

MA11266-FRA-01

Finsbury Design Ltd

Proposed Residential
Development - 6 Dwellings,
Millgate,
Whaplode

Flood Risk Assessment

March 2020



REVISION

Reference	Revision	Author	Date
MA11266-R01	Initial Issue	JMcK	March 2020

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Impermeable Areas Plan: MA11266-002
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Environment Agency Flood Zone Report
South Holland IDB Plan

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Surface Water Drainage design Calculations

1. INTRODUCTION

- 1.1 Millward have been appointed to undertake a Flood Risk Assessment (FRA) and Drainage Strategy (DS) for a proposed residential development consisting of 6 plots on land west of Millgate, Whaplode.
- 1.2 This FRA is undertaken in accordance with the NPPF and Planning Practice guidance document, (Flood Risk and Coastal Change), March 2014.
- 1.3 This FRA discusses and provides both a qualitative assessment and quantitative assessment for the residential development in terms of flood risk, future flood risk over the anticipated lifetime of the development and reference to the sequential and exception test using a precautionary and risk based approach.
- 1.4 The Drainage Strategy details both the provisional foul and surface water designs providing evidence to verify the design process and calculations to back up the drainage proposals.

2 EXISTING SITE SUMMARY

- 2.1 The site allocated for development is located on land west of Millgate in Whaplode, Lincolnshire, approximately 2 miles west from Holbeach and centred upon Grid Reference 532326E 322429N. A site location plan, drawing referenced MA11266/001, can be found contained within Appendix A.
- 2.2 The site is rectangular in shape covering approximately 0.81 Hectares (8100m²) in area. The site is bound by developed sites to the north, Millgate road and Whaplode River Drain to the east and agricultural land to the south and west.
- 2.3 Formally a plantation nursery, the site itself can be considered a partial brownfield site having been previously developed with numerous large greenhouse structures and associated concrete hardstanding. The site is now overgrown and although the majority of greenhouse structures have now been removed from the site, the concrete hardstanding still remains.
- 2.4 The existing impermeable area is detailed on drawing ref. MA11266/002 contained within Appendix A. The area of the existing concrete hardstanding is approximately 0.29Ha. This excludes any existing Greenhouse structures that may remain at the site which will be demolished and removed prior to development.
- 2.5 There is no evidence that the site is or has been formally drained. There is however an existing watercourse maintained by South Holland IDB (Whaplode River, Drain Ref: DRN197P6802), which runs parallel to the east of the site flowing south along Millgate.
- 2.6 3D LiDAR ground modelling data indicates the site to be completely flat in nature with levels reading 3.700mAOD throughout. There are no indications of low spots or variations in gradient across the site. The surrounding topography fluctuates with levels slightly higher outside the southern and western boundaries. A topographical survey will need to be undertaken to confirm levels and to check for anomalies in this data. The data shows bottom of bank levels within the existing IDB watercourse range between 2.750mAOD to 2.675mAOD. This will also need to be confirmed.

3 CONSULTATIONS

3.1 Environment Agency (EA)

- 3.1.1 The EA national flood risk maps available on their web site have been interrogated firstly to define in terms of planning what flood zone the site is contained within.
- 3.1.2 The development site is located within Flood Zone 1 which in accordance with Table 1 of the NPPF And Planning Practice guidance document, is defined as Low Probability having less than a 1 in 1000 or greater annual probability of flooding from rivers or the sea.
- 3.1.3 Therefore further consultation with the EA has not taken place due to the fact that the site is within the lowest risk area in terms of flood risk for planning.

3.2 Anglian Water (AW)

- 3.2.1 An application for a pre-development enquiry from AW has been deferred as there are no public water mains, public sewers or other assets owned by Anglian Water within the boundary or vicinity of the site.
- 3.2.2 Records show the nearest AW asset to be located approximately 1.3km to the North of the site. Due to this conveyance distance, the consideration of on-site sewerage treatment options must form the basis of the drainage strategy for the discharge of foul water from the proposed development.

4 SEQUENTIAL AND EXCEPTION TESTS

4.1 Sequential Test

- 4.1.1 The site has been assessed in line with the NPPF technical guidance. The site is confirmed to be wholly within Flood Zone 1 (Low probability) as defined in Table 1 (Flood zones) of the Planning Practice guidance document for the NPPF.
- 4.1.2 The closest area of flood zone 3 land is located approximately 100m to the north of the site at its closest point.
- 4.1.3 Table 2, (Flood risk vulnerability classification) of the same document confirms that residential development (buildings used for dwelling houses) is classified as 'More Vulnerable' development.
- 4.1.4 Table 3, (Flood risk vulnerability and flood zone 'compatibility') confirms that a development classified as 'More vulnerable' in Flood Zone 1 is classified as an appropriate development.
- 4.1.5 In terms of Sequential Test the site sits wholly within flood zone 1 which is the lowest flood risk zone.
- 4.1.6 On this basis the Sequential Test is deemed to have been passed. As the Sequential Test is passed the Exception Test does not apply.

5 PROPOSED DEVELOPMENT AND DRAINAGE STRATEGY

- 5.1 The proposed development consists of 6 dwellings in total with associated driveways, off road garages and garden areas to the rear of the proposed dwellings. Vehicular access to the development will be via Millgate to the eastern boundary as per the proposed Planning Layout contained within Appendix A.
- 5.2 The Geological Survey Map of Great Britain shows that the site and surrounding areas are underlain with Tidal Flat Deposits of Clay and Silt. The presence of clays suggest that the soils are cohesive in nature. This would mean that it is unlikely that soakaways or any other infiltration systems will be suitable on this development. However, no intrusive investigations of the ground conditions have yet been undertaken. It is therefore recommended that initial infiltration tests (to BRE 365) / ground investigations are undertaken to confirm this assumption.
- 5.3 An impermeable area plan for the proposed development (drawing ref. MA11266/002) can be found in Appendix A. The impermeable areas of the proposed development totals approximately 0.25ha. This is therefore a slight decrease in impermeable area compared to the existing site scenario (existing impermeable area is approximately 0.29Ha as discussed in Chapter 2).
- 5.4 The preliminary drainage strategy for surface water is shown on drawing MA11266/200, contained within Appendix A and is based upon the Planning Layout for the site.
- 5.5 It is proposed to outfall the surface water runoff from this site into the existing South Holland IDB Watercourse (Whaplode River Drain) to the eastern side of Millgate via a gravity system to an outfall level of 2.750mAOD (this outfall level will need to be confirmed during a full topographical survey of the site). This outfall level is quite shallow when compared to the average level of 3.700mAOD across the proposed site (circa 950mm deep). It is therefore proposed to raise levels across the development to assist in the discharge of surface water from the site via gravity.

