

FLOOD RISK ASSESSMENT & SURFACE WATER DRAINAGE STRATEGY

Job No. 19855

Proposed Residential Development
Land West of Lutton Gowts
Long Sutton
Lincolnshire
PE12 9LQ

Client: Pure Leisure Group

March 2016
Revision A

civil • structural • environmental • surveying



cost effective engineering solutions

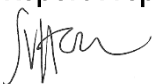
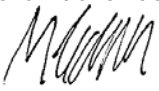
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REPORT CONTROL SHEET

Client: Pure Leisure Group

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Project Name: Proposed Residential Development
Land West of Lutton Gowts
Long Sutton
Lincolnshire
PE12 9LQ

Issue		
First Issue	February 2016	
Revision A – Site boundary adjusted	March 2016	Report Prepared & Reviewed by:  Sally Hare B.Sc (Hons) CSci, MEnvSc, MCIWEM Senior Environmental Consultant
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1.0 INTRODUCTION

1.1 Background Information

This Flood Risk Assessment & Surface Water Drainage Strategy was prepared by Plandescil Ltd on behalf of Pure Leisure Group in March 2016, to accompany a planning application for a proposed residential development of the land west of Lutton Gowt, Long Sutton, Lincolnshire, PE12 9LQ.

This report was prepared to accompany a planning application for five residential dwellings that are proposed to be located off Lutton Gowt. In addition to an assessment of the flood risk associated with the five residential dwellings planning application, consideration has been given towards the future development opportunities of the land owned by the client to ensure sufficient infrastructure has been incorporated, future proofing the site. Drawing No. 19855/802 in the **Drawings Appendix** details the application site boundary and ownership boundary. The land within the ownership boundary as shown on Drawing No. 19855/802 will herein be referred to as the site.

1.2 Objectives

This report has been prepared to evaluate the flood risk to the proposed development in addition to considering the impact of the development on the surrounding area as the site's ownership boundary exceeds 1 Hectare and is shown on the Environment Agency's Flood Map⁽⁷⁾ to be located in Flood Zone 3. This has also been required by South Holland District Council (SHDC) as the development is classified as a major application as the site's area exceeds 0.5ha.

This assessment has been prepared in accordance with the requirements of the National Planning Policy Framework, Planning Policy Guidance, Flood Risk and 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)⁽²¹⁾. 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 7.0, References.

A SuDS Checklist for Full Applications has been completed for the site and is included in **Appendix I**, the checklist has been based upon typical requirements of LLFA's.

2.0 SITE DESCRIPTION

2.1 Location

The site is located to the south of the settlement of Lutton Gowts, and to the west of Lutton Gowts highway. The site has an OS Pathfinder Grid Reference of TF 43574 24557⁽⁶⁾, refer to Drawing No. 19855/800 in the **Drawings Appendix** for the Site Location Plan. The site is located in SHDC's administration area and is within the Environment Agency's Lincolnshire and Northamptonshire area⁽⁷⁾.

2.2 Existing Site Layout

The majority of the existing site comprises Silverhill Caravan Park. An area of undeveloped greenfield land is located to the north-east of the site, as shown on Drawing No. 19855/001 in the **Drawings Appendix**. The site is accessible via an existing access off Lutton Gowts highway.

A topographical survey has been carried out of the land within the ownership boundary to determine the existing site levels, refer to Drawing No. 19855/001. 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 2.45m in the west to 4.14m in the east.

The site is situated in a rural village setting, residential dwellings are located to the west of Lutton Gowts highway, bounding the site on the south-east and north. Undeveloped/agricultural land is located to the west, south and north-east.

2.3 Proposed Development

The proposed development is for five residential dwellings, refer to Drawing No. 19855/802 in the **Drawings Appendix** detailing the proposed site layout. The site will be accessed from Lutton Gowts highway. An area in the south of the site that is presently undeveloped has been designated for the surface water run-off.

2.4 Geology

The British Geological Survey (BGS) geological map for the area⁽⁸⁾ indicates that the site is underlain by Tidal Flat Deposits (Clay & Silt) Superficial Deposits, where the Ampthill Clay Formation (Mudstone) Bedrock is located at depth. This is consistent with the findings of the Groundsure GeolInsight report⁽²⁰⁾ in **Appendix E**. Refer to Drawing No's. 19855/804 & 805 in the **Drawings Appendix** showing an extract of the BGS Superficial and Bedrock Geology Map⁽⁸⁾.

The Groundsure GeolInsight report⁽²⁰⁾ details that the Superficial Deposits have intergranular flow type with low to very low permeability. The Bedrock has a fractured flow type with low to very 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 GeolInsight report⁽²⁰⁾ does not indicate the presence of any Artificial/Made Ground on-site.

Groundsure GeolInsight 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⁽²⁰⁾.

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.
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.

2.5 Groundwater

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 in the settlements of Long Sutton to the south and Chapelgate to the west. 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
TF42SW16	1.3km south-west	1.83m	2.00m	Jan 1985	1.95m	-0.12m
TF42SW36	2.2km west	3.00m	35.00m	July 1981	2.75m	0.25m
TF42SW11	2.3km west	2.95m	15.00m	Sept 1983	2.80m	0.15m

Table 2. Depth of groundwater observed within the BGS Borehole Records⁽⁸⁾

BGS borehole data⁽⁸⁾ indicates the groundwater level to be approximately -0.12 to 0.25m AOD, suggesting the groundwater table to be a minimum of approximately 2.20m below the existing ground level of the site.

For further details on the BGS borehole logs⁽⁸⁾ and their location refer to **Appendix D**.

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 both the Tidal Flat Deposits and Ampthill Clay Formation to be classified as an Unproductive Strata. Unproductive Strata occurs where rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow.

2.6 Surface Water Flood Risk

The Environment Agency's Surface Water Flooding Maps⁽⁷⁾ indicates the majority of the site to be at very low risk of flooding. Small areas of low to high risk of surface water flooding are identified within the site, however are limited in their extent. Refer to Drawing No. 19855/810 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), the majority of the site is at very low risk of surface water flooding. A very limited localised area of surface water flooding is shown along a minor section of the north-western boundary and in the east of the site to a depth of less than 300mm and has a velocity of less than 0.25m/s. Refer to Drawing No. 19855/811 and 814 in the **Drawings Appendix** detailing the highest chance of occurrence surface water flood event.

During the medium chance of occurrence surface water flood event (between 1.0 % and 3.3% AEP), the majority of the site is at very low risk of surface water flooding. Limited localised surface water flooding is shown along a minor section of the north-western boundary, in the east of the site and in the west of the site. The depth of flooding is less than 300mm, except for in the east where flood water may extend up to 900mm. The surface water has a velocity of less than 0.25m/s. Refer to Drawing No. 19855/812 and 815 in the **Drawings Appendix** detailing the 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 at very low risk of surface water flooding. Surface water flooding is shown along a minor section of the north-western boundary, in the west and east of the site. The depth of flooding is less than 300mm, except for in the east where flood water may extend up to 900mm. The velocity of the flood water is less than 0.25m/s, except for a minor area in the east where the velocity of the flood water may exceed 0.25m/s. Refer to Drawing No. 19855/813 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 Lutton Gowts highway. As commonly experienced, some minor flooding is noted along the line of the existing ditch to the south-west of the site, but is not shown to extend on-site.

2.7 Surface Water Runoff from the Existing Site

The existing flows from the site have been calculated to ensure sufficient infrastructure has been incorporated, future proofing the site. The existing site has an impermeable area of 0.78 ha. The surface water from the existing site currently discharges onto the surrounding ground, into the ditch on the south-western boundary of the site. On this basis the runoff rates from this area of the site have been calculated based upon the Greenfield/Brownfield runoff rates, where the percentage of existing hardstanding has been factored into the calculations. It is anticipated that the impermeable area of the site will be 1.818ha of hardstanding, based upon the typical land take of residential developments. The Greenfield/Brownfield runoff rates for the area of site which is proposed to be made impermeable (1.818 ha), are shown below in **Table 2**. The Greenfield/Brownfield runoff rates shown below 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 F** for the Greenfield/Brownfield runoff rates.

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)
2016	6.3	5.4	12.6	16.0

Table 2. Predicted Greenfield/Brownfield runoff rates from the existing site.

2.8 Surface Water Runoff from the Proposed Development

The proposed residential development will create a hardstanding area of approximately 1.818 ha. **Table 3** below details the anticipated distribution of the proposed hardstanding areas as shown on Drawing No. 19855/802 in the **Drawings Appendix**.

Proposed Hardstanding Area	Surface Area (ha)
Proposed Roofs (impermeable)	0.813 ha
Proposed Adopted Roads (impermeable)	0.627 ha
Proposed Private Roads and Drives (permeable)	0.378 ha
Total Hardstanding Area	1.818 ha

Table 3. 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 4** below details the predicted amount of surface water runoff from the proposed impermeable 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 F** 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)	140.82	344.98	446.41
2016 (360 min)	18.46	46.58	64.94
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)	183.07	448.47	580.34
2116 (360 min)	24.00	60.55	84.42

Table 4. Predicted surface water runoff rates from the proposed site including climate change prior to mitigation.

2.9 Hydrology & Catchment

No surface water bodies are located on-site.

The site is located in South Holland Internal Drainage Board (IDB) catchment and is located in South Holland IDB's sub catchment of Lutton Leam drain⁽²²⁾, refer to **Appendix C**. An IDB ordinary watercourse Lutton Eau (IDB reference K16) is located to the south and west, where at its closest is 8m from site. The Lutton Eau outfalls into another IDB ordinary watercourse, the Fleet (IDB reference K08) that is located to the west and north of the site, where at its closest is 3.5m from site boundary. The Fleet outfalls into Lutton Leam (IDB reference K41) which outfalls into the River Nene approximately 5.2km east of the site. Discharge into the River Nene is controlled by the Lutton Leam Road Bridge inland sluice and Lutton Leam tidal sluice⁽²²⁾. Lutton Leam sluice is a first line of defence and Lutton Leam Road Bridge inland sluice is a second line of defence⁽²³⁾.

To establish the catchment of the Fleet when it is adjacent to the site, the Flood Estimation Handbook Web Service⁽¹⁷⁾ was consulted, which confirmed the drainage ditch has a catchment of 1.57km². The catchment is shown in **Figure 1** below.

The site is within the catchment of the Lutton Leam water body, which is the head of the catchment. Downstream of this is the transitional waterbody, the River Nene an Environment Agency main river, which outfalls into The Wash⁽¹⁸⁾. The River Nene is tidal when it is adjacent to the site⁽²¹⁾.

The River Nene is an embanked watercourse therefore has no direct floodplain in SHDC's district other than at designated flood storage areas, however has the potential to create indirect floodplains if there was a failure in an embankment⁽²¹⁾.

