APPENDIX A

Site Location Plan

ODYSSEY

Tuscany House
White Hart Lane
Basingstoke
Hampshire RG21 4AF

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Job Title	SHEPHERD NEAME, FAVERSHAM
Figure Title	SITE LOCATION PLAN
Client	MILLIKEN AND COMPANY CHARTERED SURVEYORS AND TOWN PLANNERS
Scale	1:2500 @ A3
Date	NOV 19
Designed	NM
Drawn	NM
Checked	GG
Approved	GG
Job No	18-120
Figure No	FIGURE 1
Rev	

APPENDIX B

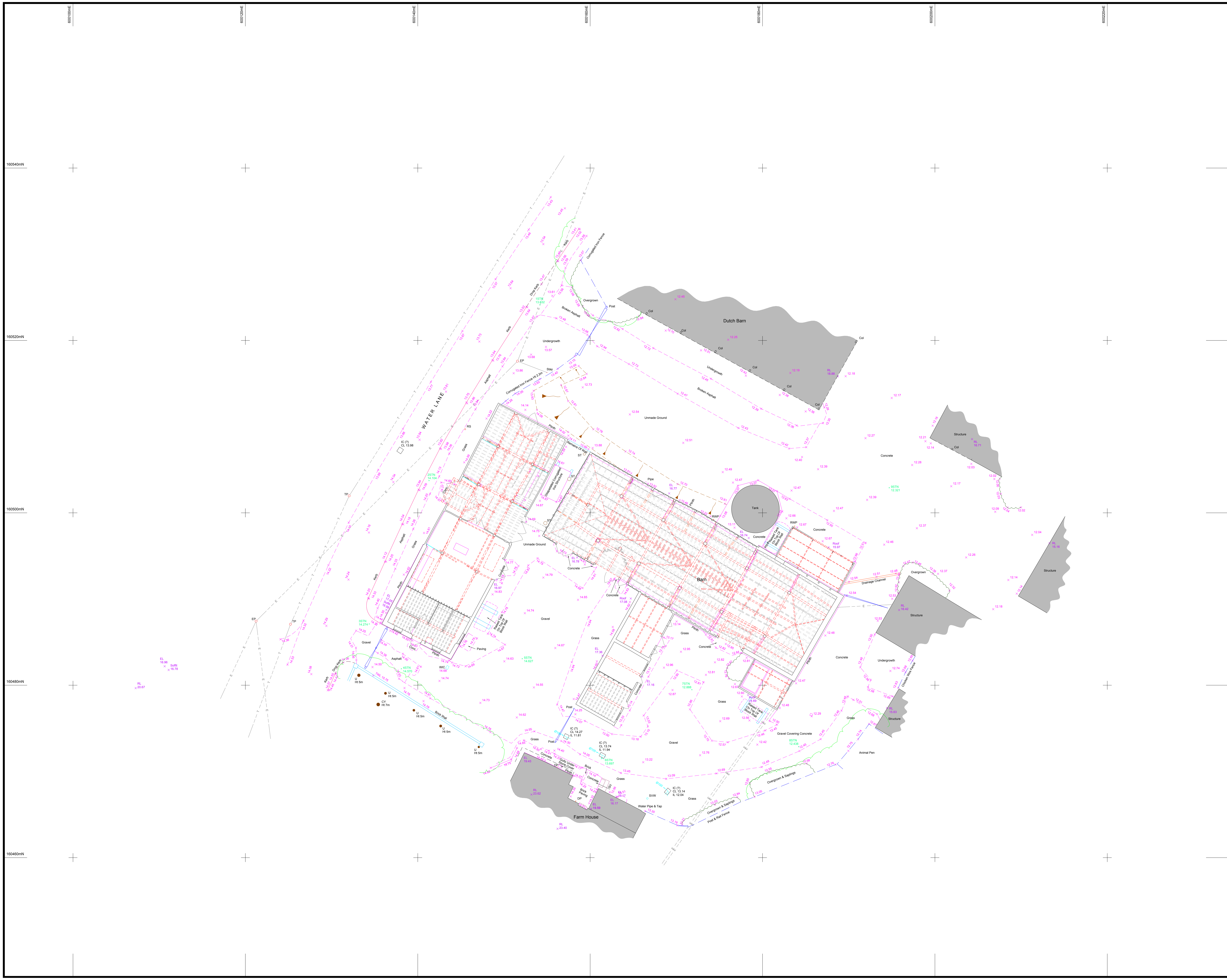
Indicative Masterplan

proposed site plan

scale: 1/200 @A1

APPENDIX C

Topographical Survey



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BW	Block Wall	GV	Gas Valve	STW	Stone Wall
CBF	Close Board Fence	Ht	Height (in meters)	SU	Step Up
CL	Cover Level	IC	Inspection Cover	SV	Stop Valve(W)Water(G)Gas
CLF	Chain Link Fence	IC(C)	(C)Combined(F)Foul(S)Storm	SVP	Soil Vent Pipe
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CH	Cherry	HZ	Hazel	PI	Pine	WA	Walnut
CY	Cypress	LA	Larch	PO	Poplar	WB	Whitebeam
DE	Dead	LB	Laburnum	RO	Rowan	WI	Willow
EL	Elm	LI	Lime	SB	Silver Birch	YE	Yew

Line Types

Steps / Ramps
Top / Bottom of Banking
Bushes / Vegetation
Change of Surface
Detail
Overhead Structure
T Telecom Overhead
T & E Telecom & Power Overhead
E Power Overhead

Fence
Building Face
Drop Kerb
Kerb
Wall / Structure
Single Gate
Double Gate
Banking
Survey Station

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USJ	Underside of Joist level / Height to underside above floor
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WHL	Window Head Level

Sloping Roof
Sloped Ceiling (Points up)
Arched / Vaulted Ceiling

Building Line / Wall Line
Detail / Steps
Overhead Detail
Partitions
Glazing

Notes

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Drawing Revisions

Rev No.	Date	Details
Original	See below	Original survey carried out

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Specialist Geospatial Surveyors

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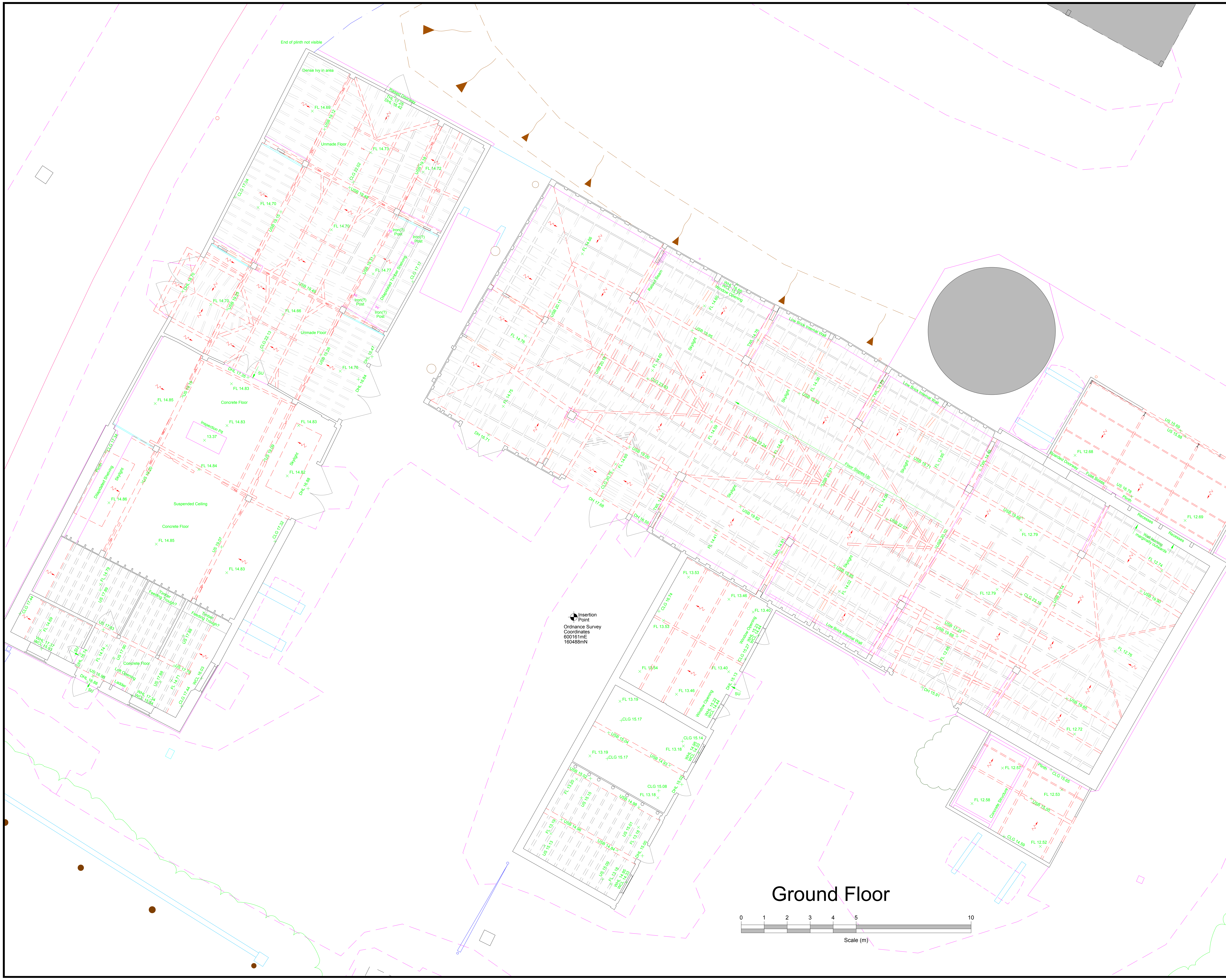
Enquiries: survey@OmegaGeo.co.uk

CLIENT: SHEPHERD NEAME

PROJECT: QUEEN COURT FARM BARNS
WATER LANE, OSPRINGE,
FAVERSHAM, KENT, ME13 8UA

TITLE: TOPOGRAPHICAL SURVEY

ORIGINAL SURVEY DATE	JULY 2018		
SCALE	1:200 @ A1	DWG. No.	1 OF 3
JOB Ref.	18-0493	CAD FILE	MBS_03



Ground Floor

Scale (m): 0 1 2 3 4 5 10

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Bushes / Vegetation
Change of Surface
Detail
Overhead Structure
T Telecom Overhead
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E Power Overhead
Fence
Building Face
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N

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Rev No.	Date	Details
Original	See below	Original survey carried out

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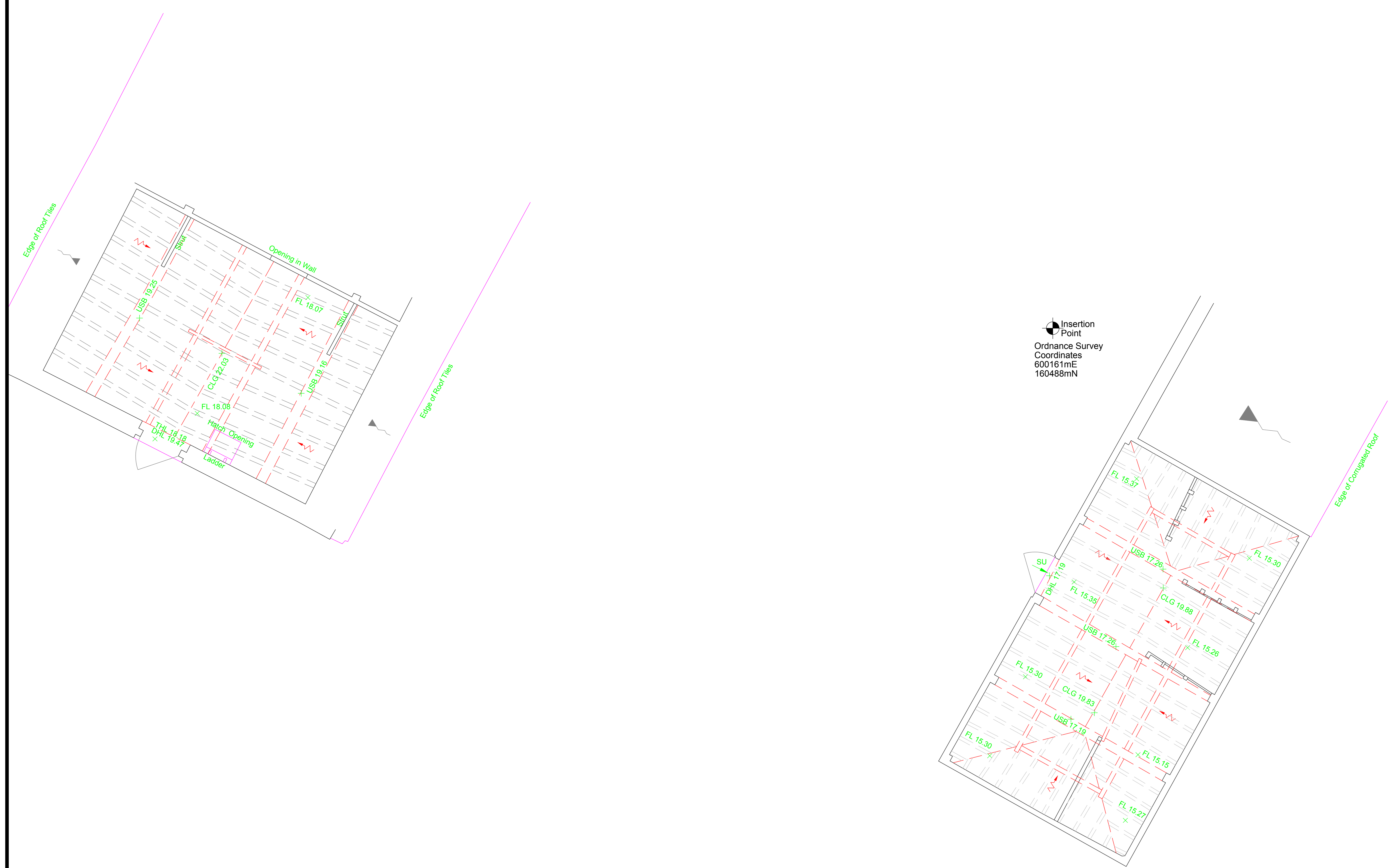
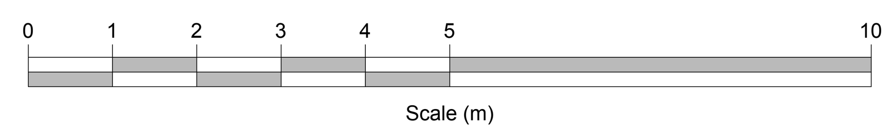
PROJECT	QUEEN COURT FARM BARNS WATER LANE, OSPRINGE, FAVERSHAM, KENT, ME13 8UA
TITLE	MEASURED BUILDING SURVEY
ORIGINAL SURVEY DATE	JULY 2018
SCALE	1:75 @ A1
DWG. No.	2 OF 3
JOB Ref.	18-0493
CAD FILE	MBS_03