- 5.6 The surface water runoff from this site is proposed to be restricted to 3.6l/s or other discharge rate agreed with the IDB. This is the lowest viable discharge rate for a vortex flow control to meet adoptable standards. A formal discharge application with South Holland IDB will need to be undertaken as part of a detailed design process.
- 5.7 Surface water from the main access road would run off via a free drain edge onto a filter strip before outfall into an underdrained swale and a network of oversized pipes which convey surface water to an offline cellular attenuation located towards the south east corner of the site. A typical cross section through the main access road is detailed in drawing number MA11266/201 contained within Appendix A. Ultimate outfall is achieved via a flow control manhole into the existing South Holland IDB Watercourse (Wapelope River Drain). The site access road will need to partially drain east directly towards the existing IDB ditch due to site level constraints and the raising of levels across the site, as discussed in section 5.5.
- 5.8 The preliminary drainage strategy assumes that private driveways and shared drives will utilise permeable paving as part of the SuDs strategy. The private driveway and roof areas are conveyed via permeable paving (designed as a sealed system providing a form of SUDS treatment) into the underdrained swales towards outfall.
- 5.9 Flows from the development are ultimately controlled via a vortex flow control to 3.6l/s maximum (or other discharge rate agreed with the IDB) for the 1 in 100 year (+40% climate change) event.
- 5.10 The required attenuation storage volume is achieved via a combination of roadside underdrained swales with oversized pipes laid at the minimum gradient of 1:500, permeable paved areas and cellular attenuation.
- 5.11 The attenuation has been sized to take the surface water flows from the development layout and store water within the site boundary for up to and including the 1 in 100 year plus 40% climate change allowance scenario in accordance with the latest guidelines on Climate Change allowances.

- 5.12 A copy of the proposed drainage strategy calculations are contained in Appendix C.
- 5.13 The preliminary drainage strategy for foul water is also shown on drawing MA11266/200, contained within Appendix A.
- 5.14 As discussed in Chapter 3.2, an on-site foul treatment will form the basis of the drainage strategy for the discharge of foul water from the proposed development.
- 5.15 SVPs and FW drainage points from each dwelling will connect into a private foul drainage system which will convey foul flows to an on site waste water treatment plant which treats the foul water before outfall into the existing IDB watercourse.
- 5.16 Outfall to the existing IDB ditch will be subject to an environment agency permit and approvals with South Holland IDB. The final specification of the treatment plants and any consents required will be confirmed as part of the detailed design process.

6 FLOOD RISK

6.1 Flooding From Fluvial and Tidal Sources

6.1.1 The residential development area is shown within Flood Zone 1 as having less than a 1 in 1000 annual probability of flooding from rivers or the sea (<0.1%). (Flood risk and Coastal Change), March 2014.

6.1.2 As the risk of flooding is low (Flood Zone 1) the residual risk of flooding from this source is **LOW**.

6.2 Flooding From Land / Adjacent Development

6.2.1 3D LiDAR ground modelling data indicates that the surrounding land to the North, South and West fluctuates in levels and topography and shows it is relatively flat in nature. Therefore any overland flow from adjacent sites, if at all, is likely to be slow and shallow.

6.2.2 The site levels are to be raised as part of the proposals which further reduces risk from this source. There are no proposed low points within the site which would create a localised depression in the ground which would be at risk of ponding / pooling water.

6.2.3 The online Environment Agency flooding maps confirm that there is a small area within the proposed site to the western boundary at **LOW** risk for surface water flooding. The rest of the site is not deemed at risk.

6.2.4 The risk of flooding from land and adjacent development is therefore considered **LOW**.

6.3 Flooding From Infrastructure Failure

6.3.1 The online Environment Agency flooding maps confirm that the site is outside the limits of any deemed flood extents from a reservoir failure and therefore the risk of flooding to the site from this source is considered **LOW**.

6.3.2 As it is proposed to raise site levels above surrounding land due to surface water drainage constraints, any source of flooding from the existing IDB watercourse that runs parallel to Millgate off the Eastern boundary, is to be considered **LOW**. Any flooding that does occur from these sources is expected to flow East across greenfield land where the natural decline in topography occurs (according to 3D LiDAR ground modelling data).

6.3.3 There are no public sewers running within or on the site boundaries, therefore the risk of flooding from sewer blocking is to be considered **LOW**.

6.4 Flooding From Groundwater

6.4.1 The Geological Survey Map of Great Britain currently has no historical borehole records within the vicinity of the site. A full ground investigation at the site will need to be undertaken in order to confirm the presence of groundwater and water table levels.

6.4.2 There are no confirmed records of groundwater flooding in the vicinity of the site in the South East Lincolnshire Strategic Flood Risk Assessment Report. Therefore, the overall the risk of flooding from this source is considered to be **LOW**.

6.4.3 As it is proposed to raise site levels, and as there should not be any dwellings localised in low points within the site, no further assessment is considered required to assess flooding from this source.

6.5 Flooding From Sewers

6.5.1 There are no public sewers running within the site boundaries and the nearest AW asset is located approximately 1.3km to the North of the site.

6.5.2 Therefore the risk of flooding from sewers failure is to be considered **LOW**.

6.5.3 Any flow velocities and depths from adjacent lands towards the site are expected to be relatively slow and shallow. Being that the site is proposed to be raised higher than the roadway binding it on the eastern boundary, the risk of flooding from all the surrounding areas is to be considered **LOW**.

6.5.4 In order to reduce any remaining risk of flooding to the proposed properties from any other source of flooding, mitigation measures have been considered and described in detail in Section 7.2.

6.6 Flooding from Climate Change

6.6.1 The proposed site drainage will be designed not to flood at the 1 in 100 year event with an allowance of 40% for climate change in line with the NPPF and Planning Practice guidance document. The surface water drainage will be designed to be restricted to a proposed rate of 3.6l/s (or other discharge rate as agreed with the IDB), and the proposed attenuation features will be designed to attenuate flow from the impermeable areas with a 6% allowance for urban creep on the proposed private areas.

6.6.2 Overall the risk of flooding from the effects of climate change is considered to be **LOW**.

7 MITIGATION MEASURES

7.1 Essential Mitigation Measures

7.1.1 The assessment of flood risk in Section 7 of this assessment confirms a **LOW** risk for all sources of flooding.

7.1.2 Therefore there is only one essential mitigation measure to be applied as part of the development. Surface water drainage for the site must be designed to accommodate the 1 in 100 year event storm scenarios including a 40% allowance for climate change without any flood waters leaving the development site to ensure no properties would flood within the site and no flood waters leave the site boundary.

7.2 Recommended Mitigation Measures

7.2.1 All dwellings should have concrete ground floors with damp proof membranes as they are regarded as the most flood resilient floor types with effective connections between the dpc and dpm and shall be constructed to a height of 150mm above the external levels. The dpm should be between the surface screed and the concrete slab as this enables the concrete floor to dry out quickly and would also protect against any rising groundwater should flood risk from this source increase over the lifetime of the development.

7.2.2 Site levels are raised above surrounding land due to surface water drainage constraints. This raising of land levels will reduce the risk of groundwater flooding of the proposed development significantly.

7.2.3 Permeable paving to private driveways and parking areas should be utilised even if infiltration SUDS are not viable as permeable paving can be designed into a sealed system before outfall into a sewer or underdrained swale. This would form part of a SUDS treatment train in line with CIRIA C753, subject to LLFA approvals.

7.2.4 It is recommended that the Finished Floor Levels to properties should be above any adjacent road levels where possible.

- 7.2.5 Where external gradients are flat or towards the dwelling entrances, provision of linear drainage should be provided to all access points.
- 7.2.6 One way valves are to be fitted to both foul and surface water pipes which connect from the dwellings to prevent backing up into the houses should any of the onsite drainage systems become surcharged.

8 CONCLUSIONS

- 8.1 This Flood Risk Assessment serves to review, assess and quantify (where applicable) the sources, or any potential flooding, the pathways of this flooding and potential receptors within the vicinity of the site.
- 8.2 The assessment of flood risk in Section 7 of this assessment confirms a **LOW** risk for of flooding from all sources.
- 8.3 The mitigation measures will provide further protection to the development and reduce any residual risk as far as practicable. It is recommended that compliance with the recommendations of this FRA is conditioned as part of any planning permission.
- 8.4 This assessment concludes that the site is suitable for development for residential use without unacceptable risk of flooding from all sources to the site itself and elsewhere for the lifetime of the development.