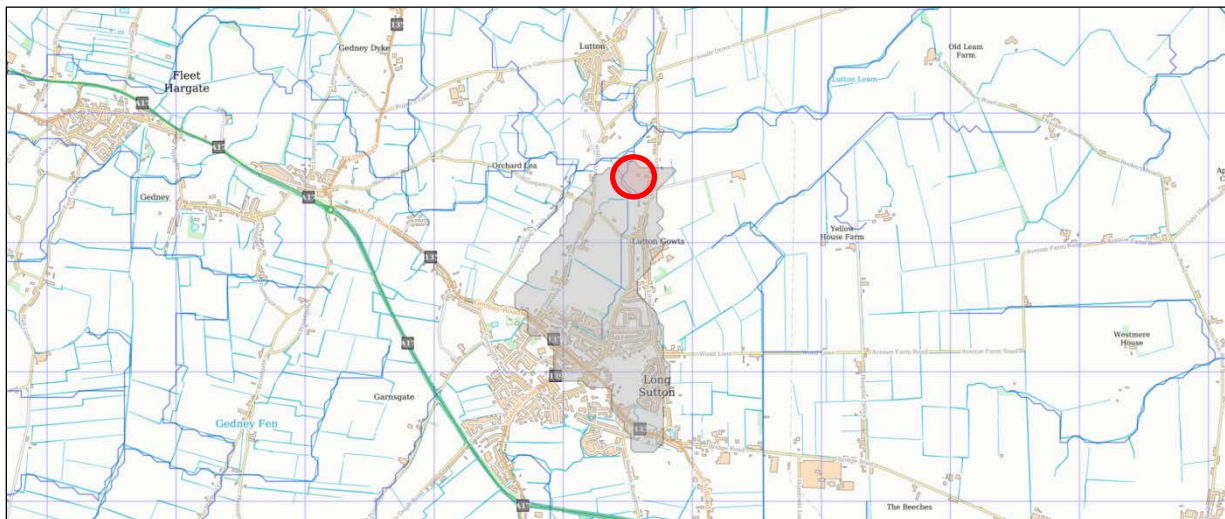


Figure 1. The catchment of the drainage network (the red circle denotes the site).

The site is within the Environment Agency's Anglian River Basin District, the Nene Management Catchment and the Nene Lower Operational Catchment⁽¹⁸⁾.

The Wash is located approximately 6km north-east and is embanked. This embankment is 28km in length and extends along The Wash frontage⁽²¹⁾.

The Wash has a secondary defence, comprising a series of embankments which divide the immediate hinterland of the primary tidal defences into a series of cells. The secondary defence provides initial storage of tidal waters should primary defence be overtopped or breached. Further landward spreading of flood water would only arise if conditions became severe enough also to give overtopping or breach of the secondary defences⁽²¹⁾.

The Tidal and Fluvial Defences map (Figure No. 5) extracted from SHDC SFRA⁽²¹⁾ is included in **Appendix B** which details the extent of the Environment Agency Embanked Defences and the Wash Secondary Defences.

The defences on the River Nene and The Wash are managed by the Environment Agency, where the Environment Agency classifies the defence on the River Nene as Good (Condition 2) to Fair (Condition 3). The Wash's primary defence is classified as Good. The Wash secondary defences are owned by respective landowners, therefore no data is available on the condition of these⁽²¹⁾. For further details on the condition of the defences, refer to the Defence Condition map (Figure No. 6) in **Appendix B**, that was extracted from SHDC SFRA⁽²¹⁾.

2.10 Fluvial & Tidal Flood Risk

NPPF, FR&CCG⁽²⁾ Table 2 Flood Risk Vulnerability Classification describes the proposed land use as having a more vulnerable land-use. NPPF, FR&CCG⁽²⁾ Table 3 shows Flood Zone 1 and 2 to be appropriate for more vulnerable developments, whilst in Flood Zone 3a the Exception Test would need to be undertaken. Refer to **Table 5** below detailing an extract of NPPF, FR&CCG⁽²⁾.

Flood Risk Vulnerability Classification		Essential Infrastructure	Water compatible	Highly vulnerable	More vulnerable	Less vulnerable
Flood Zone	Flood Zone 1	✓	✓	✓	✓	✓
	Flood Zone 2	✓	✓	Exception Test Request	✓	✓
	Flood Zone 3a	Exception Test Request	✓	x	Exception Test Request	✓
	Flood Zone 3b	Exception Test Request	✓	x	x	x

Table 5. NPPF, FR&CCG⁽²⁾ Flood zone vulnerability and flood zone 'compatibility'

Key:

✓ Development is appropriate x Development should not be permitted

A request was made to the Environment Agency in July 2015 for details on the flood risk to the site and a response was received in July 2015. The Environment Agency flood data⁽¹⁹⁾ can be found in **Appendix A**.

The site is protected by a series of sea defences along The Wash and River Nene, the risk of flooding can be categorised into three scenarios; undefended, actual and residual risk.

2.10.1 Undefended Scenario

The Basic FRA Map⁽¹⁹⁾ was provided for the site which shows the flood risk to the site and surrounding area assuming no flood defences exist. The map shows the site to be located in Flood Zone 3. Fluvial and tidal flood zones are defined as follows:

Flood Zone 1: Flood Zone 1 has less than 1 in 1000 chance of flooding at a location in any one given year (i.e., less than 0.1% AEP of flooding).

Flood Zone 2: Flood Zone 2 has a 1 in 1000 chance of flooding at a location in any one given year (i.e., a 0.1% AEP).

Flood Zone 3: Fluvial Flood Zone 3 has a 1 in 100 chance of flooding at a location in any one given year (i.e., a 1.0% annual probability of flooding). Tidal Flood Zone 3 has a 1 in 200 chance of flooding at a location in any one given year (i.e., a 0.5% AEP).

The functional floodplain comprises land where water has to flow or be stored in times of flood, within SHDC district the functional floodplain comprises only designated flood storage areas (Cowbit/Crowland washes and at Surfleet reservoir) as shown on Tidal and Fluvial Defences map (Figure No. 5) within SHDC SFRA⁽²¹⁾, an extract of this is included in **Appendix B**. This site is therefore not located in the Functional floodplain.

The Environment Agency states the following in relation to their Basic FRA Map;

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

Flood defences are, however, present throughout the fenlands and these do reduce the risk of flooding. Whilst our defences are generally in a good condition there is always a chance they can be overtopped or fail during extreme floods. With the water level in the river being above the adjacent ground level a failure of the defence could lead to flooding spreading further than identified on our flood map."⁽¹⁹⁾

This undefended scenario is based on the flood levels not taking into account the existing flood defences. However, the site is currently protected from flooding by embankments along The Wash and River Nene, therefore to fully understand the flood risk to the site it is crucial to consider the effect the flood defences have on flood risk.

2.10.2 Actual Risk

The site is protected by embanked tidal defences therefore to consider the 'real world' situation it is necessary to look at the flood risk when the flood defences are included.

The Environment Agency detail within their letter that the site will not be affected by overtopping during the 0.5% or 0.1% present day in addition to the 2115 AEP flood event.

2.10.3 Residual Risk

The residual risk refers to risk associated with the failure of the management infrastructure such as a breach to the defences. The Environment Agency⁽¹⁹⁾ have produced simulations of present day and future flood events (2115) to establish the flood risk within the area resulting from breaches to The Wash and River Nene flood defences. The simulations have produced outputs of maximum hazard, depth and velocity.

The simulations have classified the hazard ratings as defined in **Table 6** below.

Maximum Hazard	Hazard Rating	Description
Less than 0.75	Low Hazard	n/a
Between 0.75 and 1.25	Dangerous for some	Includes children, the elderly and the infirm
Between 1.25 and 2.0	Dangerous for most people	Includes the general public
Greater than 2.0	Dangerous for all	Includes emergency services

Table 6. Hazard Rating^(19 & 13).

Similar to modelling undertaken in SHDC's SFRA⁽²¹⁾ it is assumed that the modelling undertaken by the Environment Agency has included for potentially worsening flood conditions due to climate change in 2115, however has assumed that flood defences and other flood risk management measures remain unchanged from the present-day situation.

Table 7 below provides a summary of the Environment Agency breach event simulations for the present day and future flood events⁽¹⁹⁾. The SFRA included similar simulations, however the findings of these have not been incorporated below as the Environment Agency data was considered to be most representative of the present day scenario due to the date of production.

Flood AEP	Parameter	Present Day	2115
0.5%	Maximum Hazard	No flooding identified	Entire site experiences flooding. Low Hazard and Danger to Some in areas on the east, north-east and south-east. Danger to Most in the rest of the site.
	Maximum Depth	No flooding identified	Entire site experiences flooding. 0.00-0.25m depth in areas on the east and south-east. 0.25-0.50m depth in areas on the east, north-east and south-east. 0.50-1.00m minor area on east and the majority of the west and central area excluding limited areas within this that are shown to experience 1.00-2.00m of flooding.
	Maximum Velocity	No flooding identified	Entire site experiences flooding. 0-0.3m/s across entire site, excluding a limited area in the east that is shown to experience 0.30-1.0l/s.
0.1%	Maximum Hazard	Partial area of site experiences flooding. Low Hazard in the west and central area. Danger to Some in a limited area on the west and in a small area on the eastern and northern boundary No hazard identified in the rest of the site.	Entire site experiences flooding. Low Hazard in areas on the east. Danger to Some in areas on the east, north-east and south-east. Danger to Most in the rest of the site, excluding very limited areas on the southern, northern and eastern boundaries that are shown to be Dangerous to All.
	Maximum Depth	Partial area of site experiences flooding. 0.00-0.25m depth in the west and central area. 0.25-0.50m in a limited area on west and in a small area on the eastern and northern boundary. Rest of the site is shown not to experience any flooding.	Entire site experiences flooding. 0.00-0.25m depth in areas on the east. 0.25-0.50m depth in areas on the east, north-east and south-east. 0.50-1.00m depth in a minor area in the east and the majority of the west and central area excluding limited areas within this that are shown to experience 1.00-2.00m of flooding. Very minor areas on the southern boundary are shown to exceed 2.0m.
	Maximum Velocity	Partial area of site experiences flooding. 0-0.3m/s velocity of flood water in the west, north and central area. Rest of the site is shown not to experience any flooding.	Entire site experiences flooding. 0-0.3m/s across entire site, excluding a limited area in the east and south-east that are shown to experience 0.3-1.0l/s and a very limited area in the western corner of the site where the boundary abuts Luton Gowts is shown to experience 1.0-1.5l/s.

Table 7. Summary of the Environment Agency breach event simulations for present day and future flood events.

The SFRA has assessed the extent of the rapid inundation zone, where this zone represents the area within which flood water could reach a depth of 0.3m in 30 minutes or less from the onset of flooding. In this area people may find it particularly difficult to escape from a flood if they have not had prior warning to do so. The assessment has shown that the site is not situated in a rapid inundation zone presently or when the effects of climate change are considered. Refer to the Rapid Inundation Zones Present Day and 2115 map (Figure No. 16) extracted from SHDC SFRA⁽²¹⁾ that is included in **Appendix B**.

2.10.4 Flood Risk from IDB drains

The site is classified as a brownfield site, as such it is understood that the level of protection provided by the IDB drainage system is equal to the 1% (1 in 100) annual probability standard. Should the site fall outside of the urban classification the Regional Flood Risk Appraisal in the local SFRA states *"With regard to the secondary sources, the Regional Appraisal acknowledges that the majority of arterial drains are in rural areas and are designed with a degree of 'freeboard' in the system. This gives them extra capacity over the nominal design standard and helps to avoid frequent flooding."* The report continues to state *"It is therefore generally reasonable to conclude that if existing IDB systems are operated and maintained efficiently they are unlikely to pose a significant degree of flood risk. Furthermore, because Drainage Board systems usually have adequate capacity and Water Companies are required to accept surface water flows from development, neither the probability nor the consequences of flooding from secondary sources are likely to be high."*⁽²¹⁾

In the present-day 1% AEP, the IDB's consider that most of their drains may reach bank-full conditions but in urban areas there should be no flooding to property⁽²¹⁾. In agricultural areas there would probably be shallow flooding of the lowerlying parts but with only isolated instances of flooding to properties or roads⁽²¹⁾.