First Floor



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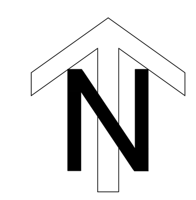

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SCALE	1:75 @ A1	DWG. No.	3 OF 3
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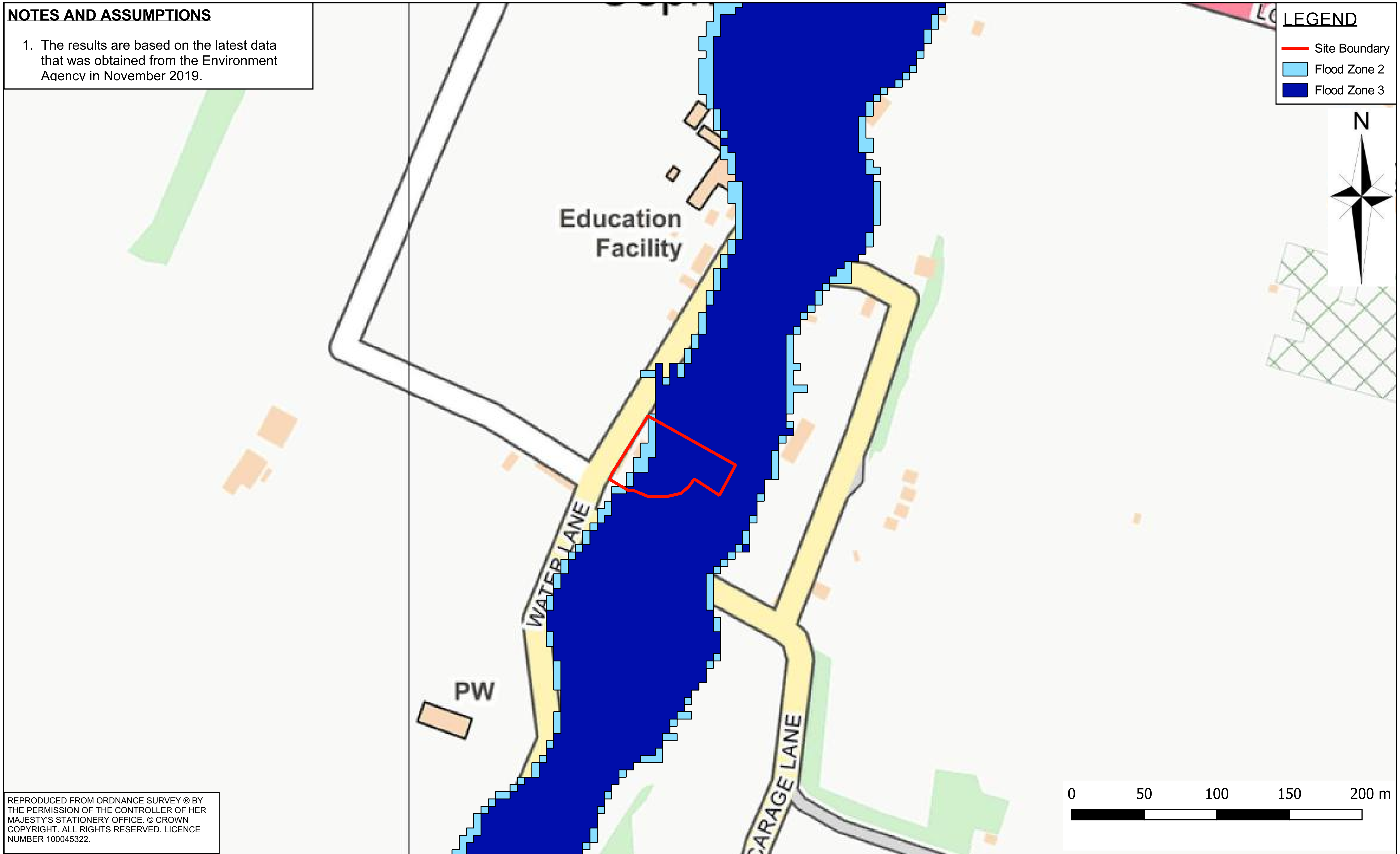
APPENDIX D

Environment Agency Records

NOTES AND ASSUMPTIONS

1. The results are based on the latest data that was obtained from the Environment Agency in November 2019.



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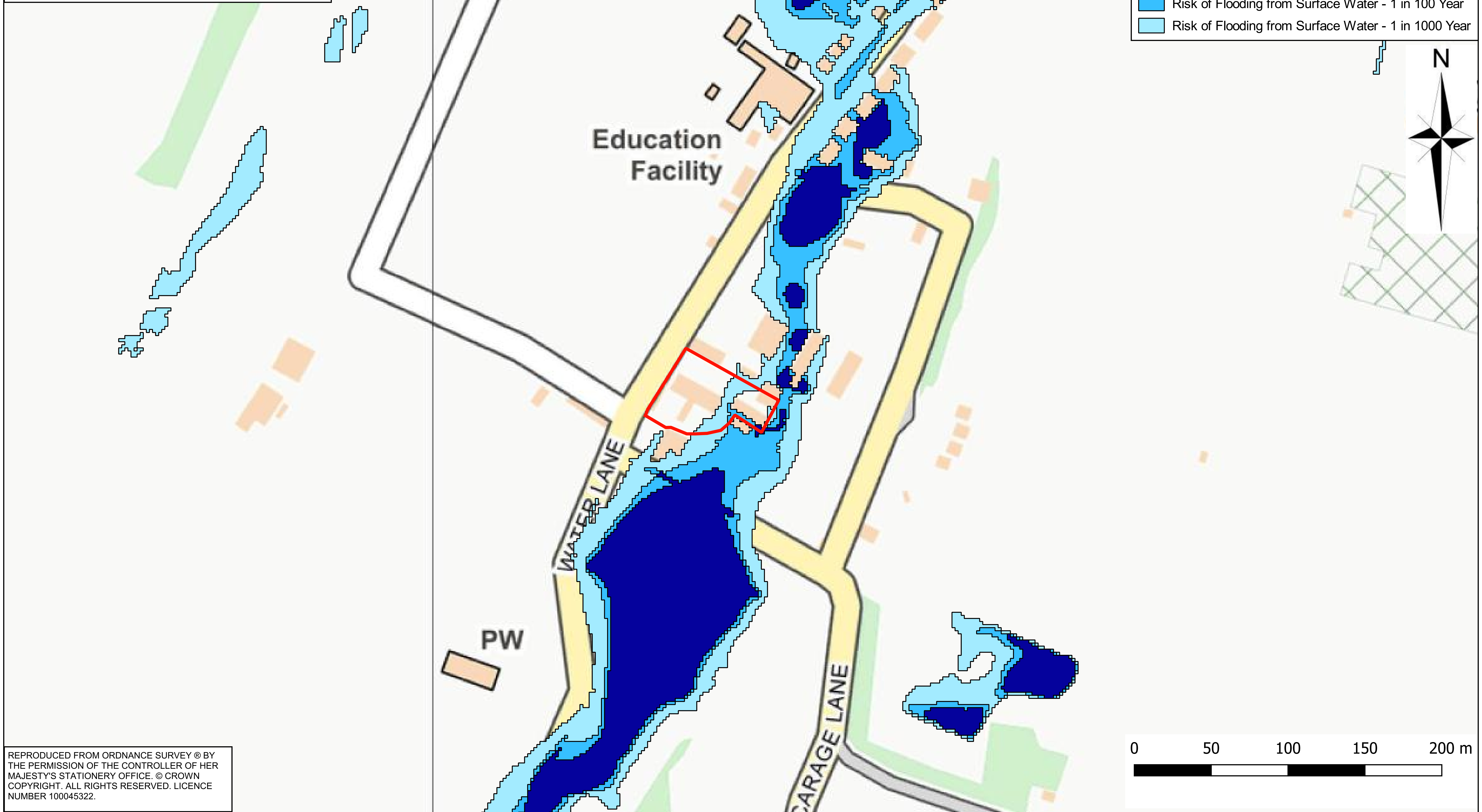
Job Title: SHEPHERD NEAME, FAVERSHAM	Client: MILLIKEN AND COMPANY CHARTERED SURVEYORS AND TOWN PLANNERS	Scale: 1:2500 @ A3	Date: NOV 19	Designed: NM
Figure Title: ENVIRONMENT AGENCY FLOOD MAP FOR PLANNING		Drawn: NM	Checked: GG	Approved: GG
		Job No: 18-120	Figure No: FIGURE 2	Rev

NOTES AND ASSUMPTIONS

1. The results are based on the latest data that was obtained from the Environment Agency in November 2019.



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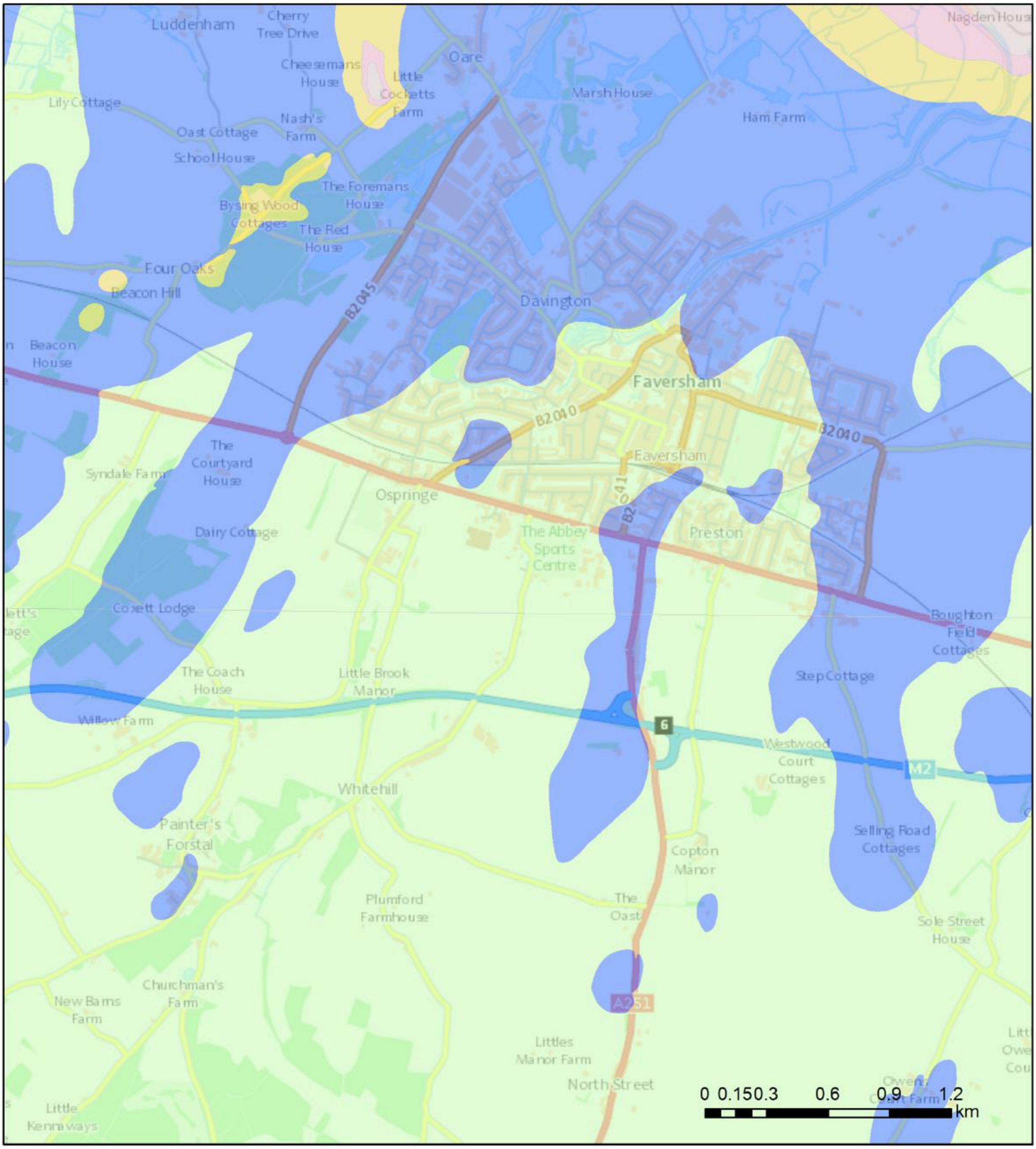
Job Title	SHEPHERD NEAME, FAVERSHAM
Figure Title	ENVIRONMENT AGENCY RISK OF FLOODING FROM SURFACE WATER
Client	MILLIKEN AND COMPANY CHARTERED SURVEYORS AND TOWN PLANNERS
Scale	1:2500 @ A3
Date	NOV 19
Designed	NM
Drawn	NM
Checked	GG
Approved	GG
Job No	18-120
Figure No	FIGURE 3
Rev	