Appendix A – Drawings

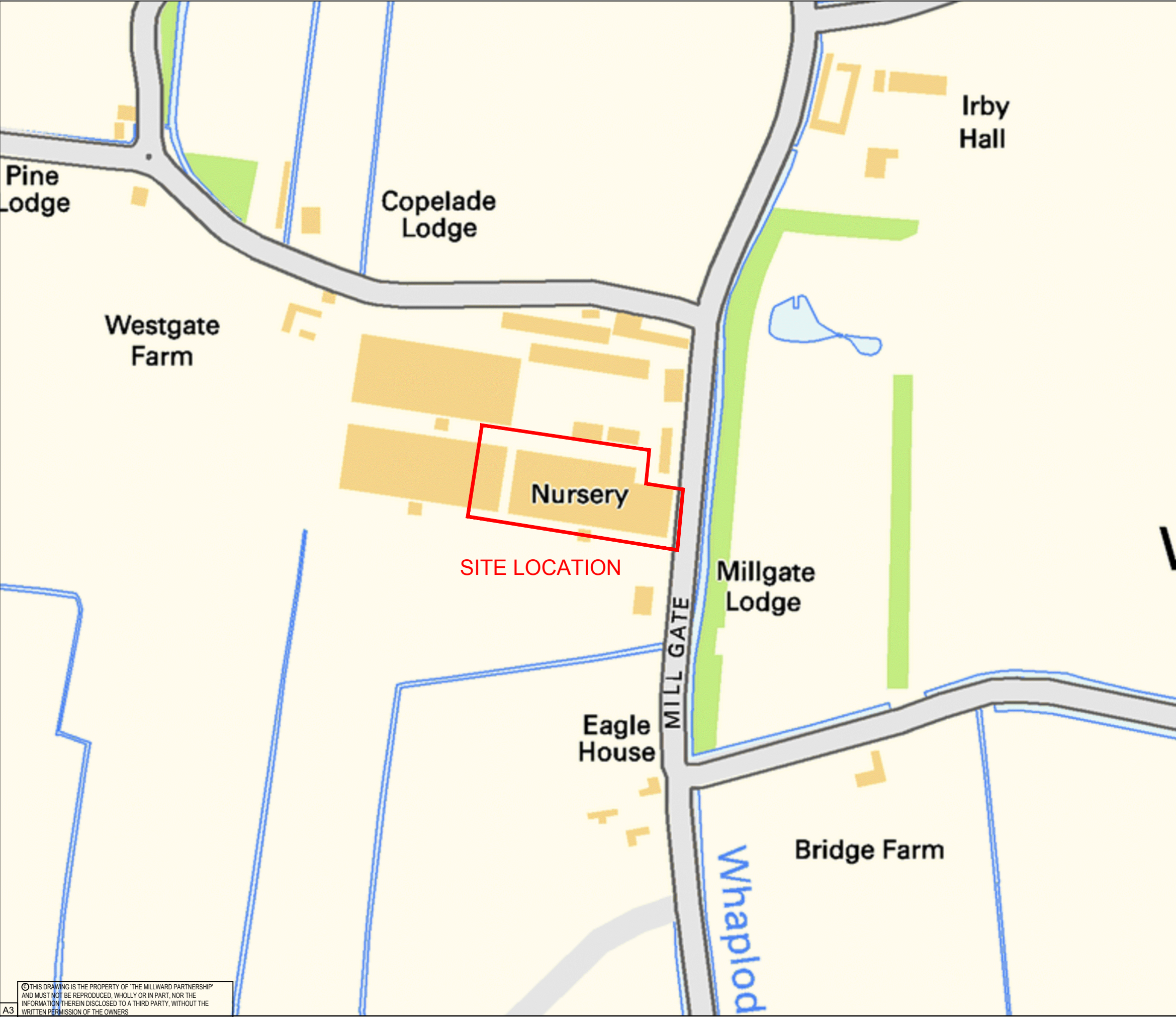
Site Location Plan: MA11266-001

Proposed Planning Layout: 1283/004

Impermeable Areas Plan: MA11266-002

Proposed Drainage Strategy: MA11266-200

Proposed Drainage Details: MA11266-201



ASSOCIATED DRAWINGS				
No.	TITLE			

NOTES				
				

REV	DATE	BY	DETAILS	CHK'D

AMENDMENTS	
CLIENT	Finsbury Design Ltd

PROJECT	
Proposed Residential Development, Millgate, Spalding, Lincs	

TITLE	
Site Location Plan	

DRAWING No:	DRAWING STATUS
MA11266 / 001	PRELIMINARY

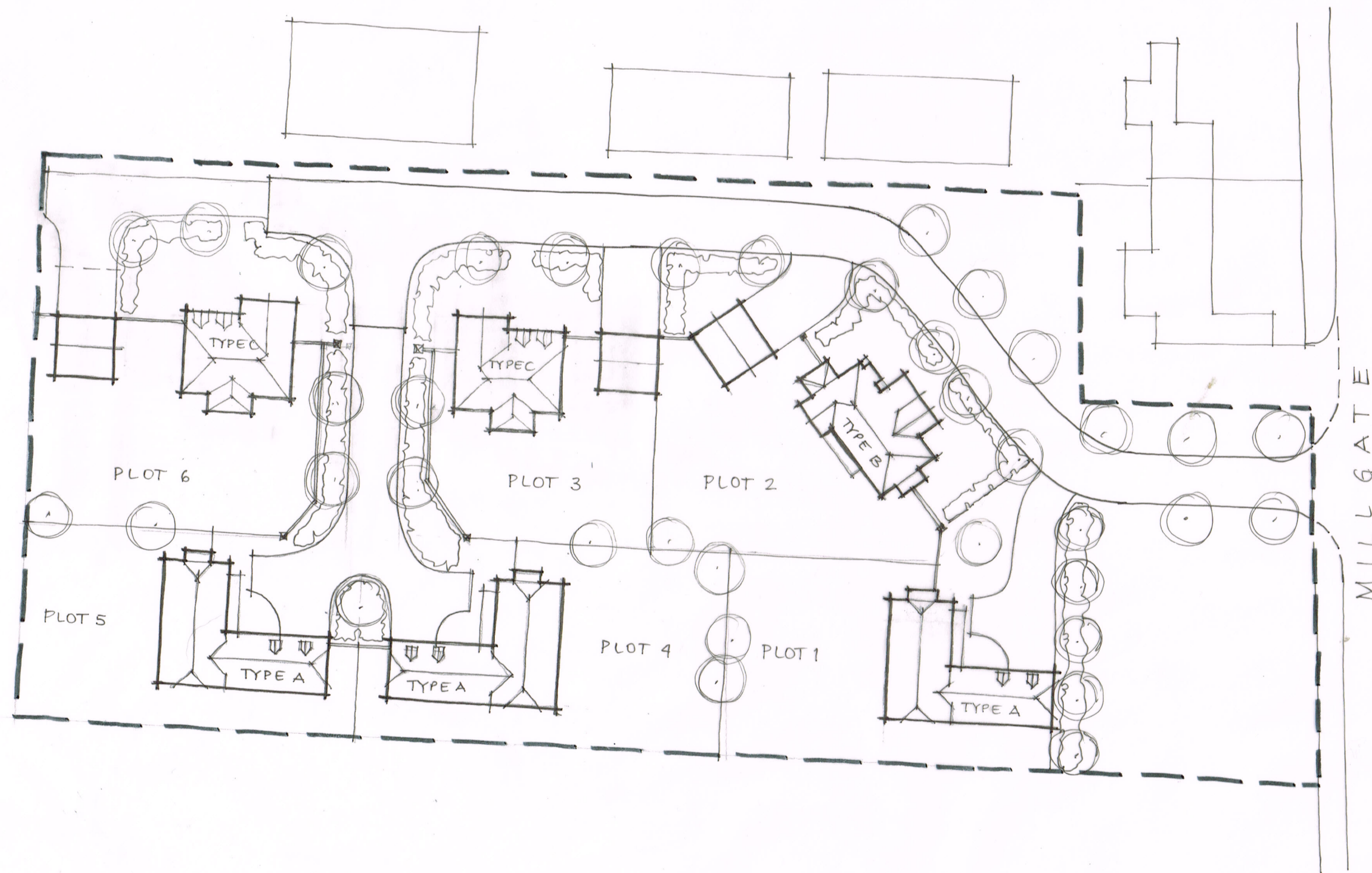
SCALE	DRAWN	ENGINEER
1:2500 @ A3	BC	

DATE	CHECKED	APPROVED BY
March 2020	JMcK	JMcK



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SCHEDULE

TYPE A	3no
TYPE B	2
TYPE C	1
TOTAL	6 units

NKW DESIGN

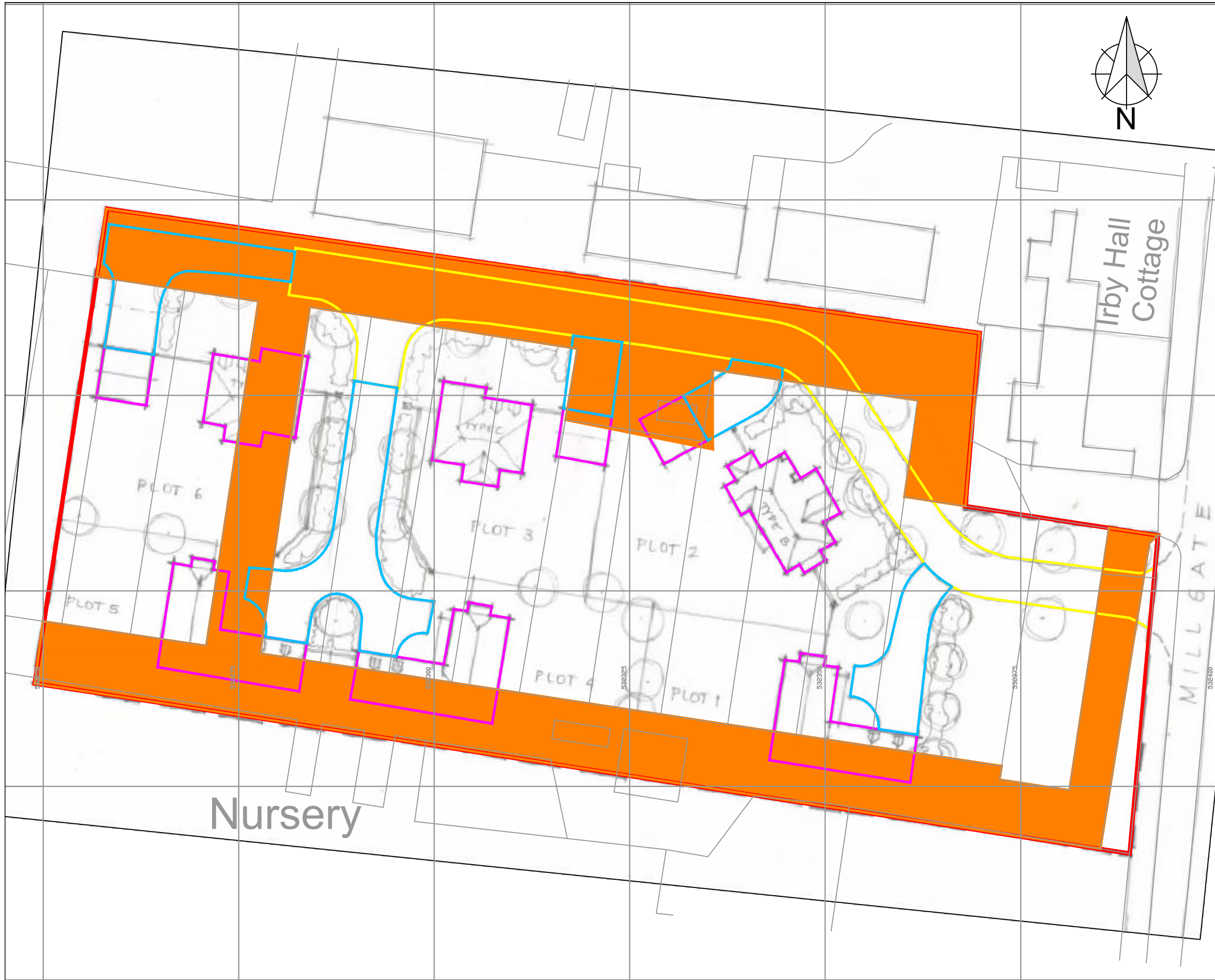
45 York Road
Wollaston
Northamptonshire
NN29 7SG
T: 01933 666130
M: 07957 837164
E: natalie@nkwdesign.co.uk

PROJECT MILLGATE, WHAPLODE
SPALDING

TITLE
PLANNING LAYOUT

SCALE 1:500 @ A3	DATE MAR 2020	DRAWN NKW
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DRAWING NUMBER 1283-004	REVISION
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ASSOCIATED DRAWINGS	
No.	TITLE

NOTES	

IMPERMEABLE AREAS:	
Proposed Dwellings	1005.6m ²
Proposed (Road)	788.4m ²
Proposed (Driveways)	729m ²
TOTAL PROPOSED =	2523m ²
Existing Impermeable Area	2910.1m ²

REV	DATE	BY	DETAILS	CHK'D
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AMENDMENTS				

CLIENT
Finsbury Design Ltd

PROJECT
Proposed Residential Development, Millgate, Spalding, Lincs

TITLE
Impermeable Area Plan

DRAWING No:	DRAWING STATUS
MA11266 / 002	PRELIMINARY

SCALE	DRAWN	ENGINEER
1:500 @ A3	BC	