The IDB systems provide flood defence by a combination of storage in the drainage channels and discharge, through pumping stations or gravity outfalls. In a flood event, each system is actively managed to achieve sufficient balance between the storm inflow, the drain storage and the possible outflow so that target standards of flood protection are maintained⁽²¹⁾.

2.10.5 Flood Risk due to Blockage or to Failure of Pumps

Bridge and sluice openings on waterways in SHDC are proportionate in size with the respective waterway, as such, the potential for blockage is low. This low risk is also sustained by the effective maintenance operations of the Environment Agency and the IDB's⁽²¹⁾.

Significant areas within SHDC are reliant on pumping to sustain their flood defence standard. Whilst the IDBs have back-up facilities to employ in the event that mains electrical power is lost, or a pump fails, major failure of the pumping systems during a period of high rainfall would lead to flooding in the respective pumped catchment. The SFRA concludes however *"the consequences, however, are not likely to be catastrophic. Since the land is relatively flat there would not be a great concentration of flood water at any one point. Instead there would be shallow flooding over a wide area."* The SFRA goes on to state that *"this would possibly affect farm buildings and minor roads but probably not directly affect many houses as these tend to have a threshold raised above the general ground level"*⁽²¹⁾.

In summary, flooding due to blockage in the waterway systems is taken as having low potential at strategic level. On the other hand, pumping systems within the District are of strategic importance though pump failure is not likely to have a great consequence for the present developed areas⁽²¹⁾.

2.11 Historical Flooding

The letter received from the Environment Agency⁽¹⁹⁾ did not include any data on historic flood events.

3.0 FLOOD RISK

3.1 Sources of Flooding

The proposed development could be at possible risk from the following sources of flooding:

- Fluvial/Tidal flooding including undefended scenario, actual and residual risk in addition to consideration of flood risk from IDB drains and blockages to structures or failure of pumps;
- Groundwater flooding; and
- Surface water flooding.

3.2 Fluvial/Tidal Flooding

The risk of fluvial and/or tidal flooding can be categorised into three scenarios; undefended, actual risk and residual risk.

3.2.1 Undefended Scenario

The undefended scenario shown on the Environment Agency's Basic FRA Map⁽¹⁹⁾ identifies the site and surrounding area to be presently located in Flood Zone 3, however is not within the functional floodplain. This scenario is based on the flood levels not taking into account the existing flood defences within the area, as such is not a 'real world' situation as it is extremely unlikely that the defences will be removed in the future due to the strategic significance the defences provide in SHDC district.

3.2.2 Actual Risk

The site is protected by the embanked defences therefore to consider the 'real world' situation it is necessary to look at the flood risk when the flood defences are included. The actual risk of flooding has been considered for the 0.5% and 0.1% present day in addition to the 2115 AEP flood event. During these scenarios the site and surroundings will not be affected by overtopping.

Shoreline Management Plans (SMP) are developed by Coastal Groups with members mainly from Local Authorities and the Environment Agency and identify the most sustainable approach to managing the flood and coastal erosion risks to the coastline in the short-term (0 to 20 years), medium term (20 to 50 years) and long term (50 to 100 years). The site is

located within the catchment of Shoreline Management Plan 4, covering 110km of coastline from Gibraltar Point to Old Hunstanton. Within this catchment The Wash Shoreline Management Plan 2⁽²⁴⁾ has been prepared to set out the short, medium and long-term plan to manage the shoreline. The policy for the frontage relevant to this assessment is to hold the existing seabank alignments in the short term. In the medium and long term, the preferred intent is to hold the existing defences. However there is the recognition that due to climate change there may be significant loss of intertidal habitats (salt marshes and mud flats) in front of the sea defences. This would increase pressure on the defences and affect the integrity of the habitat in The Wash. If this occurs, localised landward managed realignment would need to be considered as an alternative to holding the line, which has the potential to provide a more effective and sustainable sea defence solution through creating a wider foreshore as well as helping to conserve the natural environment. The intention of the realignment would not be to increase the risk to the communities that are protected by the defences, as such it is assumed that the defences would continue to be maintained so as to sustain the existing standard.

The SFRA⁽²¹⁾ details the following

"The CFMPs (Catchment Flood Management Plans) set broad flood risk management policies that will be implemented by the Environment Agency both directly and by influencing others, such as local authorities and IDBs, to achieve the stated overall catchment objectives.

The CFMPs preferred policies as relevant to South Holland District are as follows.

- *Fenland area in general (Policy Unit 3) – Policy P4, 'Take further action to sustain the current level of flood risk into the future (responding to potential increases in risk from urban development, land use change and climate change').*

In essence, therefore, the intention throughout the District will be to sustain the present position as regards flood risk, countering as necessary the effects of climate change and other factors."

It is therefore reasonable to assume there is a high likelihood that the existing defences will continue to be maintained to sustain the existing standard in SHDC.

The site is classified as a brownfield site, as such it is understood that the level of protection provided by the IDB system is equal to the 1% AEP standard, where drains may reach bank-full conditions but in urban areas there should be no flooding to property⁽²¹⁾. There is potential that the site may fall outside of the urban classification as it is located in a village environment (rural area). Nevertheless the Regional Flood Risk Appraisal details that the majority of arterial drains in rural areas are designed with a freeboard, providing extra capacity over the nominal design standard and helps to avoid frequent flooding. In agricultural areas there is a possibility that shallow flooding of the lower-lying parts may occur with only isolated instances of flooding to properties or roads.

Whilst the risk of flooding from the IDB drains is considered low, to mitigate against the potential of shallow flooding the properties should be a minimum of 300mm above the existing ground level of the site. Due to the low-lying land within SHDC it is considered that

flooding from the IDB system would be very shallow though widespread, therefore it is considered unlikely that flooding from the IDB drains would exceed this depth.

3.2.3 Residual Risk

The site is protected from flooding by the Nene and The Wash defences during the 0.5% and 0.1% present day and the 2115 AEP flood event. In addition to this The Wash has a secondary defence line that would provide protection if The Wash Frontage is breached. An assessment of the residual risk from a possible breach to River Nene or The Wash defences shows that the site may experience flooding.

During the 0.5% present event if a breach occurred to the defences the site would not experience flooding.

If a breach were to occur during the 0.1% present day AEP event, the west and central area of the site is shown to experience a low hazard, which extends to dangerous to some in a limited area on the west and in a small area on the eastern and northern boundary. The remainder of the site is shown to not be at risk of flooding. Where flooding occurs the depth may extend up to 0.50m and have a velocity of up to 0.3m/s. The maximum depth and velocity that may occur on-site has the potential to be dangerous to some users (including children, the elderly and the infirm).

When the impacts of climate change are considered for the 0.5% and 0.1% AEP event, a high percentage of the site is categorised as dangerous to most (all general public) and the depths of flooding would typically range between 0.5-2.0m on-site, with very low velocities. Some areas of site may experience less than 0.5m of flooding, where other areas may exceed 2.0m. There is potential for very limited areas to be categorised as dangerous to all.

Access and egress to the site is along Lutton Gowts highway, which is at a higher elevation to the site, therefore during the present day 0.5% and 0.1% AEP event access and egress is possible, where the majority of the route will be dry. In very limited areas the hazard is shown to be low. Access through this limited flood water is deemed acceptable to all, in accordance with R&D Technical Report FD2320/TR2⁽¹³⁾.

When the effects of climate change are considered, the depth of flooding along Lutton Gowts is shown to rarely exceeding 0.5m and has low velocities.

To reduce the risk of flooding to the properties the finished floor level of the buildings should be a minimum of 300mm above the existing ground level. The dwellings should incorporate flood resilience measures on the ground floor and all bedrooms should be located on the first floor.

Raising the floor level of the properties will minimise the risk resulting from potential flooding from the IDB drains, which would result in shallow flooding.

The site is located in the Flood Warning Area of Long Sutton to Newborough, including Sutton St James, Leverington, Wisbech St Mary, and Thorney and the Flood Alert Area of Far extent of tidal flooding from the Wash between Gibraltar point and Admiralty Point and the Tidal River

Witham, the Tidal River Welland and the Tidal River Nene. To reduce the risk and impact of flooding to the residents it is recommended that the residents register with the free Floodline Warnings Direct Service, the Environment Agency's free flood warning service on 0845 988 1188 or register online at the Environment Agency website. Floodline Warnings Direct is a free service that provides flood warnings direct to those registered by telephone, mobile, email or SMS text message using their Automatic Voice Messaging (AVM) Service advising of a possible flood event. On receipt of a flood warning or alert the residents should follow the instructions received from the Environment Agency.

Whilst the Environment Agency would not be able to predict the occurrence of a breach, they would be aware of the onset of a significant flood event that could have the potential to breach the defences. The site is at a significant distance from the rapid inundation zone⁽²¹⁾, where flood water can reach a depth of 0.3m in 30 minutes or less from the onset of flooding. Therefore should a breach event occur, due to the distance the site is situated from the rapid inundation zone and the lowlying nature of SHDC it would enable sufficient time for the residents to receive the warning and the site to be evacuated. Following planning approval a Flood Warning and Evacuation Plan for the site should be prepared, the contents of this should be followed during an evacuation of the site.

The residents should complete the Environment Agency's Personal Flood Plan, a copy of this is included within **Appendix J**⁽²⁵⁾.

The site is not located in the functional floodplain nor is it shown to flood during the 0.5% breach event. It is therefore considered that the proposal will not occupy any critical flood plain storage or cause any obstruction to the natural flow of water.

3.3 Groundwater Flooding

BGS borehole data⁽⁸⁾ indicates the groundwater level to be approximately -0.12 to 0.25m AOD, suggesting the groundwater table to be a minimum of approximately 2.20m below the existing ground level of the site.

To mitigate against the potential risk of groundwater flooding non-return valves should be installed within the foul and surface water drainage system and special consideration should be given to the foundations and building design to protect against water ingress.

As part of the mitigation measures to protect the buildings from tidal flooding the buildings will be raised 300mm above surrounding ground levels which will also form a beneficial measure to reduce the risk of groundwater flooding.

To prevent groundwater influencing the surface water drainage system, the following design criteria should be adhered to in accordance with C753 The SuDS Manual⁽¹²⁾;

- Where infiltration drainage is utilised there should be in excess of 1.0m minimum height difference between the base of a soakaway/infiltration pond and the groundwater; and/or

- Where attenuation drainage is utilised and extends to depths where groundwater may be present the attenuation storage structures should be lined to prevent groundwater ingress. Measures should be utilised to prevent floatation or structural design risks to tanks or impermeable liners.

3.4 Surface Water Flooding, Future Maintenance & Water Quality

3.4.1 Surface Water Flooding

Building Regulations Part H⁽¹¹⁾ and C753 The SuDS Manual⁽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 Ampthill Clay Formation (Mudstone) Bedrock 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 E**) details that the permeability is low to very low. Borehole records have identified the groundwater at a depth where it may 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 BRE Digest 365⁽¹⁴⁾. If it is confirmed that ground conditions are suitable for infiltration 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 south-western boundary 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 particularly any public open space (POS) 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 8** below. Drawing No. 19855/802 in the **Drawing Appendix** details areas where SuDS are proposed. 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 (Geocellular/Modular Attenuation Systems)	An attenuation system including attenuation tanks/pipes 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	Swales could be incorporated into the POS or on green verges along roads.	Potential for reducing runoff rates & volumes. Good removal of urban pollutants & pollution/blockages are visible and easily resolved.
Ponds	Ponds could be incorporated into the POS.	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	A detention basin could be incorporated into the POS.	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 & private access roads)	Permeable drives & private access roads 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.
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 8. An assessment of the suitability of the use and benefits of using SuDS.