APPENDIX E

British Geological Survey Records

18-120 Bedrock Geology

GEOINDEX ONSHORE



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GeoIndex Onshore Data Sources: NERC, Natural England, English Heritage and Ordnance Survey

Map Key

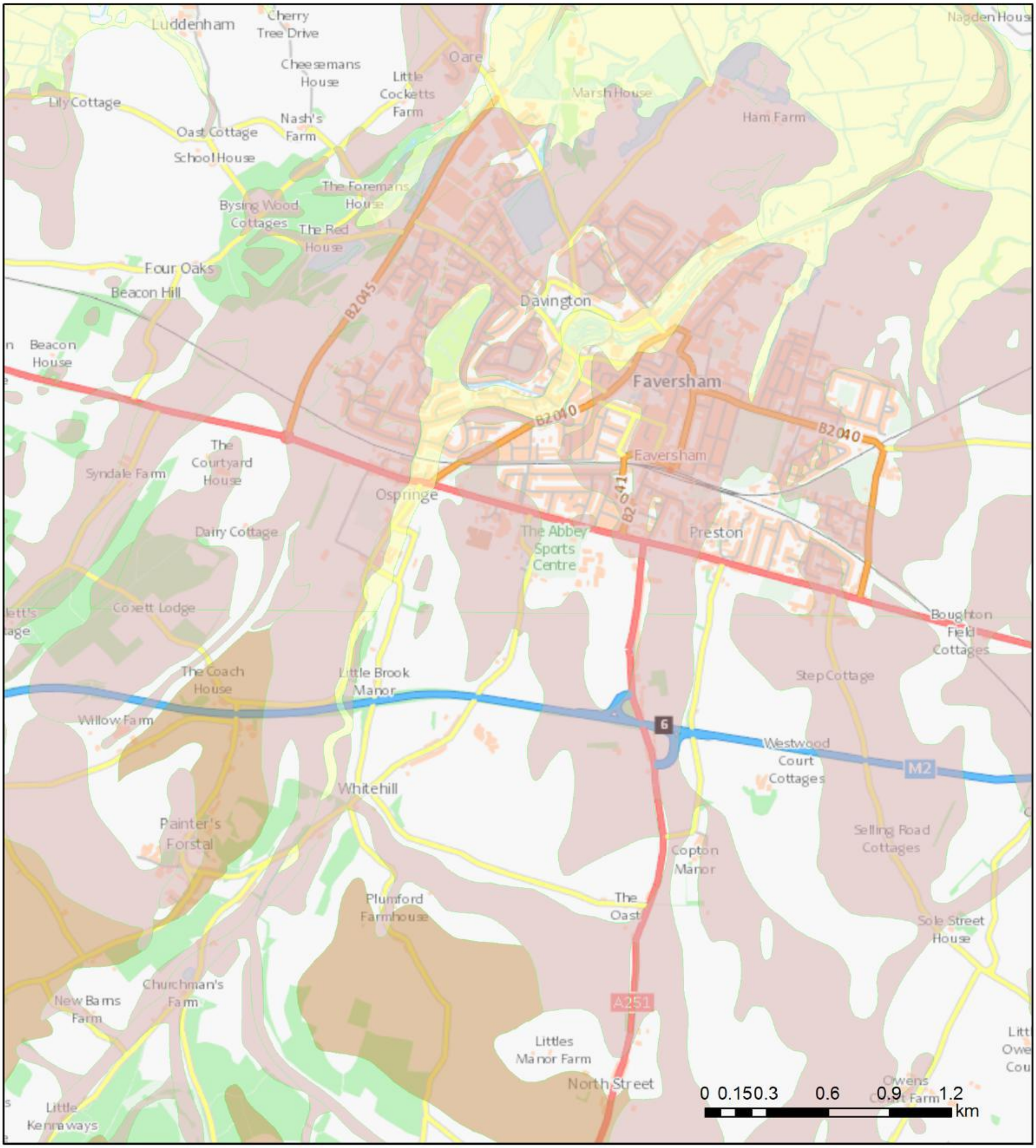
Bedrock geology 1:50,000 scale

- THANET FORMATION - SAND, SILT AND CLAY
- HARWICH FORMATION - SAND AND GRAVEL
- LONDON CLAY FORMATION - CLAY AND SILT
- SEAFORD CHALK FORMATION - CHALK
- LAMBETH GROUP - SAND
- HOLYWELL NODULAR CHALK FORMATION AND NEW PIT CHALK FORMATION (UNDIFFERENTIATED) - CHALK
- LEWES NODULAR CHALK FORMATION - CHALK
- LAMBETH GROUP - SAND, SILT AND CLAY

Selection Results

18-120 Superficial Deps

GEOINDEX ONSHORE



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GeoIndex Onshore Data Sources: NERC, Natural England, English Heritage and Ordnance Survey

Map Key

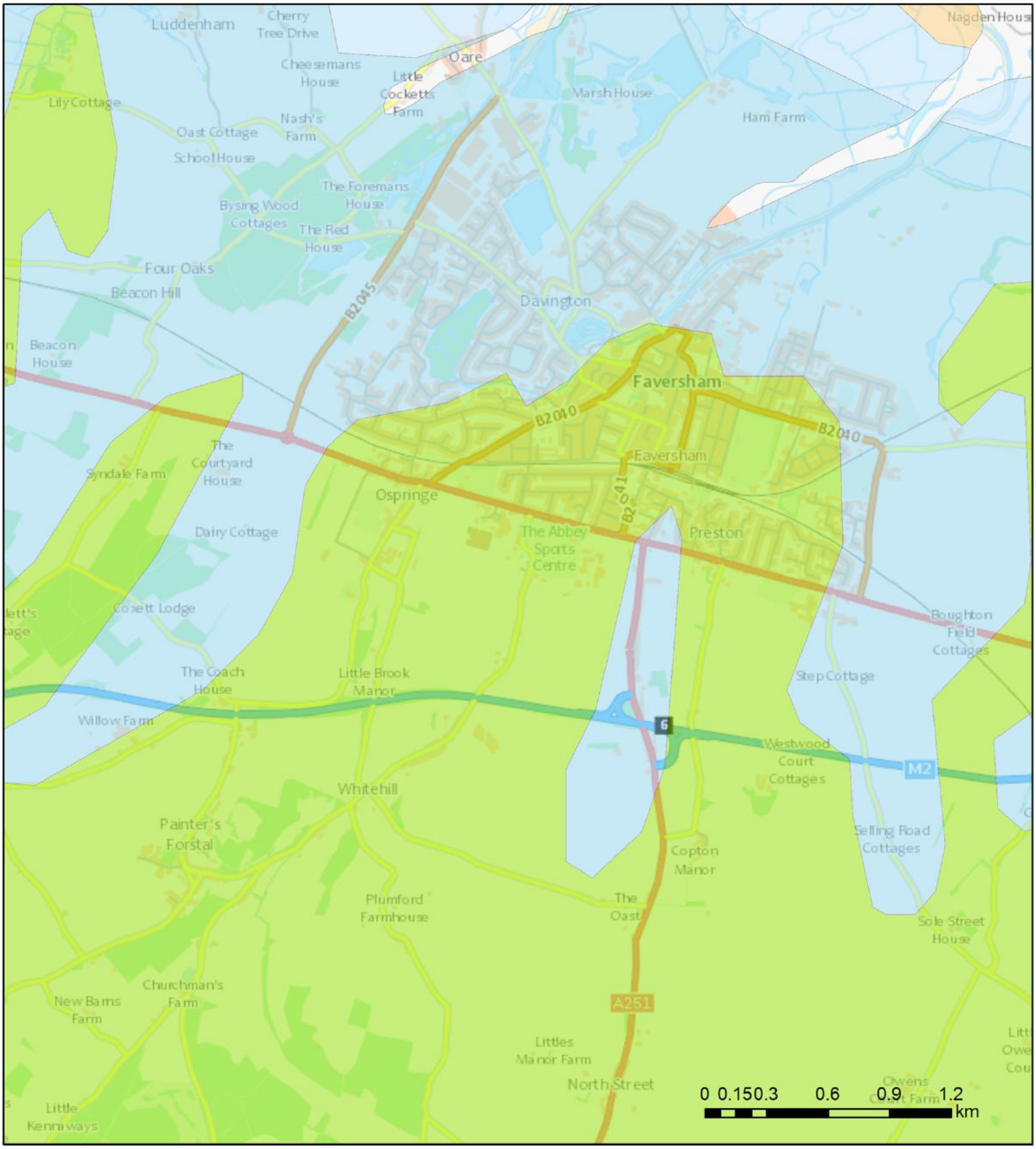
Superficial deposits 1:50,000 scale

- ALLUVIUM - CLAY, SILT, SAND AND PEAT
- HEAD - CLAY AND SILT
- RIVER TERRACE DEPOSITS, 2 - SAND AND GRAVEL
- BEACH AND TIDAL FLAT DEPOSITS (UNDIFFERENTIATED) - CLAY, SILT AND SAND
- CLAY-WITH-FLINTS FORMATION - CLAY, SILT, SAND AND GRAVEL

Selection Results

18-120 Hydrogeology

GEOINDEX ONSHORE



GeoIndex Onshore Data Sources: NERC, Natural England, English Heritage and Ordnance Survey

Map Key

Hydrogeology 1:625,000 scale

Aquifers with significant intergranular flow

- **Highly productive aquifer**
- **Moderately productive aquifer**
- **Low productivity aquifer**

Aquifers in which flow is virtually all through fractures and other discontinuities

- **Highly productive aquifer**
- **Moderately productive aquifer**
- **Low productivity aquifer**
- **Rocks with essentially no groundwater**

Selection Results

TQ 95NE/19

RECORD OF BOREHOLE NO. 137/19B

NGR 9992 5975

Ground level: + 58.1ft. O.D. Newlyn (17.72m)

Dia. of boring: 6in.

Type of boring: Shell and Auger

Lining tubes: 6in. to 16ft.

Daily Progress	Samples Depth	Samples Type	Change of Strata Legend	Change of Strata Depth	Change of Strata O.D. Level	Description of Strata
	137 4'6"	D				Soft dark brown clay with carbonaceous patches
	5'0" - 6'6" 1.52 - 1.98	U(4)				
	6'6" 1.98	D		6'6" (1.98m)	+51.6	
12.6.58	6'6" - 7'6" 1.98 7'6" 2.29 - 2.29	C(99) W				Flint gravel
				10'0 (3.1m)	+48.1	
	10'6" - 12'0" 3.20 12'0 3.66 3.66	U(4) D				Moderately hard, fissured white chalk with soft chalk in the fissures, and flints
	5.71 - 6.25 19'0" - 20'6"	U(4)				
	20'6" 6.25	D				
13.6.58	20'6" - 21'6" 6.25 - 6.55	C(67)		21'6" (6.55m)	+36.6	

Key to type of sample:

U(4) - 4in. dia. undisturbed sample.

D - disturbed sample.

W - water sample.

C( ) - dynamic cone penetration test.

No. in brackets gives No. of blows/12in. penetration.

Remarks: (Observations on ground-water, etc.)

Ground-water first encountered at depth of 7ft.6in. below ground level, rising rapidly to depth of 2ft. below ground level

Borehole collapsed on withdrawal of lining tubes

CHAINAGE 1198+00

Scale: 1in. to 4ft.