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The stone layer beneath the permeable paving is to convey flows (min 1:500 gradient) into a network of oversized pipes / underdrained swales. The underdrained swales convey flows towards an attenuation pond.

The surface water flows into the attenuation pond which provides a second stage treatment from dwellings and private driveways, and a third stage treatment for the highway run off. The pond acts as the primary treatment for roof run off and a tertiary treatment for the road run off.

The proposed system is designed to accommodate the 1 in 100 year event plus climate change allowance of 40% and a further 6% allowance for urban creep (additional paved areas through permitted development within the private garden areas of properties).

Key

-  Site Boundary
 Surface Water Sewer (Adopted)
 UD Swale
 Surface Water Sewer (Adopted) within Under Drained Swale
 Foul Sewer (Private)
 Permeable Private Driveway
 Surface Water Sewer (Private)

REV	DATE	BY	DETAILS	CHK'D
A1	AMENDMENTS			

NOTES

Drainage Startegy

DATE	CHECKED	APPROVED BY
March 2020	JMcK	JMcK

PROJECT

Proposed Residential Development, Millgate, Spalding, Lincs

SCALE	DRAWN	ENGINEER
1:250 @ A1	BC	JMcK

CLIENT

Finsbury Design Ltd

DRAWING No: MA11266 / 200	DRAWING STATUS PRELIMINARY
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Different through Design

Appendix B – Consultations

Environment Agency Flood Zone Report South Holland IDB Plan

Flood map for planning

Your reference
MA11266

Location (easting/northing)
532304/322443

Created
23 Mar 2020 14:41

Your selected location is in flood zone 1, an area with a low probability of flooding.