The surface water runoff from the proposed roofs and adopted road will discharge into a pipe network in the road and be contained in an attenuation system beneath the POS in the south of the site. The attenuation system will comprise a lined attenuation pond and shallow 300mm deep detention basin with attenuation tank/pipes below providing storage. The detention basin will not be lined to allow for any limited infiltration. Through the use of a flow control structure the runoff will discharge into the ditch.

Private 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 200mm 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 event plus climate change. The attenuation system will ensure that there is no above ground surface water flooding during the 1 in 30 year event including climate change. Refer to Micro Drainage Design Simulations in **Appendix G** for the size and design of the proposed system and Drawing No. 19855/802 detailing the proposal.

Table 9 below details the existing and proposed runoff rates from the site following mitigation measures, further details can be found within **Appendix F** and **G**. **Table 9** shows that during the 1 in 1, 1 in 30 and 1 in 100 year event the flow rate into the ditch will be significantly less than the existing site. Separate long term storage is not provided, therefore the runoff rates have been restricted to less than the QBAR rate of 6.3l/s during the 1 in 1, 1 in 30, 1 in 100 and 1 in 100 year event plus climate change, in accordance with C753 The SuDS Manual⁽¹²⁾. **Table 9** shows that during each specified storm event the flow 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				
6.3	5.4	12.6	16.0	n/a
Proposed Maximum Flow Rates to the Ditch				
n/a	3.9	5.4	6.0	6.3

Table 9. Existing and proposed maximum runoff rates from the site following mitigation measures.

Discharge into the ditch will be controlled by a Hydro-Brake flow 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⁾.

To prevent groundwater ingress into the attenuation pond it will be clay lined and the tank/pipes should be structurally supported. The permeable drives and private access roads and detention basin will be shallow, therefore the groundwater is unlikely to influence these infiltration features.

In the event where the surface water system fails or during an exceedence event consideration has been given to route surface water away from vulnerable areas through the landscape of the site towards drainage features. Where possible the external landscape 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. 19855/802 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 infiltration 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. However advice should be obtained by a geotechnical engineer prior to installation.

The associated structures and any future proposed dwellings should be offset by a minimum of 9m from the IDB drains. Following approval of the planning application, an application should be made to South Holland IDB to obtain approval of the surface water discharge which outfalls into their network.

The Environment Agency's Surface Water Flooding Maps⁽⁷⁾ details during the highest chance of occurrence surface water flood event, the majority of the site is at very low risk of surface water flooding. A very limited localised area of surface water flooding is shown along a minor section of the north-western boundary and in the east of the site to a depth of less than 300mm and has a velocity of less than 0.25m/s.

During the medium chance of occurrence surface water flood event the majority of the site is at very low risk of surface water flooding. Limited localised surface water flooding is shown along a minor section of the north-western boundary, in the east of the site and in the west of the site. The depth of flooding is less than 300mm, except for in the east where flood water may extend up to 900mm. The surface water has a velocity of less than 0.25m/s.

During the lowest chance of occurrence surface water flood event, the majority of the site is at very low risk of surface water flooding. Surface water flooding is shown along a minor section of the north-western boundary, in the west and east of the site. The depth of flooding is less than 300mm, except for in the east where flood water may extend up to 900mm. The velocity

of the flood water is less than 0.25m/s, except for a minor area in the east where the velocity of the flood water may exceed 0.25m/s.

During all three scenarios dry access and egress is possible along Lutton Gowts highway. As commonly experienced, some minor flooding is noted along the line of the existing ditch to the south-west of the site, but is not shown to extend on-site.

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

Table 3.1 (refer to **Table 10** 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 11** 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 10. 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 11. R&D Technical Report FD2320/TR2⁽¹³⁾ Danger Classifications.

Access through less than 300mm of flood water at a velocity of less than 0.50m/s is deemed acceptable to all, in accordance with R&D Technical Report FD2320/TR2⁽¹³⁾. However where flood water exceeds this depth and velocity, site users should avoid walking through the flood water, as it is considered to be dangerous for some/most as detailed in **Table 10** above. However due to the limited area of flooding it is likely that site users would be able to avoid areas that experienced flooding.

As part of the mitigation measures to protect the buildings from tidal flooding the buildings will be raised 300mm above surrounding ground levels in addition to the incorporation of flood resilience measures on the ground floor, both of these measures will be beneficial in reducing the risk of flooding from the existing surface water flows.

3.4.2 Future Maintenance

The surface water drainage network within the roads will be designed and built to Anglian Water specifications and offered to Anglian Water for adoption under a Section 104 Agreement or an inset company under license from the regulators.

Where the surface water drainage is outside of the responsibility of Anglian Water a Management Company will be put into place and an annual maintenance charge will apply to the residents to ensure the maintenance and repair is carried out together with other aspects of the site such as private roads and any ditches etc.

Where the drainage features are within an owner's boundary it will be written into the deeds of the plot that the long term maintenance and repair of the drainage system will be the responsibility of the individual owner.

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

3.4.3 Water Quality

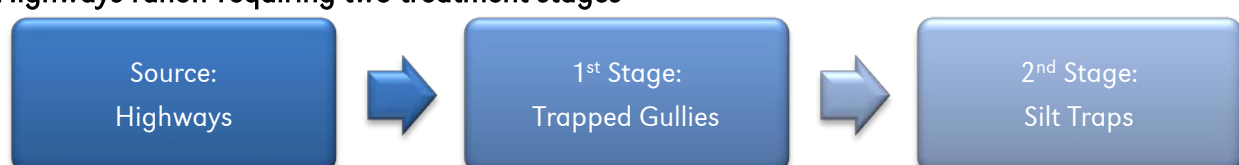
Pollution control measures should be incorporated into the design of the surface water drainage design, in accordance with C753 The SuDS Manual⁽¹²⁾, Groundwater Protection: Principles and Practice (GP3)⁽¹⁶⁾ and local guidance produced by the LLFA to minimise the risk of pollution entering into the ground 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 (roads and private drives) will require a minimum of two stages of treatment. Below is a summary of the treatment stages proposed on-site;

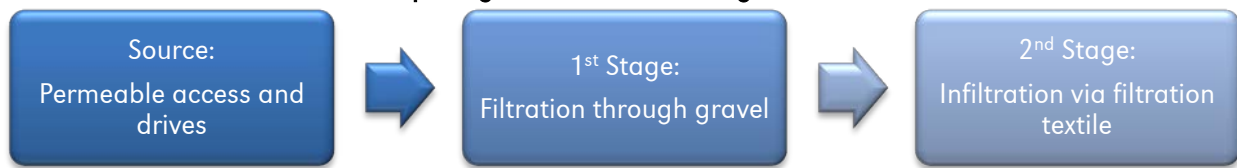
Runoff from roof requiring one treatment stage



Highways runoff requiring two treatment stages



Permeable access and drives requiring two treatment stages



Drawing No. 19855/802 in the **Drawings Appendix** details the proposed management train for the site.

3.5 Downstream Flooding

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.

The site is not located in the functional floodplain nor is it shown to flood during the 0.5% breach event. It is therefore considered that the proposal will not occupy any critical flood plain storage or cause any obstruction to the natural flow of water.

4.0 FLOOD MITIGATION MEASURES

To reduce the risk and impact of flooding the following on-site mitigation methods are recommended:

- To reduce the risk of tidal flooding the finished floor level of the dwellings should be a minimum of 300mm above the existing ground level, this will also be a beneficial way of reducing the risk of flooding from groundwater and existing surface water flows.
- The dwellings should incorporate flood resilience measures on the ground floor and all bedrooms should be located on the first floor. The incorporation of flood resilience measures will also be a beneficial way of reducing the risk of flooding from existing surface water flows.
- Following planning approval a Flood Warning and Evacuation Plan should be prepared detailing the safe evacuation of the dwellings in the unlikely occurrence of a breach event. The plan will enable occupants to evacuate prior to the occurrence of the flood event resulting from a breach in the defences.

- To reduce the risk and impact of flooding to the residents it is recommended that the residents register with the free Floodline Warnings Direct Service, the Environment Agency's free flood warning service on 0845 988 1188 or register online at the Environment Agency website. On receipt of a flood warning or alert the residents should follow the instructions received from the Environment Agency.
- The residents should complete the Environment Agency's Personal Flood Plan⁽²⁵⁾, a copy of this is included within **Appendix J**.
- To mitigate against the potential risk of groundwater flooding non-return valves should be installed within the foul and surface water drainage system and special consideration should be given to the foundations and building design to protect against water ingress.
- The surface water runoff from the site will be contained in a drainage system designed to cope up to and including the 1 in 100 year event plus climate change. The construction of the drainage features, will result in the risk of flooding from instantaneous runoff from the existing site onto the surrounding land being reduced.
- Access through less than 300mm of flood water at a velocity of less than 0.50m/s is deemed acceptable to all, in accordance with R&D Technical Report FD2320/TR2⁽¹³⁾. However where flood water exceeds this depth/velocity, site users should avoid walking through the flood water, as it is considered to be dangerous for some/most.
- 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 in **Appendix H**.
- The buildings should be constructed in accordance with the Building Regulations for protection against moisture effects.

5.0 SEQUENTIAL TEST

It is the Local Planning Authority's responsibility to apply the Sequential Test to steer proposed new development away from areas at risk of flooding. Whilst the Environment Agency, Basic Flood Map shows the site is located in Flood Zone 3, this is considered not a 'real world' situation as the site is protected by flood defences. The flood defences protect the site from the present day and the effects of climate change, as such the site is considered to be in Flood Zone 1. Table 1, 2 and 3 of NPPF, FR&CCG⁽²⁾ states that Flood Zone 1 is the preferred Flood Zone for all new development.

The Wash Shoreline Management Plan 2⁽²⁴⁾ and CFMPs⁽²¹⁾ both reports detail there will be continued commitment to maintain the defences in the short, medium and long term. It is therefore reasonable to assume there is a high likelihood that the existing defences will continue to be maintained to sustain the existing standard in SHDC.

6.0 SUMMARY

This report has evaluated the flood risk to the site in addition to considering the impact of the proposal on the surrounding area.

This report has identified that whilst the Environment Agency, Basic Flood Map shows the site is located in Flood Zone 3, this is considered not a 'real world' situation as the site is protected by flood defences. The flood defences protect the site from the present day and the effects of climate change, as such the site is considered to be in Flood Zone 1.

This report has shown that the site is at risk of flooding and without appropriate mitigation measures the site users could be at risk, however through the incorporation of the mitigation measure put in place as stated in Section 4.0 of this report, the site users will be at low risk.

The surface water runoff will discharge into a 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 surface water and groundwater 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.

7.0 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.