Drawing No: S/R/. 5102

MINISTRY OF TRANSPORT AND CIVIL AVIATION

SITE INVESTIGATION FOR PROPOSED MEDWAY TOWNS MOTOR ROAD

Soils No.: S/1755

FIG. 130

GEORGE WIMPEY & CO., LTD. CENTRAL LABORATORY HAYES

TRO6SW/44

604 609

Depth	Type	Strength kN/m²	w %	SPT N	Description	Depth	Level *
	-				TOPSOIL.	G.L	10.5
1.0	D				Soft to firm brown silty slightly sandy CLAY with chalk and occasional flints - chalk content increasing with depth.	0.4	10.1
1.7	D				Very light grey remoulded CHALK.	1.6	8.9
1.8	C			3			
2.0	D						
2.4	D				Soft dark grey-brown very silty, slightly sandy CLAY with flints, occasional silt pockets and brick traces.	2.2	8.3
2.8	C			20			
3.3	D				Flint GRAVEL with firm brown silty CLAY and occasional large cobbles. Chalk content below 4.9m increasing with depth.	2.9	7.6
4.5	D.C			20			
5.5	D						
6.0	D.C			10	White rock CHALK with some remoulded chalk and flint fragments up to cobble size.	5.7	4.8
7.0	D						
7.5	C			18			
8.0	D						
9.5	D.C			16		10.0	10.5

Drilling

Type	From	To	Size	Fluid
Shell and Auger	G.L	10.0	0.15	-

Ground Water

Struck	Behaviour	Sealed	Date	Hole	Cased	Water
			23.3.76	-	-	-
			24.3.76	10.0	-	5.0

Remarks *Ground level (and hence intermediate levels) estimated from Site Survey Plan (Drawing 75-169-1).

Borehole Record

Soil Surveys Ltd

Project Grove Place, Ospringe, Faversham, Kent.

Contract S1451

Borehole 1

Sheet 1 of 1

TR06SW 45

004 6091

Sampling Depth	Type	Properties Strength kN/m²	w %	SPT N	Strata Description	Depth	Level	Legend
					Dark silty TOPSOIL with flints.	G.L	10.5	
						0.7	9.8	
1.2	D							
1.5	C			36				
2.2	D				Coarse flint GRAVEL and coarse SAND with some clay. (proportions of gravel and sand varying with depth). Occasional brick fragments observed at 2.2 and 3.1m.			
3.0	C			18				
3.1	D							
4.5	D.C			16				
						5.5	5.0	
5.7	D				Flint GRAVEL.	5.8	4.7	
6.0	D							
6.1	C			5	White rock CHALK fragments with remoulded chalk.			
						6.8	3.7	
7.5	D.C			18	White rock CHALK with some remoulded chalk.			
9.0	D							
9.5	C			20				
						10.0	0.5	

Drilling

Type	From	To	Size	Fluid
Shell and Auger	G.L	10.0	0.15	–

Ground Water

Struck	Behaviour	Sealed	Date	Hole	Cased	Water
			24.3.76	–	–	–
			24.3.76	10.0	–	5.0

Remarks Ground level (and hence intermediate levels) estimated from Site Survey Plan (Drawing 75-169-1).

Borehole Record

Soil Surveys Ltd

Project Grove Place, Ospringe Faversham, Kent.

Contract S1451

Borehole 2

Sheet 1 of 1

APPENDIX F

Southern Water Records

Odyssey
Tuscany House
White Hart Lane
Basingstoke
Hampshire
RG21 4AF

Your ref	18-120
Our ref	309450
Date	19 September 2018
Contact	searches@southernwater.co.uk Tel 0845 272 0845 0330 303 0276 Fax 01634 844514

Attention: Nicholas Metcalfe

Dear Customer

Re: **Provision of public sewer record extract**

Location: **Shepheard Neame Water Lane Faversham Kent, ME13 8TZ**

Thank you for your order regarding the provision of extracts of our sewer and/or water main records. Please find enclosed the extracts from Southern Water's records for the above location.

We confirm payment of your fee in the sum of £49.92 and enclose a VAT receipt for your records.

Customers should be aware that there are areas within our region in which there are neither sewers nor water mains. Similarly, whilst the enclosed extract may indicate the approximate location of our apparatus in the area of interest, it should not be relied upon as showing that further infrastructure does not exist and may subsequently be found following site investigation. Actual positions of the disclosed (and any undisclosed) infrastructure should therefore be determined on site, because Southern Water does not accept any responsibility for inaccuracy or omission regarding the enclosed plan. Accordingly it should not be considered to be a definitive document.

Should you require any further assistance regarding this matter, please contact the LandSearch team.

Yours faithfully

LandSearch

VAT receipt

Ordered by:

Odyssey
White Hart Lane
Basingstoke
Hampshire
RG21 4AF

VAT registration number: 813 0378 56
Order reference: 309450
Your reference: 18-120

Receipt for provision of an extract from the public sewer and/or water main records.

Location	Costs
Shepheard Neame Water Lane Faversham Kent ME13 8TZ	£41.60
Net total	£41.60
VAT	£8.32
Total	£49.92
Paid	**Paid in full**

Thank you for your payment:

Received on: 18 September 2018

For enquiries regarding the information provided in this receipt, please contact the LandSearch team:

Tel: 0845 270 0212
0330 303 0276 (individual consumers)

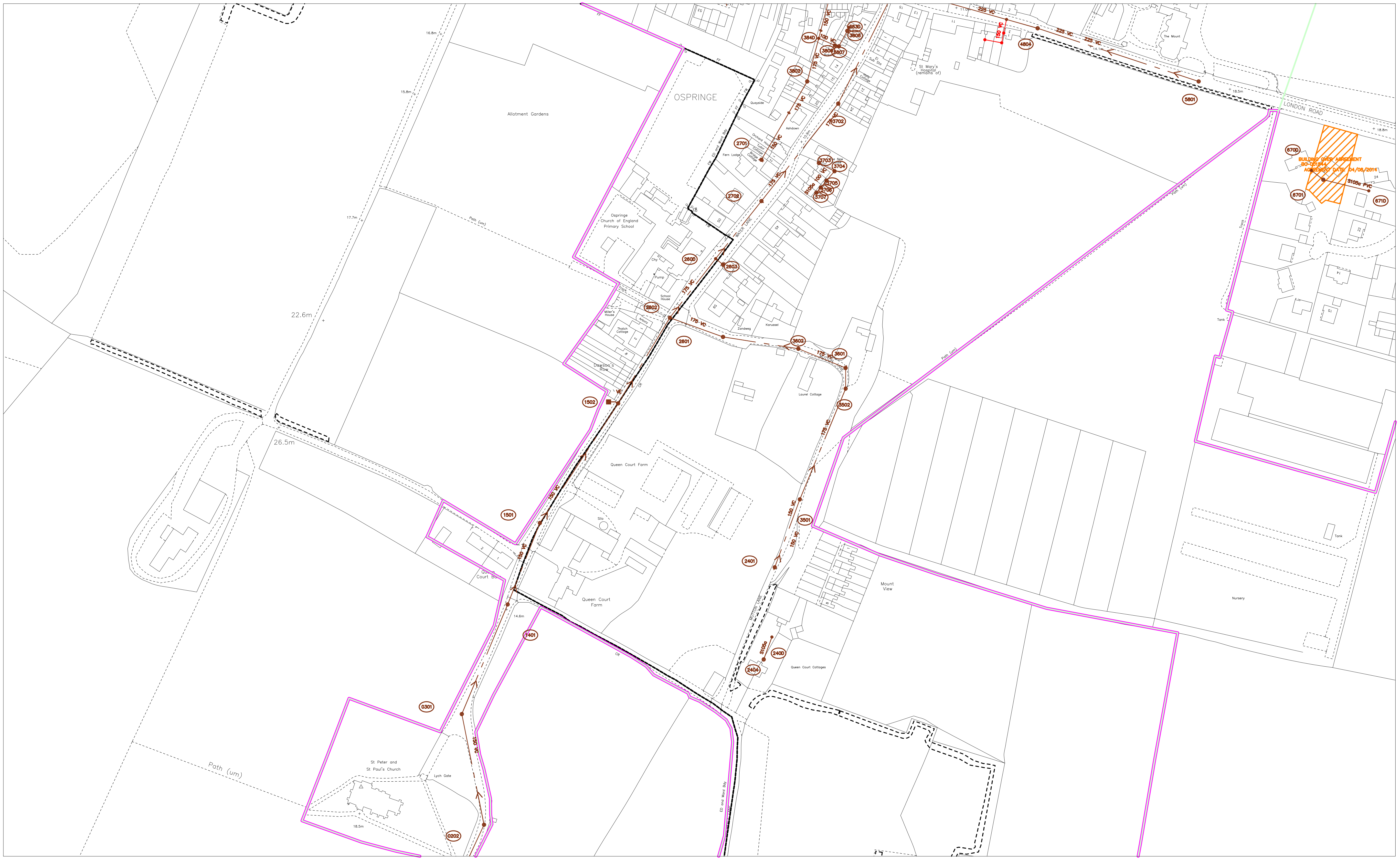
Email: searches@southernwater.co.uk

Web: www.southernwater.co.uk

LandSearch
Southern Water Services
Southern House
Capstone Road
Chatham
Kent
ME5 7QA

Southern Water

SEWER RECORDS PAGE 1 OF 2



O.S. REF.	Drawn by: ahmadr
TR0060NW	Scale: 1:2500
Title: 309450_Shepheard Neame Water L	Date: 19/09/2018

The positions of pipes shown on this plan are believed to be correct, but Southern Water Services Ltd accept no responsibility in the event of inaccuracy.
The actual positions should be determnined on site.

WARNING: BAC pipes are constructed of Bonded Asbestos Cement
WARNING: Unknown (UNK) materials may include Bonded Asbestos Cement

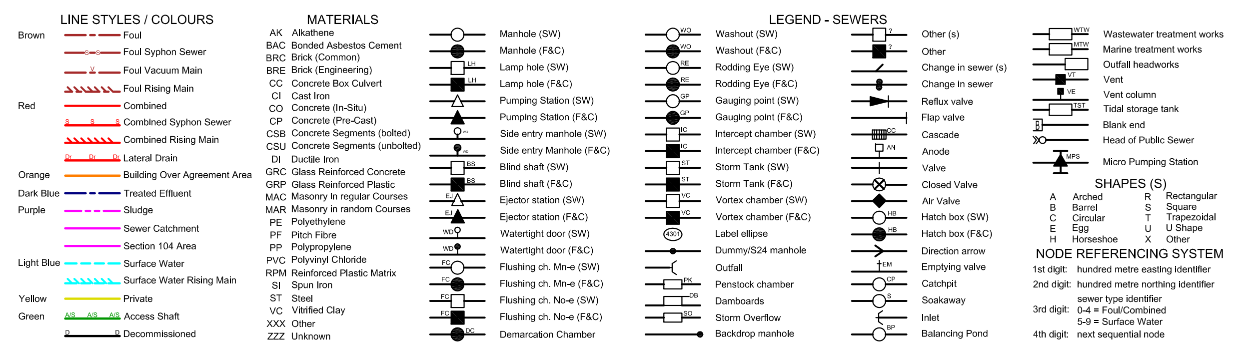
N

Southern Water

SEWER RECORDS PAGE 2 OF 2

Node	Cover	Invert	Size	Material	Shape
0202X	14.46	12.37	150	VC	CIRC
0301X	14.63	11.79	150	VC	CIRC
1401X	14.55	11.19	150	VC	CIRC
1501X	13.95	10.8	150	VC	CIRC
1502X	12.72	10.09	150	VC	CIRC
2401X	18.08	16.8	150	VC	CIRC
2404X	18.08	16.8	UNK	UNK	CIRC
2601X	11.81	10.03	175	VC	CIRC
2602X	11.63	9.69	175	VC	CIRC
2603X	11.3	9.98	100	VC	CIRC
260DX			175	VC	CIRC
2701X	10.87	9.93	150	VC	CIRC
2702X	10.85	9.02	175	VC	CIRC
3501X	18.16	16.45	175	VC	CIRC
3502X	14.63	12.61	175	VC	CIRC
3601X	13.77	11.9	175	VC	CIRC
3602X	12.38	10.37	175	VC	CIRC
3702X	10.73	8.67	175	VC	CIRC
3704X			100	VC	CIRC
3705X			100	VC	CIRC
3706X			100	VC	CIRC
3707X			100	VC	CIRC
370ZX			175	VC	CIRC
3802X	10.294		175	VC	CIRC
3806X			100	VC	CIRC
3807X			100	VC	CIRC
3808X			100	VC	CIRC
380ZX			150	VC	CIRC
383DX			100	VC	CIRC
384DX			175	VC	CIRC
4804X	12.05	9.87	225	VC	CIRC
480DX			225	VC	CIRC
481DX			150	VC	CIRC
482DX			150	VC	CIRC
483DX			150	VC	CIRC
5801X	18.07	16.264	225	VC	CIRC
6701X			UNK	PVC	CIRC
670DX			UNK	PVC	CIRC

Node	Cover	Invert	Size	Material	Shape	Node	Cover	Invert	Size	Material	Shape	Node	Cover	Invert	Size	Material	Shape



Drawn by:	ahmadr
Title:	309450_Shepheard Neame Water L
Date:	19/09/2018

Southern Water

APPENDIX G

Odyssey Fluvial Flood Study Report (Doc No. 15-347-01) and Environment Agency Correspondence

PROPOSED MIXED USE DEVELOPMENT
QUEEN COURT FARM YARD, KENT

Fluvial Flood Study Report

Report No. 15-347-01
April 2016

PROPOSED MIXED USE DEVELOPMENT
QUEEN COURT FARM YARD, KENT

Fluvial Flood Study Report

Odyssey Markides LLP
Tuscany House
White Hart Lane
Basingstoke
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RG21 4AF
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enquiries@odysseymarkides.com

Project No. 14-262

April 2016

DOCUMENT CONTROL SHEET

REV	ISSUE PURPOSE	AUTHOR	CHECKED	REVIEWED	APPROVED	DATE
-	Draft for comment	GG/JH	GG	RJH	RJH	April 2016

TABLE OF CONTENTS

1 INTRODUCTION

1.1 Appointment and Brief

1.1.1 Odyssey Markides was commissioned by Milliken and Co to assess flood risk associated with an intermittent stream (Nailbourne) historically referred to sometimes as Westbrook Stream for a proposed development at Queen Court Farm in Ospringe, Faversham. Refer to Figure 1.1 below for the site location plan.

