ODYSSEY

DEVELOPING JOURNEYS

SHEPHERD NEAME, QUEEN COURT FARMYARD SITE, OSPRINGE, FAVERSHAM

FLOOD RISK ASSESSMENT AND DRAINAGE STRATEGY

SHEPHERD NEAME, QUEEN COURT
FARMYARD SITE, OSPRINGE, FAVERSHAM

FLOOD RISK ASSESSMENT AND DRAINAGE STRATEGY ON BEHALF OF MILLIKEN AND COMPANY CHARTERED SURVEYORS AND TOWN PLANNERS

Prepared by
Odyssey
Tuscany House
White Hart Lane
Basingstoke
Hampshire
RG21 4AF

Tel: 01256 331144

August 2022

DOCUMENT CONTROL SHEET

Project Name Shepherd Neame, Queen Court Farmyard Site, Ospringe, Faversham

Project No. 18-120

Rev	Issue Purpose	Author	Checked	Reviewed	Approved	Date
-	Draft	JW	JW	GG	GG	10/11/2021
A	Updated for site layout	JW	JW	RA/NA	RA	10/08/2022
B	Final	JW	JW	RA/NA	RA	10/08/2022

CONTENTS

DRAWINGS

APPENDICES

1.0 INTRODUCTION

1.1.1 Odyssey has been commissioned by Milliken and Company Chartered Surveyors and Town Planners to provide a Flood Risk Assessment (FRA) and Drainage Strategy with respect to the construction of a proposed residential development comprising seven barn style residential units at Queen Court Farmyard Site, Water Lane, Ospringe, Faversham.

1.1.2 The site currently comprises approximately 0.7 hectares (ha) with five existing buildings. The development proposal is to demolish the five buildings and construct seven dwellings, with associated car parking areas and a new access road onto Water Lane. The site layout is presented in **Appendix A**.

1.1.3 This report comprises of the following elements:

- Summary of relevant planning policy;
- Review of existing site conditions including the hydrology, geology and existing drainage regime of the site;
- Assessment of the existing flood risk to the site; and,
- Proposed surface water management and foul drainage strategies.

2.0 EXISTING SITE

2.1 Site Location

2.1.1 The site is located at Water Lane, Faversham, which is located approximately 1.3 kilometres (km) south-west of Faversham railway station. The site is bounded by undeveloped land to the north and west, residential units to the east, undeveloped land and agricultural buildings to the south.

2.1.2 The Ordnance Survey grid reference for the site is 600278E, 160510N, and the nearest postcode is ME13 8UH.

2.1.3 The site location plan is presented in **Appendix A**.

2.2 Topography

2.2.1 A topographical survey was produced by Hook Survey Partnership in October 2011, which shows the existing levels across the site. The survey shows that levels fall from approximately 18.16 metres above ordinance datum (mAOD) in the east, towards the west down to the existing building where the levels are flatter, ranging between 12.46 and 11.48mAOD before rising to approximately 13.30mAOD at the road to the west of the site. The topographical survey is presented in **Appendix B.**

2.3 Hydrology

2.3.1 The nearest EA main river is the Faversham Creek, which is situated approximately 1.5km north-east of the site.

2.4 Geology and Hydrogeology

2.4.1 British Geological Survey (BGS) mapping (accessed August 2022) indicates that the bedrock geology of the site consists of Seaford Chalk Formation. There are superficial deposits of Alluvium – clay, silt, sand and gravel, and Head – gravel, sand, silt and clay over the western side of the site. The BGS records are presented in **Appendix C**.

2.4.2 There are three borehole scans that were taken near the site location, which can provide insight into the geology of the site. A short description of each is provided below.

2.4.3 Borehole scan TR06SW44 was taken approximately 450m north-east of the Site, and shows a topsoil layer extending down 0.4m below ground level (bgl), before a layer of *'soft to fine brown silty slightly sandy Clay'* extends down a further 1.2m bgl, and a layer of *'very light grey* *remoulded chalk'* extends a further 0.6m bgl. From there, a layer of *'soft dark-grey brown slightly sandy Clay'* extends for a further 0.7m bgl, before a layer of *'flint gravel with firm brown silty Clay'* extends for a further 2.8m bgl. Finally, a layer of *'white rock Chalk with some remoulded Chalk'* then extends down a further 4.3m bgl to the bottom of the borehole at a depth of 10.0m bgl.

2.4.4 Borehole TR06SW45 was taken approximately 450m north-east of the Site and shows a layer of *'dark silty topsoil'* extending for 0.7m bgl, before a layer of '*coarse flint gravel and coarse sand with some clay'* extends a further 4.8m bgl. A layer of *'flint gravel'* is present for a further 0.3m, before a layer of *'white rock chalk fragments with remoulded chalk'* extends down for a further 1.0m, and a layer of *'white rock chalk with some remoulded chalk'* extends a further 3.2m bgl to the bottom of the borehole at a depth of 10.0m bgl.

2.4.5 Borehole TQ95NE19 was taken approximately 780m south-west of the site and shows a layer of *'soft dark brown clay'* extending down 2.0m bgl, before flint gravel extends down a further 1.1m. After this, moderately fissured white chalk extends a further 3.4m bgl to reach the bottom of the borehole at 6.0m bgl.

2.4.6 These borehole scans are presented in **Appendix C.**

2.4.7 British Geological Survey hydrogeological mapping shows that the site lies within the White Chalk Subgroup, described as a *'highly productive aquifer'*.

2.4.8 The site is not in any of the EA's Source Groundwater Protection Zones. However, the development shall still adhere to the EA's 'Approach to Groundwater Protection' guidance to ensure that groundwater quality is maintained and improved across the Site.

2.4.9 It should be noted that borehole scan TQ95NE19 first encountered groundwater at a depth of 2.3m bgl, while scans TR06SW44 and TR06SW45 struck groundwater at 5.0m bgl.

2.5 Existing Drainage Regime

2.5.1 According to Southern Water records, there are no surface water sewers in the immediate vicinity of the site. It is therefore anticipated that surface water currently naturally infiltrates into the ground.

2.5.2 The site is currently in a brownfield state, and considering the underlying geology, it is anticipated that surface water from the site either infiltrates directly into the ground at source or near it after running off the existing buildings and impermeable areas.

2.5.3 Southern Water records show an existing foul water sewer running along Water Lane. This sewer is a 150mm system, running from the south of the site along Water Lane and up to the junction between Water Lane and Mutton Lane, where it increases to a 175mm pipe network. The flows then head in a northerly direction up Water Lane towards its junction with London Road.

2.5.4 The Southern Water sewer records are presented in **Appendix D**.

2.5.5 The developable area for this site is less than 50ha, meaning that the Institute of Hydrology (IoH) Report 124 Flood Estimation for Smaller Catchments (1994) method was used to estimate greenfield peak flow rates. This methodology is approved in the EA's Rainfall Runoff Management for Developments Report, and the parameters of the calculation can be seen below in **Table 3.1.**

Table 3.1: ICP SuDS Parameters

Parameter	Value	Unit
SAAR	700	mm
Soil Index	0.150	-
Region	7	-
Urban	0.000	-

2.5.6 **Table 3.2** summarises the estimated current greenfield runoff rates for the site (0.241ha). Supporting calculations are presented in **Appendix E**.

Table 3.2 Greenfield Runoff rates

Return Period	Total Existing Greenfield Discharge Rates (l/s)	Existing Greenfield Discharge Rates (l/s/ha)
QBAR	0.1	0.41
Q_{30}	0.2	0.83
Q_{100}	0.3	1.24

3.0 PROPOSED DEVELOPMENT

3.1.1 The proposed development would demolish the five existing buildings and construct seven dwellings, with associated car parking areas, cycle storage and a new access road onto Water Lane.

3.1.2 The proposed site layout is presented in **Appendix A**.

4.0 PLANNING POLICY

4.1 Flood and Water Management Act (2010)

4.1.1 The Flood and Water Management Act (FWMA) was introduced on 8th April 2010. It was intended to implement Sir Michael Pitt's recommendations following the widespread summer 2007 floods. Guidance and information notes are published online by Defra to address a range of different aspects concerning the act.

4.1.2 The FWMA encourages the use of Sustainable Drainage Systems (SuDS) on development sites by removing the automatic right to connect to sewers.

4.1.3 The development proposals for this site will adhere to the FWMA through the provision of SuDS as a fundamental component of the surface water drainage scheme.

4.2 National Planning Policy Framework (2021)

4.2.1 The National Planning Policy Framework (NPPF) sets out the Government's planning policies, and how these policies should be applied. Planning Practice Guidance (PPG) is available online and provides additional guidance to the NPPF, as well as providing links to relevant detailed documents. Section 4.3 provides further detail on the PPG.

4.2.2 Paragraph 159 of the NPPF states that "*inappropriate development in areas at risk of flooding should be avoided by directing development away from areas of highest risk (whether existing or future). Where development is necessary in such areas, the development should be made safe for its lifetime without increasing flood risk elsewhere*."

4.2.3 Paragraph 167 of the NPPF states "*when determining planning applications, local planning authorities should ensure that flood risk is not increased elsewhere. Where appropriate, applications should be supported by a site-specific flood-risk assessment. Development should only be allowed in areas at risk of flooding where, in the light of this assessment (and the sequential and exception tests, as applicable) it can be demonstrated that:*

- *Within the site, the most vulnerable development is located in areas of lowest flood risk unless there are overriding reasons to prefer a different location.*
- *The development is appropriately flood resistant and resilient such that, in the event of a flood, it could be quickly brought back into use without significant refurbishment.*
- *It incorporates sustainable drainage systems, unless there is clear evidence that this would be inappropriate.*
- *Any residual risk can be safely managed, and*

- *Safe access and escape routes are included where appropriate, as part of an agreed emergency plan."*

4.2.4 In accordance with the NPPF, a site-specific FRA is required for sites within the following categories:

- In Flood Zone 1, all proposals involving:
  - Sites of one hectare (ha) or more.
  - Land which has been identified by the EA as having critical drainage problems.
  - Land identified in a strategic flood risk assessment (SFRA) as being at increased flood risk in the future.
  - Land that may be subject to other sources of flooding, where its development would introduce a more vulnerable use.
  - All proposals for development in Flood Zone 2 and 3.

4.3 Planning Practice Guidance (2021)

4.3.1 The PPG provides additional direction to the NPPF, with details provided in each section of the document on how to conform to the NPPF.

4.3.2 All land in England is classified as falling into one of three main flood zones, with the zones referring to the probability of river or sea flooding, ignoring the existence of defences. The PPG identifies and describes the EA flood zones as:

- Flood Zone 1: Low probability – land assessed as having less than a 1 in 1,000 annual probability of river or sea flooding (<0.1% Annual Exceedance Probability (AEP)).
- Flood Zone 2: Medium probability – land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (1% - 0.1% AEP).
- Flood Zone 3: High probability – land assessed as having a 1 in 100 or greater annual probability of river flooding (≥1% AEP), or a 1 in 200 or greater annual probability of sea flooding (≥0.5% AEP).
- Flood Zone 3b: The Functional Floodplain – land where water has to flow or be stored in times of flood (as identified by the LPAs in the SFRA).

4.3.3 The current PPG sets out the following drainage hierarchy that the discharge of surface water runoff should adhere to:

- Into the ground (infiltration).
- To a surface water body.
- To a surface water sewer, highway drain, or another drainage system.

- To a combined sewer.

4.4 Non-Statutory Technical Standards for Sustainable Drainage Systems (2015)

4.4.1 The Non-Statutory Technical Standards for Sustainable Drainage Systems was published by the Department for Environment, Food and Rural Affairs (DEFRA) in March 2015.

4.4.2 The standards are to be used in order to manage surface water runoff in accordance with Schedule 3 of the FWMA.

4.4.3 The document provides guidance on runoff destination, peak flow rate, volume and control of water quality and function.

4.4.4 The LPA may set local requirements for planning permission that have the effect of more stringent requirements than those of the standards.

4.5 Kent County Council Local Flood Risk Management Strategy (2017)

4.5.1 The Local Flood Risk Management Strategy (LFRMS) sets out a countywide strategy for managing the risks of flooding, by coordinating the work of Risk Management Authorities (RMAs), ensure that organisations work together to provide effective solutions to problems, and by improving public understanding of flood risk management in Kent.

4.5.2 Section 5.6 discusses *'SuDS Adoption and Maintenance' and states that Kent County Council will 'identify any opportunities to improve the uptake of open SuDS and promote the wider benefits'.*

4.5.3 Chapter 6 covers the *'Objectives and Actions'* of the LFRMS, and contains a 4-part action plan, detailing each objective and how it shall be delivered. Objective 3 is *'Resilient Planning'* and states an ambition that '*development and spatial planning in Kent takes account of flood risk issues and plans to effectively manage any impacts'.*

4.6 Swale Borough Council Surface Water Management Plan (2012)

4.6.1 The Surface Water Management Plan (SWMP) was produced by Kent County Council, and aims at *'effectively understanding and managing flood risks that arise from local flooding, which is defined by the Flood and Water Management Act 2010 as flooding from surface runoff, groundwater and ordinary watercourses.'*

4.6.2 The plan is split into four phases – *'Phase 1. Preparation', 'Phase 2. Risk Assessment', 'Phase 3 & 4 – Options and Action Plan'.* Phase 4 presents an action plan, written by Kent County Council, that divides up ownership of various flood risk management responsibilities, and attributes a *'Lead Action Owner'* and *'Supporting Action Owner(s)'* to each.

4.7 Kent County Council's Drainage and Planning Policy

4.7.1 The Kent County Council Drainage and Planning Policy Document sets out nine SuDS Policies. They are as follows:

- Policy One is summarised as '*follow the Drainage Hierarchy'* which is set out in **Section 4.3** of this Flood Risk Assessment and Drainage Strategy.
- Policy Two states, '*any proposed new drainage scheme must manage all sources of surface water and should be designed to match greenfield discharge rates, and volumes as far as possible. Development in previously developed land should also seek to reduce discharge rates and volumes off-site and utilise existing connections where feasible. Drainage schemes should provide for exceedance flows and surface flows from offsite, ensure emergency ingress and egress and protect any existing drainage connectivity, so that flood risk is not increased on-site or off site'.*
- Policy Three states, '*drainage schemes should be designed to follow existing drainage flow paths and catchments and retain where possible existing watercourses and features.*'
- Policy Four states, '*new development should be designed to take full account of any existing flood risk, irrespective of the source of flooding. Where a site or its immediate surroundings have been identified to be at flood risk, all opportunities to reduce the identified risk should be investigated at the master planning stage of design and subsequently incorporated at the detailed design stage. Remedial works and surface water infrastructure improvements may be identified in the immediate vicinity of the development to facilitate surface water discharge from the proposed development site*.'
- Policy Five states, '*The design of the drainage system must account for the likely impacts of climate change and changes in impermeable area over the design life of the development. Appropriate allowances should be applied in each case. A sustainable drainage approach which considers control of surface runoff at the surface and at source is preferred and should be considered prior to other design solutions*.'
- Policy Six states, '*Any proposed drainage schemes must be designed to be maintainable to ensure that the drainage system continues to operate as design and must be accompanies with a defined maintenance plan.'*
- Policy Seven states, '*When designing a surface water management scheme, full consideration must be given to the system's capacity to remove pollutants and to the*

cleanliness of the water being discharged from the site, irrespective of the receiving system.'

- Policy Eight states, '*Drainage design must consider opportunities for inclusion of amenity and multifunctionality objectives and this provide multi-functional use of open space with appropriate design for drainage measures within the public realm. Local environmental objectives may identify other benefits which can be agreed to be delivered through appropriate design of the drainage system.'*
- *Policy Nine states, 'Drainage design must consider opportunities for biodiversity enhancement, through provision of appropriately designed surface systems, consideration of connectivity to adjacent water bodies or natural habitats, and appropriate planting specification.'*

4.8 Swale Borough Council Strategic Flood Risk Assessment (2020)

4.8.1 The Strategic Flood Risk Assessment (SFRA) provides "*flood risk evidence and long-term strategy to support the management and planning of development protect the environment, deliver infrastructure and promote sustainable communities*". Within the SFRA there are also general policy recommendations, as well as a series of useful maps and figures.

