanding areas now and for the lifetime of the development prior to

mitigation. Within the calculation of the impermeable areas, permeable surfaces have been included as these features have been linked to the main surface water drainage system. The following values are calculated using the Modified Rational Formula with average rainfall intensities based on the FSR/FEH rainfall parameters for the site with a Cv value of 0.75 and a Cr value of 1.30. As recommended in Flood Estimate Handbook, Volume 2[10] FSR rainfall parameters were used for storm durations that were less than 30 minute duration, whereas events exceeding this were calculated using FEH rainfall data. Storm durations of 15 and 360 minutes were used for comparison. To allow for an increase in rainfall due to the effects of climate change over the lifetime of the development (100 years for residential development) the rainfall intensities have been increased by 30%. Refer to **Appendix B** for surface water runoff rate calculations.

Storm Event	1 in 1 year event (l/s)	1 in 30 year event (l/s)	1 in 100 year event (l/s)
2016 (15 min)	16.93	41.50	53.73
2016 (360 min)	2.17	5.39	7.47
Storm Event (including CC)	**1 in 1 Year event (l/s)**	**1 in 30 year event (l/s)**	**1 in 100 year event (l/s)**
2116 (15 min)	22.02	53.95	69.85
2116 (360 min)	2.83	7.01	9.71

Table 5. Predicted surface water runoff rates from the proposed development including climate change prior to mitigation.

3.0 SURFACE WATER DRAINAGE STRATEGY

3.1 Surface Water Drainage

Building Regulations Part H[11] and The SUDs Manual C753[12] recommends that surface water drainage should discharge into an infiltration drainage system where practical. Should infiltration drainage not be possible the next preferred option is to discharge to a watercourse at a restricted rate, and following this restricted discharge to the sewer.

Infiltration drainage would be the preferred method of disposing of the surface water runoff, however the presence of Tidal Flat Deposits (Clay & Silt) Superficial Deposits and Kimmeridge Clay bedrock underlying the site will reduce the infiltration potential of the ground.

Table 25.1 in the C753 The Suds Manual[12] details that the Superficial Deposits and Bedrock underlying the site are a poor to very poor infiltration material, and the Groundsure GeoInsight Report[20] (**Appendix A**) details that the permeability is low to very low. Borehole records have identified the groundwater at a depth where it would be difficult to achieve a minimum of 1.0m between the base of the soakaway and groundwater table, as required by C753 The SUDS Manual[12]. As such it is anticipated that infiltration drainage will not be an appropriate method of surface water disposal.

However to confirm this, following approval of the planning permission permeability tests should be carried out to BRE3 Digest 365[14]. If it is confirmed that ground conditions are suitable for soakage drainage and that the depth of groundwater is sufficiently below any proposed drainage features, an infiltration system would be designed as this would be the preferred method for draining the site. The infiltration drainage system will be designed in accordance with C753 The Suds Manual[12] and Building Regulations Part H[11]. If infiltration is used consideration should be given to the impact of this on running sands and compressible deposits.

Should permeability tests show that infiltration drainage is not appropriate, the surface water runoff from the proposed development will discharge at a restricted rate into the existing drainage ditch on the northern boundary of the site via an attenuation system.

Due to the uncertainty of the use of infiltration on-site a schematic attenuation drainage scheme has been designed below.

The site has the potential to provide SuDS techniques, to assess the suitability of the use and benefits to the site a review of various techniques have been discussed in **Table 6** below. The use of the SuDS techniques should be considered and incorporated where appropriate during the detailed design of the proposal.

SuDS Feature	Appropriate to Development	Benefit
Rainwater harvesting	Rainwater butts could be provided to each plot.	Reduces volume of water discharged from the site. With careful design, can provide source control of stormwater runoff. Reduces demand on mains water.
Sub-Surface Storage (Geocelluar/Modular Attenuation Systems)	Plot attenuation could be utilised.	High void ratios providing high storage volume capacity. Lightweight, easy to install and robust. Capable of managing high flow events. Can be installed beneath trafficked or non-trafficked areas & under POS. Long term physical & chemical stability.
Swales	Sufficient space is not available.	Potential for reducing runoff rates & volumes. Good removal of urban pollutants & pollution/ blockages are visible and easily resolved.
Ponds	Sufficient space is not available.	Can cater for all storms. Good removal capacity of urban pollutants. Can be used where groundwater is vulnerable. High potential ecological, aesthetic & amenity.
Local Detention Basin	Sufficient space is not available.	Provide storage for a wide range of rainfall events. Can be used where groundwater is vulnerable. Potential for dual land use. Easy to maintain. Safe and visual capture of accidental spillages.
Pervious Pavements (permeable drives & access)	Permeable drives & access could be utilised despite presence of clay within the soils due to the shallow depth & large infiltration area that this type of drainage provides.	Potential for reducing runoff rates & volumes. No additional land take. Effective in removal of urban pollutants. Removes need for gully pots & manholes. Eliminates surface ponding and surface ice. Low maintenance.

SuDS Feature	Appropriate to Development	Benefit
Green Roofs	Not appropriate for the type of dwelling proposed.	Mimic predevelopment state of building footprint. Good removal capability of atmospherically deposited urban pollutants. Can be used in high density developments. Ecological, aesthetic & amenity benefits. No additional land take.
Plot Infiltration	Percolation tests should be undertaken following planning approval to confirm suitability.	High void ratios providing high storage volume capacity. Lightweight, easy to install and robust. Capable of managing high flow events. Can be installed beneath trafficked or non-trafficked areas & under POS. Long term physical & chemical stability.

Table 6. An assessment of the suitability of the use and benefits of using SuDS.

The surface water runoff from the proposed hardstanding (0.215 ha including roofs, private access and drives) will discharge into attenuate crates within the gardens that will outfall into the surface water ditch to the north, as shown on Drawing No. 20630/003 in the **Drawings Appendix**.

The private access and drives will be constructed using porous techniques (SuDS) to benefit from any limited infiltration and improve water quality. Porous techniques can be utilised despite the presence of clay within the soils due to the shallow depth and large infiltration area that this type of drainage provides. The permeable areas will have a minimum of 150mm of open graded sub-base for water storage, the depth of this will be confirmed during the detailed design phase following planning approval. The permeable areas have been linked to the drainage network to ensure flows in excess of the sub-base capacity can flow into the piped surface water drainage system. The permeable areas will be lined with a filter Geotextile, such as Charcon Permafilter SuDS Geotextile. The incorporation of the filter Geotextile will improve the water quality of the surface water entering into the ground.

The attenuation drainage system will contain up to and including the 1 in 100 year storm event plus climate change. The attenuation system will ensure that there is no above ground surface water flooding during the 1 in 30 event. The attenuation crates should be lined to prevent groundwater ingress. For details on the size and design of the crates refer to Drawing No. 20630/003 and the Micro Drainage Design Simulations in **Appendix B**.

Table 7 below details the existing and proposed runoff rates from the site following mitigation measures, further details can be found within **Appendix B.** The volume of runoff from site will increase, therefore the runoff rates have been restricted to 2.0l/s for all specified storm events. Reducing the runoff rates during the 1 in 30, 1 in 100 and 1 in 100 year event plus climate change, will help reduce the risk of flooding downstream from short duration high intensity rainfall. **Table 7** shows that during the 1 in 1, 1 in 30, 1 in 100 and 1 in 100 year event plus climate change the flow into the ditch will be less than the existing pre-climate change rates of discharge for the lifetime of the development.

Storm Event				
QBAR (l/s)	1 in 1 year event (l/s)	1 in 30 year event (l/s)	1 in 100 year event (l/s)	1 in 100 year event + CC (l/s)
Existing Flow Rates to the Ditch				
0.3	2.0	4.9	8.1	n/a
Proposed Maximum Flow Rates to the Ditch				
n/a	1.8	2.0	2.0	2.0

Table 7. Existing and proposed maximum runoff rates from the site following mitigation measures.