1.1.2 The majority of the site falls within Flood Zone 3 and the Environment Agency (EA) do not hold suitable flood levels for the area to inform a site specific Flood Risk Assessment for the site. It was therefore necessary to carry out hydraulic modelling to determine flood levels and the resulting flood extents. Once agreed this data can then be used to inform the sequential approach within the site and therefore confirming the land available for development. Please see Table 1.1 below for the project summary;

TABLE 1-1 PROJECT SUMMARY

Project name:	Queen Court Farm Yard, Kent
Project type:	Hydraulic modelling of mainly overland flow and watercourses at the site and its immediate surroundings.
What is being modelled?	The Nailbourne (Westbrook Stream)
What existing modelling exists?	No hydraulic modelling currently exists.
What modelling has been undertaken and why was that approach chosen?	ESTRY-TUFLOW as detailed 1D (1-dimensional) -2D (2-dimensional) modelling package.
What hydrological analysis exists?	No hydrological analysis is available for the watercourses at the site.
What hydrological analysis has been undertaken?	Peak flow estimates and hydrographs for the 20%, 5%, 1%, 1% plus climate change and 0.1% Annual Exceedance Probability (AEP) scenarios.
What outputs have been produced?	Flood maps and levels for the 20%, 5%, 1%, 1% plus climate change and 0.1% Annual Exceedance Probability (AEP) scenarios.

1.2 Scope of Works

1.2.1 The primary aim of the modelling study is to identify the pre-development flood levels and floodplain extents in order to determine the land area available for development.

1.2.2 The flood levels and floodplain extents were therefore established for the following scenarios:

- 20% AEP (1 in 5 year);
- 5% AEP (1 in 20 year);
- 1% AEP (1 in 100 year);
- 1% AEP plus climate change allowance (1 in 100 year + 20%); and

- 0.1% AEP (1 in 1000 year).

1.2.3 The scope of works for the fluvial hydraulic modelling includes the following tasks:

- Prepare a Specification for a Topographical Survey of the watercourses and structures;
- Download available LiDAR data;
- Procure NextMap DTM data;
- Undertake hydrological analysis in order to obtain peak flows and hydrographs for the 20%, 5%, 1%, 1% plus climate change and 0.1% Annual Exceedance Probability (AEP) scenarios;
- Process the cross-sectional, topographical and structural survey data required to construct the hydraulic model;
- Construct computational grid with sufficient detail and prepare bathymetric map based on the LiDAR data (bare-earth) and NEXTMap DTM to form the basis of the 2D TUFLOW model;
- Construct a 1D-2D Flood Modeller Pro - TUFLOW hydraulic model using ground model, surveyed watercourse sections and hydraulic structure data;
- Assess the model performance against historical flooding if available and undertake calibration of the model;
- Run the baseline ESTRY -TUFLOW model for the 20%, 5%, 1%, 1% plus climate change and 0.1% Annual Exceedance Probability (AEP) scenarios to assess flood depth, velocity and flow routes associated with the watercourses in the vicinity of the site;
- Carry out sensitivity testing of the model (for parameters such as Mannings roughness, blockage scenarios and structure coefficients);
- Map the baseline 20%, 5%, 1%, 1% plus climate change and 0.1% Annual Exceedance Probability (AEP) flood plain extents within the vicinity of the site;
- Prepare modelling report. Submit model and modelling report to the Environment Agency and Swale Borough Council; and
- Once approved, the hydraulic model will be used to define the Flood Zone classification at the site and test any possible flood mitigation options required.

1.3 Project Limitations

1.3.1 Odyssey Markides hydraulic modelling is based on best practice and guidance current at the time of undertaking the project.

1.3.2 The baseline modelling undertaken assesses flood risk for an existing site/area in its current state. Any increase in flood risk caused by any alterations or future works to the area which are not modelled in the post-development scenarios are not included in this assessment.

1.3.3 The modelling undertaken is based on the interpretation and assessment of data provided by third parties. Odyssey Markides cannot be held responsible for the accuracy of the third party data and the conclusions and findings of this report may change if the data is amended or updated after the date of consultation.

1.3.4 The conclusions of the modelling report are based on the data gathered for the purpose of the project and therefore are limited in their accuracy in proportion to the validity of the dataset. The data gathered in turn has been based on an agreed scope of works. Odyssey Markides cannot guarantee that the data used is the best available at the time of the modelling, but it is the best available data that could be gathered within the scope of the agreed instruction.

1.4 Site Description

1.4.1 The site is located in Ospringe near Faversham. Refer to Figure 1.1 below for the site location map and Table 1-2 below for a summary.

TABLE 1-2 Site Description Summary

Site National Grid Reference:	The Ordnance Survey (OS) grid reference at the centre of the site is (600230, 160550) and the nearest post code is ME13 8UD.
Site area:	The total site area is approximately 1.1 hectares and the proposals are for a residential development.
Current use:	The site currently has a number of existing buildings mainly utilised for agricultural use. There are also large sections of open green space at the site.
Wider setting:	The site is bounded by Water Lane to west, Vicarage Lane to the south and Mutton Lane to the north and east.
Existing water bodies:	The Westbrook Stream (a winterbourne) has not flowed for many a year. The stream though currently dry rises from the Kent Downs to the south and used to flow past Ospringe Church and then through Queen Court Farm before turning west and discharging into Water Lane which acted as both road and river. This section on Water Lane was culverted in the early 1960s and the stream has since dried up.
Existing flood defences:	There are no known formal flood defences currently protecting the site.
Any other important comments:	No.

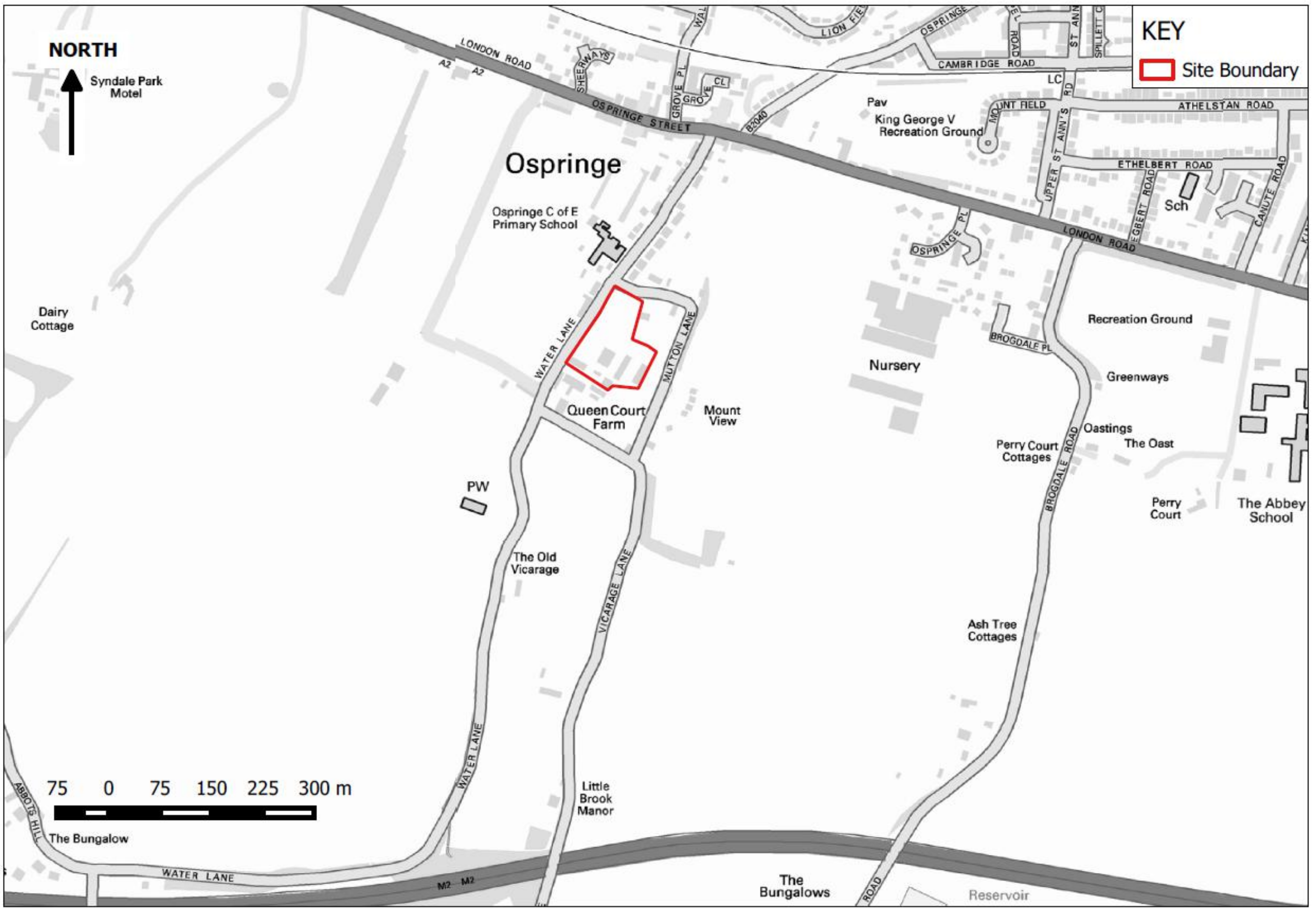

Figure 1:1 Site location

2 INPUT DATA

2.1 Key Input Data

2.1.1 Various sources of information have been utilised for this project with some of the relevant data sets listed in Table 2-1 below.

TABLE 2-1 Dataset Utilised

Dataset	Source	Date	Use	Quality[1]
Topographical channel survey	Trigon Surveys Ltd	Surveyed in January 2016	Provides cross section and structure details for the modelled ditches and overland key flood routes. Refer to Appendix B.	1
LiDAR (Light Detection And Ranging)	Environment Agency LiDAR	2011 and 2004	LiDAR data is only available for areas downstream of the A2 Canterbury Road.	1-2
NextMap DTM	NextMap	2012	The majority of the areas at the site and upstream do not have LiDAR coverage. NextMap DTM data has been utilised in the model build. Refer to Figure 2.1 below for the coverage.	2
Existing flood defences:	None			
Hydrometric data	None			
Any other important comments:	None			

[1] Data quality scoring taken from Multi-Coloured Manual (Flood Hazard Research Centre, 2005) – 1 = best possible, 2 = data with known deficiencies, 3 = gross assumptions, 4 = heroic assumptions