4.9 Swale Borough Council Local Plan (2017)

4.9.1 The Local Plan sets out the vision and overall strategy for development in the area, and how it will be achieved for the period 2014 – 2031, with regards to national planning policy and guidance.

4.9.2 Paragraph 7.6.40 states that *'drainage must be considered at the earliest stages of the development process to ensure that the most sustainable option can be delivered in all cases'.*

4.9.3 Point no.2 of Policy DM21 states that proposals will *'avoid inappropriate development in areas at risk of flooding and where development would increase flood risk elsewhere'.*

4.9.4 Point no.4 of Policy DM21 states that proposals will *'include, where possible, sustainable drainage systems to restrict runoff to an appropriate discharge rate, maintain or improve the quality of the receiving watercourse, to enhance biodiversity and amenity and increase potential for grey water recycling. Drainage strategies (including surface water management schemes) for major developments should be carried out to the satisfaction of the Lead Local Flood Authority.'*

5.0 SOURCES OF FLOOD RISK

5.1 Fluvial Flooding

5.1.1 Fluvial flooding is caused by high flows in rivers or streams exceeding the capacity of the river channel and spilling into the floodplain, or in some cases non-designated floodplain, which can occur after a period of heavy rainfall.

5.1.2 The Environment Agency (EA) Flood Map for Planning (accessed July 2022) shows that part of the site is in Flood Zones 2 and 3. However, the EA also confirmed that their current online flood maps are not detailed and accurate enough to inform a site-specific FRA. The EA Flood Map for Planning is presented in **Appendix F**.

5.1.3 Odyssey therefore carried out detailed hydrological and hydraulic modelling in the vicinity of the site in 2016 to better refine the flood maps. This was conducted using site specific data, including channel surveys of all the ditches and culverts and any hydraulically significant structures upstream of the site such as the M2 culvert 700m to the south of the site and the nearby Vicarage Lane crossing. The EA online flood maps do not include the same level of detail.

5.1.4 The results of the modelling study showed a significant reduction of the floodplain and confirmed all the proposed dwellings are in Flood Zone 1 and garages are in Flood Zones 1 and 2; the proposed garages will be kept to existing ground levels and made resilient to flooding.

5.1.5 The initial modelling study (reference 15-347-01), which was carried out for an adjacent part of the site, has been approved by the EA and now replaces the current online flood maps. Correspondence was received from the EA in June 2016 stating that they '*do not hold any detailed modelling of the watercourse affecting this site. Therefore, we accept the submitted model outputs as the best available information for this proposed development. We are satisfied with the methodology used and the results produced.*' The EA correspondence and the full modelling report are presented in **Appendix G**.

5.1.6 A more recent modelling study has been carried out for the site which is based on the same EA approved model. The full modelling report is presented in **Appendix H**.

5.1.7 The baseline modelling results are shown in **Figures 5.1 – 5.3**.

Figure 5.1: Baseline 1 in 100 Year Extent

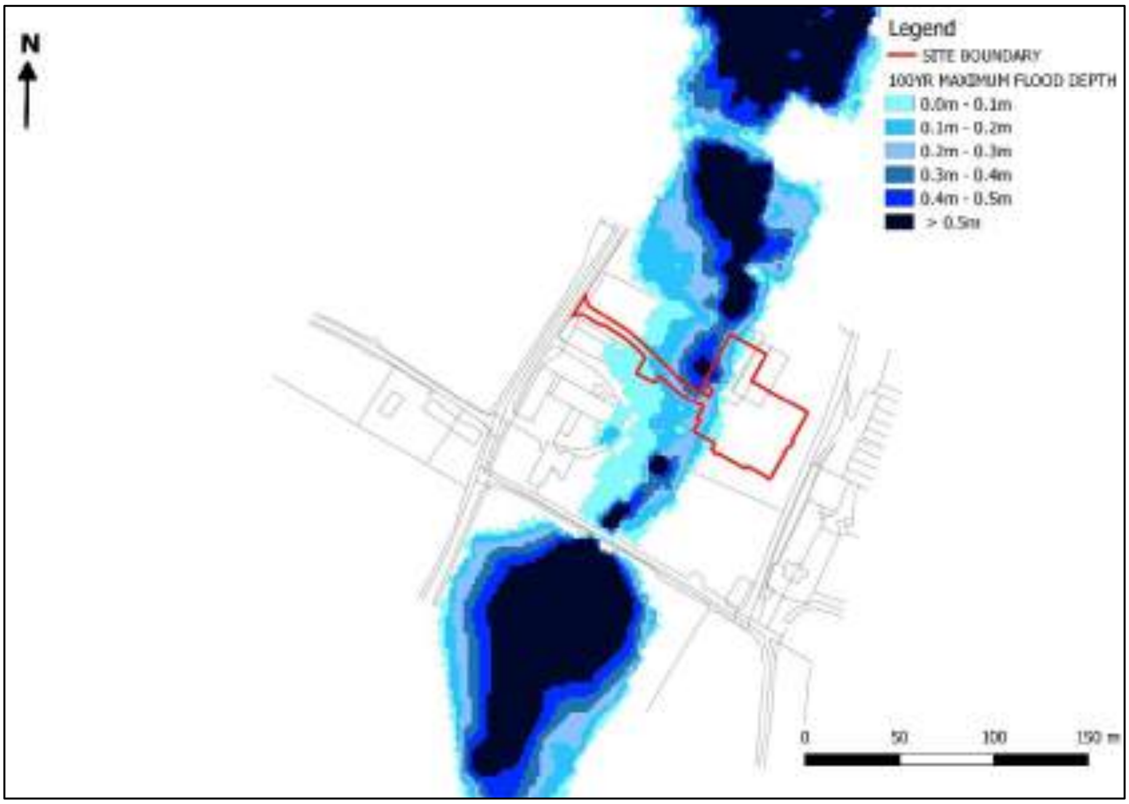


Figure 5.2: Baseline 1 in 100 Year + 22% Climate Change Extent

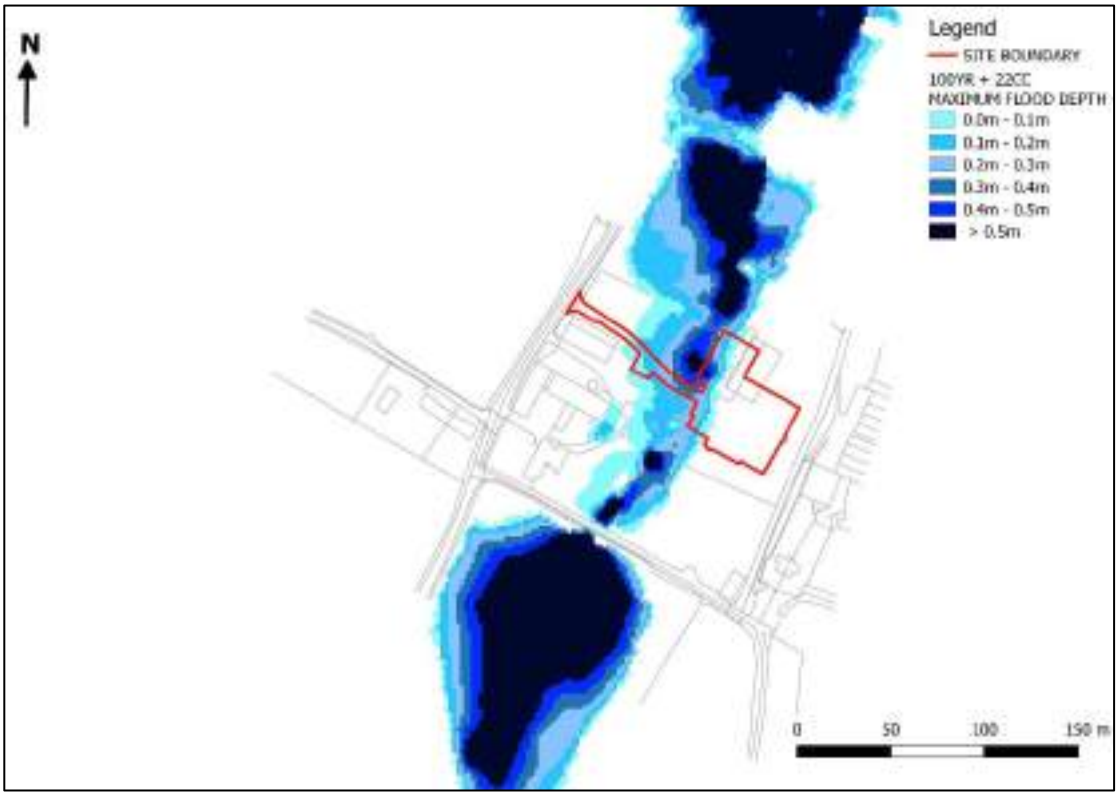
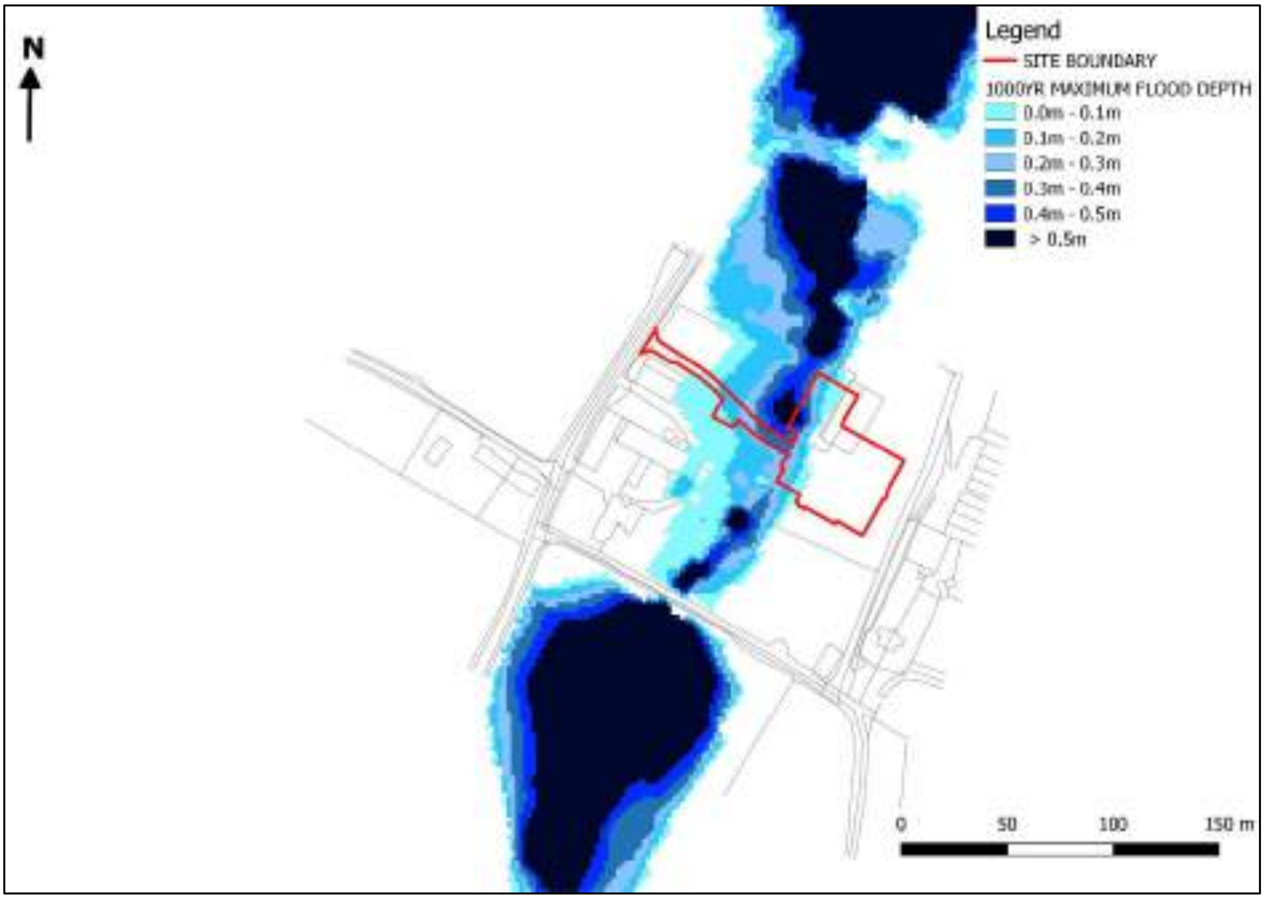
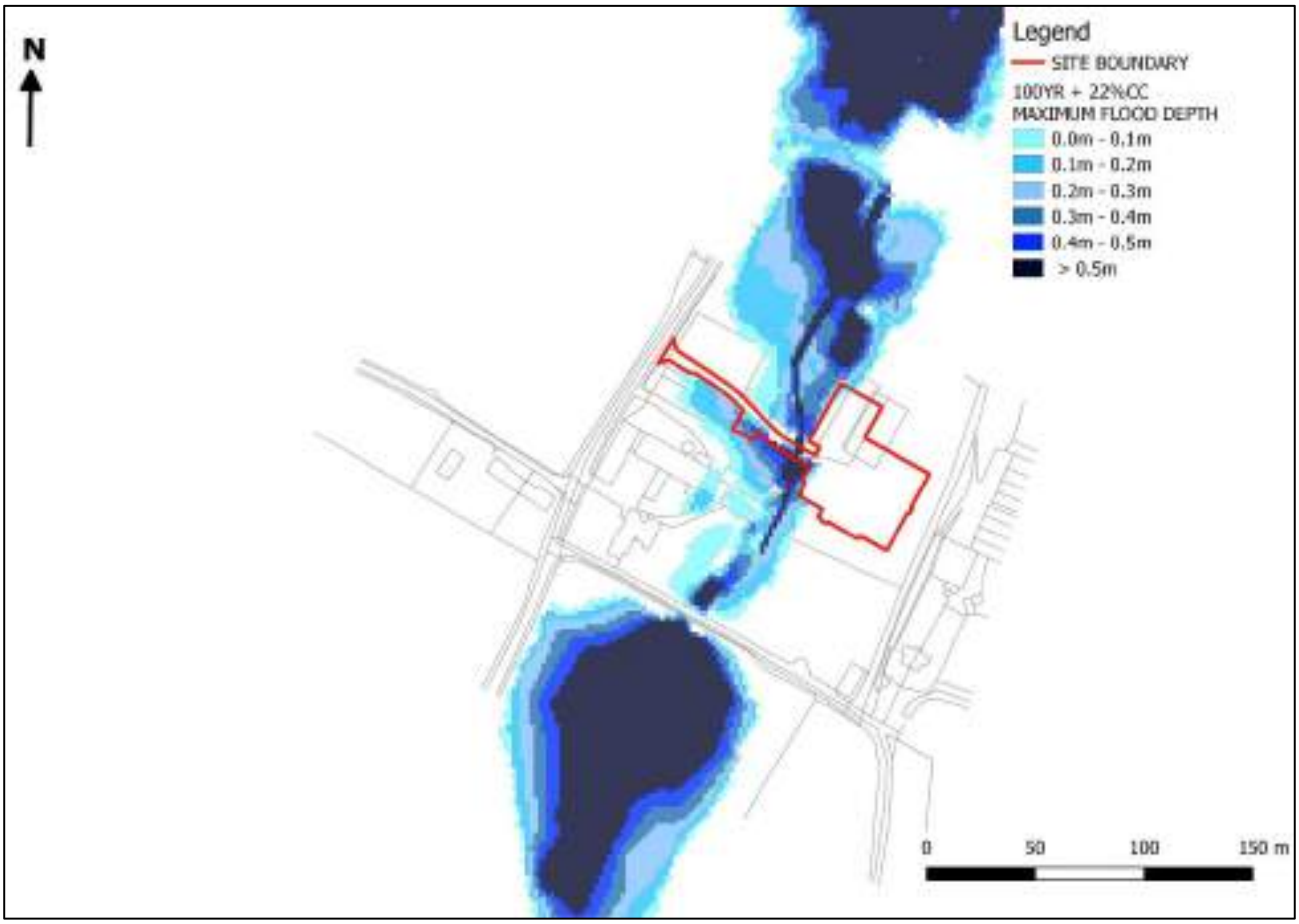


Figure 5.3: Baseline 1 in 1000 Year Extent



5.1.8 It is proposed to construct a swale network along the centre of the site to capture the flows from the critical culvert along Vicarage Lane. **Figure 5.4** shows the post development modelling results for the 1 in 100 year + 22% CC extent. It is shown that the entire dwellings are outside of the flood extents except for two garages which will be made resilient to flooding

Figure 5.4: Post Development Scenario - 1 in 100 Year + 22% Climate Change Extent



5.1.9 Based on these flood levels, it is recommended that the Finished Floor Levels (FFLs) of the dwellings in flood risk areas to be raised by 300mm above the maximum design flood levels of 12.30mAOD to 12.40mAOD south of the proposed access road, and 11.9mAOD to 12.10mAOD north of the proposed access road. As such, the FFLs for dwellings south of the road will be set at a minimum of 12.70 mAOD and the FFLs for north of the road will be set at a minimum of 12.30mAOD. The proposed access road is required to be higher (13.3mAOD) in some locations to allow for suitable cover of 1.2m above the proposed swale culvert.