Discharge into the ditch will be controlled by a Hydro-Brake outflow control that is designed to discharge the flow into the ditch during the 1 in 1 year, 1 in 30 year and 1 in 100 year rainfall event including climate change. The flow control will vary the discharge into the ditch depending on the event i.e. with a 1 in 1 year event the rate of runoff discharging into the ditch will be less than the 1 in 100 year event, as the hydraulic head on the flow control will be reduced therefore discharging at a slower rate than a larger event. The flow control should be designed in accordance with C753 The SuDS Manual[(12)].

In the event where the surface water system fails or during exceedance events, consideration has been given to route flood water away from vulnerable areas and where possible the levels will fall to the drainage features. Where possible the external landscaping and paving levels will fall away from the buildings and the access road levels near buildings will be set lower than the finished floor levels of the buildings. Refer to Drawing No. 20630/003 for overland flow routes.

The increase in hardstanding areas will create an increase in the current surface water runoff generated within the site. However through the incorporation of a surface water drainage system the increased surface water runoff will be entirely contained within an on-site soakage drainage system or in an attenuation drainage system and discharge from site at a controlled rate to the ditch. Therefore the proposal will not increase the risk of flooding on-site.

It is considered that the site will currently result in limited infiltration to the ground due to the underlying ground conditions. The installation of a predominantly attenuated drainage system is considered to have a low likelihood of increasing the hazard of compressible deposits or running sands on-site.

Following approval of the planning application, an application should be made to King's Lynn IDB to obtain approval of the surface water discharge which ultimately outfalls into their network.

Prior to construction the following should be undertaken;

- The existing culvert beneath Wildfields Road should be rod and jet cleaned.

- The outlet and headwall to the open drain on the northern side of Wildfields Road should be repaired.
- The existing culvert beneath Hall Road should be rod and jet cleaned, and any repairs to the culvert or headwalls undertaken.

The Environment Agency's Surface Water Flooding Maps[7] indicates the site to be at low to very low risk of surface water flooding. The majority of the site is located in an area of very low risk of surface water flooding, a limited area of low risk is identified in the centre and in two areas on the eastern boundary.

During the highest and medium chance of occurrence surface water flood event, no surface water flooding is shown on site.

During the lowest chance of occurrence surface water flood event, the majority of the site is located in an area of very low risk of surface water flooding. A limited area of surface water flooding is identified in the centre of the site and in two areas on the eastern boundary. The depth of the surface water is shown to be less than 300mm and have a velocity of less than 0.25m/s.

The maps show the surface water to predominantly originate from within the site or just to the east, it is therefore considered that the construction of specifically designed drainage features which permits controlled surface water collection and discharge, will reduce the risk of surface water flooding on-site.

Table 3.1 (refer to **Table 8** below) in R&D Technical Report FD2320/TR2[13] is accepted by the Environment Agency as a standard to define the danger to people based upon the depth and velocity of flood water. The Danger Classifications are based upon the definition in R&D Technical Report FD2320/TR2[13] and are included in **Table 9** below.

Velocity (m/s)	Depth of flooding											
	0.05	0.10	0.20	0.30	0.40	0.50	0.60	0.80	1.00	1.50	2.00	2.50
0.00												
0.10												
0.25												
0.50												
1.00												
1.50												
2.00												
2.50												
3.00												
3.50												
4.00												
4.50												
5.00												

Key:
- Danger for some
- Danger for most
- Danger for all

Table 8. R&D Technical Report FD2320/TR2[13], Danger to People for Different combinations of depth and velocity.

Danger	Description
Dangerous for some	Includes children, the elderly and the infirm
Dangerous for most people	Includes the general public
Dangerous for all	Includes emergency services

Table 9. R&D Technical Report FD2320/TR2[13] Danger Classifications.

Access through less than 300mm of flood water at less than 0.25m/s is deemed acceptable to all, in accordance with R&D Technical Report FD2320/TR2[13].

3.2 Future Maintenance

Where the surface water drainage is within an owner's plot it will be including in the deeds of the plot, that the long term maintenance and repair of the drainage system will be the responsibility of the individual plot owner.

Where the surface water drainage is outside of the responsibility of the owner, a Management Company will be put into place. An annual maintenance charge will apply to plot owner to ensure the maintenance and repair is carried out together with other aspects of the site such as private roads etc.

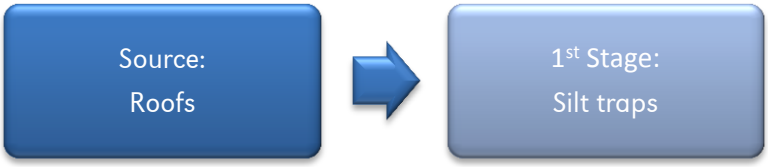
Refer to **Appendix C** for the Surface Water Maintenance Schedule detailing the management plan for the site.

3.3 Water Quality

Pollution control measures should be incorporated into the design of the surface water drainage design, in accordance with C753 The SuDS Manual[12], Groundwater Protection: Principles and Practice (GP3)[16] and local guidance produced by the LLFA to minimise the risk of pollution entering into the ground or surface waters.

The number of treatment stages will depend upon the source of the runoff. Surface water runoff from roofs will require one stage of treatment, while surface water runoff from areas at higher risk of contamination (private access and drives) will require two stages of treatment. Below is a summary of the treatment stages proposed on-site;

Roof runoff requiring one treatment stage



Permeable drives and access requiring two treatment stages

Drawing No. 20630/003 in the **Drawings Appendix** details the proposed management train for the site.

3.4 Impact Downstream

It is evident that any hydrological change within the catchment will have an effect downstream.

The increase in hardstanding areas will create an increase in the surface water runoff generated within the site prior to mitigation. However through the incorporation of a sustainable surface water drainage system the increased surface water runoff will be entirely contained within an on-site soakage drainage system or in an attenuation drainage system and discharge from site at a controlled rate to the ditch, therefore the proposal complies with NPPF.

The installation of the surface water drainage system will reduce the risk of flooding from instantaneous runoff which currently discharges onto the surrounding ground.

4.0 SUMMARY

The surface water runoff will discharge into a sustainable drainage system, designed to contain up to and including the 1 in 100 year rainfall event including climate change. To prevent pollution to the underlying geology, groundwater and surface water an appropriate level of water treatment stages have been incorporated into the design. To reduce the risk of flooding due to the failure of the surface water drainage system over its lifespan, a maintenance scheme for the drainage should be adhered to, as detailed within this report.

5.0 REFERENCES

A variety of public, published and site-specific information sources have been consulted in the compilation of this report, a list of these sources can be found below.

1. Communities and Local Government (2012) National Planning Policy Framework (NPPF).

2. Planning Practice Guidance Suite (2016) National Planning Policy Framework, Flood Risk & Coastal Change Guidance (NPPF, FR&CCG).

3. Communities and Local Government (2010) Planning Policy Statement 25: Development & Flood Risk (PPS 25).

4. Google website (2016) Google Maps.

5. Bing website (2016) Bing Maps.

6. UK Grid Reference Finder website (2016) UK Grid Reference Finder Maps.

7. Environment Agency website (2016) What's In Your Back Yard Maps (WIYBY).

8. British Geological Survey website (2016) Geology of Britain viewer. Scale 1:50,000.

9. British Geological Survey website (2016) Viewer for scanned hydrogeology maps of the UK. Scale 1:125,000.

10. Duncan Faulkner (1999) Flood Estimation Handbook 2: Rainfall Frequency Estimation.

11. The Building Regulations (2010) Drainage & Waste Disposal.

12. CIRIA (2015) The SUDS Manual, CIRIA C753.

13. Defra / Environment Agency Flood & Coastal Defence R & D Programme (2007) Flood Risk Assessment Guidance for New Development, Phase 2, R&D Technical Report FD2320/TR2.

14. BRE Digest (2007) BRE Digest 365, Soakaway Design.

15. Flood & Coastal Erosion Risk Management Research & Development Programme (2013) Rainfall Runoff Management for Developments, Report SC030219.