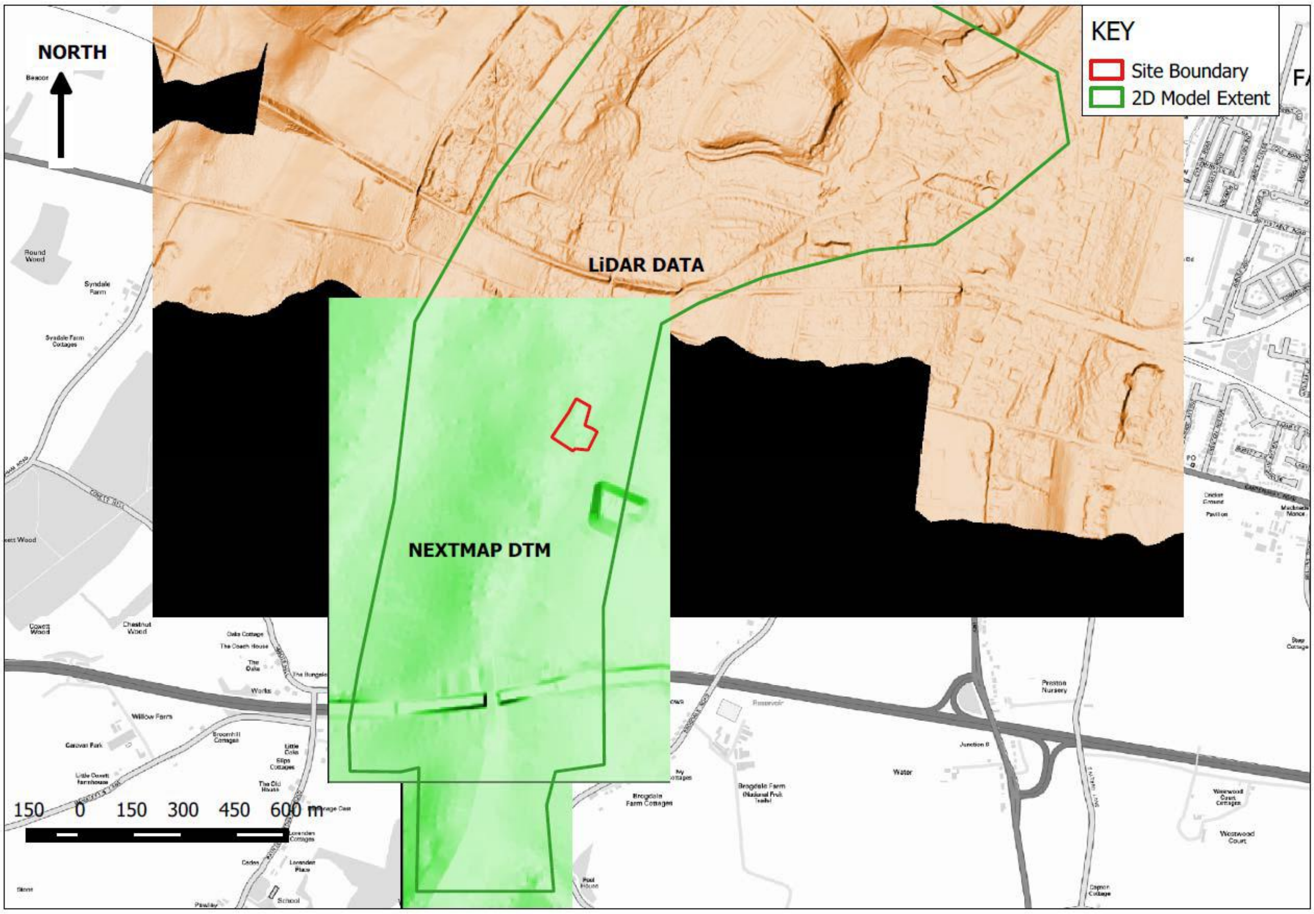

Figure 2:1 LiDAR and NEXTMap data coverage

3 MODELLING METHODOLOGY

3.1 Hydrological Analysis

3.1.1 A full hydrological analysis was undertaken in order to derive the peak flow and hydrographs for the hydraulic model as described in Table 3.1 below. Refer to Appendix A for the full hydrological analysis.

TABLE 3-1 Hydrological Analysis

Summary of hydrological analysis required:	Design flow hydrographs for input into the hydraulic models.
Number and location of flood estimation points:	Two flow estimation points at; • NGR 599950,159650 (Upstream of the site at the M2) • NGR 600300,160800 (Downstream of the site at the A2 Canterbury Road)
Peak flows, hydrographs or hyetographs?	Hydrographs
Return periods:	1 in 5, 20, 100 and 1 in 1000 year (20%, 5%, 1%, 0.1% AEP respectively).
Climate change estimation?	1% AEP (1 in 100 year) increased by 20%.
Choice of approach?	Revitalised Flood Hydrographs (ReFH) scaled to Statistical Method peak flows.
Reason for approach:	The statistical method for estimating flood flows is favoured as it is based on a much larger dataset of flood events, and has been more directly calibrated to reproduce flood frequency on UK catchments giving it a greater confidence in deriving the index flood (QMED).
Comparison against other approaches undertaken?	Yes – ReFH peak flows.
How flows were incorporated into the hydraulic model?	ReFH hydrographs scaled to fit statistical method peak flows and incorporated into ESTRY-TUFLOW.

3.1.2 The key catchment descriptors for all the catchments assessed in the hydrological analysis are in Table 3-2 below;

TABLE 3-2 Key Catchment Characteristics

Catchment:	**M2**	**A2**
EASTING (m)	599950	600300
NORTHING (m)	159650	160800
AREA (ha)	50.44	52.63
FARL:	1	1
PROPWET:	0.34	0.34
BFIHOST:	0.714	0.713
DPLBAR (km):	7.42	8.46
DPSBAR (m/km):	52.7	52.2
SAAR (mm):	760	755
SPRHOST:	28.76	28.84
URBEXT1990	0.0035	0.0048
URBEXT2000	0.0032	0.0042
FPEXT:	0.023	0.0241
Pumped watercourse?	No	No
Any unusual catchment features? In particular is BFIHOST>0.65, SPRHOST<0.20, URBEXT>0.125, FARL<0.90 or high FPEXT?	The catchment is permeable with a BFIHOST value of 0.714	Permeable catchment with a BFIHOST value of 0.713

3.1.3 The final peak flow estimates for the above catchments were calculated using the FEH Statistical Analysis method, and summarised in Table 3-3 below. Refer to Appendix A for the full hydrological analysis.

TABLE 3-3 Summary of Peak Flows

Catchment:	**Reach A (m^3/s)**	**Reach B (m^3/s)**
20% AEP (1 in 5 year)	6.02	6.17
5% AEP (1 in 20 year)	8.04	8.24
1% AEP (1 in 100 year)	10.71	10.97
1% AEP + 20% (1 in 100 year CC)	12.85	13.17
0.1% AEP (1 in 1000 year)	19.95	20.28

3.2 Baseline Hydraulic Modelling

3.2.1 The process undertaken in the baseline hydraulic modelling is detailed in Table 3-4 below.

TABLE 3-4 Hydrological Analysis

Summary of hydrological analysis required:	Design flow hydrographs.
What existing modelling exists?	There are no existing hydraulic models for the area.
What modelling has been undertaken and why was that approach chosen?	**ESTRY-TUFLOW** combines an accurate, very stable 1D channel solver able to model channels and culverted networks with a 2D floodplain model based on a finite grid approach. The two solvers are dynamically linked, such that water can flow from the channel to the floodplain, and vice-versa.
What software version(s) have been used?	TUFLOW – v2013-12-AE-iSP-w64
How have watercourse channels been represented?	The watercourse geometry was constructed using ESTRY and based on the surveyed cross sections. Where appropriate, sections were trimmed to ensure no double counting of the floodplain. 2No. cross sections at the upstream end of the hydraulic model were extracted from NextMap DTM data. Refer to Figure 3.1 below for the hydraulic model schematic.
How have watercourse channel	The culverts within the model domain have all been modelled as per the recommendations in TUFLOW.

<table>
<tr><td>structures been represented?</td><td></td></tr>
<tr><td>How have sewer networks been represented?</td><td>No sewer networks were modelled as part of the above proposals.</td></tr>
<tr><td>How has the floodplain/ground surface been represented?</td><td>The 2D domain was constructed using TUFLOW and based upon filtered LiDAR data and NextMap 5m DTM data. A grid size of 4m was chosen to allow for detailed modelling of the overland flow paths. Refer to Figure 3.1 below for the hydraulic model schematic.</td></tr>
<tr><td>How have different models been linked?</td><td>The boundary between the 1D and 2D models was chosen, as appropriate, for each individual cross section. An HX boundary (Head-eXchange or Head from eXternal source) was used for the link in TUFLOW, which takes the water level from Flood Modeller Pro and applies it along the boundary to allow flow into the 2D domain.

The area between the 1D-2D boundary (HX lines) was set to ‘inactive’ in the 2D model to ensure that flow was not double-counted. Care was also taken to ensure that the width of the 1D element was reflected in the width of the inactive cells.</td></tr>
<tr><td>Have any adjustments to the raw DTM been made?</td><td>To ensure a better and more accurate link between the two models, a thick Z line (a 3D polyline) was snapped along the boundary based on surveyed levels (and where needed LiDAR) to ensure that the 2D domain levels match the Flood Modeller Pro model.</td></tr>
<tr><td>How have flood defences been represented?</td><td>There are no known formal flood defences along the modelled watercourses.</td></tr>
<tr><td>What boundary conditions have been used?</td><td>A HQ (head verses flow) boundary based on floodplain slope in TUFLOW was created to allow flow to exit the model at the downstream end of the 2D domain.</td></tr>
<tr><td>What roughness values have been used?</td><td>Channel and floodplain roughness were represented within the model by using Manning’s n values for roughness. Parameters were chosen with reference to standard values, using site visit photographs and engineering judgement.

<table>
<tr><th>ISIS</th><th>Manning’s n</th></tr>
<tr><td>In-channel – normal bed</td><td>n = 0.045</td></tr>
<tr><td>TUFLOW</td><td>Manning’s n</td></tr>
<tr><td>Grass</td><td>0.04</td></tr>
<tr><td>Woodland</td><td>0.1</td></tr>
<tr><td>Roads</td><td>0.02</td></tr>
<tr><td>Buildings</td><td>1.0</td></tr>
<tr><td>Inland Water</td><td>0.03</td></tr>
<tr><td>Roadside</td><td>0.02</td></tr>
<tr><td>Paths</td><td>0.03</td></tr>
<tr><td>Rail</td><td>0.03</td></tr>
</table></td></tr>
<tr><td>What structure coefficients have been used?</td><td>The parameterization of the culvert energy losses were set to default ESTRY values for circular and rectangular culverts.</td></tr>
<tr><td>Are there any changes to default model or run parameters? Why?</td><td>No changes to default parameters.</td></tr>
</table>

What timestep has been used?	A 1.5 second time step was used for the 2D. This is in accordance with the recommendations that the 2D time step should be no smaller than a quarter and less than half the 2D grid size. A 1D time step of 0.1 seconds was utilised to aid model stability.

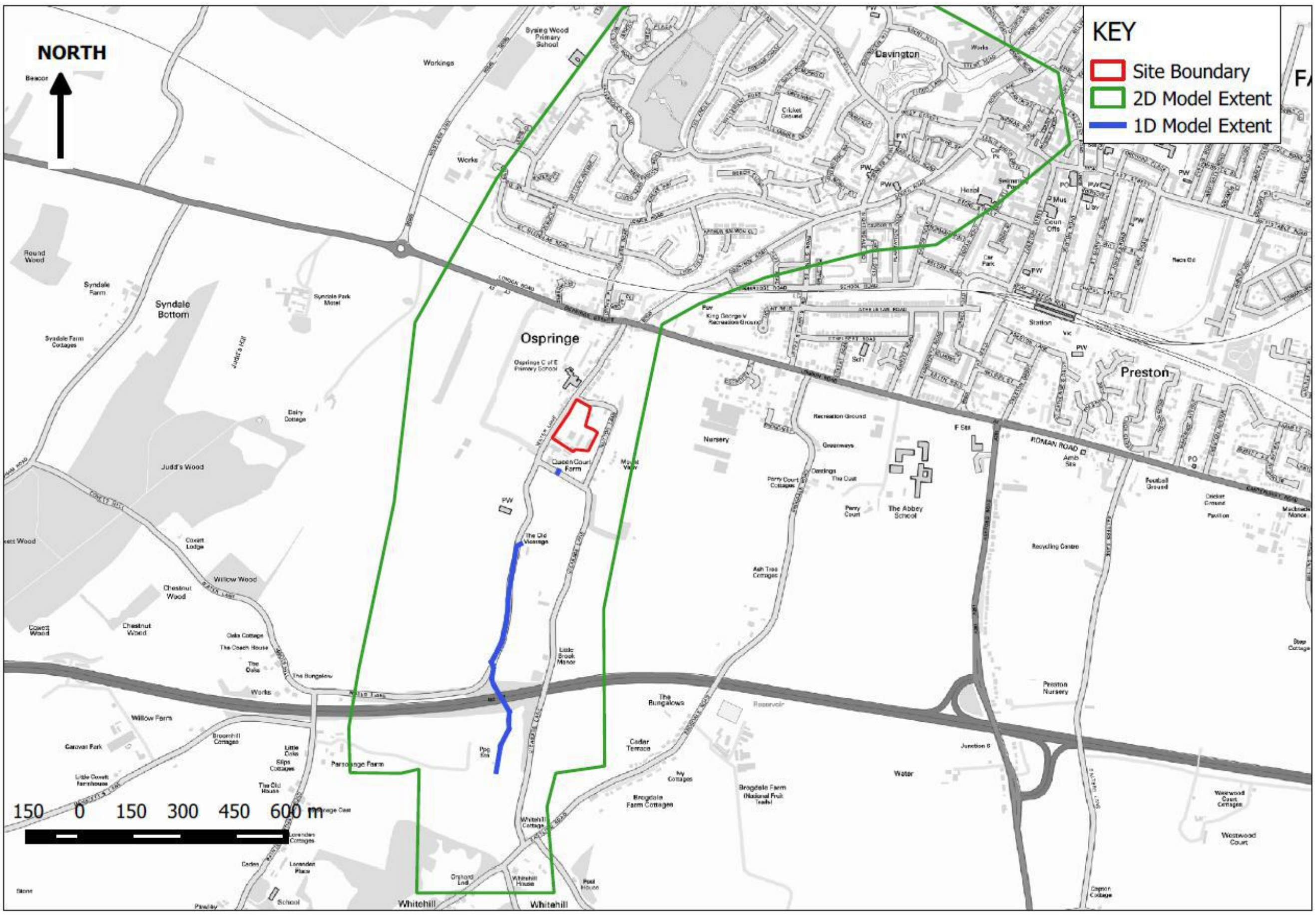

Figure 3:1 Hydraulic model schematic

4 MODEL PROVING

4.1 Calibration and other models

4.1.1 Table 4.1 below summarises the calibration and verification of the hydraulic models.

TABLE 4-1 Calibration and Sensitivity

Was data available for calibration and verification?	No.
Is there an existing model that can be compared against?	There is currently no existing model for the area.
Has sensitivity testing been undertaken in lieu of calibration?	Yes.
Has sensitivity testing been undertaken to support the calibration?	Yes.