5.1.10 The flood risk vulnerability classification of residential dwellings is 'more vulnerable'. In accordance with the PPG, development of this nature in Flood Zone 1 is acceptable without an Exception Test.

5.1.11 A small section of the garages shall be situated in Flood Zone 2. These garages are classified as 'less vulnerable' and therefore, in accordance with the PPG, development of this nature is permitted in Flood Zone 2. These garages would be made resilient to flooding.

5.1.12 The Swale Borough Council SFRA Historic Flooding Mapping shows that the site is outside the historic flood extents. The Swale Borough Council SFRA mapping is presented in **Appendix F**.

5.2 Surface Water Flooding

5.2.1 Surface water (pluvial) flooding usually occurs during high intensity rainfall, when the excess water cannot be absorbed into the ground. However, it can also occur with low intensity rainfall in areas where the land has a low permeability.

5.2.2 The EA Risk of Flooding from Surface Water mapping (accessed July 2022) shows that a section down the middle of the site is likely at 'low risk' and 'medium risk' with small localised areas of 'high risk which are likely to be linked to the watercourse flowing through the site. The mapping does not take account of any drainage features which may be present within and in the vicinity of the site.

5.2.3 The medium and low risk areas are indicated to be in the location of the proposed road and do not affect the proposed dwellings. The flood depth for the medium risk area is shown to be below 300mm. The remainder of the site is at 'very low risk' of flooding from Surface Water. The EA Risk of Flooding from Surface Water mapping is presented in **Appendix F**.

5.2.4 Finished floor levels for the dwellings will be raised by a minimum of 300mm, which would reduce the risk of any minor localised ponding or overland surface water flows from entering the buildings. Additionally, the garages will be made resilient to flooding. Any additional mitigation measures, as described in the CLG document Improving Flood Performance of New Buildings, should be utilised to prevent surface water entering the buildings.

5.2.5 The risk of flooding from this source is considered to be low.

5.3 Tidal Flooding

5.3.1 Tidal flood sources include the sea and estuaries, and tidal flooding is often caused by high tides with meteorological and storm events. Tidal flooding can be extremely rapid and its effects severe; deep fast-flowing water can create an extreme hazard.

5.3.2 The most significant recorded flood events primarily caused by tidal flooding in the Swale Borough occurred in 1953, 1978 and 2013. The event on the 6th December 2013 was the largest tidal surge in 60 years and resulted in the internal flooding of 30 homes and businesses. There is no specific reference to the site being affected by this flood event and no historic tidal flooding has been recorded on the site.

5.3.3 The Modelled breach extents mapping in the Swale SFRA does not show the site to be within the breach extents. The modelled breach extents mapping is presented in **Appendix F**.

5.3.4 The EA is working in partnership with Swale Borough Council, Kent County Council, Faversham Town Council and Southern Water to develop a tidal defence scheme for the area, to protect low-lying properties.

5.3.5 The risk of flooding from tidal sources is considered to be low.

5.4 Groundwater Flooding

5.4.1 Groundwater flooding occurs when periods of abnormally high rainfall result in the emergence of groundwater at the surface, often flooding basements and causing damage to property and infrastructure.

5.4.2 The Swale Borough Council SFRA Groundwater Flood Mapping also suggests that the site is affected by areas where the groundwater is at or very near (within 0.025m of) the ground surface and where the groundwater is between 0.5m and 5m below the ground surface. The Swale Borough Council SFRA Groundwater Flood Mapping is presented in **Appendix F**.

5.4.3 The risk of flooding from groundwater is considered to be low.

5.5 Sewer Flooding

5.5.1 Flooding can occur due to the failure of existing foul or surface water drainage infrastructure. If flows within the drainage system exceed the designed capacity or foreign matter causes blockages, overflow to the surface can occur leading to flooding.

5.5.2 The Swale Borough Council SFRA states that there have been 8 recorded sewer incidents within the ME13 8 postcode area, where the site is located.

5.5.3 The risk of flooding from sewer flooding is considered to be low.

5.6 Flooding from Artificial Sources

5.6.1 Failure and overtopping of reservoirs and navigable water bodies, and failure of water mains, constitute the primary means of flooding from artificial sources.

5.6.2 The Swale Borough Council Flood Risk from Reservoirs mapping indicates that the site is not located within the maximum extent of flooding. The Swale Borough Council Flood Risk from Reservoirs mapping is presented in **Appendix F**.

5.6.3 The risk of flooding from artificial sources is considered to be very low.

6.0 THE SEQUENTIAL AND THE EXCEPTION TEST

6.1 The Sequential Test

6.1.1 The EA's flood zones are the starting point for the Sequential approach promoted by the NPPF, and are shown on the EA flood mapping. The NPPF's Planning Practice Guidance (PPG) identifies that the overall aim of the Sequential Test is to steer new developments to Flood Zone 1 (NPPF, 2012).

6.1.2 As stated by the NPPF, development should not be allocated or permitted if there are reasonably available sites appropriate for the proposed development in areas with lower probability of flooding. The SFRA will provide the basis for applying this test (NPPF, 2012).

6.1.3 Following application of the Sequential Test, if it is not possible for the development to be located in zones with lower probability of flooding (Flood Zone 1), proposed sites should take into account the flood risk vulnerability of land uses (Table 2, PPG) and consider reasonable sites in Flood Zone 2, and apply the Exception Test if required (Table 3, PPG). Only where there are no reasonably available sites in Flood Zone 1 and Flood Zone 2 should the suitability of sites in Flood Zone 3 be considered, taking into account the flood risk vulnerability of land uses and applying the Exception Test if required.

6.1.4 The dwellings will be built within Flood Zone 1, and therefore the Sequential Test is considered to be passed.

6.2 The Exception Test

6.2.1 For the Exception Test to be passed a development proposal:

- Must demonstrate that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a SFRA;
- The development should be on developable brownfield land or, if not, it must be demonstrated that there is no such alternative land available; and
- An FRA must demonstrate that the development will be safe for its lifetime taking into account the vulnerability of its users, without increasing flood risk elsewhere, and where possible, reducing flood risk overall.

6.2.2 The dwellings will be built within Flood Zone 1, and therefore an exception test is not required.

7.0 SURFACE WATER DRAINAGE STRATEGY REQUIREMENTS

7.1.1 Any surface water drainage strategy must demonstrate that the proposed development would be drained in a sustainable manner, commensurate with local and national policy. The NPPF requires that flood risk to land and property is not increased as a result of new development.

7.2 Proposed Drainage Strategy

7.2.1 The indicative surface water drainage strategy described below is detailed in **Drawing 18-120-100A.** The drainage strategy is presented in **Appendix E.**

7.2.2 As set out in **Section 4.3**, the drainage hierarchy states that the most-preferred method of surface water discharge is '*infiltration into the ground*'.

7.2.3 According to BGS mapping, the underlying geology on the site is Seaford Chalk Formation – Chalk. It is known that chalk is a permeable bedrock, and alongside the absence of any surface water sewer network in the area, it is deemed that infiltration is a suitable method of surface water discharge on this site.

7.2.4 It is proposed that surface water generated by the proposed development would be attenuated in two infiltrating tanks, one would be located in the courtyard between the residential units that will serve the dwellings, garages and courtyard area. The second would be located north of the access road on the western side of the site and would serve the access road only.

7.2.5 A conservative infiltration rate for chalk of 1×10^{-5} metres per second (m/s) has been used in the calculations.

7.2.6 The surface water would be infiltrated on site, so there would be no surface water runoff leaving the proposed development. This would provide betterment to downstream areas from the site by reducing their surface water flood risk.

7.2.7 The infiltrating tanks have been designed to accommodate surface water from all rainfall events up to the 1 in 100 year plus 40% climate change storm in line with the latest climate change allowance guidance. Supporting MicroDrainage calculations are presented in **Appendix E.**

7.2.8 Urban creep has been accounted for in the drainage calculations by adding 10% of the roof areas to the total impermeable area for the proposed SuDS features.

7.2.9 In the event of exceedance, it is anticipated that surface water shall pool at the low point in the centre channel on site, and shall subsequently flow into the proposed swale constructed on site.

The modelling results show that the access road will not flood in the 1 in 100 year storm event, including a 22% allowance for climate change, therefore access and egress would remain possible.

7.2.10 As previously mentioned, Odyssey has completed a modelling study to predict the flood levels for the area. Based on the flood levels predicted in this modelling study, FFLs in flood risk areas shall be raised by 300mm above the modelled flood levels, to ensure the development is suitably flood resilient.

7.3 Water Quality

7.3.1 Water quality is a key component of a SuDS system. Steps shall be taken to ensure that water quality on site and leaving the site is not negatively impacted by the proposed development. **Table 7.1** details the Pollution Hazard Indices of the different land use classifications of the site, in accordance with the CIRIA SuDS Manual (2015) C753.

Table 7.1: Pollution Hazard Indices for Proposed Development

Land Use	Pollution Hazard Level	Total Suspended Solids (TSS)	Metals	Hydro-carbons
Residential roofs	Very Low	0.2	0.2	0.05
Individual property driveways, residential car parks, low traffic roads (e.g. cul-de-sacs, home zones and general access roads) and non-residential car parking with infrequent change (e.g. schools, offices) i.e. <300 traffic movements/day	Low	0.5	0.4	0.4

7.3.2 The pollution hazard level for the proposed development is therefore ‘low’. All surface water generated by the development would be treated through a layer of soil beneath the infiltration tanks. The indicative SuDS mitigation indices for the soil layer can be seen in **Table 7.2** below.

Table 7.2: SuDS Mitigation Indices for Proposed SuDS Features

Type of SuDS Component	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Infiltration tank – A soil with good contaminant attenuation potential of at least 300mm in depth	0.4	0.3	0.3

7.3.3 **Table 7.2** demonstrates the tanks with a layer of soil with good contamination attenuation potential of at least 300mm in depth, alone, would not provide a sufficient level of surface water runoff treatment prior to discharging to the groundwater. However, the layer of soil would be at least 600mm in depth, and as such, sufficient treatment would be achieved.

7.3.4 Adhering to the following equation, as per The SuDS Manual, the mitigation indices for the deeper soil layers would be as per **Table 7.3**.

$$\text{Total SuDS Mitigation Index} = \text{mitigation index}_1 + 0.5\ (\text{mitigation index}_2)$$

Table 7.3: SuDS Mitigation Indices for Surface Water Infiltrating into the Ground

Total Suspended Solids (TSS)	Metals	Hydrocarbons
(0.4 +0.2) = 0.6 > 0.5 therefore ok	(0.3+0.15) =0.45> 0.4 therefore ok	(0.3+0.15) =0.45 >0.4 therefore ok

7.4 SuDS Maintenance Requirements

7.4.1 Maintenance of the drainage system and SuDS features would be carried out in accordance with the manufacturer guidance and through an approved maintenance management plan to minimise the residual flood risk of drainage system blockage.

7.4.2 Maintenance would be the responsibility of the developer to assign, however the '*operation and maintenance requirements for soakaways*' table has been extracted from The SuDS Manual and is presented in **Appendix I**.

8.0 FOUL WATER DRAINAGE STRATEGY

8.1.1 Peak design discharges for residential dwellings will be calculated based on Sewerage Sector Guidance:

Residential domestic flow = 4000 litres/dwelling/day (peak)

8.1.2 It is proposed that foul flows from the development (0.32l/s) would be drained by gravity to a new proposed pumping station located in the south end of one of the garage buildings, prior to being pumped to a new manhole on the existing public Southern Water foul network that runs along Water Lane, to the west of the site. The new connection would be subject to approval by Southern Water.

8.1.3 The proposed pumping station would be Type 2 to cater for the number of proposed dwellings and would require a 10m buffer to any dwellings.

8.1.4 Southern Water has a duty to improve its network to cater for proposed developments. This is funded via increased infrastructure charges to developers. Should there be a requirement for offsite improvement works, Southern Water would programme these works with due regard to the build programme of the proposed development.

9.0 SUMMARY AND CONCLUSIONS

9.1.1 Odyssey has been commissioned by Milliken and Company Chartered Surveyors and Town Planners to provide a Flood Risk Assessment (FRA) and Drainage Strategy with respect to the construction of a proposed residential development comprising seven barn style residential units at Queen Court Farmyard Site, Water Lane, Ospringe, Faversham.

9.1.2 The EA Flood Map for Planning (accessed July 2022) shows that the site lies in Flood Zones 2 and 3 associated with fluvial flooding. However, the EA confirmed that their current online flood maps are not detailed and accurate enough to inform a site-specific FRA. Odyssey therefore carried out a site-specific fluvial modelling study for this site using a 2016 hydraulic model which was developed for a vicinity of the site and approved by the EA.

9.1.3 The fluvial modelling results indicated a significant reduction of the floodplain and confirmed that all the proposed dwellings are in Flood Zone 1, with garages in Flood Zones 1 and 2. The proposed garages will be kept at existing ground levels and will be made resilient to flooding.

9.1.4 Risk of flooding from other sources is considered to be low.

9.1.5 The chalk bedrock suggests that infiltration techniques would be feasible for the site. It is proposed that surface water generated by the proposed development would be attenuated in two infiltrating tanks. A conservative infiltration rate for chalk of 1×10^{-5} m/s has been used in the calculations. The infiltration tanks have been designed to accommodate a 1 in 100 year storm plus 40% to account for climate change. An additional 10% of impermeable area has been included to account for urban creep.

9.1.6 It is proposed that foul flows from the development (0.32l/s) would be drained by gravity to a new proposed pumping station located in the south end of one of the garage buildings, prior to being pumped to a new manhole on the existing public Southern Water foul network that runs along Water Lane, to the west of the site. The new connection would be subject to approval by Southern Water.

9.1.7 This FRA demonstrates that in flood context, the proposals are safe and appropriate and do not cause increased flood risk. Also, the FRA demonstrates that the proposed development could be drained in a sustainable manner, commensurate with local and national policy.