16. Environment Agency (2013) Groundwater Protection: Principles and practice (GP3).

17. Centre for Ecology & Hydrology (2016) Flood Estimation Handbook Web Service.

18. Environment Agency (2016) Catchment Data Explorer.

19. Breckland Council (2015) SuDS Checklist Full Applications

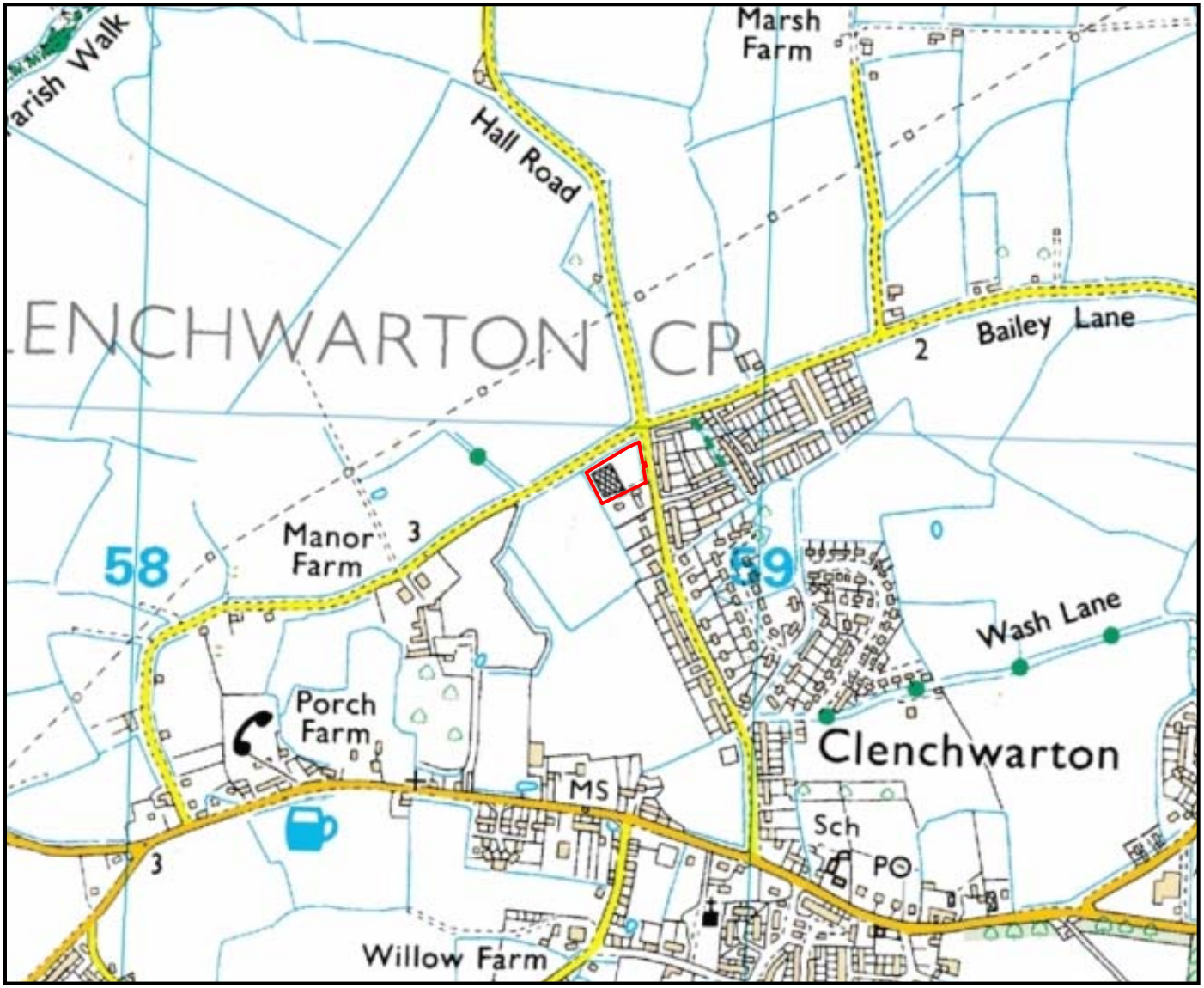
20. Groundsure (2016) Groundsure Geoinsight (refer to **Appendix A**)

21. Geoff Beel Consultancy (2015) Flood Risk Assessment.

DRAWINGS APPENDIX

CONTENTS

Drawing No. 20630/800	**-**	**Site Location Plan**
Drawing No. 20630/001	**-**	**Topographical Survey**
Drawing No. 20630/003	**-**	**Proposed Site Plan**
Drawing No. 20630/803	**-**	**Environment Agency Flood Map (Fluvial & Tidal)**
Drawing No. 20630/810	**-**	**Environment Agency Surface Water Flooding Map**
Drawing No. 20630/811	**-**	**Environment Agency Surface Water Depth Map – High Chance of Occurrence**
Drawing No. 20630/812	**-**	**Environment Agency Surface Water Depth Map – Medium Chance of Occurrence**
Drawing No. 20630/813	**-**	**Environment Agency Surface Water Depth Map – Low Chance of Occurrence**
Drawing No. 20630/814	**-**	**Environment Agency Surface Water Velocity Map – High Chance of Occurrence**
Drawing No. 20630/815	**-**	**Environment Agency Surface Water Velocity Map – Medium Chance of Occurrence**
Drawing No. 20630/816	**-**	**Environment Agency Surface Water Velocity Map – Low Chance of Occurrence**



Source: Bing Maps

N

plandescil
consulting engineers
Connaught Road Attleborough Norfolk NR17 2BW
Telephone: (01953) 452001 Fax: (01953) 456955
E-mail: pdc@plandescil.co.uk www.plandescil.co.uk
civil • structural • environmental • surveying

Client
Ian H Bix Associates Ltd

Project
Proposed Residential Development
Land between Wildfields Road & Hall Road
Clenchwarton, Norfolk

Drawing Title
Site Location Plan

Scale	Date	Drawn By
N.T.S	February 2016	SVH

Drawing No.	Rev
20630/800	0

Survey Notes

1. All levels and coordinates relate to a GPS derived datum. Control was established using Ordnance Survey's Active GPS Network OSGB32(36). Translated from ETRS89 using OSGM02 and OSTN02 models. Control station information may not be shown on this drawing, please contact Plandescil Ltd should you require assistance.

2. All levels shown adjacent to kerb lines have been taken at channel face unless stated otherwise.

3. Not all existing services are necessarily shown on this drawing. All services that could be located at the time of the survey have been positioned but should be taken as approximate and used as a guide to their presence. Clarification of all underground routes should be confirmed by the individual service provider and prior to project construction.

4. Land ownership boundaries and legal title extents have not been identified in this survey. Fences have been surveyed at post positions and changes of direction. Hedges located at face or line of main stem, see drawing note to specify.

5. Not all trees have been surveyed, trees shown as below have been fixed by trunk position. Level relates to ground at base of trunk.

Example of surveyed tree, species not recorded unless stated. Trunk diameter shown to scale, average canopy spread surveyed and plotted to scale.

Areas of dense trees and vegetation have been shown by the approximate ground coverage and have no trunk positioning.

Areas of non surveyed planting, positions shown indicatively only, or perimeter surveyed where level information is present.