This means:

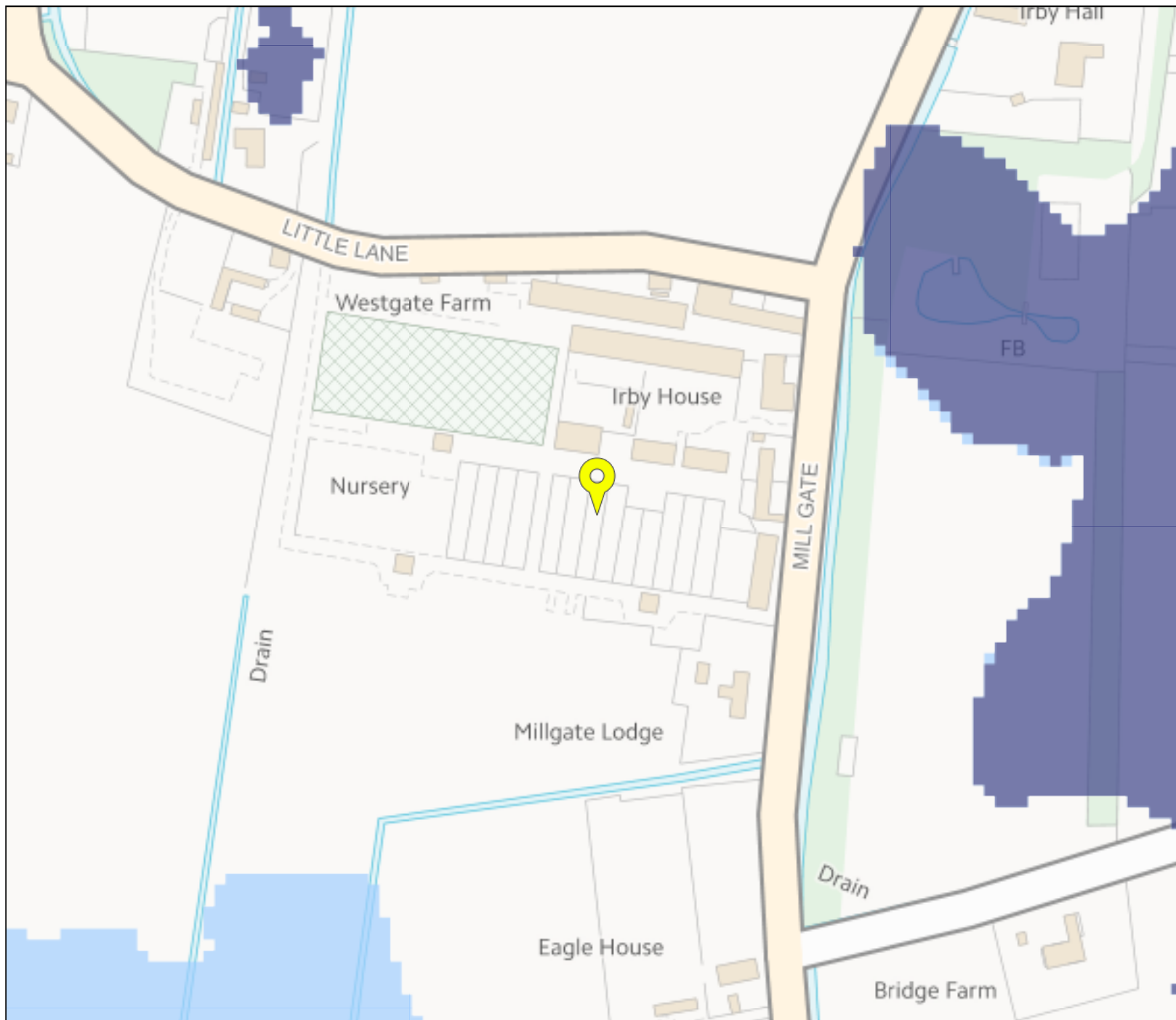
- you don't need to do a flood risk assessment if your development is smaller than 1 hectare and not affected by other sources of flooding
- you may need to do a flood risk assessment if your development is larger than 1 hectare or affected by other sources of flooding or in an area with critical drainage problems

Notes

The flood map for planning shows river and sea flooding data only. It doesn't include other sources of flooding. It is for use in development planning and flood risk assessments.

This information relates to the selected location and is not specific to any property within it. The map is updated regularly and is correct at the time of printing.

The Open Government Licence sets out the terms and conditions for using government data.
<https://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/>



Flood map for planning

Your reference

MA11266

Location (easting/northing)