APPENDIX A

Site Location Plan and Site Layout Plan

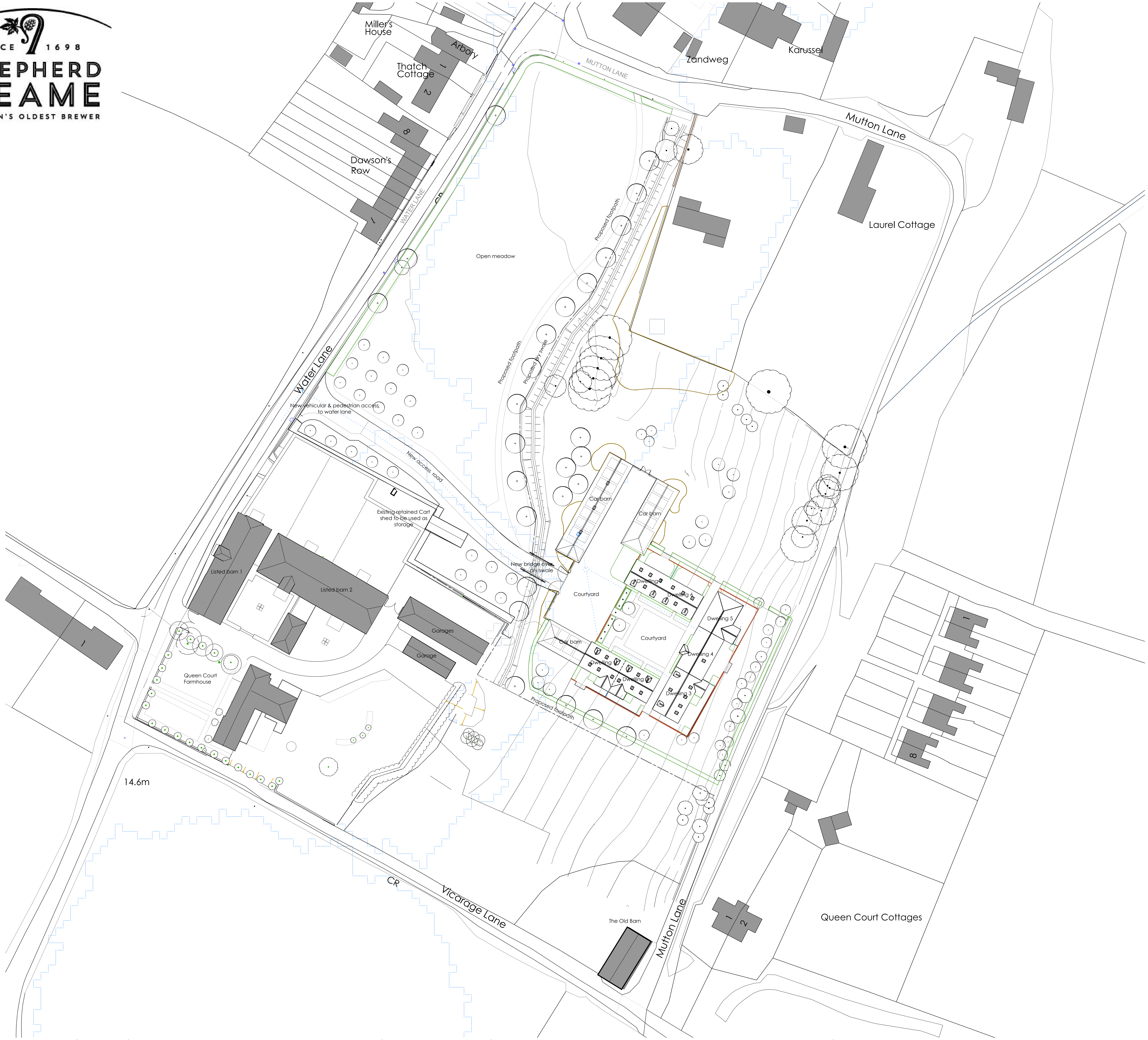
ODYSSEY

Tuscany House
White Hart Lane
Basingstoke
Hampshire RG21 4AF

Telephone: 01256 331144
Fax: 01256 331134
E: enquiries@odysseyconsult.co.uk
W: www.odysseyconsult.co.uk

Job Title	SHEPHERD NEAME, FAVERSHAM
Figure Title	SITE LOCATION PLAN
Client	MILLIKEN AND COMPANY CHARTERED SURVEYORS AND TOWN PLANNERS
Scale	1:5000 @ A3
Date	AUG 22
Designed	MSS
Drawn	MSS
Checked	RA
Approved	RA
Job No	18-120
Figure No	FIGURE 100
Rev	A

SHEPHERD NEAME
SINCE 1698
BRITAIN'S OLDEST BREWER



This drawing and the design are the copyright of ***ON Architecture Ltd only.***
This drawing should not be copied or reproduced without written consent.

All dimensions are to be checked on site prior to setting out and fabrication and ***ON Architecture Ltd*** should be notified of any discrepancy prior to proceeding further.

For Construction & Fabrication Purposes - Do not scale from this drawing, use only the illustrated dimensions herein. Additional dimensions are to be requested and checked directly.

Illustrated information from 3rd party consultants/specialists is shown as indicatively only.See other consultant / specialist drawings for full information and detail.

All aspects of the architectural design concerning fire performance / fire safety (whether or not illustrated / annotated) are to be considered as 'For Approval' only, irrespective of the drawing status / suitability.

Scale: 1:500
0 10 30 50m

N

Key:

- Existing Surrounding Built Context
- Flood Plain
- Fence
- Existing buildings to be demolished
- Proposed foul drainage and pumping station - subject detailed design

DRAFT

FOR COMMENT ONLY

Revision Note & Date

Rev	Date	Note	Amended	Checked
P01	27.06.2022	PRELIMINARY ISSUE TO CLIENT FOR COMMENT	ES	LH
P02	28.06.2022	MINOR AMENDMENTS TO CLIENT COMMENT	ES	LH
P03	22.07.2022	UPDATES TO SITE LAYOUT TO CLIENT COMMENT	ES	LH
P04	29.07.2022	PROPOSED BRIDGE AND INDICATTIVE DRAINAGE SHOWN	ES	----
----	----	----	----	----
----	----	----	----	----
----	----	----	----	----
----	----	----	----	----
----	----	----	----	----
----	----	----	----	----

ON ARCHITECTURE

Canterbury Studio
Logan House, St Andrews Close
Canterbury,
CT1 2RP

info@onarchitecture.co.uk
onarchitecture.co.uk
01227 634334

Project Title
PROPOSED RESIDENTIAL DEVELOPMENT,
LAND ADJACENT TO QUEEN COURT FARM, OSPRINGE

Clients Details
SHEPHERD NEAME

Drawing Title
PROPOSED SITE PLAN

BIM Number
21.153-ONA-XX-00-DR-A - 0101

Scale	Date	Drawn	Checked
1:500@A1	29.07.2022	ES	----

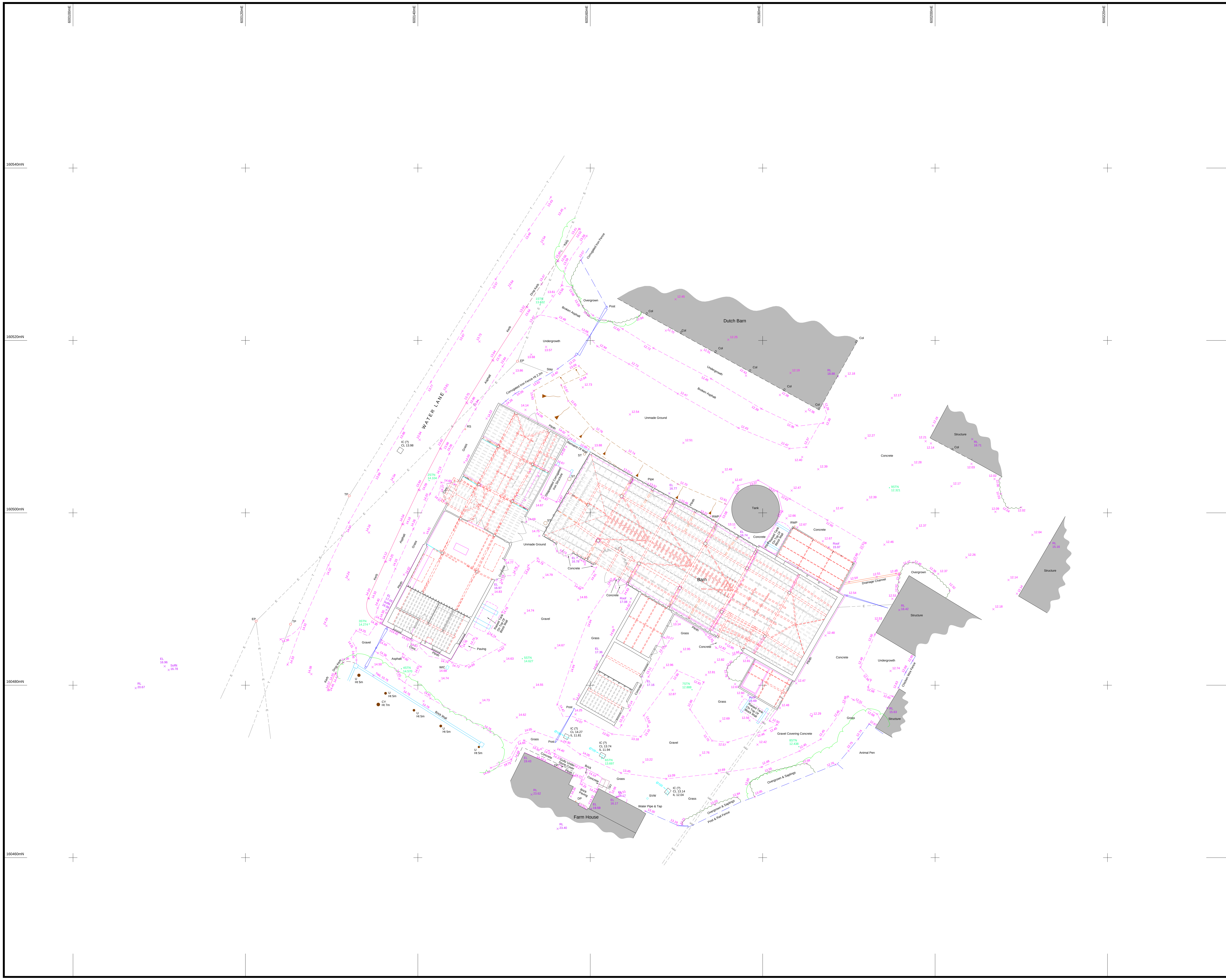
Drawing Status
PLANNING

Project No.	Drawing No.	Status	Revision
21.153	0101	A3	P04

Proposed residential development on derelict land adjacent to Queen Court Farm, Ospringe

APPENDIX B

Topographical Survey



Topographical Survey Legend

BEB	Belisha Beacon	FH	Fire Hydrant	RL	Ridge Level
BH	Borehole	FL	Flood Light	RS	Road Sign
BL	Base Level	FP	Flag Pole	RTW	Retaining Wall
BO	Bollard	G	Gully	RWP	Rain Water Pipe
BP	Brick Pillar	GB	Grit Box	SEG	Side Entry Gully
BPav	Brick Paving	GIC	Gas Inspection Cover	SI	Sign
BRW	Brick Wall	GM	Gas Meter	SSL	Structural Slab Level
BS	Bus Stop	GP	Gas Pipe	STN	Survey Station
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
Conc	Concrete	IL	Invert Level	TAC	Tactile Paving
CPF	Chestnut Paling Fence	JB	Junction Box	TCB	Telephone Call Box
CPO	Concrete Post	LP	Lamp Post	TEP	Telegraph & Electric Pole
CPS	Concrete Paving Slabs	MB	Multi Boled Tree	THL	Threshold Level
CRW	Concrete Retaining Wall	MK	Service Marker	TIC	Telecom Inspection Cover
CW	Concrete Wall	MRF	Metal Railing Fence	TM	Ticket Machine
DC	Drainage Channel	NP	Name Plate	TL	Traffic Light
DIL	Dilapidated	OBF	Open Board Fence	TLCB	Traffic Light Control Box
DP	Down Pipe	PB	Post Box	TP	Telegraph Pole
DPC	Damp Proof Course	PCF	Post & Chain Fence	TWL	Top Of Wall Level
EIC	Electric Inspection Cover	PM	Parking Meter	UTL	Unable To Lift
EL	Eaves Level	PNF	Panel Fence	WIC	Water Inspection Cover
EP	Electric Pole	PRF	Post & Rail Fence	WM	Water Meter
ER	Earth Rod	PRL	Parapet Wall Level	WMF	Wire Mesh Fence
FB	Flower Bed	PWF	Post & Wire Fence	WTL	Water Level
FFL	Finished Floor Level	RE	Rodding Eye	VP	Vent Pipe

Tree Species

AC	Acer	FR	Fruit	LN	London Plane	SC	Sweet Chestnut
AL	Alder	HA	Hawthorn	LO	Locust	SP	Spruce
AS	Ash	HB	Hornbeam	MA	Maple	ST	Stump
BE	Beech	HC	Horse Chestnut	MG	Magnolia	SY	Sycamore
CE	Cedar	HY	Holly	OA	Oak	U	Unidentified
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

Measured Building Survey Legend

ACL	Arch Center Level / Height above floor
ASL	Arch Spring Level / Height above floor
C-H	Window Cill to Window Head Dimension
CLG	Ceiling Level / Height above floor
DH	Door Head Height above floor
DHL	Door Head Level
F-C	Floor to Window Cill Dimension
FL	Floor Level
RU	Ramp Up
SCLG	Suspended / False Ceiling Level / Height above floor
SL	Slab Level
SU	Step(s) Up
TH	Threshold Height above floor
THL	Threshold Level
TWL	Top of Wall Level
US	Underside Level / Height above floor
USB	Underside of Beam level / Height to underside above floor
USJ	Underside of Joist level / Height to underside above floor
WACL	Window Arch Center Level
WASL	Window Arch Spring Level
WCL	Window Cill Level
WHL	Window Head Level

Sloping Roof
Sloped Ceiling (Points up)
Arched / Vaulted Ceiling
Building Line / Wall Line
Detail / Steps
Overhead Detail
Partitions
Glazing

Notes

All levels and coordinates are related to the Ordnance Survey national grid by means of GPS using the Leica Smartnet RTK network. One survey control point has been fixed using GPS and then the survey orientated to an additional GPS points. No scale factor has been applied therefore only the fixed GPS point is a true Ordnance Survey position.

All dimensions are in meters.
Do not scale from this drawing.
Tree girths and canopy spreads are surveyed as a mean size and shown to scale. Tree heights are quoted based on an estimation taken from the ground and have not been accurately confirmed. Whilst every effort is made to identify tree species and sizes, no responsibility can be taken for the accuracy of this information and an Arborologist should be consulted for confirmation.
Eave levels are taken at the bottom of the lowest roof tile.
It is recommended that all invert levels and pipe sizes be checked prior to construction.
Drawing correct at time of survey and to scale.
Any setting out works should be undertaken using Omega Geomatics Ltd survey control only.

All building measurements are taken to existing finishes or faces which are constant and represent an average face or wall line.
All window head and window cill levels are internal measurements.
Ceiling height measurements are taken to a point which best represents the general room height.