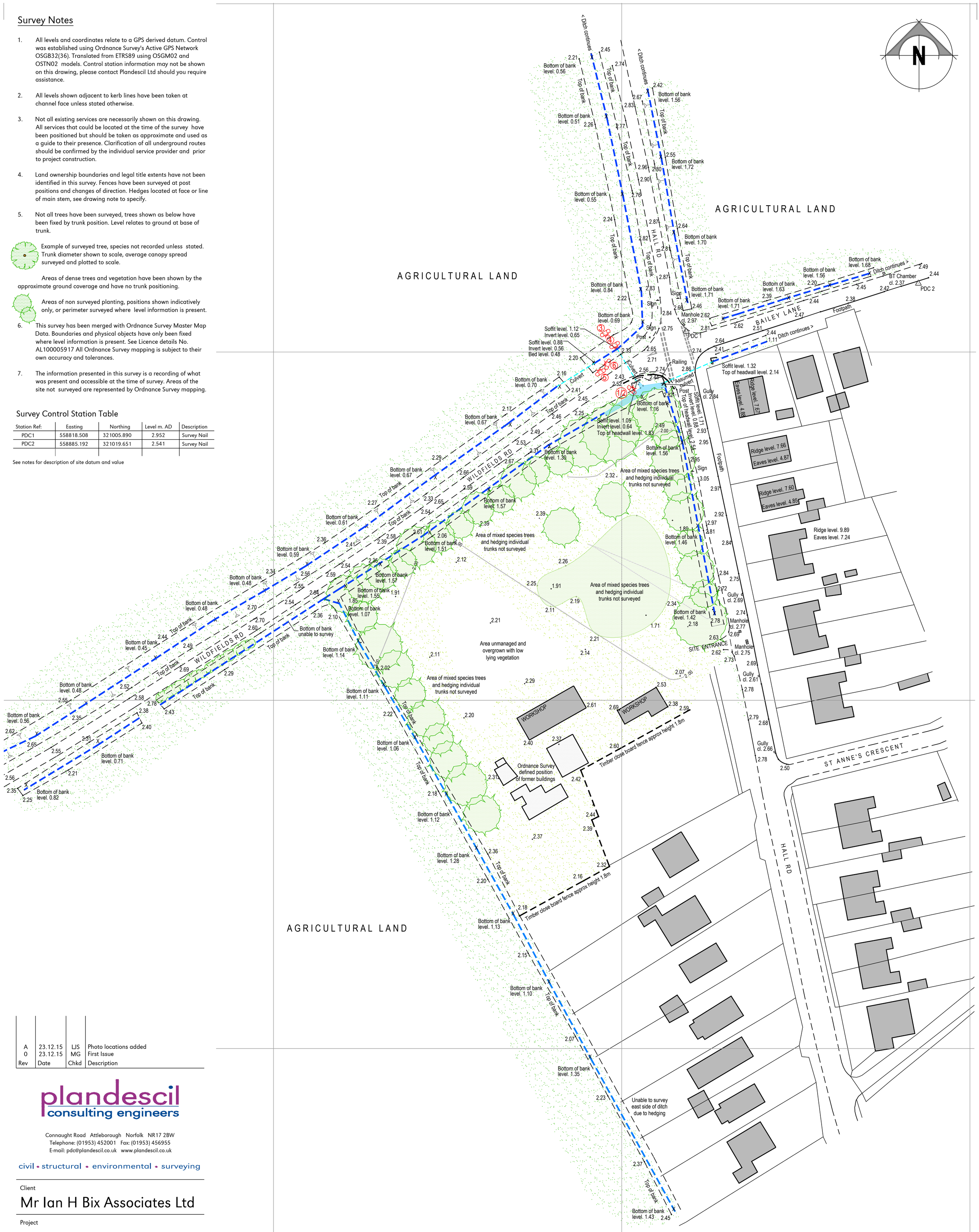
6. This survey has been merged with Ordnance Survey Master Map Data. Boundaries and physical objects have only been fixed where level information is present. See Licence details No. AL100005917 All Ordnance Survey mapping is subject to their own accuracy and tolerances.

7. The information presented in this survey is a recording of what was present and accessible at the time of survey. Areas of the site not surveyed are represented by Ordnance Survey mapping.

Survey Control Station Table

Station Ref:	Easting	Northing	Level m. AD	Description
PDC1	558818.508	321005.890	2.952	Survey Nail
PDC2	558885.192	321019.651	2.541	Survey Nail

See notes for description of site datum and value



Rev	Date	Chkd	Description
A	23.12.15	LJS	Photo locations added
0	23.12.15	MG	First Issue

plandescil
consulting engineers

Connaught Road Attleborough Norfolk NR17 2BW
Telephone: (01953) 452001 Fax: (01953) 456955
E-mail: pdc@plandescil.co.uk www.plandescil.co.uk

civil • structural • environmental • surveying

Client

Mr Ian H Bix Associates Ltd

Project

Hall Lane
Clenchwarton
Norfolk

Drawing Title

Topographical Survey

Scale U.N.O.	Date	Drawn By
1:500	December 2015	LJS

Drawing No.	Rev
20630/001	A

1:500 - DRAWING SCALE REFERENCE (m)

20 10 5 0 10 20 30 40 50

1:500 - DRAWING SCALE REFERENCE (m)

10 5 2.5 0 5 10 15 20 25

KEY

Proposed impermeable Roof Area = 0.105 Ha

Proposed permeable Private Drive Area = 0.110 Ha

Rod and jet clean the existing outlet culvert beneath Wildfields Road. Repair outlet and headwall to the open drain on the north side of the road.

Rod and jet clean the existing outlet culvert beneath Hall Road. Repair headwalls both sides if necessary.

Headwall with flap valve

Vortex Flow Control

Attenuation Crates 21.0 x 2.5 x 0.8m deep

Attenuation Crates 23.0 x 2.5 x 0.8m deep

Attenuation Crates 13.0 x 2.5 x 0.8m deep

Attenuation Crates 13.0 x 2.5 x 0.8m deep

Attenuation Crates 9.0 x 2.5 x 0.8m deep

Plot 1

Plot 2

Plot 3

Plot 4

Plot 5

Plot 6

Plot 7

Plot 8

Plot 9

Plot 10

WILDFIELDS RD

BAILEY LANE

Footpath

Ditch continues >

Bottom of bank unable to survey

Workshop to be demolished

WORKSHOP

Timber close board fence approx height 1.8m

SITE ENTRANCE

Ridge level. 7.66
Eaves level. 4.87

Ridge level. 7.60
Eaves level. 4.85

Ridge level. 9.89
Eaves level. 7.24

N

Ordnance Survey

FOR PLANNING

Rev	Date	Chkd	Description
0	20.01.16	MJH	First Issue

plandescil consulting engineers

Connaught Road Attleborough Norfolk NR17 2BW
Telephone: (01953) 452001 Fax: (01953) 456955
E-mail: pdc@plandescil.co.uk www.plandescil.co.uk

civil • structural • environmental • surveying

Client

Mr Ian H Bix Associates Ltd

Project

Proposed Residential Development On Land Between Wildfields Road and Hall Road

Drawing Title

Proposed Site Plan

Scale U.N.O.	Date	Drawn By
(A3) 1:500	Jan 2016	MJH

Drawing No. 20630/003 Rev 0

Source: Environment Agency

N

Legend

- Main River
- Flood Zone 1 (less than 0.1% annual probability of flooding)
- Flood Zone 2 (0.1% annual probability of flooding)
- Flood Zone 3 (1.0% annual probability of flooding)

plandescil
consulting engineers

Connaught Road Attleborough Norfolk NR17 2BW
Telephone: (01953) 452001 Fax: (01953) 456955
E-mail: pdc@plandescil.co.uk www.plandescil.co.uk