532304/322443

Scale

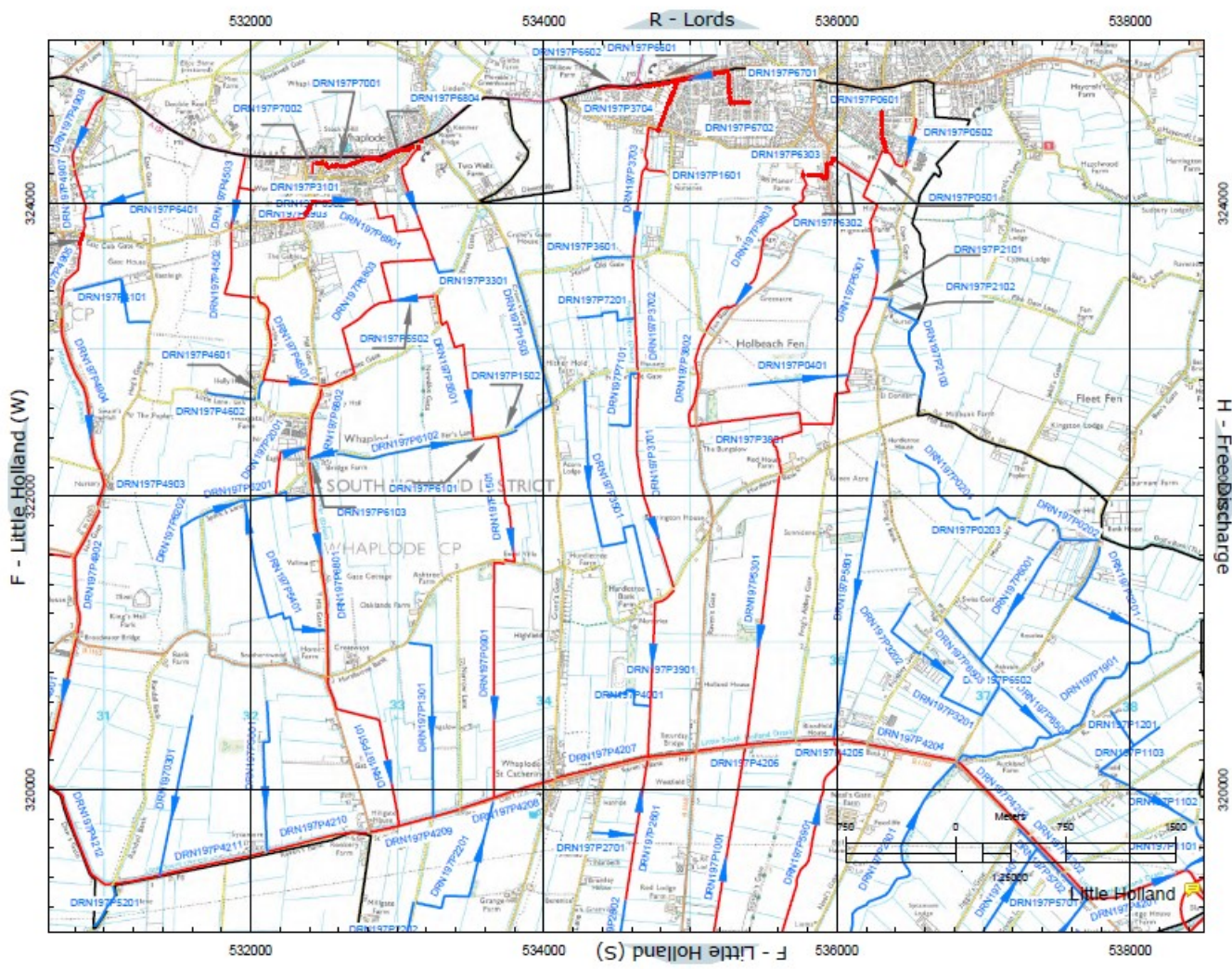
1:2500

Created

23 Mar 2020 14:41

-  Selected point
-  Flood zone 3
-  Flood zone 3: areas benefitting from flood defences
-  Flood zone 2
-  Flood zone 1
-  Flood defence
-  Main river
-  Flood storage area

0 20 40 60m



Little Holland (N)

South Holland
Drainage Board

LEGEND

- Catchment Boundary
- High Priority Watercourse
- Ordinary Watercourse
- High Priority Pipeline
- Ordinary Pipeline
- Water Control Structure
- Pumping Station
- Inland Sluice
- Tidal Sluice

KEY MAP

SCALE	SHEET NUMBER
Best fit	CMT197P
PLOT DATE	
02/02/2016	
FILE NAME	
SHIDB_webmap2013.d	

Appendix C – WinDES Calculation Results

Surface Water Drainage Design Calculations

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XP Solutions	Network 2017.1.2	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	19.000	Add Flow / Climate Change (%)	0
Ratio R	0.400	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.165	4-8	0.113

Total Area Contributing (ha) = 0.278

Total Pipe Volume (m³) = 34.961

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.000	19.314	0.040	482.9	0.035	5.00	0.0	0.600	o	600	Pipe/Conduit	
S2.000	11.033	0.075	147.1	0.064	5.00	0.0	0.600	o	150	Pipe/Conduit	
S1.001	14.244	0.029	491.2	0.030	0.00	0.0	0.600	o	600	Pipe/Conduit	
S1.002	9.719	0.020	486.0	0.018	0.00	0.0	0.600	o	600	Pipe/Conduit	
S1.003	7.407	0.015	493.8	0.017	0.00	0.0	0.600	o	600	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL E (m)	I.Area (ha)	E Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.000	50.00	5.29	3.125	0.035	0.0	0.0	0.0	1.10	311.4	4.7
S2.000	50.00	5.22	3.610	0.064	0.0	0.0	0.0	0.83	14.6	8.7
S1.001	50.00	5.51	3.085	0.128	0.0	0.0	0.0	1.09	308.8	17.4
S1.002	50.00	5.66	3.056	0.147	0.0	0.0	0.0	1.10	310.4	19.9
S1.003	50.00	5.77	3.036	0.164	0.0	0.0	0.0	1.09	307.9	22.2

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XP Solutions	Network 2017.1.2	

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.004	14.007	0.029	483.0	0.011	0.00	0.0	0.600	o	600	Pipe/Conduit	
S1.005	25.305	0.051	496.2	0.034	0.00	0.0	0.600	o	600	Pipe/Conduit	
S1.006	8.937	0.018	496.5	0.019	0.00	0.0	0.600	o	600	Pipe/Conduit	
S1.007	21.339	0.043	496.3	0.046	0.00	0.0	0.600	o	600	Pipe/Conduit	
S1.008	19.102	0.130	146.9	0.004	0.00	0.0	0.600	o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.004	50.00	5.98	3.021	0.175	0.0	0.0	0.0	1.10	311.4	23.7
S1.005	50.00	6.37	2.992	0.209	0.0	0.0	0.0	1.09	307.2	28.3
S1.006	50.00	6.51	2.941	0.227	0.0	0.0	0.0	1.09	307.1	30.8
S1.007	50.00	6.84	2.923	0.274	0.0	0.0	0.0	1.09	307.2	37.1
S1.008	50.00	7.13	2.880	0.278	0.0	0.0	0.0	1.08	42.8	37.6

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Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam., L*W (mm)	PN	Pipe Out Invert Level (m)	Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)	Backdrop (mm)
S1	4.925	1.800	Open Manhole	1800	S1.000	3.125	600				
S2	4.900	1.290	Open Manhole	600	S2.000	3.610	150				
S2	4.885	1.800	Open Manhole	1800	S1.001	3.085	600	S1.000	3.085	600	
								S2.000	3.535	150	
S3	4.860	1.804	Open Manhole	1800	S1.002	3.056	600	S1.001	3.056	600	
S4	4.840	1.804	Open Manhole	1800	S1.003	3.036	600	S1.002	3.036	600	
S5	4.825	1.804	Open Manhole	1800	S1.004	3.021	600	S1.003	3.021	600	
S6	4.800	1.808	Open Manhole	1800	S1.005	2.992	600	S1.004	2.992	600	
S7	4.750	1.809	Open Manhole	1800	S1.006	2.941	600	S1.005	2.941	600	
S8	4.725	1.802	Open Manhole	1800	S1.007	2.923	600	S1.006	2.923	600	
S9	4.380	1.500	Open Manhole	2400	S1.008	2.880	225	S1.007	2.880	600	
S	3.750	1.000	Open Manhole	0		OUTFALL		S1.008	2.750	225	

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PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.000	o	600	S1	4.925	3.125	1.200	Open Manhole	1800
S2.000	o	150	S2	4.900	3.610	1.140	Open Manhole	600
S1.001	o	600	S2	4.885	3.085	1.200	Open Manhole	1800
S1.002	o	600	S3	4.860	3.056	1.204	Open Manhole	1800
S1.003	o	600	S4	4.840	3.036	1.204	Open Manhole	1800
S1.004	o	600	S5	4.825	3.021	1.204	Open Manhole	1800
S1.005	o	600	S6	4.800	2.992	1.208	Open Manhole	1800
S1.006	o	600	S7	4.750	2.941	1.209	Open Manhole	1800
S1.007	o	600	S8	4.725	2.923	1.202	Open Manhole	1800
S1.008	o	225	S9	4.380	2.880	1.275	Open Manhole	2400

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.000	19.314	482.9	S2	4.885	3.085	1.200	Open Manhole	1800
S2.000	11.033	147.1	S2	4.885	3.535	1.200	Open Manhole	1800
S1.001	14.244	491.2	S3	4.860	3.056	1.204	Open Manhole	1800
S1.002	9.719	486.0	S4	4.840	3.036	1.204	Open Manhole	1800
S1.003	7.407	493.8	S5	4.825	3.021	1.204	Open Manhole	1800
S1.004	14.007	483.0	S6	4.800	2.992	1.208	Open Manhole	1800
S1.005	25.305	496.2	S7	4.750	2.941	1.209	Open Manhole	1800
S1.006	8.937	496.5	S8	4.725	2.923	1.202	Open Manhole	1800
S1.007	21.339	496.3	S9	4.380	2.880	0.900	Open Manhole	2400
S1.008	19.102	146.9	S	3.750	2.750	0.775	Open Manhole	0