N

Drawing Revisions

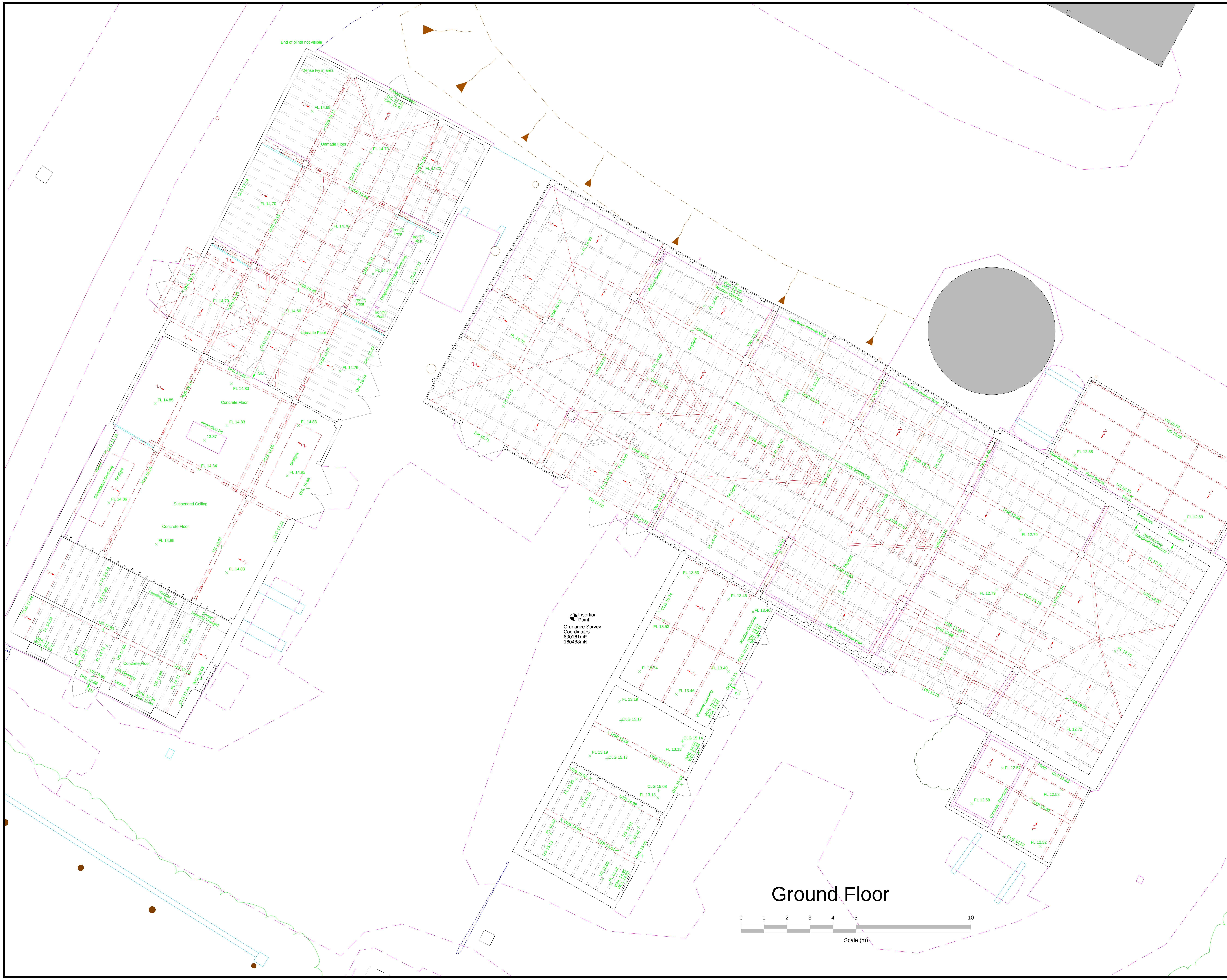
Rev No.	Date	Details
Original	See below	Original survey carried out

ΩMEGA GEOMATICS
Specialist Geospatial Surveyors
chartered ICES
RICS

Unit 5 Hoath Business Centre
Hoath Lane
Gillingham
Kent ME8 0BF
Tel: +44 (0)1634 751 002
Web: www.OmegaGeo.co.uk
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



Topographical Survey Legend

BEB	Belisha Beacon	FH	Fire Hydrant	RL	Ridge Level
BH	Borehole	FL	Flood Light	RS	Road Sign
BL	Base Level	FP	Flag Pole	RTW	Retaining Wall
BO	Bollard	G	Gully	RWP	Rain Water Pipe
BP	Brick Pillar	GB	Grit Box	SEG	Side Entry Gully
BPav	Brick Paving	GIC	Gas Inspection Cover	SI	Sign
BRW	Brick Wall	GM	Gas Meter	SSL	Structural Slab Level
BS	Bus Stop	GP	Gas Pipe	STN	Survey Station
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
Conc	Concrete	IL	Invert Level	TAC	Tactile Paving
CPF	Chestnut Paling Fence	JB	Junction Box	TCB	Telephone Call Box
CPO	Concrete Post	LP	Lamp Post	TEP	Telegraph & Electric Pole
CPS	Concrete Paving Slabs	MB	Multi Boled Tree	THL	Threshold Level
CRW	Concrete Retaining Wall	MK	Service Marker	TIC	Telecom Inspection Cover
CW	Concrete Wall	MRF	Metal Railing Fence	TM	Ticket Machine
DC	Drainage Channel	NP	Name Plate	TL	Traffic Light
DIL	Dilapidated	OBF	Open Board Fence	TLCB	Traffic Light Control Box
DP	Down Pipe	PB	Post Box	TP	Telegraph Pole
DPC	Damp Proof Course	PCF	Post & Chain Fence	TWL	Top Of Wall Level
EIC	Electric Inspection Cover	PM	Parking Meter	UTL	Unable To Lift
EL	Eaves Level	PNF	Panel Fence	WIC	Water Inspection Cover
EP	Electric Pole	PRF	Post & Rail Fence	WM	Water Meter
ER	Earth Rod	PRL	Parapet Wall Level	WMF	Wire Mesh Fence
FB	Flower Bed	PWF	Post & Wire Fence	WTL	Water Level
FFL	Finished Floor Level	RE	Rodding Eye	VP	Vent Pipe

Tree Species

AC	Acer	FR	Fruit	LN	London Plane	SC	Sweet Chestnut
AL	Alder	HA	Hawthorn	LO	Locust	SP	Spruce
AS	Ash	HB	Hornbeam	MA	Maple	ST	Stump
BE	Beech	HC	Horse Chestnut	MG	Magnolia	SY	Sycamore
CE	Cedar	HY	Holly	OA	Oak	U	Unidentified
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

Measured Building Survey Legend

ACL	Arch Center Level / Height above floor
ASL	Arch Spring Level / Height above floor
C-H	Window Cill to Window Head Dimension
CLG	Ceiling Level / Height above floor
DH	Door Head Height above floor
DHL	Door Head Level
F-C	Floor to Window Cill Dimension
FL	Floor Level
RU	Ramp Up
SCLG	Suspended / False Ceiling Level / Height above floor
SL	Slab Level
SU	Step(s) Up
TH	Threshold Height above floor
THL	Threshold Level
TWL	Top of Wall Level
US	Underside Level / Height above floor
USB	Underside of Beam level / Height to underside above floor
USJ	Underside of Joist level / Height to underside above floor
WACL	Window Arch Center Level
WASL	Window Arch Spring Level
WCL	Window Cill Level
WHL	Window Head Level

Sloping Roof
Sloped Ceiling (Points up)
Arched / Vaulted Ceiling
Building Line / Wall Line
Detail / Steps
Overhead Detail
Partitions
Glazing

Notes

All levels and coordinates are related to the Ordnance Survey national grid by means of GPS using the Leica Smartnet RTK network. One survey control point has been fixed using GPS and then the survey orientated to an additional GPS points. No scale factor has been applied therefore only the fixed GPS point is a true Ordnance Survey position.

All dimensions are in meters.
Do not scale from this drawing.
Tree girths and canopy spreads are surveyed as a mean size and shown to scale. Tree heights are quoted based on an estimation taken from the ground and have not been accurately confirmed. Whilst every effort is made to identify tree species and sizes, no responsibility can be taken for the accuracy of this information and an Arborologist should be consulted for confirmation.
Eave levels are taken at the bottom of the lowest roof tile.
It is recommended that all invert levels and pipe sizes be checked prior to construction.
Drawing correct at time of survey and to scale.
Any setting out works should be undertaken using Omega Geomatics Ltd survey control only.

All building measurements are taken to existing finishes or faces which are constant and represent an average face or wall line.
All window head and window cill levels are internal measurements.
Ceiling height measurements are taken to a point which best represents the general room height.

N

Drawing Revisions

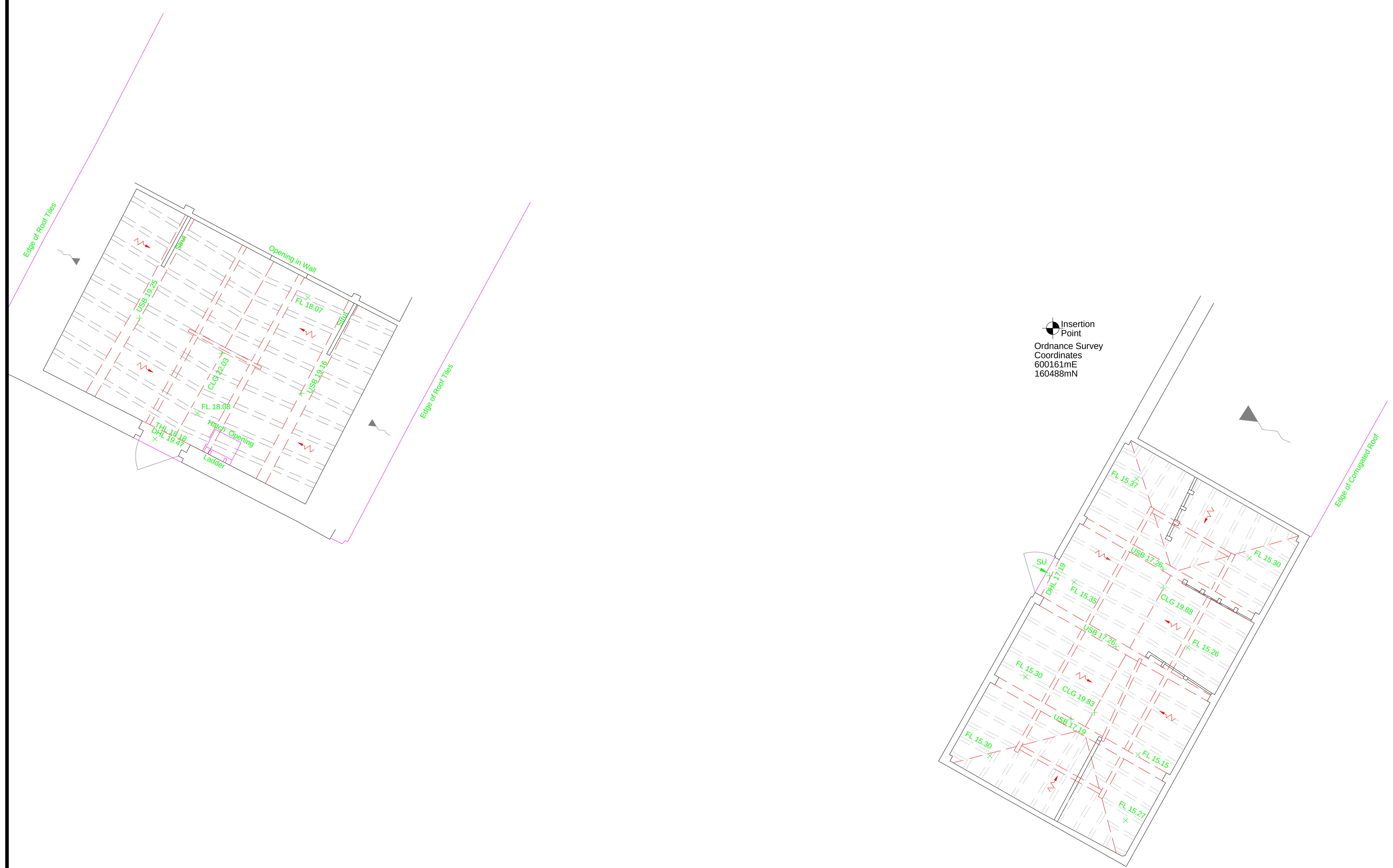
Rev No.	Date	Details
Original	See below	Original survey carried out

ΩMEGA GEOMATICS
Specialist Geospatial Surveyors
chartered ICES
RICS

Unit 5 Hoath Business Centre
Hoath Lane
Gillingham
Kent ME8 0BF

Tel: +44 (0)1634 751 002
Web: www.OmegaGeo.co.uk
Enquiries: survey@OmegaGeo.co.uk

CLIENT	SHEPHERD NEAME		
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

0 1 2 3 4 5 10

Scale (m)

Topographical Survey Legend

BEB	Belisha Beacon	FH	Fire Hydrant	RL	Ridge Level
BH	Borehole	FL	Flood Light	RS	Road Sign
BL	Base Level	FP	Flag Pole	RTW	Retaining Wall
BO	Bollard	G	Gully	RWP	Rain Water Pipe
BP	Brick Pillar	GB	Grit Box	SEG	Side Entry Gully
BPav	Brick Paving	GIC	Gas Inspection Cover	SI	Sign
BRW	Brick Wall	GM	Gas Meter	SSL	Structural Slab Level
BS	Bus Stop	GP	Gas Pipe	STN	Survey Station
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
Conc	Concrete	IL	Invert Level	TAC	Tactile Paving
CPF	Chestnut Paling Fence	JB	Junction Box	TCB	Telephone Call Box
CPO	Concrete Post	LP	Lamp Post	TEP	Telegraph & Electric Pole
CPS	Concrete Paving Slabs	MB	Multi Boled Tree	THL	Threshold Level
CRW	Concrete Retaining Wall	MK	Service Marker	TIC	Telecom Inspection Cover
CW	Concrete Wall	MRF	Metal Railing Fence	TM	Ticket Machine
DC	Drainage Channel	NP	Name Plate	TL	Traffic Light
DIL	Dilapidated	OBF	Open Board Fence	TLCB	Traffic Light Control Box
DP	Down Pipe	PB	Post Box	TP	Telegraph Pole
DPC	Damp Proof Course	PCF	Post & Chain Fence	TWL	Top Of Wall Level
EIC	Electric Inspection Cover	PM	Parking Meter	UTL	Unable To Lift
EL	Eaves Level	PNF	Panel Fence	WIC	Water Inspection Cover
EP	Electric Pole	PRF	Post & Rail Fence	WM	Water Meter
ER	Earth Rod	PRL	Parapet Wall Level	WMF	Wire Mesh Fence
FB	Flower Bed	PWF	Post & Wire Fence	WTL	Water Level
FFL	Finished Floor Level	RE	Rodding Eye	VP	Vent Pipe

Tree Species

AC	Acer	FR	Fruit	LN	London Plane	SC	Sweet Chestnut
AL	Alder	HA	Hawthorn	LO	Locust	SP	Spruce
AS	Ash	HB	Hornbeam	MA	Maple	ST	Stump
BE	Beech	HC	Horse Chestnut	MG	Magnolia	SY	Sycamore
CE	Cedar	HY	Holly	OA	Oak	U	Unidentified
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

Measured Building Survey Legend

ACL	Arch Center Level / Height above floor
ASL	Arch Spring Level / Height above floor
C-H	Window Cill to Window Head Dimension
CLG	Ceiling Level / Height above floor
DH	Door Head Height above floor
DHL	Door Head Level
F-C	Floor to Window Cill Dimension
FL	Floor Level
RU	Ramp Up
SCLG	Suspended / False Ceiling Level / Height above floor
SL	Slab Level
SU	Step(s) Up
TH	Threshold Height above floor
THL	Threshold Level
TWL	Top of Wall Level
US	Underside Level / Height above floor
USB	Underside of Beam level / Height to underside above floor
USJ	Underside of Joist level / Height to underside above floor
WACL	Window Arch Center Level
WASL	Window Arch Spring Level
WCL	Window Cill Level
WHL	Window Head Level

Sloping Roof
Sloped Ceiling (Points up)
Arched / Vaulted Ceiling
Building Line / Wall Line
Detail / Steps
Overhead Detail
Partitions
Glazing

Notes

All levels and coordinates are related to the Ordnance Survey national grid by means of GPS using the Leica Smartnet RTK network. One survey control point has been fixed using GPS and then the survey orientated to an additional GPS points. No scale factor has been applied therefore only the fixed GPS point is a true Ordnance Survey position.

All dimensions are in meters.
Do not scale from this drawing.
Tree girths and canopy spreads are surveyed as a mean size and shown to scale. Tree heights are quoted based on an estimation taken from the ground and have not been accurately confirmed. Whilst every effort is made to identify tree species and sizes, no responsibility can be taken for the accuracy of this information and an Arborologist should be consulted for confirmation.
Eave levels are taken at the bottom of the lowest roof tile.
It is recommended that all invert levels and pipe sizes be checked prior to construction.
Drawing correct at time of survey and to scale.
Any setting out works should be undertaken using Omega Geomatics Ltd survey control only.

All building measurements are taken to existing finishes or faces which are constant and represent an average face or wall line.
All window head and window cill levels are internal measurements.
Ceiling height measurements are taken to a point which best represents the general room height.