civil · structural · environmental · surveying

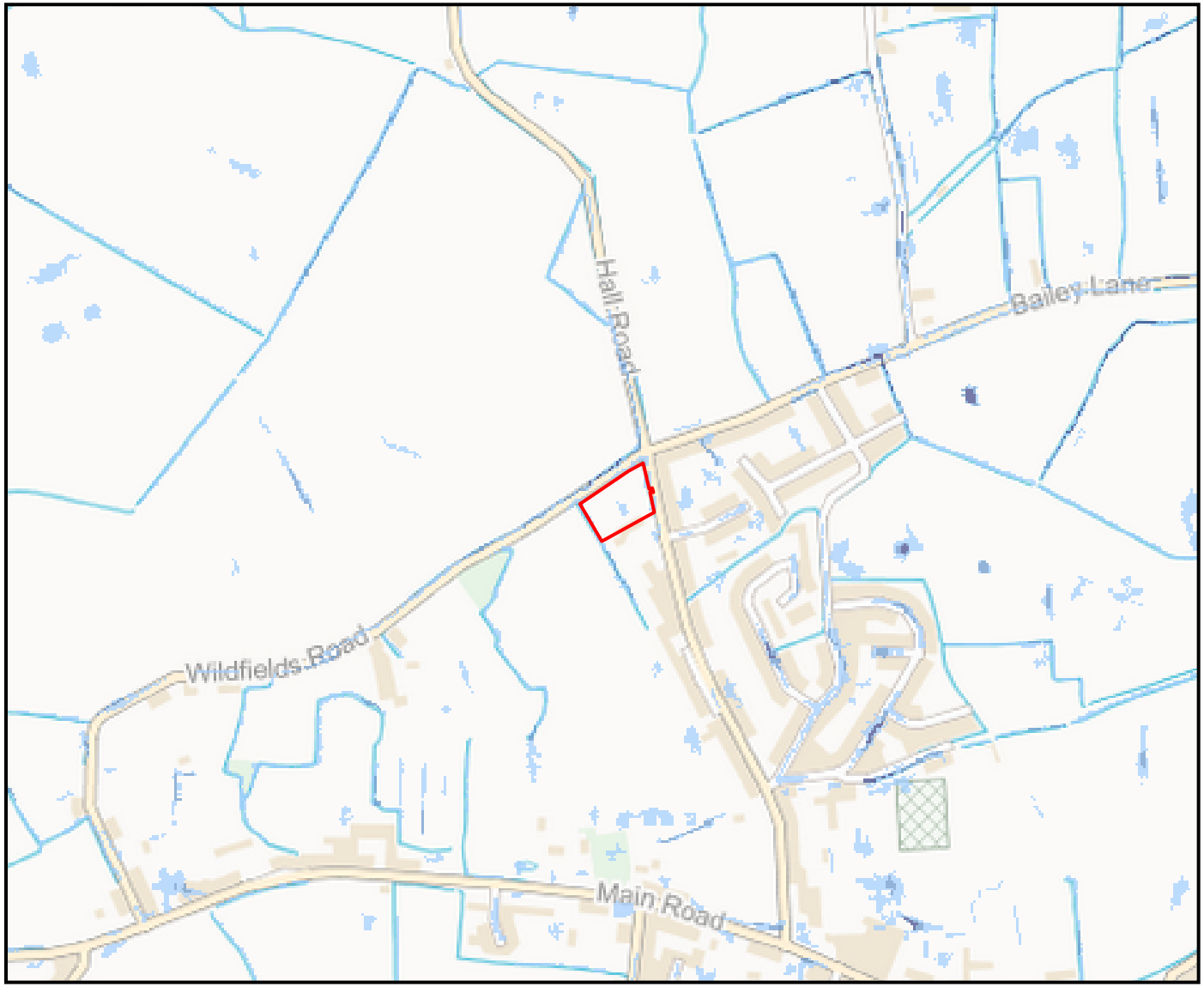
Client
Ian H Bix Associates Ltd

Project
Proposed Residential Development
Land between Wildfields Road & Hall Road
Clenchwarton, Norfolk

Drawing Title
Environment Agency Flood Map (Fluvial & Tidal)

Scale	Date	Drawn By
N.T.S	February 2016	SVH

Drawing No.	Rev
20630/803	0



Source: Environment Agency

N

Legend

- Very Low (less than 1 in 1000 (0.1%))
- Low (between 1 in 1000 (0.1%) & 1 in 100 (1%))
- Medium (between 1 in 100 (1%) & 1 in 30 (3.3%))
- High (Greater than 1 in 30 (3.3%))

plandescil
consulting engineers

Connaught Road Attleborough Norfolk NR17 2BW
Telephone: (01953) 452001 Fax: (01953) 456955
E-mail: pdc@plandescil.co.uk www.plandescil.co.uk

civil • structural • environmental • surveying

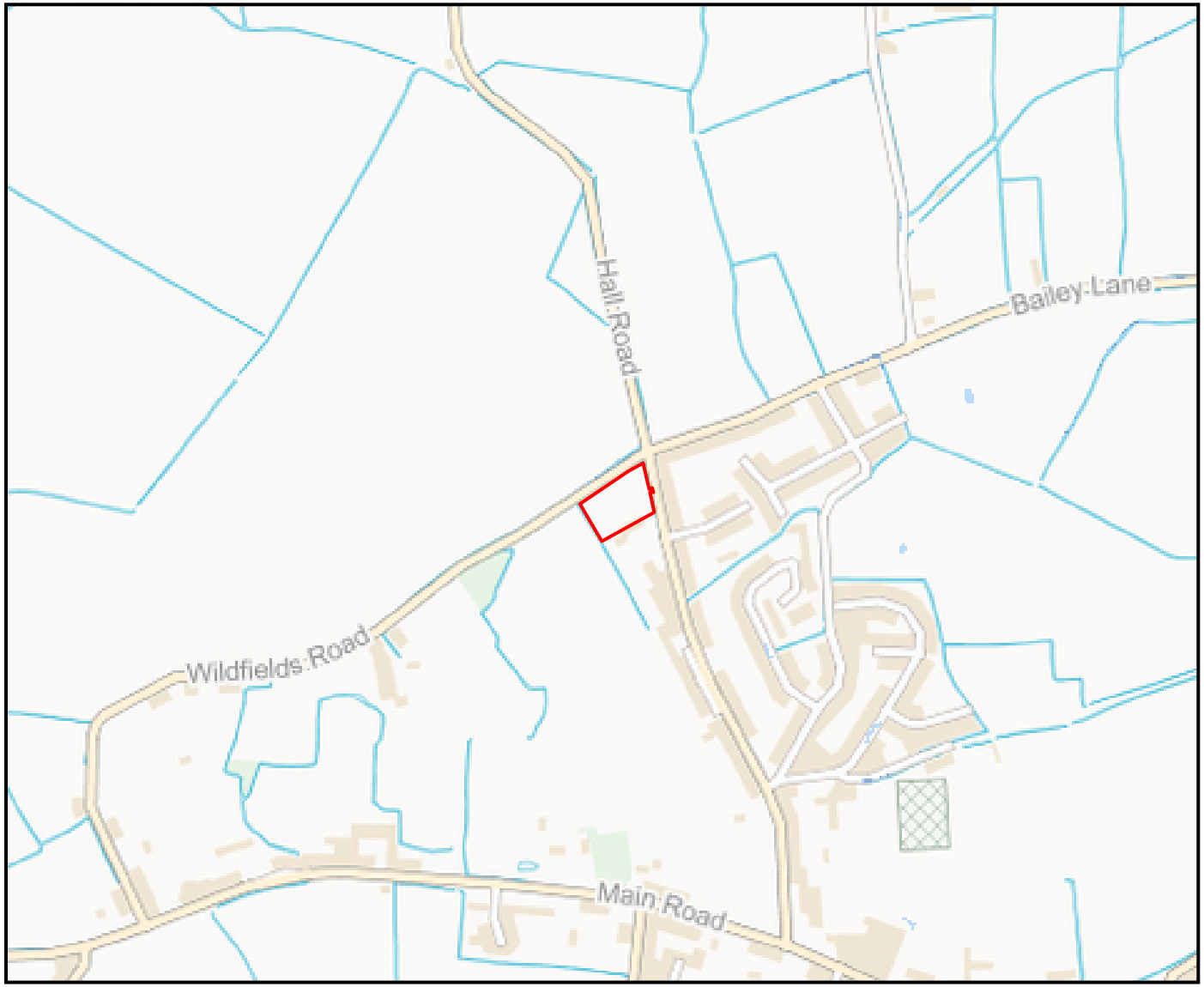
Client
Ian H Bix Associates Ltd

Project
Proposed Residential Development
Land between Wildfields Road & Hall Road
Clenchwarton, Norfolk