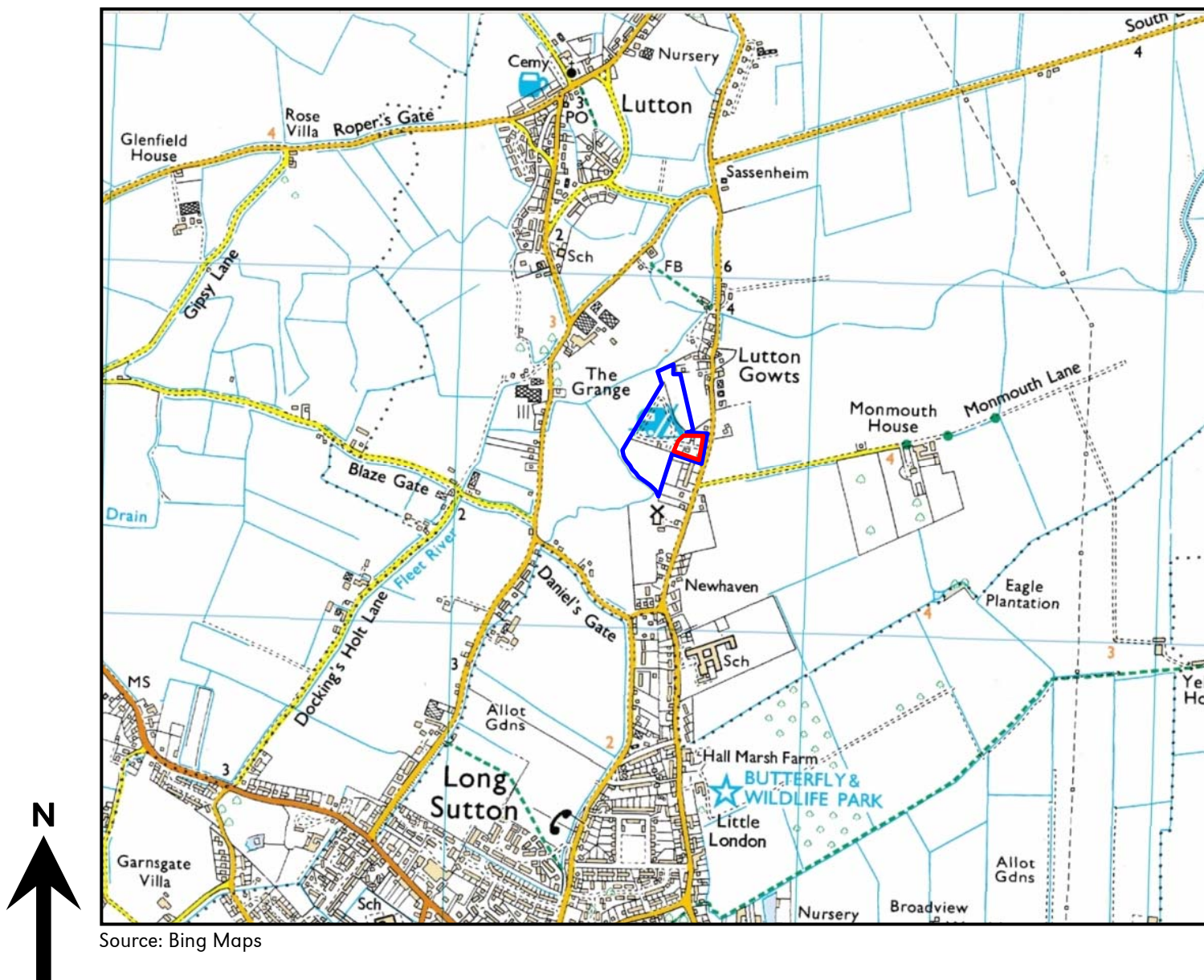
1. Communities and Local Government (2012) National Planning Policy Framework (NPPF).
2. Planning Practice Guidance Suite (2016) National Planning Policy Framework, Flood Risk & Coastal Change Guidance (NPPF, FR&CCG).
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4. Google website (2016) Google Maps.
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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. Environment Agency (2015) Letter from Environment Agency (refer to **Appendix A**)
20. Groundsure (2016) Groundsure Geosight (refer to **Appendix E**)
21. Royal Haskoning (2010) South Holland District Council, Update of Strategic Flood Risk Assessment.
22. South Holland Internal Drainage Board (2011) South Holland Internal Drainage Board Catchment K – Lutton Leam (refer to **Appendix C**)
23. South Holland Internal Drainage Board (2011) South Holland Internal Drainage Board Tidal Sluices First and Second Line of Defence (refer to **Appendix C**)
24. East Anglia Coastal Group (2010) The Wash Shoreline Management Plan 2
25. Environment Agency (2016) Personal Flood Plan

DRAWINGS APPENDIX

CONTENTS

Drawing No. 19855/800	- Site Location Plan
Drawing No. 19855/001	- Topographical Survey
Drawing No. 19855/802	- Proposed Site Plan Showing Schematic Drainage Layout
Drawing No. 19855/804	- British Geological Survey Superficial Geology Map
Drawing No. 19855/805	- British Geological Survey Bedrock Geology Map
Drawing No. 19855/810	- Environment Agency Surface Water Flooding Map
Drawing No. 19855/811	- Environment Agency Surface Water Depth Map – High Chance of Occurrence
Drawing No. 19855/812	- Environment Agency Surface Water Depth Map – Medium Chance of Occurrence
Drawing No. 19855/813	- Environment Agency Surface Water Depth Map – Low Chance of Occurrence
Drawing No. 19855/814	- Environment Agency Surface Water Velocity Map – High Chance of Occurrence
Drawing No. 19855/815	- Environment Agency Surface Water Velocity Map – Medium Chance of Occurrence
Drawing No. 19855/816	- Environment Agency Surface Water Velocity Map – Low Chance of Occurrence



Source: Bing Maps

Legend

- Site Boundary
- Ownership Boundary

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Pure Leisure Group

Project
Proposed Residential Development
Land West of Lutton Gowts
Long Sutton
Lincolnshire, PE12 9LQ

Drawing Title
Site Location Plan

Scale N.T.S	Date March 2016	Drawn By SVH
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Drawing No. 19855/800	Rev A
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Survey Notes

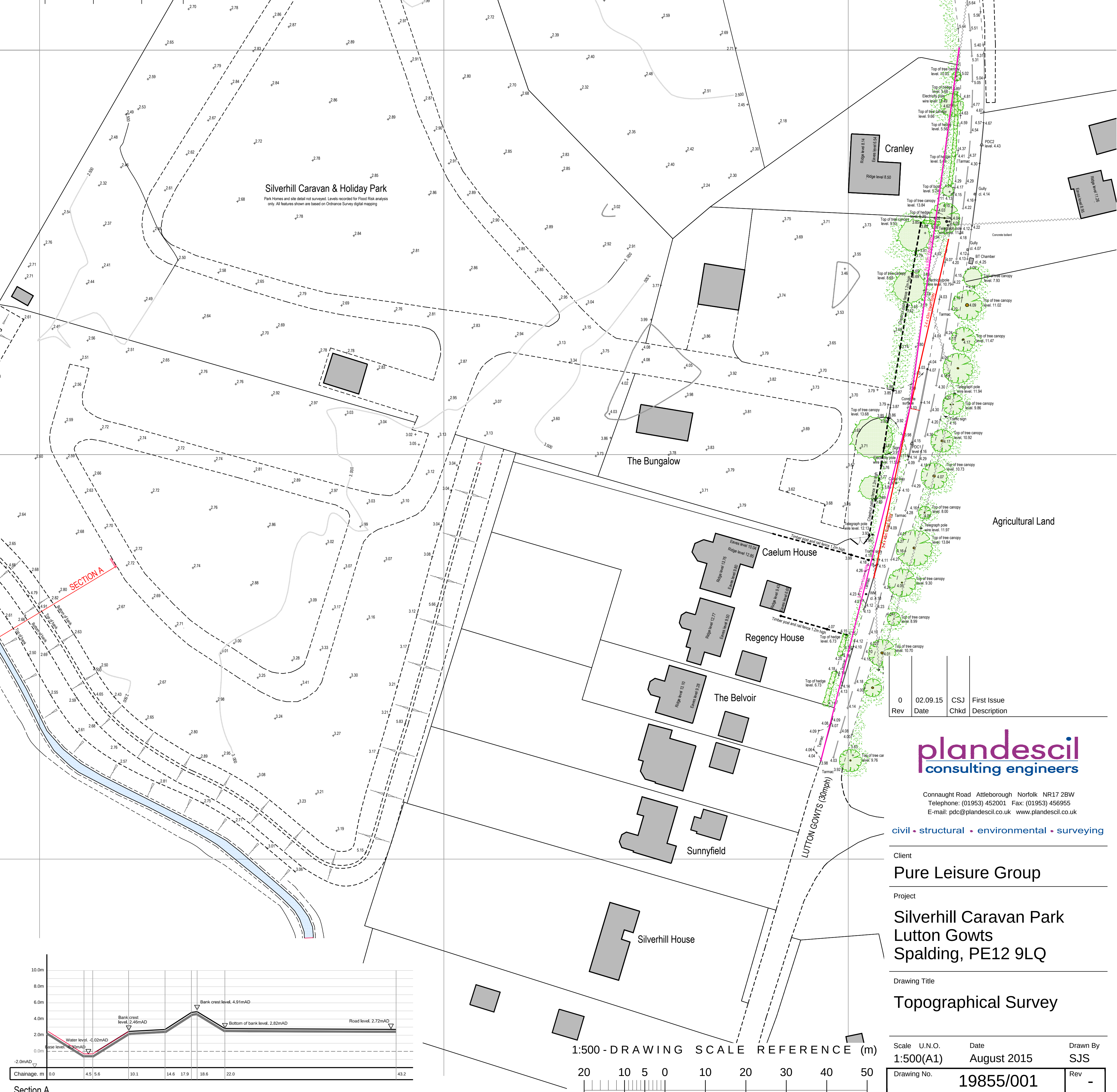
1. All levels and coordinates relate to a GPS derived datum. Control was established using Ordnance Survey's Active GPS Network OSGB32(36). Translated from ETRS89 using OSGM02 and OSTN02 models. Control station information may not be shown on this drawing, please contact Plandescil Ltd should you require 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	543715.736	324576.711	4.16	Survey Nail
PDC2	543733.014	324576.581	4.43	Survey Nail