N

Drawing Revisions

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

ΩMEGA GEOMATICS
Specialist Geospatial Surveyors

chartered ICES
RICS

Unit 5 Hoath Business Centre
Hoath Lane
Gillingham
Kent ME8 0BF
Tel: +44 (0)1634 751 002
Web: www.OmegaGeo.co.uk
Enquiries: survey@OmegaGeo.co.uk

CLIENT SHEPHERD NEAME

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.	3 OF 3
JOB Ref.	18-0493	CAD FILE	MBS_03

APPENDIX C

British Geological Survey Records

Sampling / Properties / Strata

TR06SW 44

604 609

Depth	Type	Strength kN.m²	w %	SPT N
1.0	D			
1.7	D			
1.8	C			3
2.0	D			
2.4	D			
2.8	C			20
3.3	D			
4.5	D.C			20
5.5	D			
6.0	D.C			10
7.0	D			
7.5	C			18
8.0	D			
9.5	D.C			16

Description	Depth	Level *
	G.L	10.5
TOPSOIL.	0.4	10.1
Soft to firm brown silty slightly sandy CLAY with chalk and occasional flints - chalk content increasing with depth.	1.6	8.9
Very light grey remoulded CHALK.	2.2	8.3
Soft dark grey-brown very silty, slightly sandy CLAY with flints, occasional silt pockets and brick traces.	2.9	7.6
Flint GRAVEL with firm brown silty CLAY and occasional large cobbles. Chalk content below 4.9m increasing with depth.	5.7	4.8
White rock CHALK with some remoulded chalk and flint fragments up to cobble size.	10.0	10.5

Drilling

Type	From	To	Size	Fluid
Shell and Auger	0.1	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

TR06 SW 45

004 bore

Sampling Depth	Type	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							
3.0	C			18	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.			
3.1	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

TQ95NE/14

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
	4'6" (1.37)	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 - 2.29)	C(99)				Flint gravel
	7'6" (2.29)	W				
				10'0" (3.1m)	+48.1	
	10'6" - 12'0" (3.20 - 3.66)	U(4)				Moderately hard, fissured white chalk with soft chalk in the fissures, and flints
	12'0" (3.66)	D				
	19'0" - 20'6" (5.79 - 6.25)	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

Scale: 1in. to 8ft.
Drawing No.: S.W. 5102

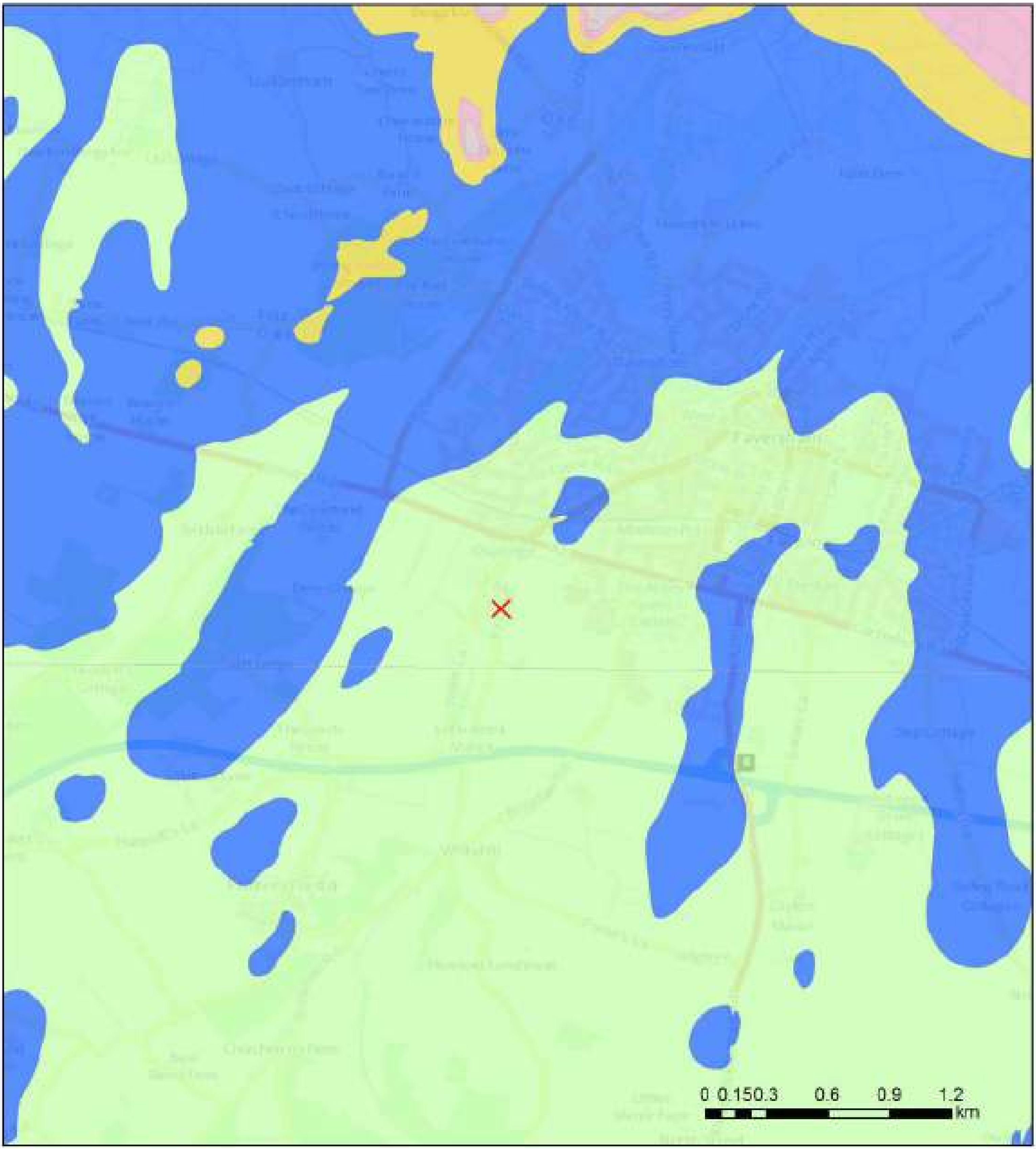
MINISTRY OF TRANSPORT AND CIVIL AVIATION
SITE INVESTIGATION FOR PROPOSED MEDWAY TOWNS MOTOR ROAD

Soils No.: S/1755

FIG. 130

GEORGE WIMPEY & CO., LTD.   CENTRAL LABORATORY   HAYES

Bedrock

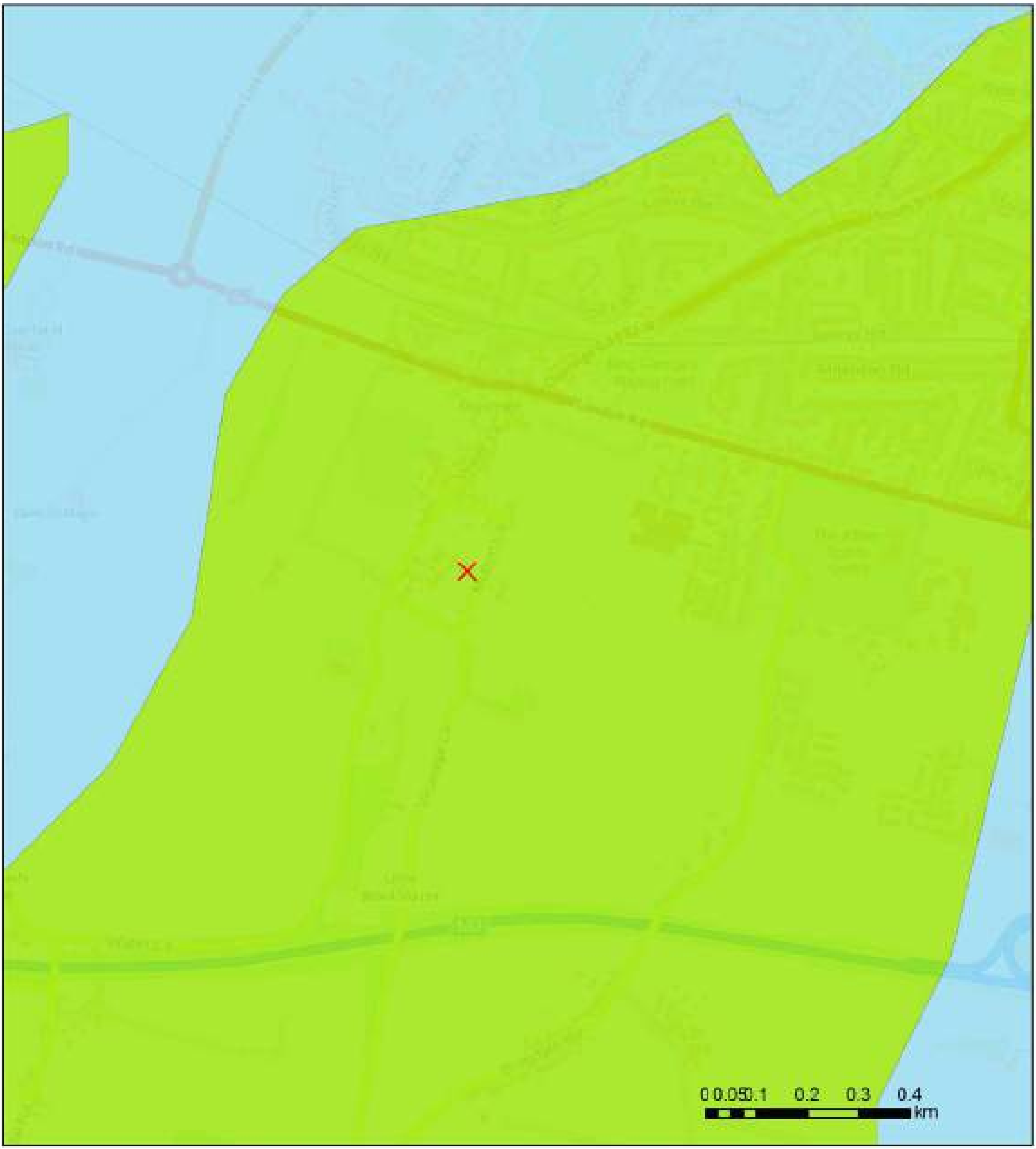


Map Key

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

Hydrogeology



Geolndex 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

Superficial Deposits

Map Key

Superficial deposits 1:50,000 scale

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

APPENDIX D

Southern Water Sewer Records

Southern Water

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)

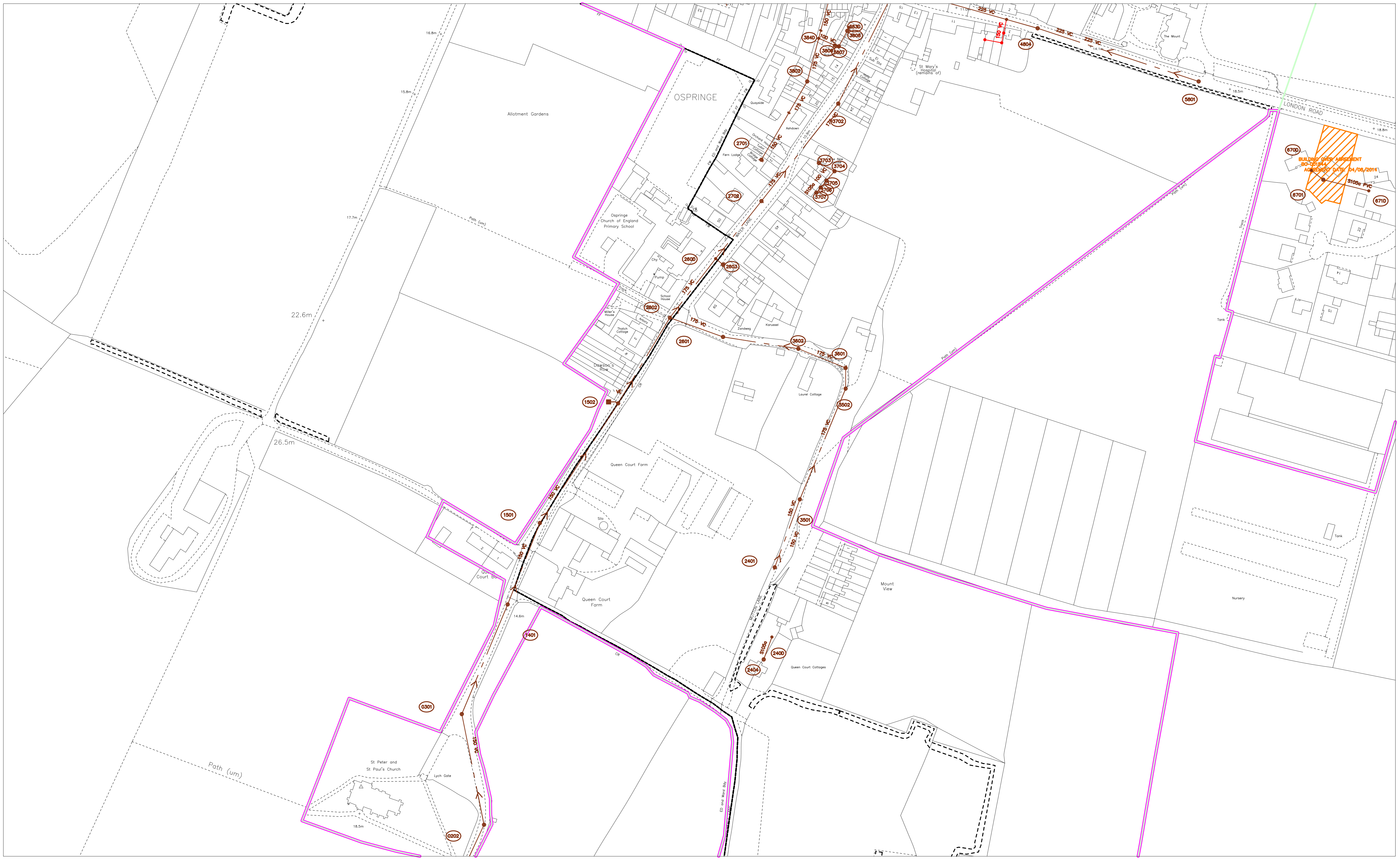
Email: searches@southernwater.co.uk

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. TR0060NW	Drawn by: ahmadr	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.
	Scale: 1:2500	WARNING: BAC pipes are constructed of Bonded Asbestos Cement WARNING: Unknown (UNK) materials may include Bonded Asbestos Cement
Title: 309450_Shepheard Neame Water L	Date: 19/09/2018	Based upon Ordnance Survey Digital Data with the permission of the controller of H.M.S.O. Crown Copyright Reserved Licence No. WU 298530.