Drawing Title
Environment Agency Surface Water Flooding Map

Scale	Date	Drawn By
N.T.S	February 2016	SVH

Drawing No.	Rev
20630/810	0



Source: Environment Agency

N

Legend

- Below 300mm
- 300-900mm
- Over 900mm

plandescil
consulting engineers

Connaught Road Attleborough Norfolk NR17 2BW
Telephone: (01953) 452001 Fax: (01953) 456955
E-mail: pdc@plandescil.co.uk www.plandescil.co.uk

civil • structural • environmental • surveying

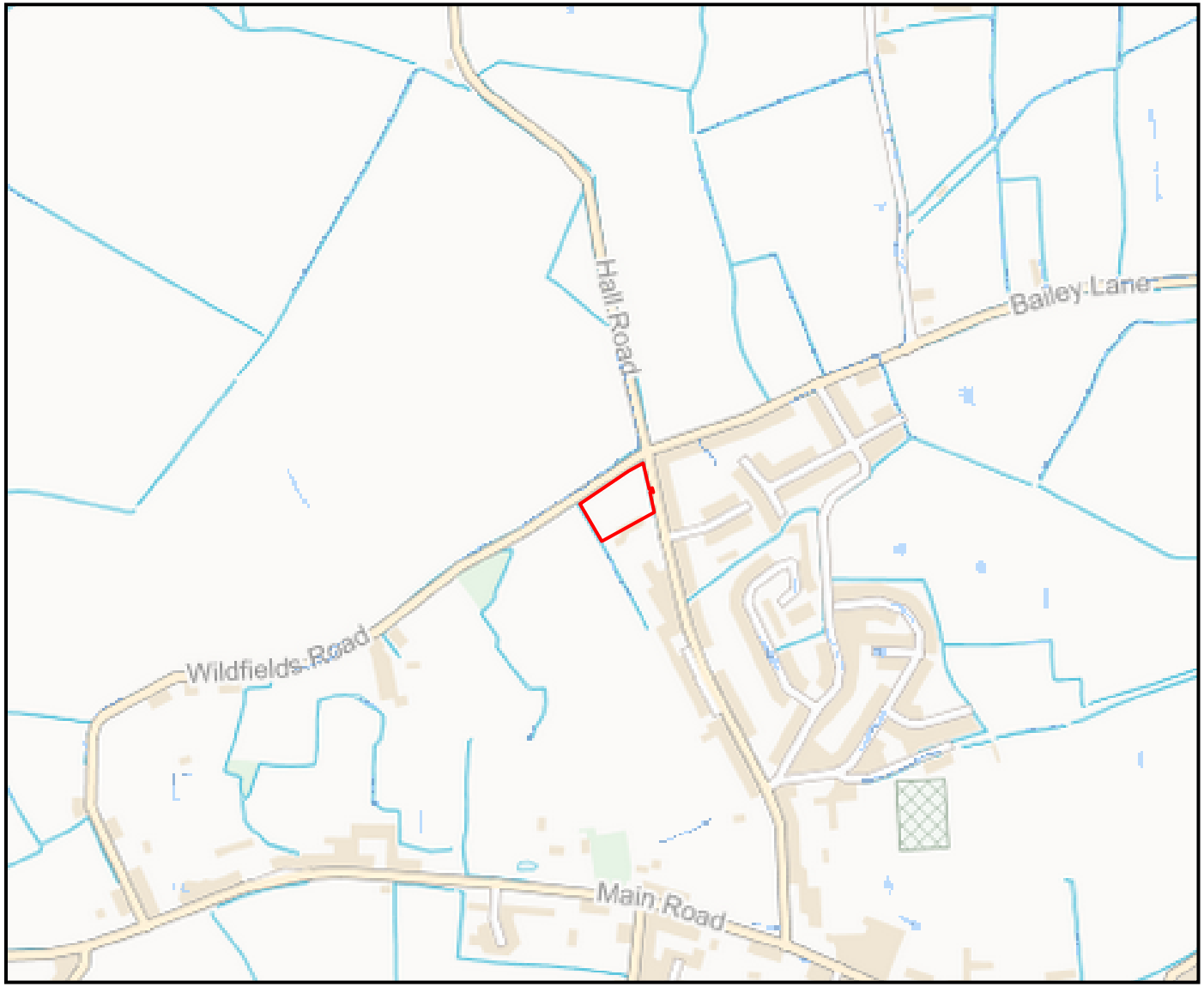
Client
Ian H Bix Associates Ltd

Project
Proposed Residential Development
Land between Wildfields Road &
Hall Road
Clenchwarton, Norfolk

Drawing Title
Environment Agency Surface
Water Depth Map - High
Chance of Occurrence

Scale	Date	Drawn By
N.T.S	February 2016	SVH

Drawing No.	Rev
20630/811	0



Source: Environment Agency

N

Legend

- Below 300mm
- 300-900mm
- Over 900mm

plandescil
consulting engineers

Connaught Road Attleborough Norfolk NR17 2BW
Telephone: (01953) 452001 Fax: (01953) 456955
E-mail: pdc@plandescil.co.uk www.plandescil.co.uk