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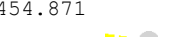
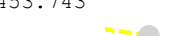
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Setting Out Information - Site Coordinates (Storm)

PN	USMH Name	Dia/Len (mm)	Width (mm)	US Easting (m)	US Northing (m)	Layout (North)
S1.000	S1	1800		532283.922	322465.438	
S2.000	S2	600		532293.703	322450.397	
S1.001	S2	1800		532301.731	322457.965	
S1.002	S3	1800		532315.866	322456.206	
S1.003	S4	1800		532325.493	322454.871	
S1.004	S5	1800		532332.813	322453.743	
S1.005	S6	1800		532346.309	322449.996	
S1.006	S7	1800		532360.308	322428.915	
S1.007	S8	1800		532367.197	322423.221	
S1.008	S9	2400		532388.098	322418.922	

PN	DSMH Name	Dia/Len (mm)	Width (mm)	DS Easting (m)	DS Northing (m)	Layout (North)
S1.008	S	0		532407.138	322417.383	

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Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	User	-	100	0.022	0.022	0.022
	User	-	100	0.013	0.013	0.035
2.000	User	-	100	0.030	0.030	0.030
	User	-	100	0.017	0.017	0.047
	User	-	100	0.017	0.017	0.064
1.001	User	-	100	0.013	0.013	0.013
	User	-	100	0.017	0.017	0.030
1.002	User	-	100	0.012	0.012	0.012
	User	-	100	0.006	0.006	0.018
1.003	User	-	100	0.010	0.010	0.010
	User	-	100	0.007	0.007	0.017
1.004	User	-	100	0.011	0.011	0.011
1.005	User	-	100	0.012	0.012	0.012
	User	-	100	0.022	0.022	0.034
1.006	User	-	100	0.013	0.013	0.013
	User	-	100	0.005	0.005	0.019
1.007	User	-	100	0.012	0.012	0.012
	User	-	100	0.016	0.016	0.029
	User	-	100	0.018	0.018	0.046
1.008	User	-	100	0.004	0.004	0.004
				Total	Total	Total
				0.278	0.278	0.278

Surcharged Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
---------------------	--------------	--------------	--------------	------------------	----------	--------

S1.008 S 3.750 2.750 0.000 0 0

Datum (m) 0.000 Offset (mins) 0

Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)
720	1.000	2880	1.000	5040	1.000	7200	1.000	9360	1.000
1440	1.000	3600	1.000	5760	1.000	7920	1.000	10080	1.000
2160	1.000	4320	1.000	6480	1.000	8640	1.000		

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Online Controls for Storm

Hydro-Brake® Optimum Manhole: S9, DS/PN: S1.008, Volume (m³): 12.2

Unit Reference	MD-SHE-0087-3600-1200-3600
Design Head (m)	1.200
Design Flow (l/s)	3.6
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	87
Invert Level (m)	2.880
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	3.6
Flush-Flo™	0.362	3.6
Kick-Flo®	0.742	2.9
Mean Flow over Head Range	-	3.2

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.7	1.200	3.6	3.000	5.5	7.000	8.2
0.200	3.4	1.400	3.9	3.500	5.9	7.500	8.5
0.300	3.6	1.600	4.1	4.000	6.3	8.000	8.8
0.400	3.6	1.800	4.3	4.500	6.7	8.500	9.0
0.500	3.5	2.000	4.6	5.000	7.0	9.000	9.3
0.600	3.4	2.200	4.8	5.500	7.3	9.500	9.5
0.800	3.0	2.400	5.0	6.000	7.6		
1.000	3.3	2.600	5.2	6.500	7.9		

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Storage Structures for Storm

Porous Car Park Manhole: S2, DS/PN: S2.000

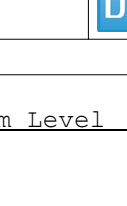
Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.5
Membrane Percolation (mm/hr)	1000	Length (m)	53.0
Max Percolation (l/s)	81.0	Slope (1:X)	500.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	3.610	Membrane Depth (mm)	200

Cellular Storage Manhole: S9, DS/PN: S1.008

Invert Level (m)	2.900	Safety Factor	2.0
Infiltration Coefficient Base (m/hr)	0.00000	Porosity	0.95
Infiltration Coefficient Side (m/hr)	0.00000		

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	150.0	150.0	0.401	0.0	170.0
0.400	150.0	170.0			

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1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	6.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	0.000
Hot Start Level (mm)	0	Inlet Coefficient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	2
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.400
Region England and Wales Cv (Summer)	0.750		
M5-60 (mm)	19.000	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	450.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	OFF		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) SurchARGE	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.000	S1	15 Winter	1	+0%	100/60 Winter				3.211
S2.000	S2	30 Winter	1	+0%	100/15 Summer				3.669
S1.001	S2	15 Winter	1	+0%	100/60 Summer				3.203
S1.002	S3	15 Winter	1	+0%	100/60 Summer				3.181
S1.003	S4	15 Winter	1	+0%	100/60 Summer				3.161
S1.004	S5	15 Winter	1	+0%	100/60 Summer				3.148
S1.005	S6	15 Winter	1	+0%	100/60 Summer				3.117
S1.006	S7	15 Winter	1	+0%	100/30 Winter				3.076
S1.007	S8	15 Winter	1	+0%	100/30 Winter				3.049
S1.008	S9	120 Winter	1	+0%	30/15 Winter				3.040

Surcharged Flooded					Pipe	Level
PN	US/MH Name	Depth (m)	Volume (m³)	Flow / Cap.	Overflow (l/s)	Status Exceeded
S1.000	S1	-0.514	0.000	0.02	4.5	OK
S2.000	S2	-0.091	0.000	0.33	4.4	OK
S1.001	S2	-0.482	0.000	0.06	10.0	OK

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1 year Return Period Summary of Critical Results by Maximum Level (Rank 1)
for Storm

PN	US/MH Name	Surcharged Flooded		Flow / Overflow Cap. (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
		Depth (m)	Volume (m ³)				
S1.002	S3	-0.475	0.000	0.08	11.5	OK	
S1.003	S4	-0.475	0.000	0.07	12.9	OK	
S1.004	S5	-0.473	0.000	0.08	13.9	OK	
S1.005	S6	-0.475	0.000	0.07	16.4	OK	
S1.006	S7	-0.465	0.000	0.11	17.8	OK	
S1.007	S8	-0.474	0.000	0.10	21.2	OK	
S1.008	S9	-0.065	0.000	0.08	3.2	OK	