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

LINE STYLES / COLOURS

- Brown: Foul; Foul Syphon Sewer; Foul Vacuum Main; Foul Rising Main
- Red: Combined; Combined Syphon Sewer; Combined Rising Main; Lateral Drain
- Orange: Building Over Agreement Area
- Dark Blue: Treated Effluent
- Purple: Sludge; Sewer Catchment; Section 104 Area
- Light Blue: Surface Water; Surface Water Rising Main
- Yellow: Private
- Green: Access Shaft
- Decommissioned

MATERIALS

AK Alkathene
BAC Bonded Asbestos Cement
BRC Brick (Common)
BRE Brick (Engineering)
CC Concrete Box Culvert
CI Cast Iron
CO Concrete (In-Situ)
CP Concrete (Pre-Cast)
CSB Concrete Segments (bolted)
CSU Concrete Segments (unbolted)
DI Ductile Iron
GRC Glass Reinforced Concrete
GRP Glass Reinforced Plastic
MAC Masonry in regular Courses
MAR Masonry in random Courses
PE Polyethylene
PF Pitch Fibre
PP Polypropylene
PVC Polyvinyl Chloride
RPM Reinforced Plastic Matrix
SI Spun Iron
ST Steel
VC Vitrified Clay
XXX Other
ZZZ Unknown

LEGEND - SEWERS

Manhole (SW); Manhole (F&C); Lamp hole (SW); Lamp hole (F&C); Pumping Station (SW); Pumping Station (F&C); Side entry manhole (SW); Side entry Manhole (F&C); Blind shaft (SW); Blind shaft (F&C); Ejector station (SW); Ejector station (F&C); Watertight door (SW); Watertight door (F&C); Flushing ch. Mn-e (SW); Flushing ch. Mn-e (F&C); Flushing ch. No-e (SW); Flushing ch. No-e (F&C); Demarcation Chamber

Washout (SW); Washout (F&C); Rodding Eye (SW); Rodding Eye (F&C); Gauging point (SW); Gauging point (F&C); Intercept chamber (SW); Intercept chamber (F&C); Storm Tank (SW); Storm Tank (F&C); Vortex chamber (SW); Vortex chamber (F&C); Label ellipse; Dummy/S24 manhole; Outfall; Penstock chamber; Damboards; Storm Overflow; Backdrop manhole

Other (s); Other; Change in sewer (s); Change in sewer; Reflux valve; Flap valve; Cascade; Anode; Valve; Closed Valve; Air Valve; Hatch box (SW); Hatch box (F&C); Direction arrow; Emptying valve; Catchpit; Soakaway; Inlet; Balancing Pond

Wastewater treatment works; Marine treatment works; Outfall headworks; Vent; Vent column; Tidal storage tank; Blank end; Head of Public Sewer; Micro Pumping Station

SHAPES (S)

A Arched; B Barrel; C Circular; E Egg; H Horseshoe; R Rectangular; S Square; T Trapezoidal; U U Shape; X Other

NODE REFERENCING SYSTEM

1st digit: hundred metre easting identifier
2nd digit: hundred metre northing identifier
3rd digit: sewer type identifier 0-4 = Foul/Combined 5-9 = Surface Water
4th digit: next sequential node

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

Southern Water

APPENDIX E

MicroDrainage Calculations and Preliminary Surface Water Drainage Strategy (Reference 18-120-100)

P:\18-120 - Shepherd Neame, Faversham\Tech\Acad\Drawings\100 Series - Phase 2\18-120-100 Preliminary Drainage Strategy.dwg

NOTES

1. DO NOT SCALE FROM THIS DRAWING. WORK FROM MEASURED DIMENSIONS ONLY.
2. THIS DRAWING IS FOR PLANNING PURPOSES ONLY AND IS TO BE READ IN CONJUNCTION WITH ALL OTHER DRAWINGS ISSUED BY THE ARCHITECT.
3. SURROUNDING TOPOGRAPHICAL DATA WAS PRODUCED BY HOOK SURVEYS IN OCTOBER 2011. ODYSSEY DOES NOT TAKE RESPONSIBILITY FOR THE ACCURACY OF THE SURVEY INFORMATION.
4. SITE LAYOUT HAS BEEN PROVIDED BY ON ARCHITECTURE (DWG REFERENCE 21.153-ONA-XX-00-DR-A-0101 P4 DATED 29.07.22).
5. PROPOSALS ARE INDICATIVE ONLY TO DEMONSTRATE THE PRELIMINARY DRAINAGE STRATEGY AND ARE SUBJECT TO EVOLVE IN LINE WITH DETAILED DESIGN REQUIREMENTS.
6. INFILTRATING SuDS FEATURES HAVE BEEN DESIGNED WITH AN INFILTRATION COEFFICIENT OF 1.0×10^{-5}m/s.
7. CONNECTION TO EXISTING SOUTHERN WATER SEWER IS SUBJECT TO DISCUSSIONS WITH SOUTHERN WATER TO CONFIRM CAPACITY.
8. THE FOUL PUMPING STATION IS TO BE PRIVATE AND UNDERGROUND.

LEGEND:

- SITE BOUNDARY
- PROPOSED SURFACE WATER SEWER NETWORK
- PROPOSED FOUL WATER SEWER NETWORK
- EXISTING FOUL WATER SEWER PIPEWORK AND MANHOLE (SOUTHERN WATER)
- INFILTRATING CELLULAR STORAGE TANK WITH 5m BUFFER
- INDICATIVE TYPE 2 FOUL PUMPING STATION WITH 10m BUFFER FROM THE WET WELL
- 1 IN 100 YEAR PLUS 22% CLIMATE CHANGE DESIGN FLOOD EXTENTS
- PROPOSED FOUL RISING MAIN

Rev	Amendments	Drn	Chk	App	Date
A	AMENDED FOR NEW SITE LAYOUT	MSS	JW	GG	03.08.22

ODYSSEY
Tuscany House
White Hart Lane
Basingstoke
Hampshire RG21 4AF
Telephone: 01256 331144
Fax: 01256 331134
E: info@odysseyconsult.co.uk
W: www.odysseyconsult.co.uk

Job Title
SHEPHERD NEAME FAVERSHAM

Drawing Title
PRELIMINARY DRAINAGE STRATEGY - PHASE 2

Client
MILIKEN & COMPANY CHARTERED SURVEYORS & TOWN PLANNERS

Scale	Date	Designed
1:250 @ A1	AUG 21	JW
Drawn	**Checked**	**Approved**
MSS	NA	RA
Job No	**Drawing No**	**Rev**
18-120	18-120/100	A

ICP SUDS Mean Annual Flood

Input

Return Period (years)	2	Soil	0.150
Area (ha)	0.241	Urban	0.000
SAAR (mm)	700	Region Number	Region 7

Results	**l/s**
QBAR Rural	0.1
QBAR Urban	0.1
Q2 years	0.1
Q1 year	0.1
Q30 years	0.2
Q100 years	0.3

Summary of Results for 100 year Return Period (+40%)

Half Drain Time : 1498 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	9.973	0.433	1.0	82.3	O K
30 min Summer	10.040	0.500	1.0	95.0	O K
60 min Summer	10.114	0.574	1.0	109.0	O K
120 min Summer	10.192	0.652	1.0	123.9	O K
180 min Summer	10.238	0.698	1.0	132.5	O K
240 min Summer	10.268	0.728	1.0	138.4	O K
360 min Summer	10.307	0.767	1.0	145.7	O K
480 min Summer	10.328	0.788	1.0	149.8	O K
600 min Summer	10.340	0.800	1.0	151.9	O K
720 min Summer	10.344	0.804	1.0	152.8	O K
960 min Summer	10.351	0.811	1.0	154.1	O K
1440 min Summer	10.337	0.797	1.0	151.4	O K
2160 min Summer	10.308	0.768	1.0	146.0	O K
2880 min Summer	10.281	0.741	1.0	140.8	O K
4320 min Summer	10.203	0.663	1.0	126.1	O K
5760 min Summer	10.131	0.591	1.0	112.4	O K
7200 min Summer	10.063	0.523	1.0	99.5	O K
8640 min Summer	10.000	0.460	1.0	87.3	O K
10080 min Summer	9.941	0.401	1.0	76.1	O K
15 min Winter	10.026	0.486	1.0	92.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	219.665	0.0	19
30 min Summer	127.589	0.0	34
60 min Summer	74.108	0.0	64
120 min Summer	43.044	0.0	124
180 min Summer	31.325	0.0	184
240 min Summer	25.002	0.0	242
360 min Summer	18.195	0.0	362
480 min Summer	14.522	0.0	482
600 min Summer	12.192	0.0	602
720 min Summer	10.568	0.0	722
960 min Summer	8.515	0.0	960
1440 min Summer	6.280	0.0	1282
2160 min Summer	4.632	0.0	1644
2880 min Summer	3.732	0.0	2044
4320 min Summer	2.699	0.0	2852
5760 min Summer	2.144	0.0	3640
7200 min Summer	1.793	0.0	4464
8640 min Summer	1.550	0.0	5192
10080 min Summer	1.370	0.0	5960
15 min Winter	219.665	0.0	19

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
30 min Winter	10.101	0.561	1.0	106.6	O K
60 min Winter	10.184	0.644	1.0	122.4	O K
120 min Winter	10.275	0.735	1.0	139.6	O K
180 min Winter	10.328	0.788	1.0	149.7	O K
240 min Winter	10.365	0.825	1.0	156.7	O K
360 min Winter	10.413	0.873	1.0	165.8	O K
480 min Winter	10.441	0.901	1.0	171.2	O K
600 min Winter	10.458	0.918	1.0	174.5	O K
720 min Winter	10.468	0.928	1.0	176.4	O K
960 min Winter	10.485	0.945	1.0	179.6	O K
1440 min Winter	10.483	0.943	1.0	179.2	O K
2160 min Winter	10.443	0.903	1.0	171.5	O K
2880 min Winter	10.405	0.865	1.0	164.3	O K
4320 min Winter	10.292	0.752	1.0	142.9	O K
5760 min Winter	10.182	0.642	1.0	122.0	O K
7200 min Winter	10.078	0.538	1.0	102.2	O K
8640 min Winter	9.981	0.441	1.0	83.7	O K
10080 min Winter	9.892	0.352	1.0	66.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
30 min Winter	127.589	0.0	34
60 min Winter	74.108	0.0	64
120 min Winter	43.044	0.0	122
180 min Winter	31.325	0.0	180
240 min Winter	25.002	0.0	240
360 min Winter	18.195	0.0	358
480 min Winter	14.522	0.0	474
600 min Winter	12.192	0.0	590
720 min Winter	10.568	0.0	706
960 min Winter	8.515	0.0	932
1440 min Winter	6.280	0.0	1370
2160 min Winter	4.632	0.0	1772
2880 min Winter	3.732	0.0	2196
4320 min Winter	2.699	0.0	3112
5760 min Winter	2.144	0.0	3976
7200 min Winter	1.793	0.0	4824
8640 min Winter	1.550	0.0	5616
10080 min Winter	1.370	0.0	6352

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 600300 160800 TR 00300 60800
C (1km)	-0.023
D1 (1km)	0.322
D2 (1km)	0.355
D3 (1km)	0.306
E (1km)	0.315
F (1km)	2.520
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.202

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.202

Model Details

Storage is Online Cover Level (m) 11.940

Cellular Storage Structure

Invert Level (m) 9.540 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.03600 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	200.0	200.0	1.201	0.0	267.9
1.200	200.0	267.9			

Summary of Results for 100 year Return Period (+40%)

Half Drain Time : 1236 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	10.451	0.371	0.2	15.9	O K
30 min Summer	10.508	0.428	0.2	18.3	O K
60 min Summer	10.570	0.490	0.2	21.0	O K
120 min Summer	10.635	0.555	0.2	23.7	O K
180 min Summer	10.672	0.592	0.2	25.3	O K
240 min Summer	10.697	0.617	0.2	26.4	O K
360 min Summer	10.725	0.645	0.2	27.6	O K
480 min Summer	10.739	0.659	0.2	28.2	O K
600 min Summer	10.745	0.665	0.2	28.4	O K
720 min Summer	10.745	0.665	0.2	28.4	O K
960 min Summer	10.743	0.663	0.2	28.3	O K
1440 min Summer	10.726	0.646	0.2	27.6	O K
2160 min Summer	10.699	0.619	0.2	26.5	O K
2880 min Summer	10.671	0.591	0.2	25.3	O K
4320 min Summer	10.597	0.517	0.2	22.1	O K
5760 min Summer	10.528	0.448	0.2	19.1	O K
7200 min Summer	10.464	0.384	0.2	16.4	O K
8640 min Summer	10.406	0.326	0.2	13.9	O K
10080 min Summer	10.353	0.273	0.2	11.7	O K
15 min Winter	10.496	0.416	0.2	17.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	219.665	0.0	19
30 min Summer	127.589	0.0	34
60 min Summer	74.108	0.0	64
120 min Summer	43.044	0.0	124
180 min Summer	31.325	0.0	182
240 min Summer	25.002	0.0	242
360 min Summer	18.195	0.0	362
480 min Summer	14.522	0.0	482
600 min Summer	12.192	0.0	602
720 min Summer	10.568	0.0	720
960 min Summer	8.515	0.0	952
1440 min Summer	6.280	0.0	1170
2160 min Summer	4.632	0.0	1556
2880 min Summer	3.732	0.0	1960
4320 min Summer	2.699	0.0	2768
5760 min Summer	2.144	0.0	3576
7200 min Summer	1.793	0.0	4328
8640 min Summer	1.550	0.0	5104
10080 min Summer	1.370	0.0	5848
15 min Winter	219.665	0.0	19

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
30 min Winter	10.560	0.480	0.2	20.5	O K
60 min Winter	10.631	0.551	0.2	23.5	O K
120 min Winter	10.706	0.626	0.2	26.8	O K
180 min Winter	10.750	0.670	0.2	28.6	O K
240 min Winter	10.779	0.699	0.2	29.9	O K
360 min Winter	10.816	0.736	0.2	31.5	O K
480 min Winter	10.836	0.756	0.2	32.3	O K
600 min Winter	10.847	0.767	0.2	32.8	O K
720 min Winter	10.851	0.771	0.2	33.0	O K
960 min Winter	10.858	0.778	0.2	33.2	O K
1440 min Winter	10.842	0.762	0.2	32.6	O K
2160 min Winter	10.803	0.723	0.2	30.9	O K
2880 min Winter	10.762	0.682	0.2	29.2	O K
4320 min Winter	10.650	0.570	0.2	24.4	O K
5760 min Winter	10.545	0.465	0.2	19.9	O K
7200 min Winter	10.447	0.367	0.2	15.7	O K
8640 min Winter	10.360	0.280	0.2	12.0	O K
10080 min Winter	10.285	0.205	0.2	8.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
30 min Winter	127.589	0.0	33
60 min Winter	74.108	0.0	64
120 min Winter	43.044	0.0	122
180 min Winter	31.325	0.0	180
240 min Winter	25.002	0.0	240
360 min Winter	18.195	0.0	356
480 min Winter	14.522	0.0	472
600 min Winter	12.192	0.0	588
720 min Winter	10.568	0.0	700
960 min Winter	8.515	0.0	924
1440 min Winter	6.280	0.0	1344
2160 min Winter	4.632	0.0	1684
2880 min Winter	3.732	0.0	2136
4320 min Winter	2.699	0.0	3028
5760 min Winter	2.144	0.0	3864
7200 min Winter	1.793	0.0	4680
8640 min Winter	1.550	0.0	5368
10080 min Winter	1.370	0.0	6056

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 600300 160800 TR 00300 60800
C (1km)	-0.023
D1 (1km)	0.322
D2 (1km)	0.355
D3 (1km)	0.306
E (1km)	0.315
F (1km)	2.520
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.039

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.039

Model Details

Storage is Online Cover Level (m) 12.080

Cellular Storage Structure

Invert Level (m) 10.080 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.03600 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	45.0	45.0	0.801	0.0	66.5
0.800	45.0	66.5			

APPENDIX F

Flood Mapping

Environment Agency

Flood map for planning

Your reference	Location (easting/northing)	Created
Shephard Neame	**600245/160525**	**15 Jul 2022 12:10**

Your selected location is in flood zone 3, an area with a high probability of flooding.