civil • structural • environmental • surveying

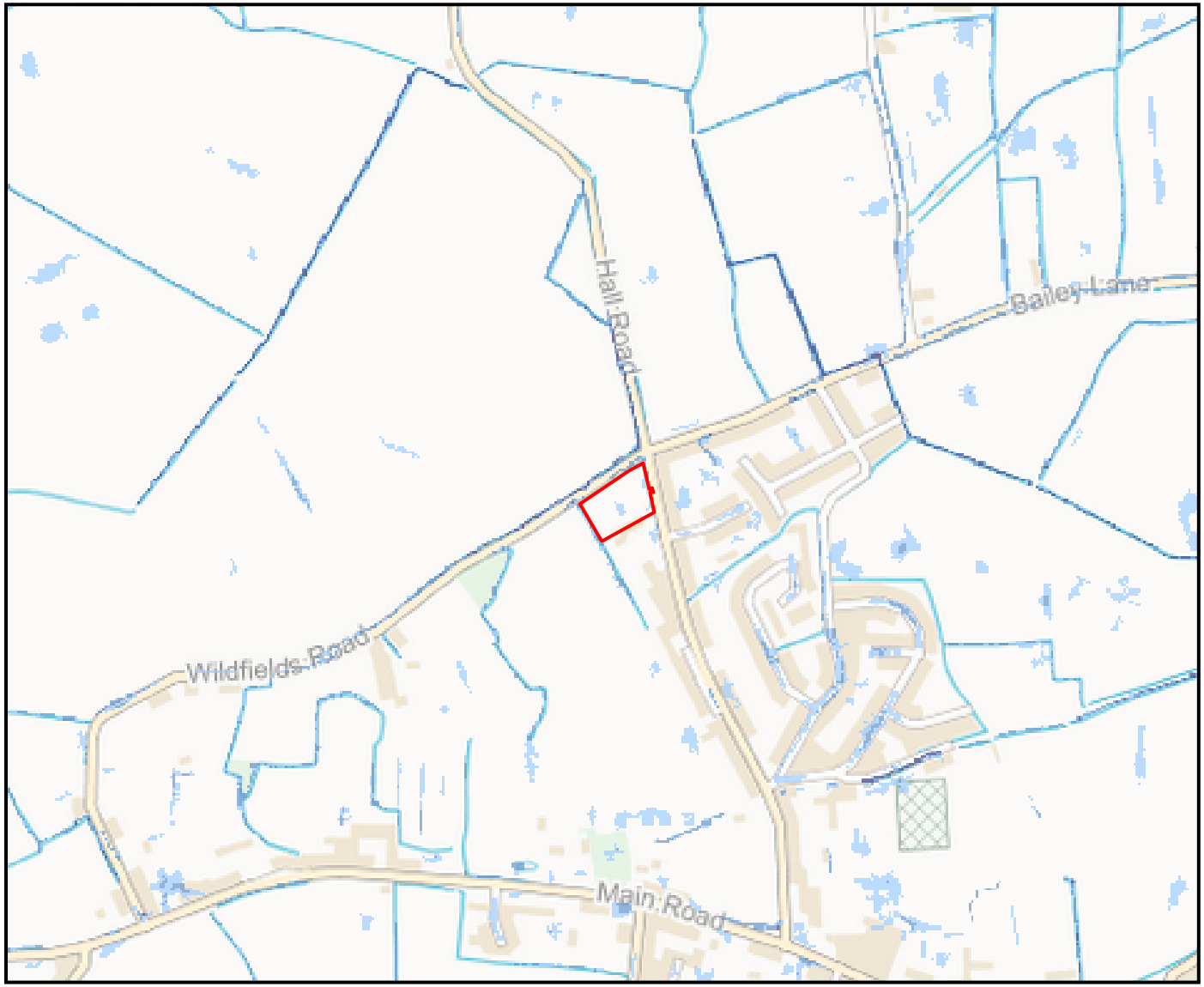
Client
Ian H Bix Associates Ltd

Project
Proposed Residential Development
Land between Wildfields Road &
Hall Road
Clenchwarton, Norfolk

Drawing Title
Environment Agency Surface
Water Depth Map - Medium
Chance of Occurrence

Scale	Date	Drawn By
N.T.S	February 2016	SVH

Drawing No.	Rev
20630/812	0



Source: Environment Agency

N

Legend

- Below 300mm
- 300-900mm
- Over 900mm

plandescil
consulting engineers

Connaught Road Attleborough Norfolk NR17 2BW
Telephone: (01953) 452001 Fax: (01953) 456955
E-mail: pdc@plandescil.co.uk www.plandescil.co.uk

civil • structural • environmental • surveying

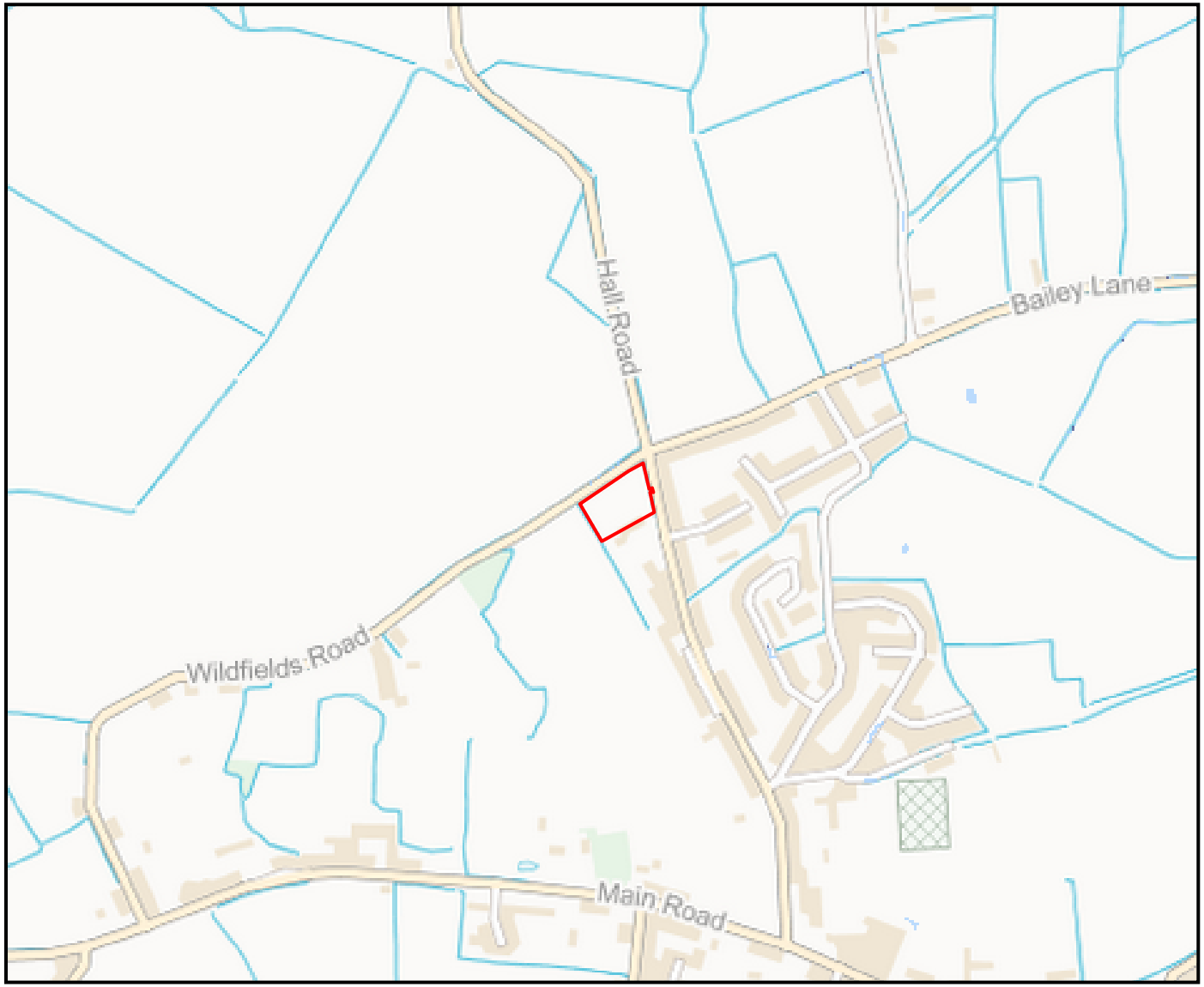
Client
Ian H Bix Associates Ltd

Project
Proposed Residential Development
Land between Wildfields Road &
Hall Road
Clenchwarton, Norfolk

Drawing Title
Environment Agency Surface
Water Depth Map - Low
Chance of Occurrence

Scale	Date	Drawn By
N.T.S	February 2016	SVH

Drawing No.	Rev
20630/813	0



Source: Environment Agency

N

Legend

- Less than 0.25m/s
- Over 0.25m/s
- Direction of water

plandescil
consulting engineers

Connaught Road Attleborough Norfolk NR17 2BW
Telephone: (01953) 452001 Fax: (01953) 456955
E-mail: pdc@plandescil.co.uk www.plandescil.co.uk