0	02.09.15	CSJ	First Issue
Rev	Date	Chkd	Description

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Project

**Silverhill Caravan Park
Lutton Gowts
Spalding, PE12 9LQ**

Drawing Title

Topographical Survey

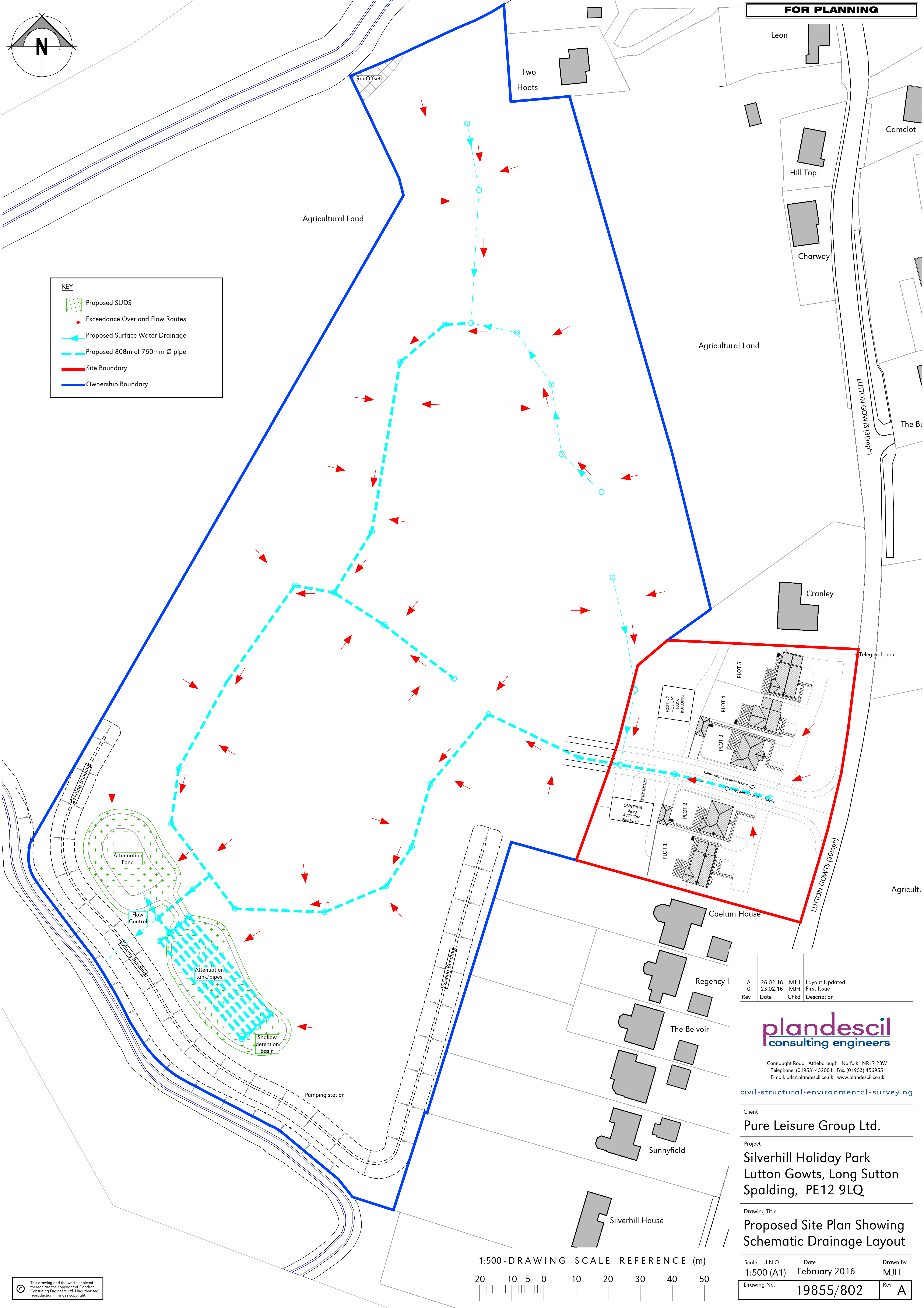
Scale U.N.O.
1:500(A1)

Date
August 2015

Drawn By
SJS

Drawing No.
19855/001

Rev
-



KEY

- Proposed SUDS
- Exceedance Overland Flow Routes
- Proposed Surface Water Drainage
- Proposed 808m of 750mm Ø pipe
- Site Boundary
- Ownership Boundary

FOR PLANNING

A	26.02.16	MJH	Layout Updated
0	23.02.16	MJH	First Issue
Rev	Date	Chkd	Description

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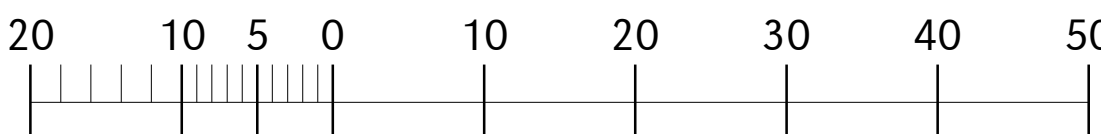
Client
Pure Leisure Group Ltd.

Project
**Silverhill Holiday Park
Lutton Gowts, Long Sutton
Spalding, PE12 9LQ**

Drawing Title
**Proposed Site Plan Showing
Schematic Drainage Layout**

Scale	U.N.O.	Date	Drawn By
1:500 (A1)		February 2016	MJH
Drawing No.	19855/802	Rev	A

1:500 - DRAWING SCALE REFERENCE (m)





Based upon Geology of Britain Viewer, with the permission of the British Geological Survey.

Legend

 Tidal Flat Deposits
(Clay & Silt)

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Drawing Title
British Geological Survey
Superficial Geology Map

Scale N.T.S	Date March 2016	Drawn By SVH
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Drawing No. 19855/804	Rev A
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Based upon Geology of Britain Viewer, with the permission of the British Geological Survey.

Legend

 Amphill Clay
Formation (Mudstone)

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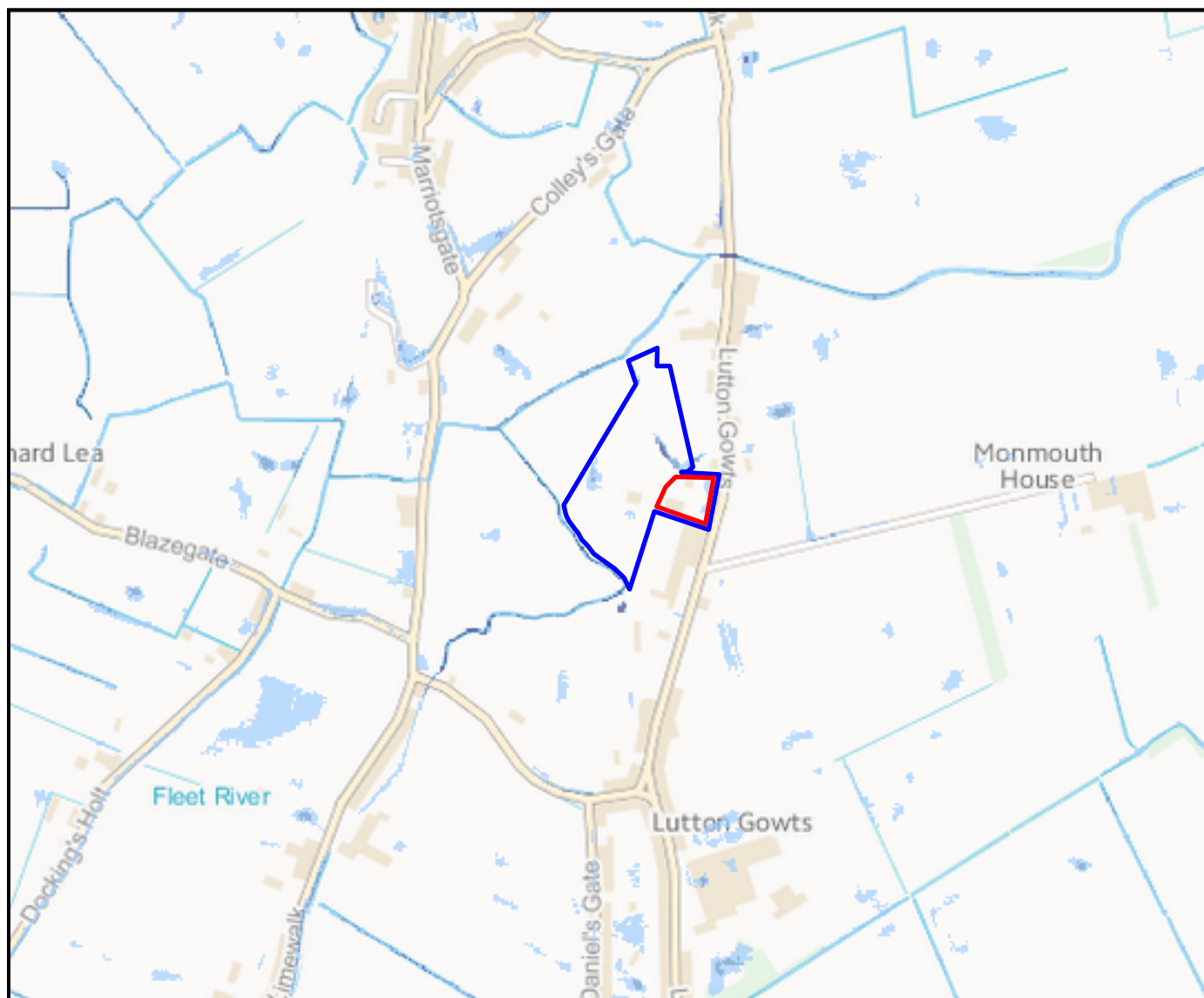
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Drawing Title
British Geological Survey
Bedrock Geology Map

Scale N.T.S	Date March 2016	Drawn By SVH
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Drawing No. 19855/805	Rev A
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Source: Environment Agency

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%))

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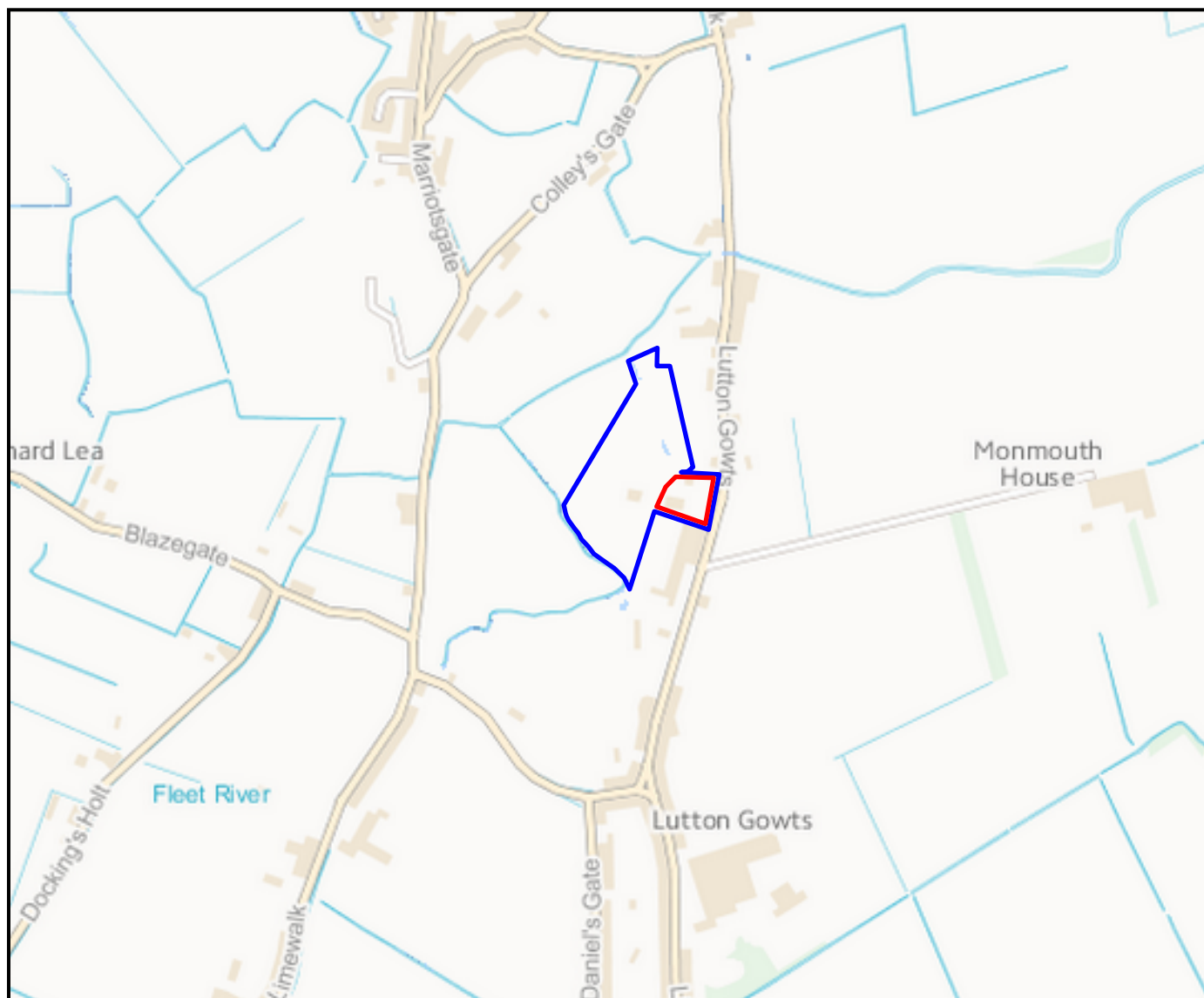
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Proposed Residential Development
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Lincolnshire, PE12 9LQ