4.2 Sensitivity Analysis

TABLE 4-2 Calibration and Sensitivity

What sensitivity tests have been undertaken?	+/-20% roughness, +/-20% culvert coefficients and 50% blockage at the Vicarage Lane culvert immediately upstream of the site.
Are there any significant differences between the baseline and sensitivity tests?	Roughness – fairly minor differences. Approximately 70mm maximum increase in peak water level at the site for +20% roughness for a localised area but generally less than 10mm. Culvert coefficients – minor differences. 20mm increase in peak water level at the site.
Is the model sensitive to key parameters tested?	Roughness – On average generally insensitive to changes in roughness at the site. Culvert coefficients – generally insensitive to changes in culvert coefficients at the site.

4.3 Blockage analysis

TABLE 4-2 Calibration and Sensitivity

Was blockage analysis undertaken?	Yes
What scenarios were tested?	A 50% blockage of the culvert on Vicarage Lane immediately upstream of the site.
What were the key outcomes?	The hydraulic modelling results show that there is a maximum increase of 30mm in flood levels at the site as a result of the blockage. Care will have to be taken to ensure that the culvert is kept clear of debris.

4.4 Run Performance

4.4.1 A summary of the run performance is summarised in Table 4-2 below;

TABLE 4-2 Run Performance

Is the model stable?	Yes, very little fluctuation in model results throughout both solvers.
Is the mass balance error sensible?	Yes, the final cumulative mass balance for the 1 in 100 year event is 1.13%. This is within the +/-3% recommended within the TUFLOW manual as appropriate values.
Are there any negative water depths?	No
What warnings and checks does the model give? Are any systematic of problems?	All warnings and checks associated with non-critical checks by TUFLOW.
Any other comments?	No
Is the model 'healthy'?	Yes

5 MODEL RESULTS

5.1 Baseline Design Runs

5.1.1 The primary aim of the hydraulic modelling study is to identify the pre-development flood levels and flood plain extent in order to determine the land was available for development purposes. The model was used to predict flood levels for the following events:

- 20% AEP (1 in 5 year);
- 5% AEP (1 in 20 year);
- 1% AEP (1 in 100 year);
- 1% AEP plus climate change (1 in 100 year plus climate change); and
- 0.1% (1 in 1000 year).

5.1.2 The modelling results show that the M2 Motorway 500m upstream of the site and the Vicarage Lane immediately to the south constitute critical hydraulic structures. The embankments acts as a hydrological boundaries and the culverts throttles the flows before being discharged through the site.

5.1.3 The predicted peak water levels for the watercourse and ditches indicate that overland flood flows are generally out of bank at the modelled ditch adjacent to Water Lane. The floodplain is significantly wider at the upstream end of the M2 Motorway as shown in Figures 5.1 – 5.5 below.