civil • structural • environmental • surveying

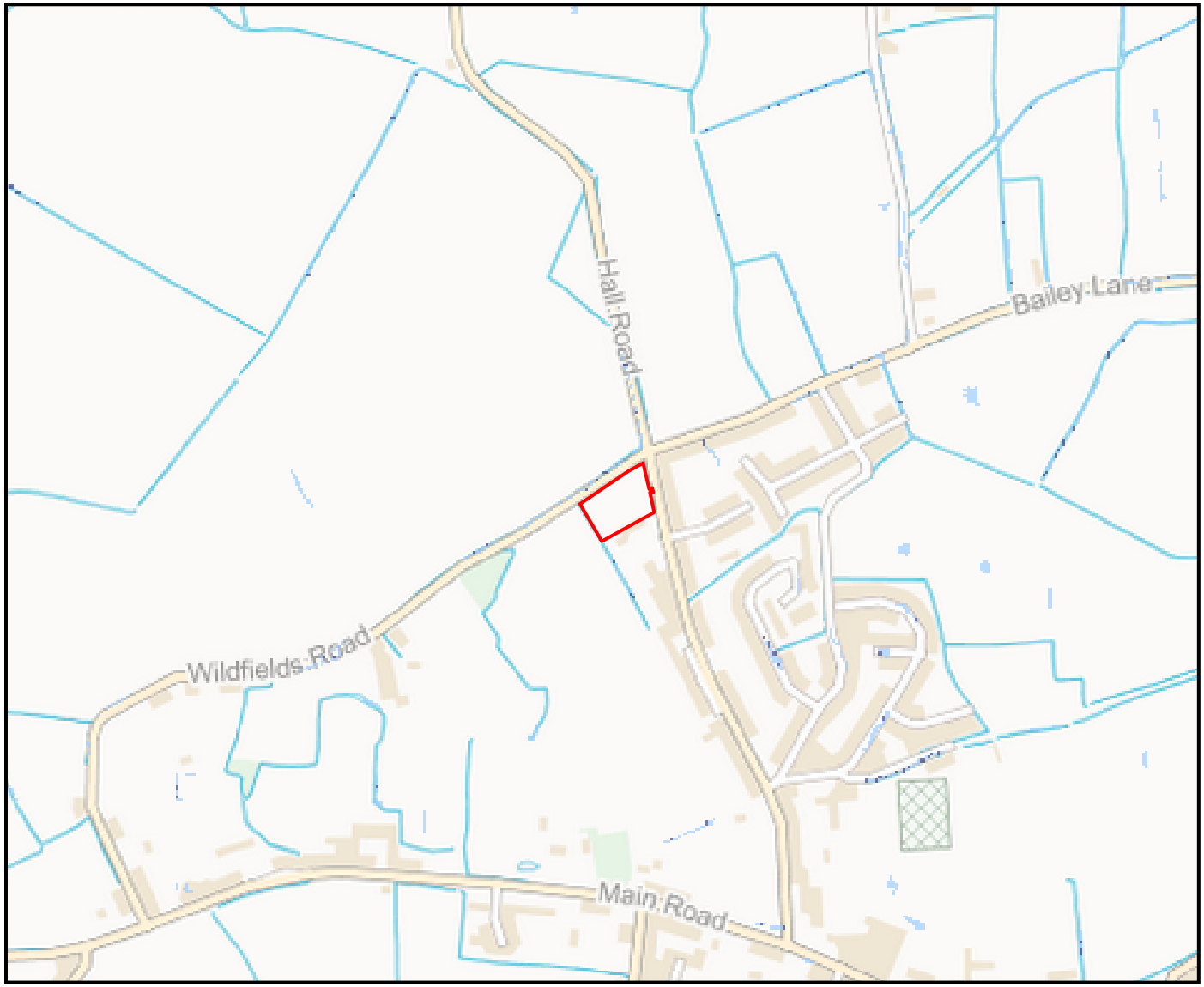
Client
Ian H Bix Associates Ltd

Project
Proposed Residential Development
Land between Wildfields Road &
Hall Road
Clenchwarton, Norfolk

Drawing Title
Environment Agency Surface
Water Velocity Map - High
Chance of Occurrence

Scale	Date	Drawn By
N.T.S	February 2016	SVH

Drawing No.	Rev
20630/814	0



Source: Environment Agency

N

Legend

- Less than 0.25m/s
- Over 0.25m/s
- Direction of water

plandescil
consulting engineers

Connaught Road Attleborough Norfolk NR17 2BW
Telephone: (01953) 452001 Fax: (01953) 456955
E-mail: pdc@plandescil.co.uk www.plandescil.co.uk

civil • structural • environmental • surveying

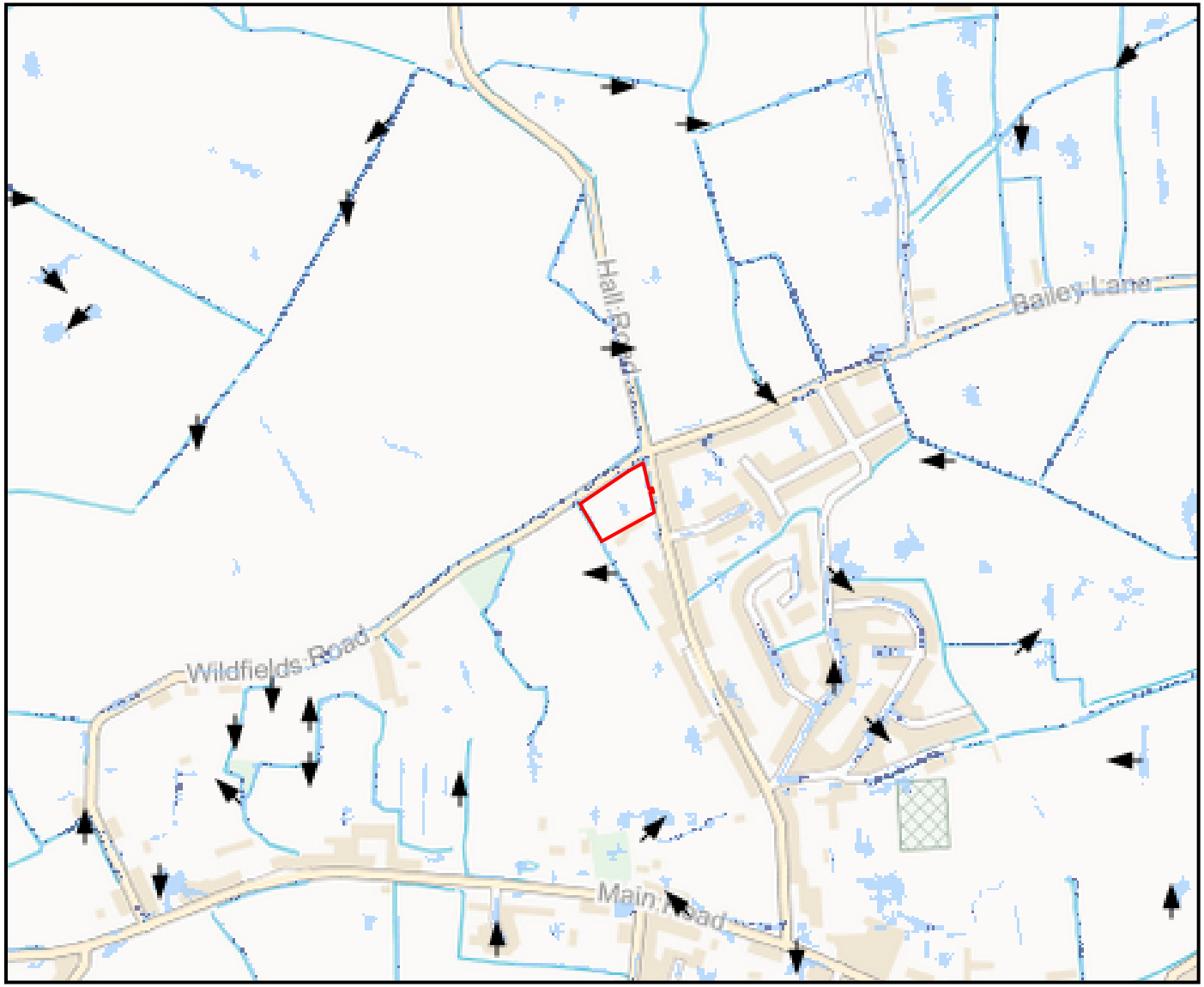
Client
Ian H Bix Associates Ltd

Project
Proposed Residential Development
Land between Wildfields Road & Hall Road
Clenchwarton, Norfolk

Drawing Title
Environment Agency Surface Water Velocity Map - Medium Chance of Occurrence

Scale	Date	Drawn By
N.T.S	February 2016	SVH

Drawing No.	Rev
20630/815	0



Source: Environment Agency

N

Legend

- Less than 0.25m/s
- Over 0.25m/s
- Direction of water

plandescil
consulting engineers

Connaught Road Attleborough Norfolk NR17 2BW
Telephone: (01953) 452001 Fax: (01953) 456955
E-mail: pdc@plandescil.co.uk www.plandescil.co.uk

civil • structural • environmental • surveying

Client
Ian H Bix Associates Ltd

Project
Proposed Residential Development
Land between Wildfields Road & Hall Road
Clenchwarton, Norfolk

Drawing Title
Environment Agency Surface Water Velocity Map - Low Chance of Occurrence

Scale	Date	Drawn By
N.T.S	February 2016	SVH

Drawing No.	Rev
20630/816	0