Drawing Title
Environment Agency Surface
Water Flooding Map

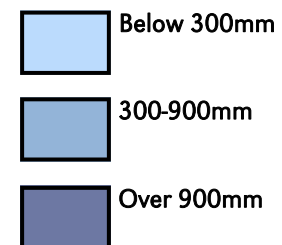
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Drawing No. 19855/810	Rev A
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Source: Environment Agency

Legend



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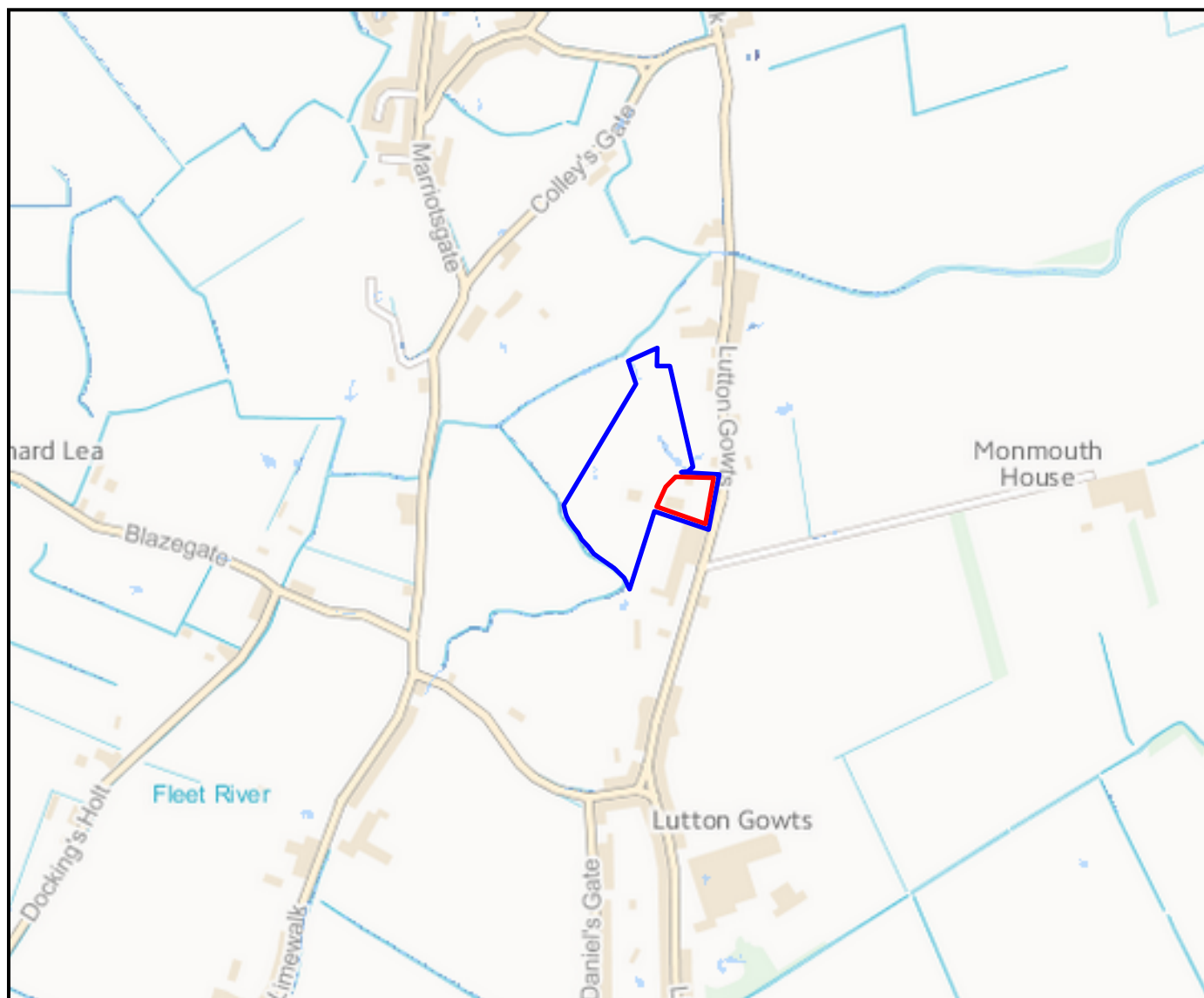
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Drawing Title
Environment Agency Surface
Water Depth Map - High
Chance of Occurrence

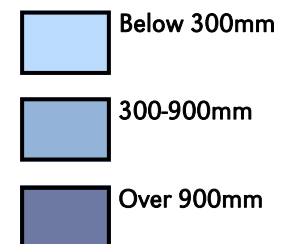
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Drawing No. 19855/811	Rev A
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Source: Environment Agency

Legend



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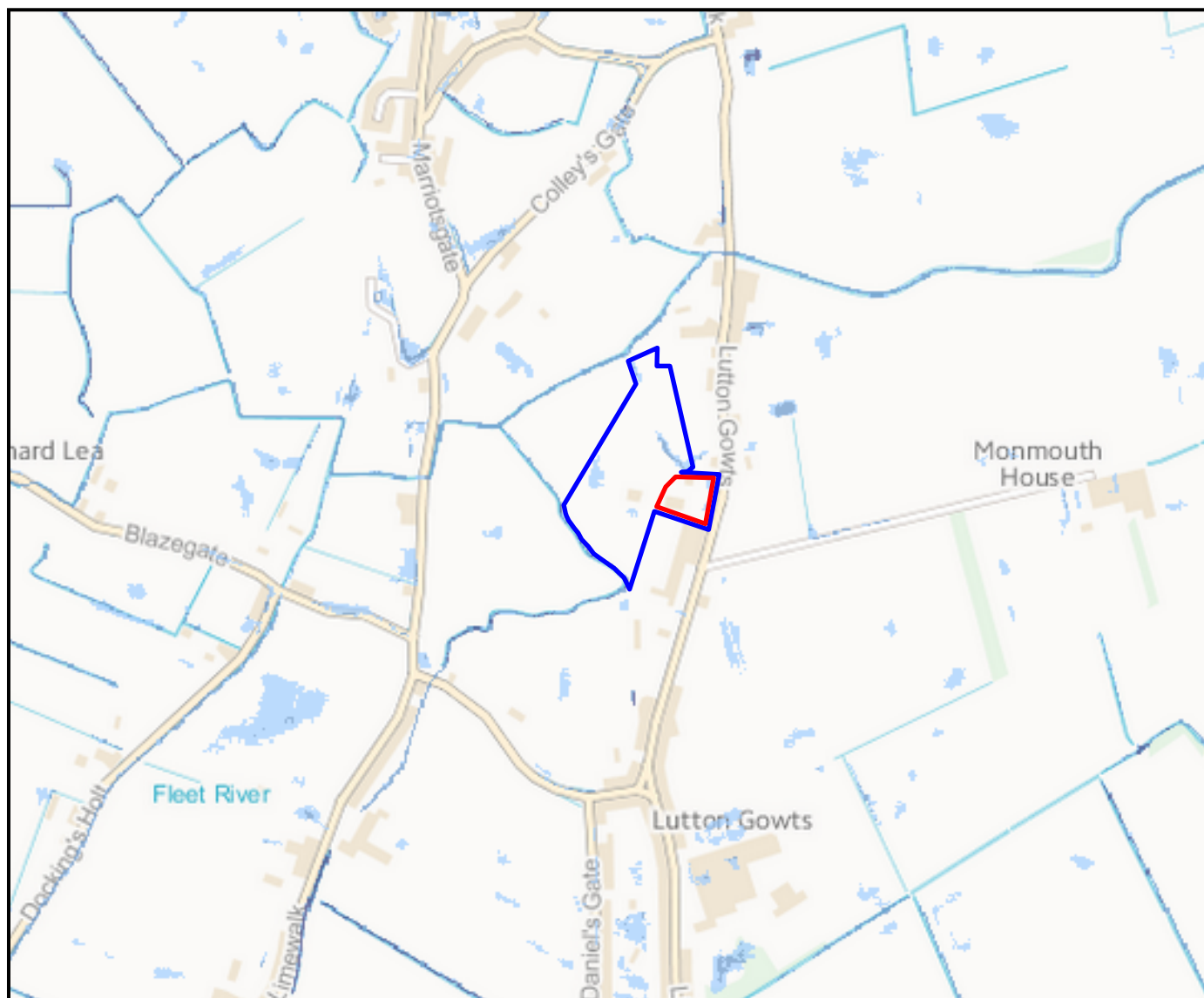
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Drawing Title
Environment Agency Surface
Water Depth Map - Medium
Chance of Occurrence

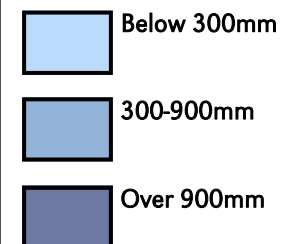
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Drawing No. 19855/812	Rev A
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Source: Environment Agency