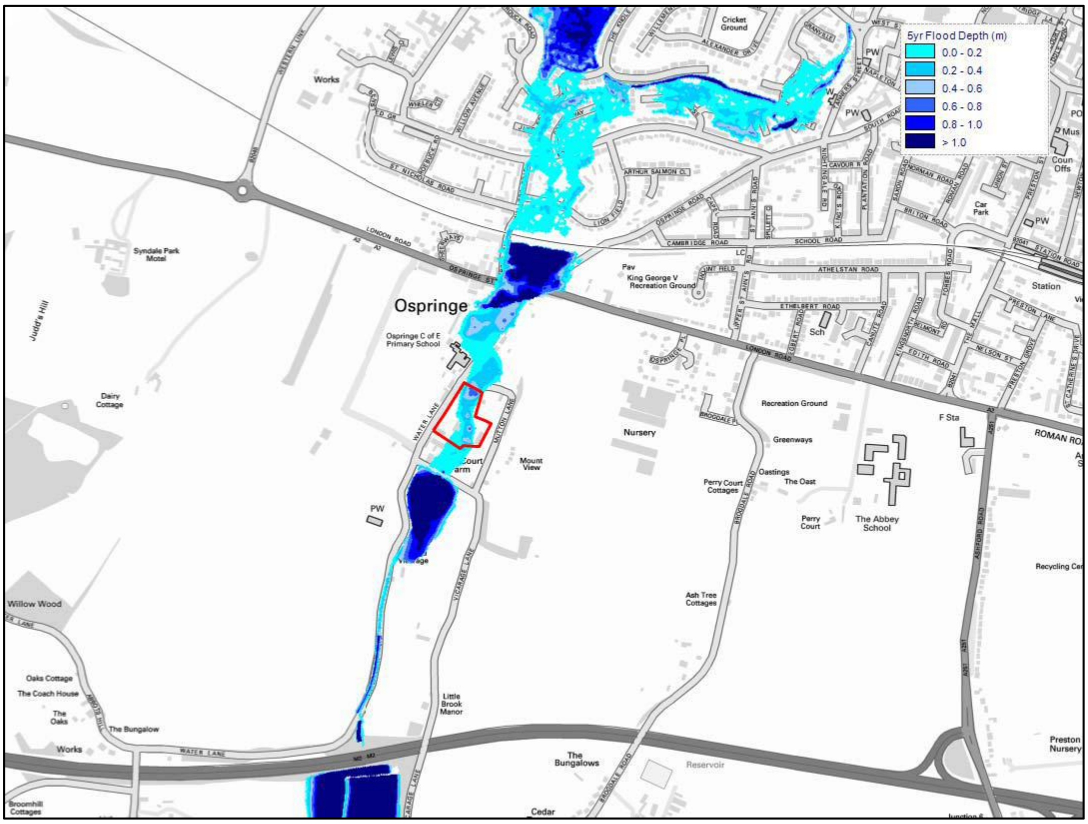

Figure 5:1 Baseline 1 in 5 year peak flood depths

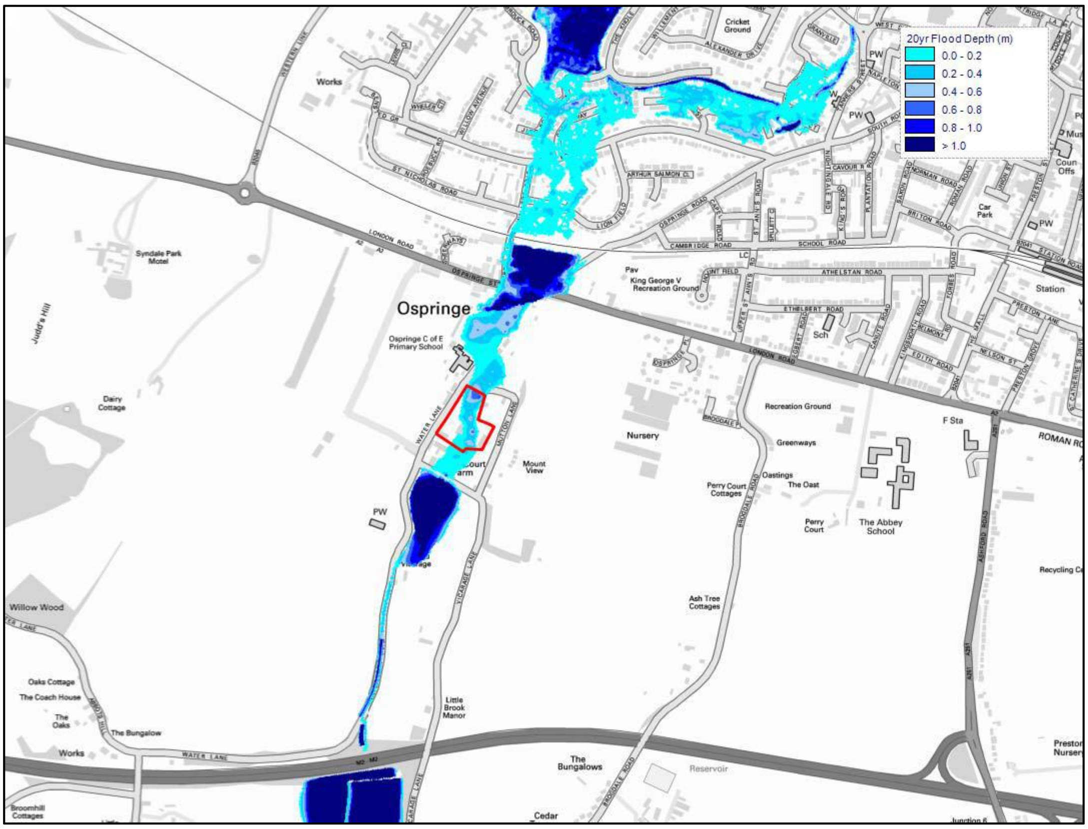

Figure 5:2 Baseline 1 in 20 year peak flood depths

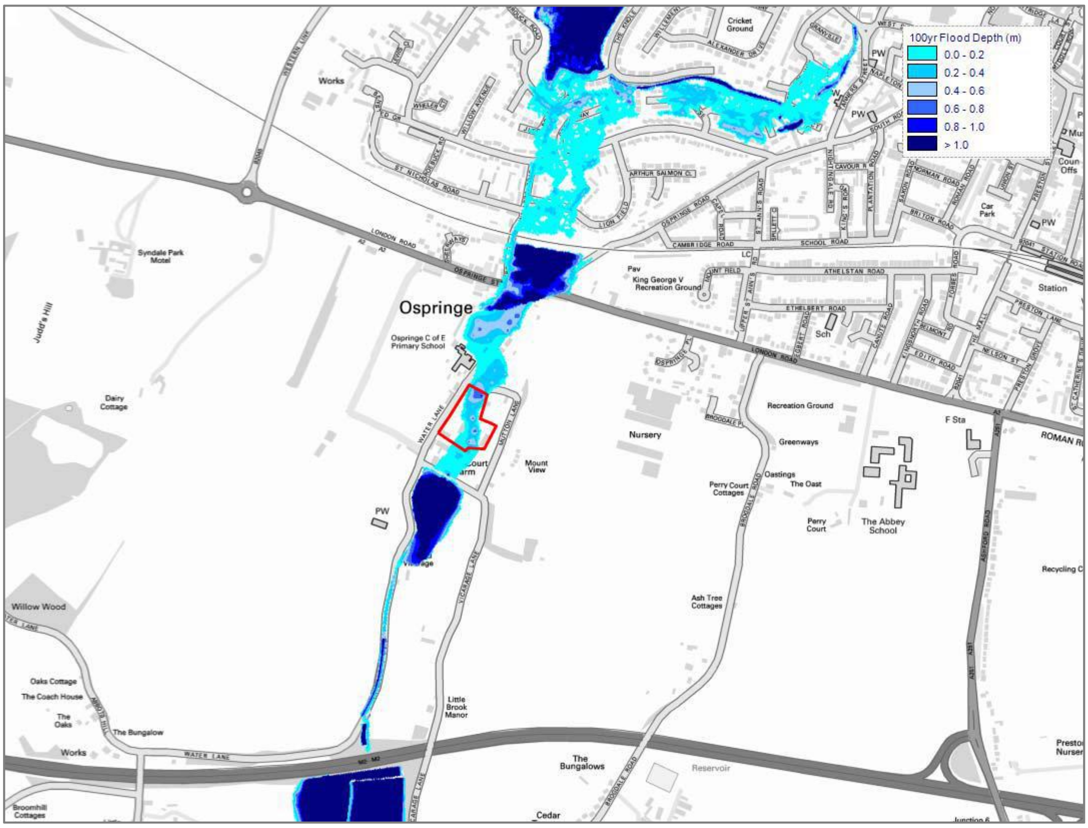

Figure 5:3 Baseline 1 in 100 year peak flood depths

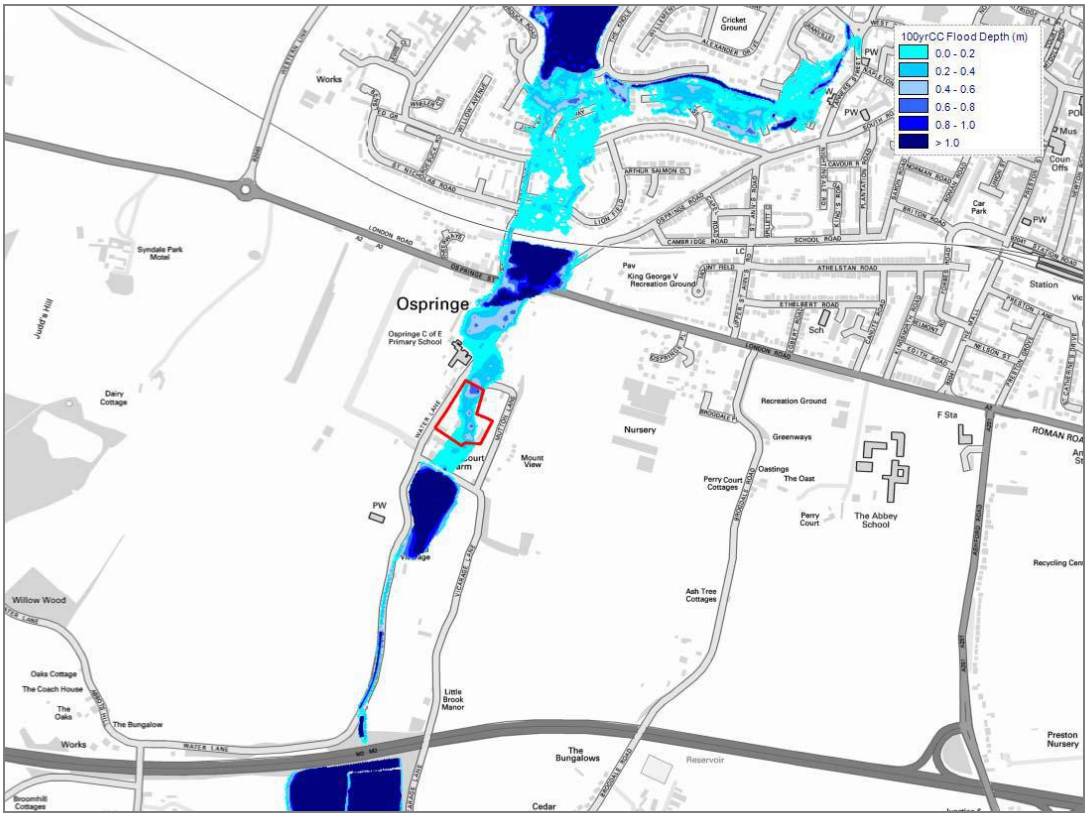

Figure 5:4 Baseline 1 in 100 year plus climate change peak flood depths

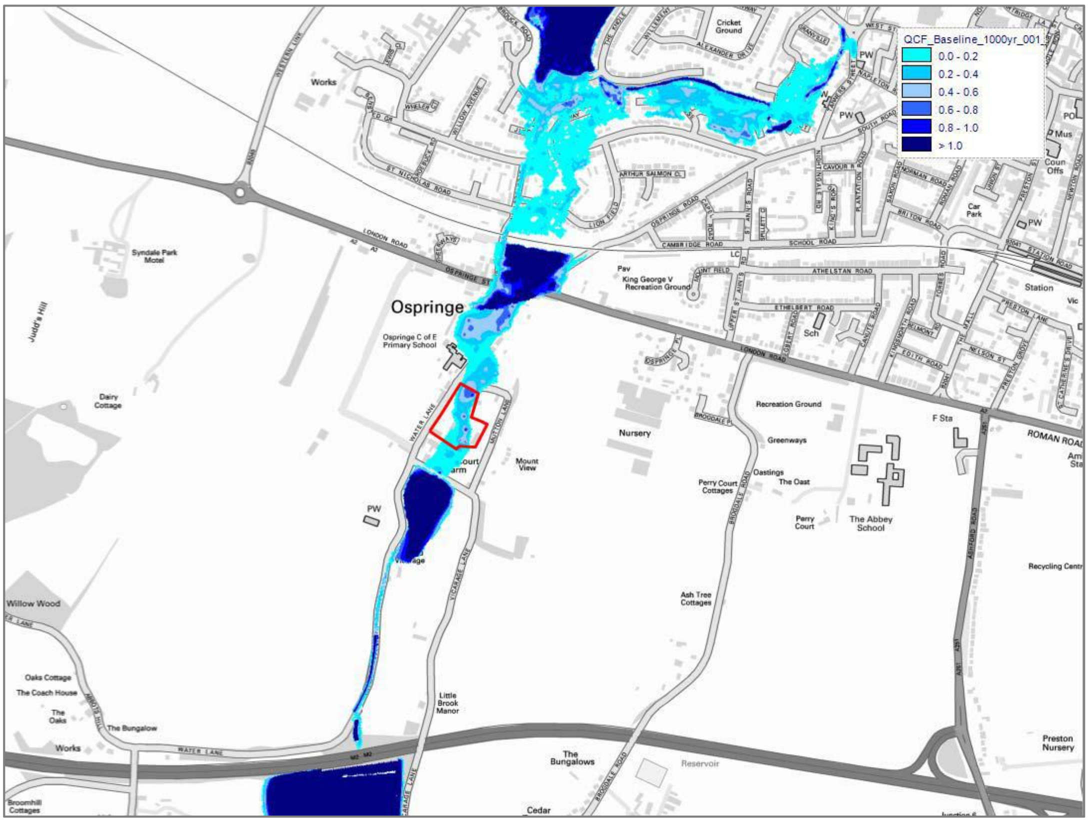

Figure 5:5 Baseline 1 in 1000 year peak flood depths

6 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

6.1.1 Odyssey Markides was commissioned by Milliken and Co to assess flood risk associated with an intermittent stream (Nailbourne) historically referred to sometimes as Westbrook Stream for a proposed development at Queen Court Farm in Ospringe, Faversham.

6.1.2 The majority of the site falls within Flood Zone 3 and the Environment Agency (EA) do not hold suitable flood levels for the area to inform a site specific Flood Risk Assessment for the site. It was therefore necessary to carry out hydraulic modelling to determine flood levels and the resulting flood extents. Once agreed this data can then be used to inform the sequential approach within the site and therefore confirming the land available for development.

6.1.3 The fluvial model was constructed using the ESTRY- TUFLOW which combines an accurate, very stable 1D channel solver able to model channels and culverted networks with a 2D floodplain model based on a finite grid approach. The two solvers are dynamically linked, such that water can flow from the channel to the floodplain, and vice-versa.

6.1.4 The sensitivity analysis has shown that the flood levels at the site are not sensitive to any variation in structure coefficients and roughness; however the sensitivity results show the model is moderately sensitive to flow though the variations in flow inputs results in small changes to the flood extents at the site.

6.1.5 The following limitations to the hydraulic are notes;

- No hydrometric data exists for the ditches within the study area. This meant that the model could not be calibrated against observational data to further improve confidence in the results;
- The floodplain ground level data outside the topographical survey was sourced from LiDAR and NextMap data and may not accurately represent all the flow paths; and
- The catchment is highly permeable and most of the FEH flow estimation methods are outside the ranges for permeable catchments.

6.1.6 It is recommended that the hydraulic model and associated hydrological analysis are accepted as best available source of information and the model results will inform the following;

- Flood Zone classification at the site;
- Testing of flood mitigation options to ensure that the proposals do not exacerbate flooding in all areas upstream and downstream of the site;
- Finished floor levels for the proposed development parcels;
- Flood hazard mapping to inform safe access and egress from the site; and
- Soffit levels for proposed crossings or bridges on the existing watercourses.

APPENDICES

APPENDIX A
Hydrology

1.1 FEH Index Flood (QMED)

1.1.1 QMED from Catchment Descriptors

1.1.1 The study reach is The Nailbourne (Westbrook Stream), a tributary of Faversham Creek that runs through the Faversham town centre in Kent.

1.1.2 The FEH catchment descriptors are initially used to derive an estimate of QMED (Table 1). Since the catchment of the study reach is classified as essentially rural ($URBEXT_{2000}$ < 0.030), urban adjustment would be unnecessary.

Table 1 QMED from Catchment Descriptors at Subject Site

Site	QMED from catchment descriptors (m^3/s)
Reach Nr A2	4.234
Reach Nr M2	4.132

1.1.2 QMED at Donor Sites

1.1.3 The flow estimation process requires the adjustment of the empirically derived QMED flows using recorded flow data at one or more nearby Environment Agency flow measurement stations. The Environment Agency does not operate any gauging stations in the Faversham Creek catchment or its tributaries. The nearest gauging stations, as available on the NRFA website (version 3.3.4, released August 2014), with catchments that drain areas within 10km of the site are summarised in Table 2.

Table 2 EA Gauging Stations near the Cold Ash Catchment

CEH Ref No.	Watercourse	Location	Grid Ref	Flow record start	Flow record end	Number of years
40011	Great Stour	Horton	TR115553	01/07/1964	30/09/2012	48
40008	Great Stour	Wye	TR048470	18/07/1960	30/09/2012	52
40022	Great Stour	Chart Leacon	TQ992422	20/03/1967	30/09/2012	45
40005	Beult	Stilebridge	TQ758477	01/10/1958	30/09/2001	43

1.1.4 NRFA provides the following comments on these four gauges:

- **40011 - Great Stour at Horton.** A broad crested weir with crest width 10.55 m, insensitive, in trapezoidal section with velocity-area section for flows >20 m^3/s. The weir is a British Standard horizontal and broad crested, both upstream and downstream faces having a rounded nose, however it has a non-standard 0.02 m height variation along the crest width (1.8m). Flow is contained by sloping side bunds, with no wing walls. Bed is open textured gravel of considerable depth, which is a feature of the River Stour from Wye to Canterbury. There is a confluence 0.2 km upstream of the gauge, upstream of which the Stour flows through multiple channels. Telemetry present. All flows contained and the station has never gone out of range at the weir throughout the record, however a 2002 station review revealed that secondary flow paths present along the public footpath between the channel and sewage ponds. Structure-full flow 46.0 m^3/s; bank full flow 46.23 m^3/s. Problems with downstream channel erosion at the end of the concrete structure, resulting in a local channel widening of approximately 2 m. Electromagnetic gauge installed 1992 but rarely used as weir rating is so reliable. Flow records are suitable for medium range floods (QMED) determination and pooling group analysis.

- **40008 - Great Stour at Wye**. A triangular profile Crump weir with 7.63m width, drowns at approximately 3 m^3/s / 0.63m. Velocity-area station present downstream for high flows gauging. Previously a broad crested weir (1960-62) which was subject to premature drowning frequently due to weed growth and the low design of the weir sill. Low confidence in this site. In 1962, sill was raised and the downstream section was dredged by approximately 23cm. It was proposed to clear the weed annually to prevent further drowning, however conservation concerns have halted this in recent years. The River Stour is wide and shallow at the gauging station, the floodplain is limited by the railway line. Wye Bridge contains 5 arches with secondary arches between the river & railway line to accommodate very high flows. Inspection of the gauge in 2002 for a rating review suggests a secondary flow path upstream of Wye Bridge possibly results in flow through the secondary culverts, bypassing the gauge. Bank is overtopped at 1.65m stage, flow contained in floodplain to 1.85m stage; possible secondary flow path present along footpath between railway station and channel. The visit also revealed some siltation and in channel vegetation. The weir conforms to British Standards up to 0.3m stage. Flow records are suitable for QMED and pooling.
- **40022 - Great Stour at Chart Leacon**. A flat V shape weir with 7.96m wide crest superseded a Velocity Area station (1967-1979). The VA station was installed to provide design data for future structure and was subject to vegetation problems. Flat V weir has very shallow approach depth, flow becomes non-modular at stages >0.217m. The gauge suffers from vegetation and channel siltation problems, the latter possibly caused by concrete energy dissipation blocks downstream of the gauge. The 2002 review suggests that these may reduce the effectiveness of the gauge at moderate flows due to the already limited drop off of the weir. The weir does not conform to British Standard as the downstream slope is inadequate and the approach channel is not straight and uniform. Outflow from Singleton Lake will impact flow over the weir. Gauge is located 3.5km upstream of the confluence with the East Stour. The low modular limit, Singleton Lake outflows & backwater effects from the B2229 road bridge hinder the gauges effectiveness at high flows. Gaugings taken by wading with rods, which can result in an underestimation of flow through the gauge. Telemetry present. Flow records are suitable for QMED determination however may not be suitable for pooling due to few high flow gaugings and rating cannot be validated beyond QMED.
- **40005 - Beult at Stilebridge**. Weir was demolished in July 2001, leaving a cableway 33m upstream. The new Flat-V weir has now been completed in 2003. It is slightly upstream of the old site, by the cableway. A crest tapping sensor is due to be installed as well as a downstream level recorder. An ultrasonic gauge with the new structure came online in October 2002, however it has yet to be calibrated. Flood banks confine flows, the floodplain beyond this is approximately 300-400m wide. Structure limit at 1m / 6.1 m^3/s. Telemetry present. The previous weir consisted of a compound broad-crested structure, with the central flume separated by short divide piers (which could trap debris) from the broad-crested flanking sections. The ends of the dividing walls caused disturbance of flow, although modelling showed a negligible overall impact. Old station was regarded as full range (aside from largest exceptional events). The station is located on a long and reasonably straight reach of the River Beult at approximately 110m downstream of the Stilebridge and 12 km upstream of the Medway confluence. The Medway may control the levels in severe floods. Some upstream accretion & colonisation by reeds, unlikely to jeopardise rating. Data presented only for the original weir site, hence no data from July 2001. Flow records are suitable for QMED and pooling.

1.1.5 From the comments provided by NRFA, the flow data is considered suitable for QMED at all four stations and therefore a detailed analysis of the high flow ratings at these four gauges is not considered necessary as part of this study. Therefore, the available AMAX series at these sites is used in the flood estimation process described below.

1.1.3 Donor Adjusted QMED

1.1.6 FEH requires that the catchment descriptor derived QMED at an ungauged site is adjusted using the ratio between QMED from the catchment descriptors and QMED from flow data at a local donor gauging station. As detailed above there are four suitable potential donor gauging stations with flow records considered suitable for estimating QMED. However in selecting a suitable gauging station FEH provides hydrological similarity criteria as follows;

- AREA - a factor of no more than 4 or 5