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<u>30 year Return Period Summary of Critical Results by Maximum Level (Rank 1)</u> <u>for Storm</u>																																																																																																																																												
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Climate Change (%) 0, 0, 40																																																																																																																																												
<table><tr><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td><td>Water</td></tr><tr><td>PN</td><td>US/MH</td><td>Storm</td><td>Return Period</td><td>Climate Change</td><td>First (X) Surge</td><td>First (Y) Flood</td><td>First (Z) Overflow</td><td>Overflow Act.</td><td>Level</td><td></td></tr><tr><td>S1.000</td><td>S1</td><td>15 Winter</td><td>30</td><td>+0%</td><td>100/60 Winter</td><td></td><td></td><td></td><td>3.297</td><td></td></tr><tr><td>S2.000</td><td>S2</td><td>30 Winter</td><td>30</td><td>+0%</td><td>100/15 Summer</td><td></td><td></td><td></td><td>3.714</td><td></td></tr><tr><td>S1.001</td><td>S2</td><td>15 Winter</td><td>30</td><td>+0%</td><td>100/60 Summer</td><td></td><td></td><td></td><td>3.292</td><td></td></tr><tr><td>S1.002</td><td>S3</td><td>15 Winter</td><td>30</td><td>+0%</td><td>100/60 Summer</td><td></td><td></td><td></td><td>3.271</td><td></td></tr><tr><td>S1.003</td><td>S4</td><td>180 Winter</td><td>30</td><td>+0%</td><td>100/60 Summer</td><td></td><td></td><td></td><td>3.265</td><td></td></tr><tr><td>S1.004</td><td>S5</td><td>180 Winter</td><td>30</td><td>+0%</td><td>100/60 Summer</td><td></td><td></td><td></td><td>3.265</td><td></td></tr><tr><td>S1.005</td><td>S6</td><td>180 Winter</td><td>30</td><td>+0%</td><td>100/60 Summer</td><td></td><td></td><td></td><td>3.265</td><td></td></tr><tr><td>S1.006</td><td>S7</td><td>180 Winter</td><td>30</td><td>+0%</td><td>100/30 Winter</td><td></td><td></td><td></td><td>3.264</td><td></td></tr><tr><td>S1.007</td><td>S8</td><td>180 Winter</td><td>30</td><td>+0%</td><td>100/30 Winter</td><td></td><td></td><td></td><td>3.264</td><td></td></tr><tr><td>S1.008</td><td>S9</td><td>180 Winter</td><td>30</td><td>+0%</td><td>30/15 Winter</td><td></td><td></td><td></td><td>3.263</td><td></td></tr></table>																			Water	PN	US/MH	Storm	Return Period	Climate Change	First (X) Surge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Level		S1.000	S1	15 Winter	30	+0%	100/60 Winter				3.297		S2.000	S2	30 Winter	30	+0%	100/15 Summer				3.714		S1.001	S2	15 Winter	30	+0%	100/60 Summer				3.292		S1.002	S3	15 Winter	30	+0%	100/60 Summer				3.271		S1.003	S4	180 Winter	30	+0%	100/60 Summer				3.265		S1.004	S5	180 Winter	30	+0%	100/60 Summer				3.265		S1.005	S6	180 Winter	30	+0%	100/60 Summer				3.265		S1.006	S7	180 Winter	30	+0%	100/30 Winter				3.264		S1.007	S8	180 Winter	30	+0%	100/30 Winter				3.264		S1.008	S9	180 Winter	30	+0%	30/15 Winter				3.263	
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S1.007	S8	180 Winter	30	+0%	100/30 Winter				3.264																																																																																																																																			
S1.008	S9	180 Winter	30	+0%	30/15 Winter				3.263																																																																																																																																			
<table><tr><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td><td></td></tr><tr><td colspan="2"></td><td>US/MH</td><td>Depth</td><td>Volume</td><td>Flow / Overflow</td><td>Pipe</td><td colspan="2"></td><td>Level</td><td></td></tr><tr><td>PN</td><td>Name</td><td></td><td>(m)</td><td>(m³)</td><td>Cap. (l/s)</td><td>Flow (l/s)</td><td>Status</td><td>Exceeded</td><td></td><td></td></tr><tr><td>S1.000</td><td>S1</td><td></td><td>-0.428</td><td>0.000</td><td>0.05</td><td>11.1</td><td>OK</td><td></td><td></td><td></td></tr><tr><td>S2.000</td><td>S2</td><td></td><td>-0.046</td><td>0.000</td><td>0.83</td><td>10.9</td><td>OK</td><td></td><td></td><td></td></tr><tr><td>S1.001</td><td>S2</td><td></td><td>-0.393</td><td>0.000</td><td>0.17</td><td>27.9</td><td>OK</td><td></td><td></td><td></td></tr></table>																						US/MH	Depth	Volume	Flow / Overflow	Pipe			Level		PN	Name		(m)	(m³)	Cap. (l/s)	Flow (l/s)	Status	Exceeded			S1.000	S1		-0.428	0.000	0.05	11.1	OK				S2.000	S2		-0.046	0.000	0.83	10.9	OK				S1.001	S2		-0.393	0.000	0.17	27.9	OK																																																																					
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30 year Return Period Summary of Critical Results by Maximum Level (Rank 1)
for Storm

PN	US/MH Name	Surcharged Flooded		Flow / Overflow		Pipe Flow	Status	Level Exceeded
		Depth (m)	Volume (m³)	Cap.	(l/s)	(l/s)		
S1.002	S3	-0.385	0.000	0.21		32.4	OK	
S1.003	S4	-0.371	0.000	0.07		12.5	OK	
S1.004	S5	-0.356	0.000	0.08		13.2	OK	
S1.005	S6	-0.327	0.000	0.06		15.5	OK	
S1.006	S7	-0.277	0.000	0.10		16.1	OK	
S1.007	S8	-0.259	0.000	0.09		19.3	OK	
S1.008	S9	0.158	0.000	0.09		3.6	SURCHARGED	

100 year Return Period Summary of Critical Results by Maximum Level (Rank
1) for Storm

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	6.000
Hot Start (mins)	0	MADD Factor * 10m ³ /ha Storage	0.000
Hot Start Level (mm)	0	Inlet Coefficient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Synthetic Rainfall Details

```
Margin for Flood Risk Warning (mm) 450.0      DVD Status OFF
      Analysis Timestep    Fine Inertia Status OFF
      DTS Status          OFF
```

										Water
	US/MH			Return	Climate	First (X)	First (Y)	First (Z)	Overflow	Level
PN	Name	Storm		Period	Change	Surcharge	Flood	Overflow	Act.	(m)
S1.000	S1	240	Winter	100	+40%	100/60	Winter			4.058
S2.000	S2	240	Winter	100	+40%	100/15	Summer			4.059
S1.001	S2	240	Winter	100	+40%	100/60	Summer			4.058
S1.002	S3	240	Winter	100	+40%	100/60	Summer			4.058
S1.003	S4	240	Winter	100	+40%	100/60	Summer			4.058
S1.004	S5	240	Winter	100	+40%	100/60	Summer			4.058
S1.005	S6	240	Winter	100	+40%	100/60	Summer			4.058
S1.006	S7	240	Winter	100	+40%	100/30	Winter			4.057
S1.007	S8	240	Winter	100	+40%	100/30	Winter			4.057
S1.008	S9	240	Winter	100	+40%	30/15	Winter			4.056

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100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Surcharged Flooded		Flow / Overflow		Pipe Flow	Status	Level Exceeded
		Depth (m)	Volume (m³)	Cap.	(l/s)	(l/s)		
S1.002	S3	0.402	0.000	0.09		14.3	SURCHARGED	
S1.003	S4	0.422	0.000	0.08		15.5	SURCHARGED	
S1.004	S5	0.437	0.000	0.10		16.1	SURCHARGED	
S1.005	S6	0.466	0.000	0.08		18.9	SURCHARGED	
S1.006	S7	0.516	0.000	0.12		19.0	SURCHARGED	
S1.007	S8	0.534	0.000	0.11		23.6	SURCHARGED	
S1.008	S9	0.951	0.000	0.09		3.6	FLOOD RISK	