Legend



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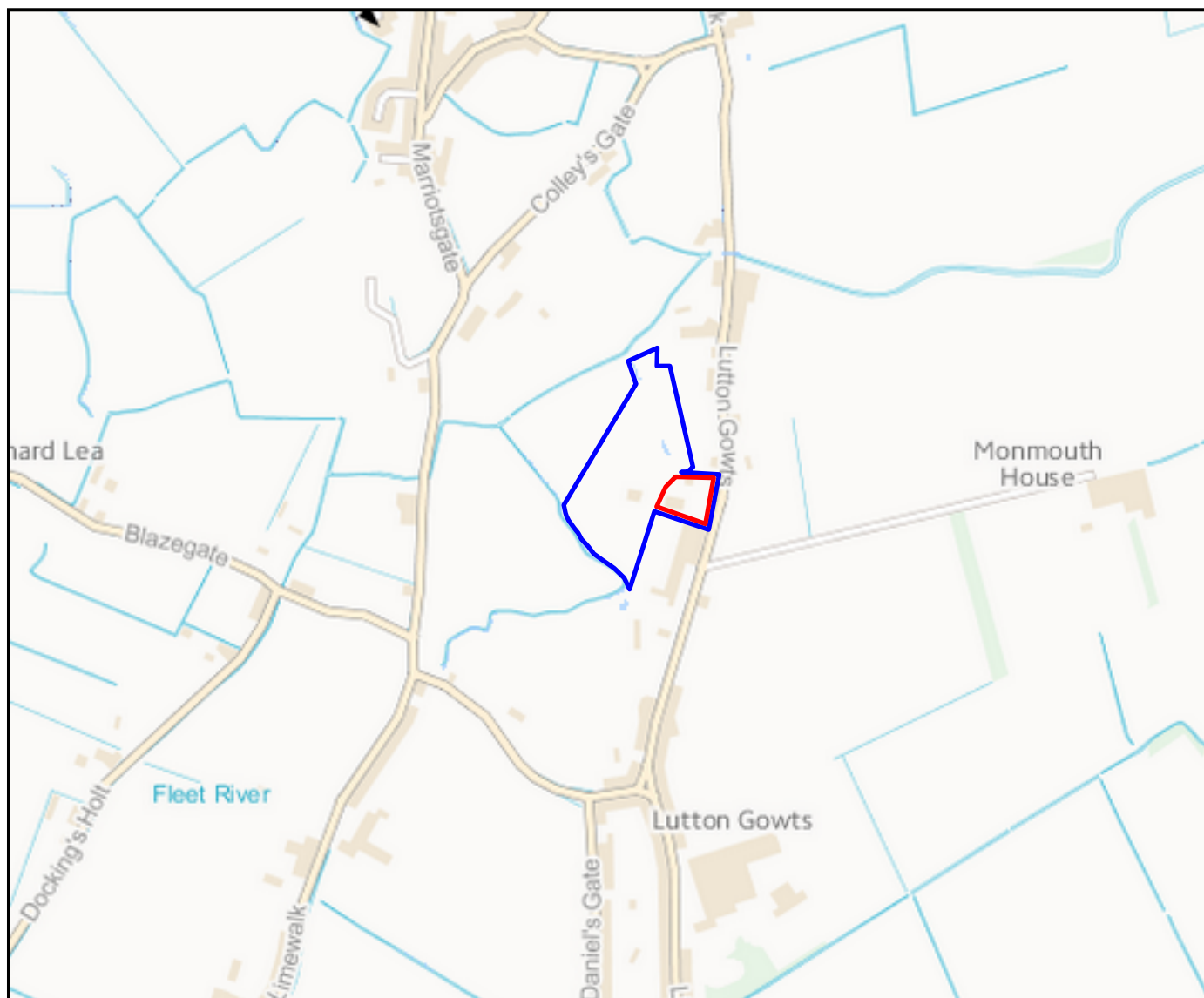
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Drawing Title
Environment Agency Surface
Water Depth Map - Low
Chance of Occurrence

Scale N.T.S	Date March 2016	Drawn By SVH
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Drawing No. 19855/813	Rev 0
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Source: Environment Agency

Legend

 Less than 0.25m/s

 Over 0.25m/s

 Direction of water

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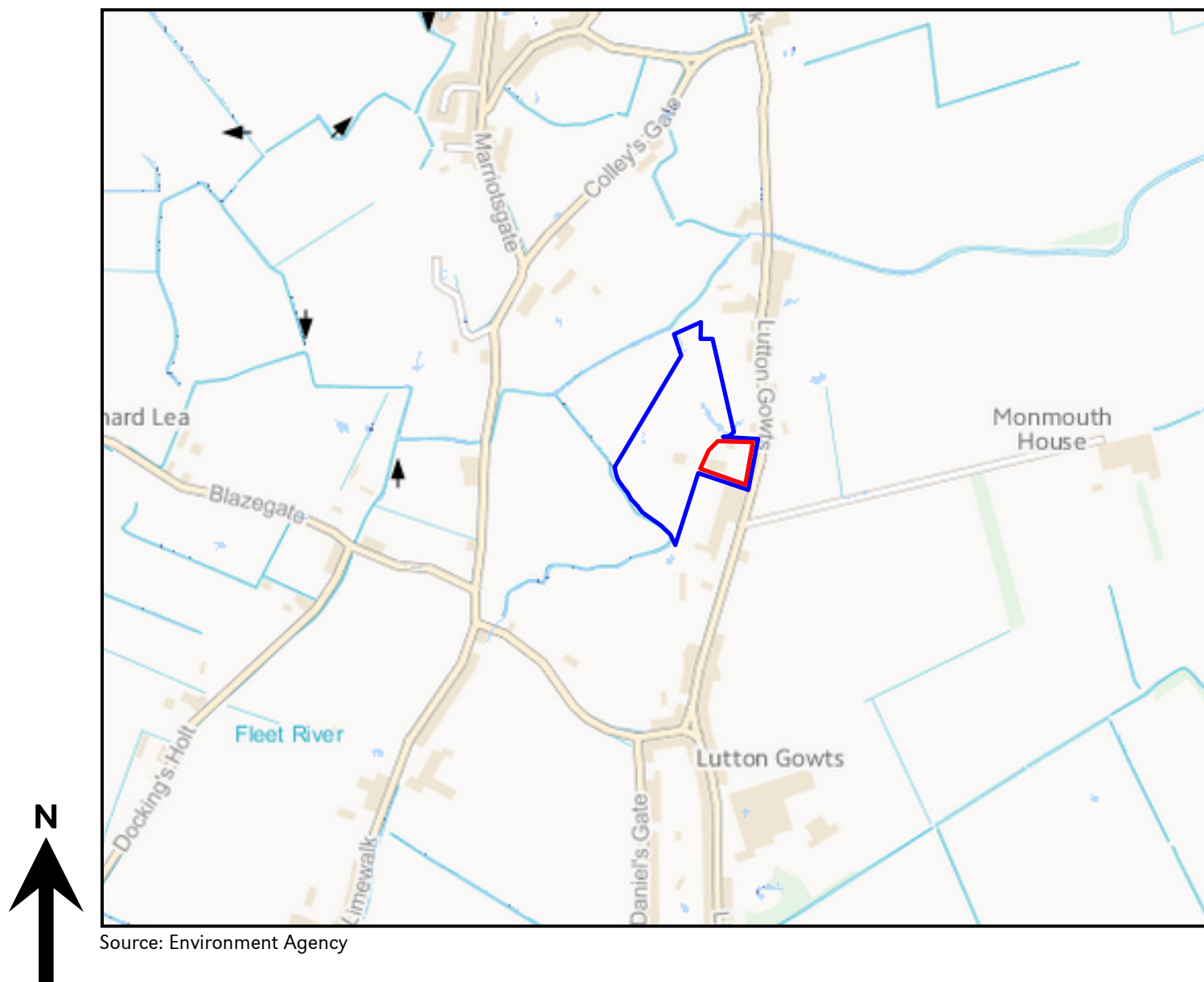
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Drawing Title
Environment Agency Surface
Water Velocity Map - High
Chance of Occurrence

Scale N.T.S	Date March 2016	Drawn By SVH
Drawing No. 19855/814		Rev A



Source: Environment Agency

Legend

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

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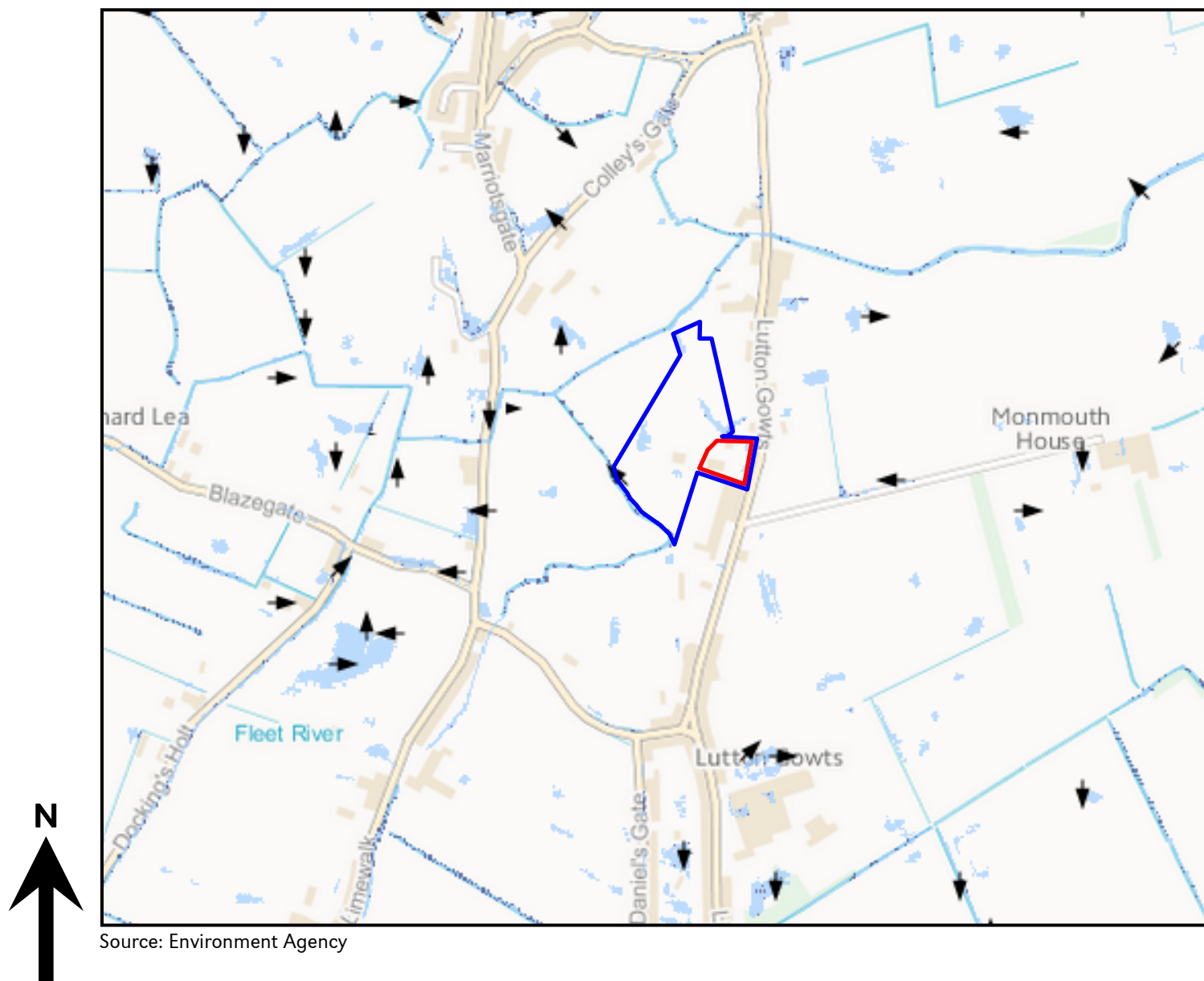
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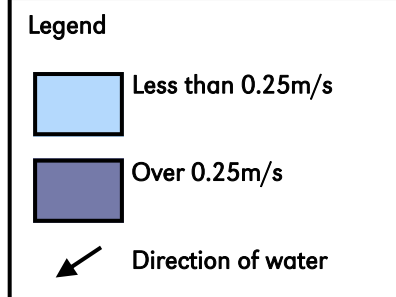
Drawing Title
Environment Agency Surface
Water Velocity Map - Medium
Chance of Occurrence

Scale N.T.S	Date March 2016	Drawn By SVH
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Drawing No. 19855/815	Rev A
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Source: Environment Agency



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

Scale N.T.S	Date March 2016	Drawn By SVH
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Drawing No. 19855/816	Rev A
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