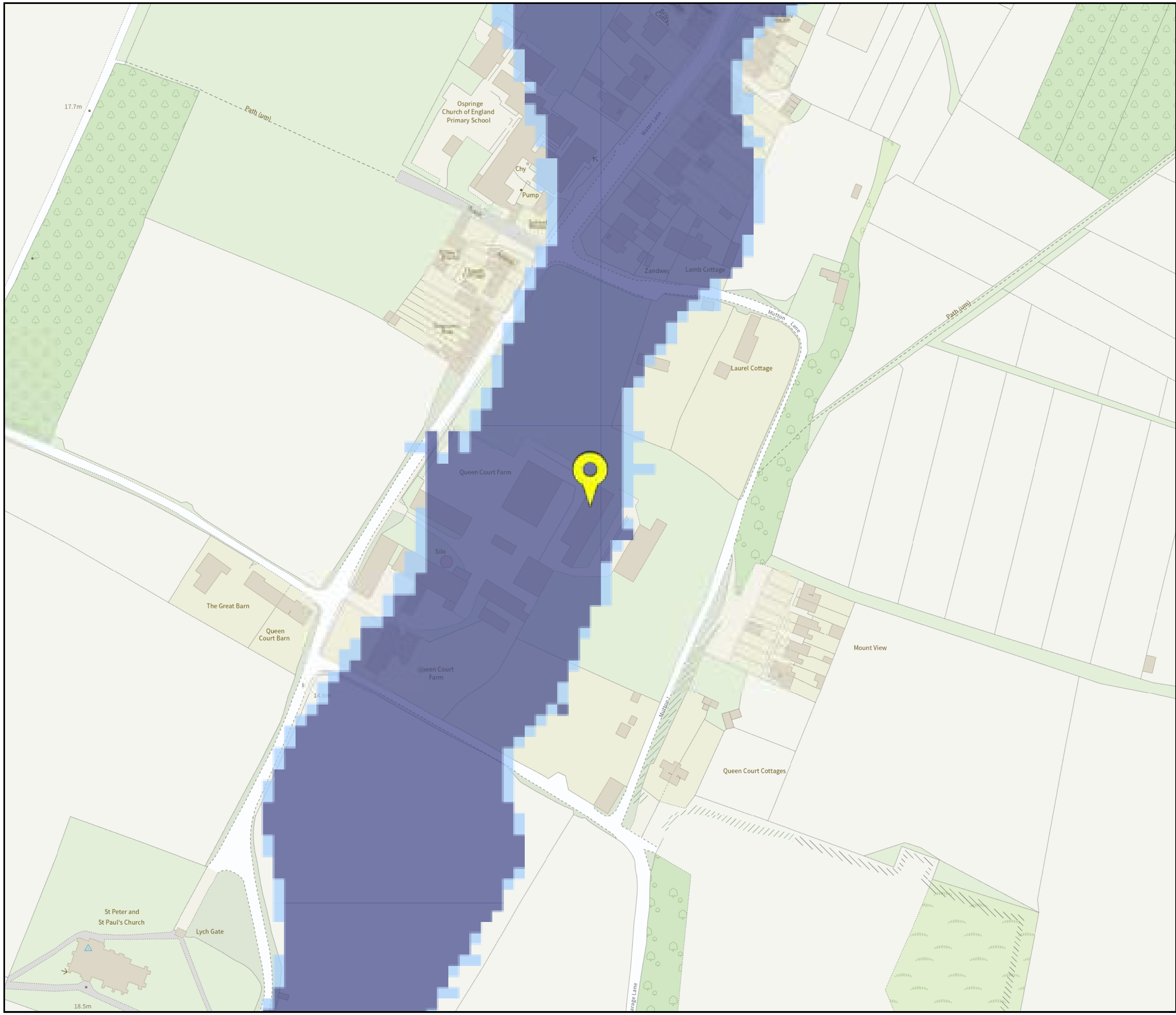
This means:

- you must complete a flood risk assessment for development in this area
- you should follow the Environment Agency's standing advice for carrying out a flood risk assessment (see www.gov.uk/guidance/flood-risk-assessment-standing-advice)

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.



Environment Agency

Flood map for planning

Your reference
Shephard Neame

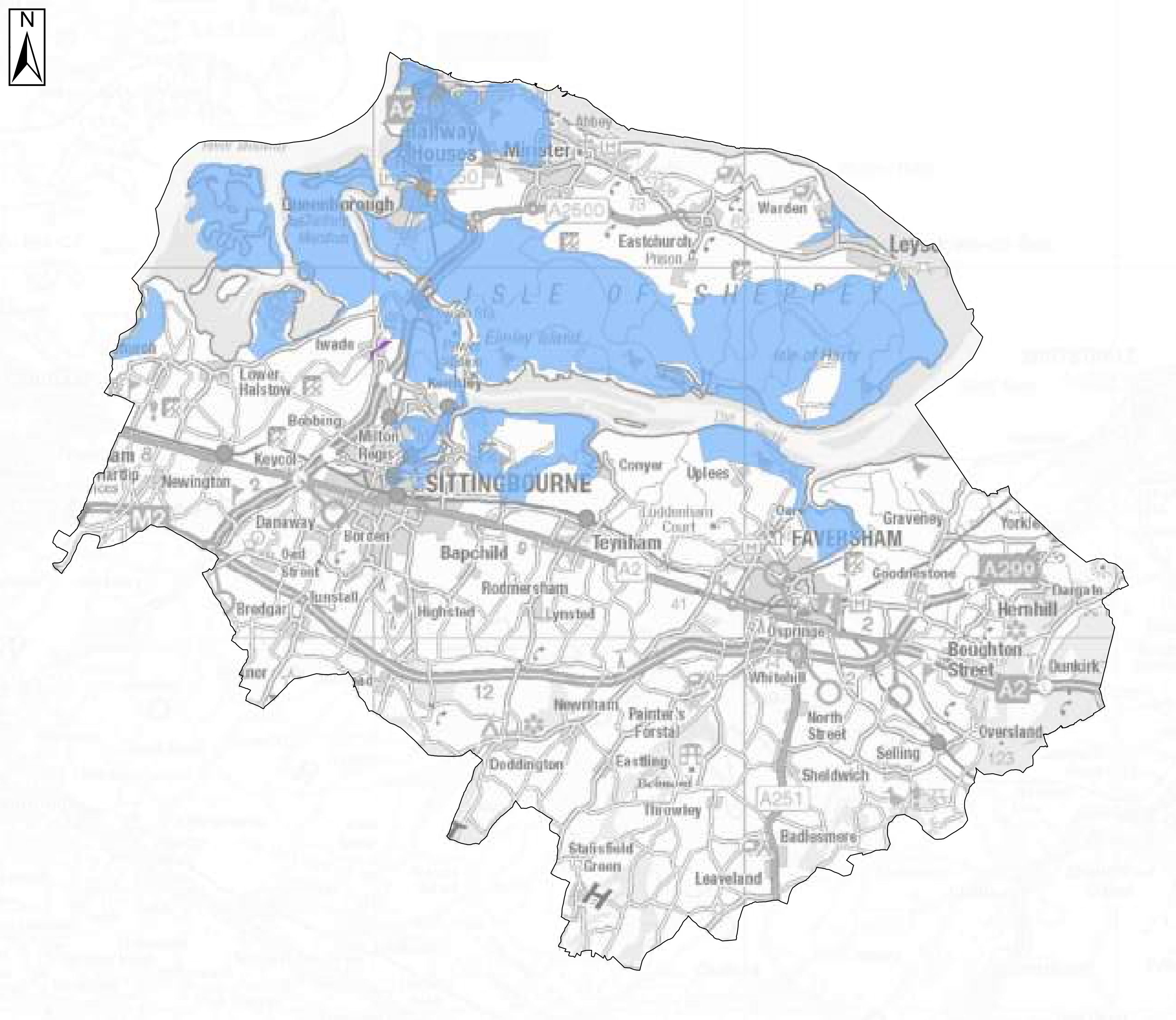
Location (easting/northing)
600245/160525

Scale
1:2500

Created
15 Jul 2022 12:10

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

0 20 40 60m



Key Plan

Legend

Swale Borough

Enviornment Agency's Recorded Flood Outlines

Flooding from the sea

Flooding from Main Rivers

Notes

The Historic Flood Map shows the recorded flood outlines available from the Environment Agency. The dataset records historical flooding from rivers, the sea, groundwater and surface water.

It is possible that the pattern of flooding has changed and areas would now flood or not flood under different circumstances.

Please note that not all historical records may be shown on this map, and that it is therefore advised you contact the Environment Agency for updated information.

The map does not included recorded incidents of flooding held by Kent County Council or Southern Water.

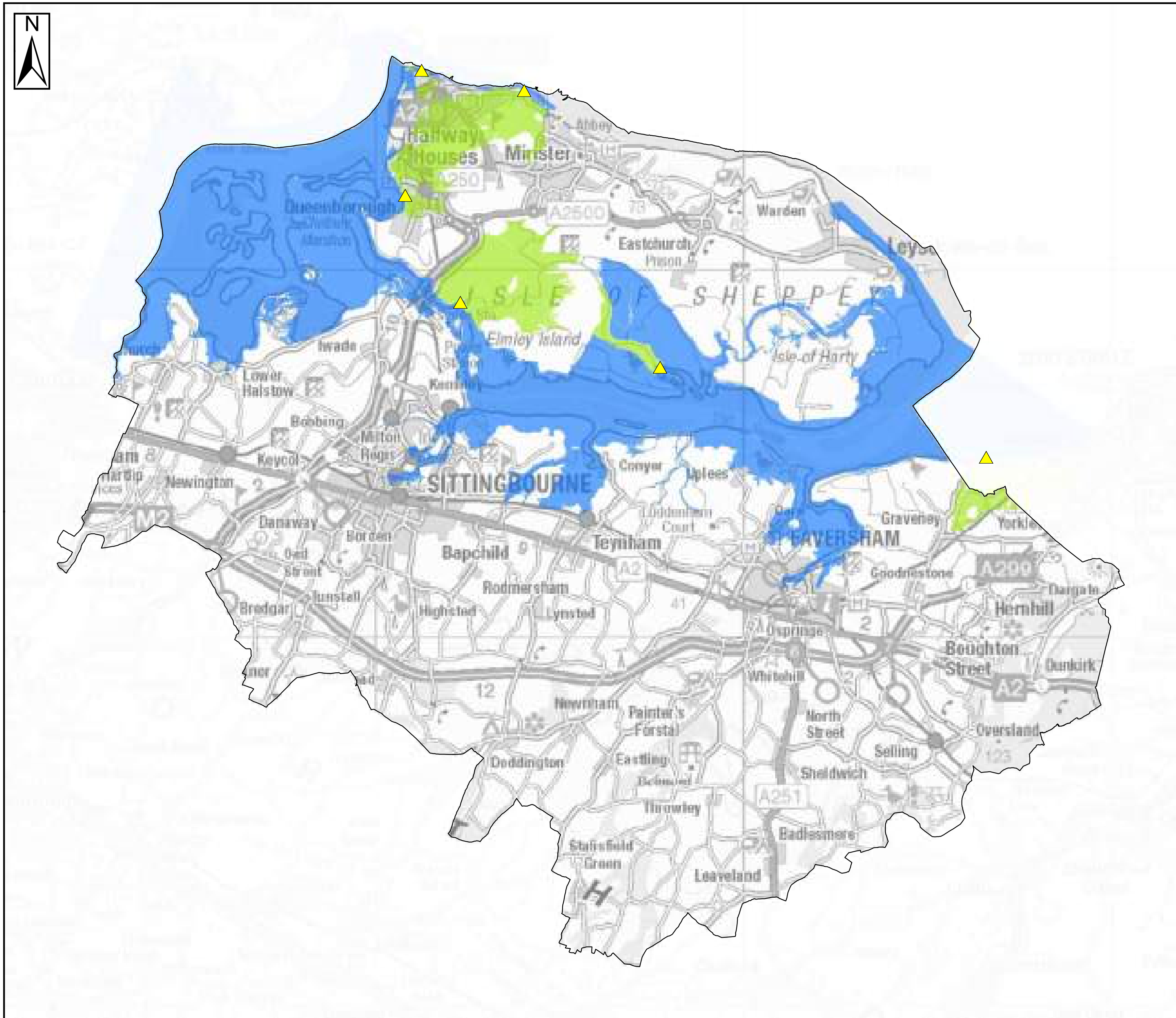
0 1.25 2.5 5 **Kilometres**

SWALE BOROUGH COUNCIL

SFRA: APPENDIX A
HISTORIC FLOODING

Extent of flooding from surface water

High Medium Low Very low Location you selected



Key Plan

Legend

- Swale Borough
- Locations of modelled breaches
- Modelled breach flood extents
- Baseline flood extents (0.5% AEP)

Notes

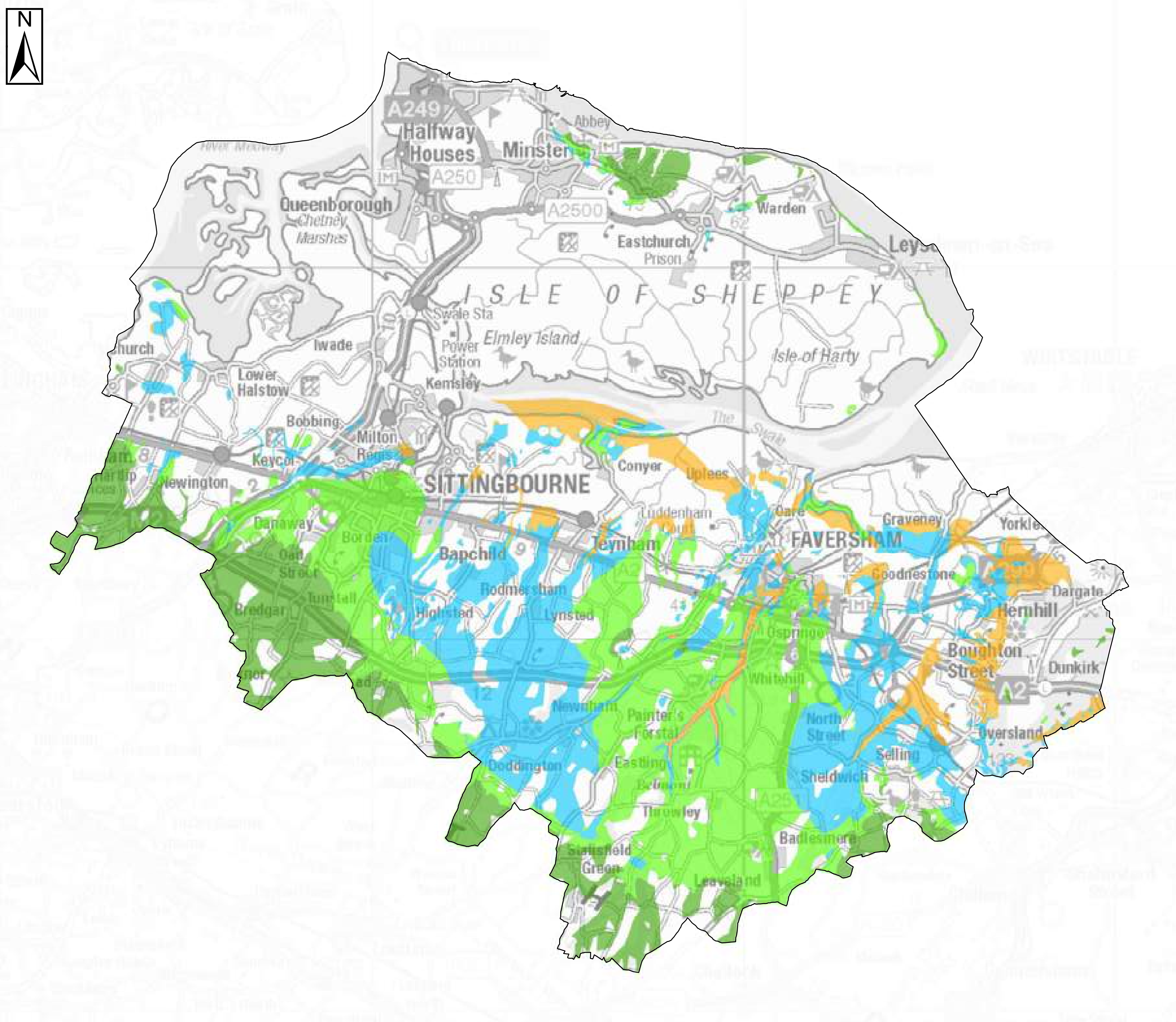
Breaches modelled as part of the North Kent Coast modelling study (2019) that are predicted to impact flooding within the Local Plan area are shown. The total area predicted to be impacted by the breaches is represented as the areas shaded green, For further information on the predicted extents for individual breaches the modelling study should be referred to.

The locations selected for testing of breach failure were based on where the Environment Agency had identified area where a defence failure could have a high impact. The possibility of breach failure at other locations is plausible and further analysis should be undertaken as part of site-specific flood risk assessments where defences are present and sites may therefore be at risk of a breach event.

0 1.25 2.5 5 Kilometres

SWALE BOROUGH COUNCIL

SFRA: APPENDIX I
MODELLED BREACH EXTENTS



Key Plan

Legend

Swale Borough

JBA Groundwater Flood Map Depths

- No risk.
- Groundwater levels are either at or very near (within 0.025m of) the ground surface.
- Groundwater levels are between 0.025m and 0.5m below the ground surface.
- Groundwater levels are between 0.5m and 5m below the ground surface.
- Groundwater levels are at least 5m below the ground surface.

Notes

The modelled groundwater levels are not predictions of typical groundwater levels, rather they are flood levels. The 5m resolution JBA Groundwater Flood Map categorises the head difference (m) between the predicted groundwater levels and the surface level into five feature classes based on the 100-year flood model outputs.

It should be noted that the JBA Groundwater Flood Map is suitable for general broad-scale assessment of the groundwater flood hazard in an area, but is not explicity designed for the assessment of flood hazard at the scale of a single property.

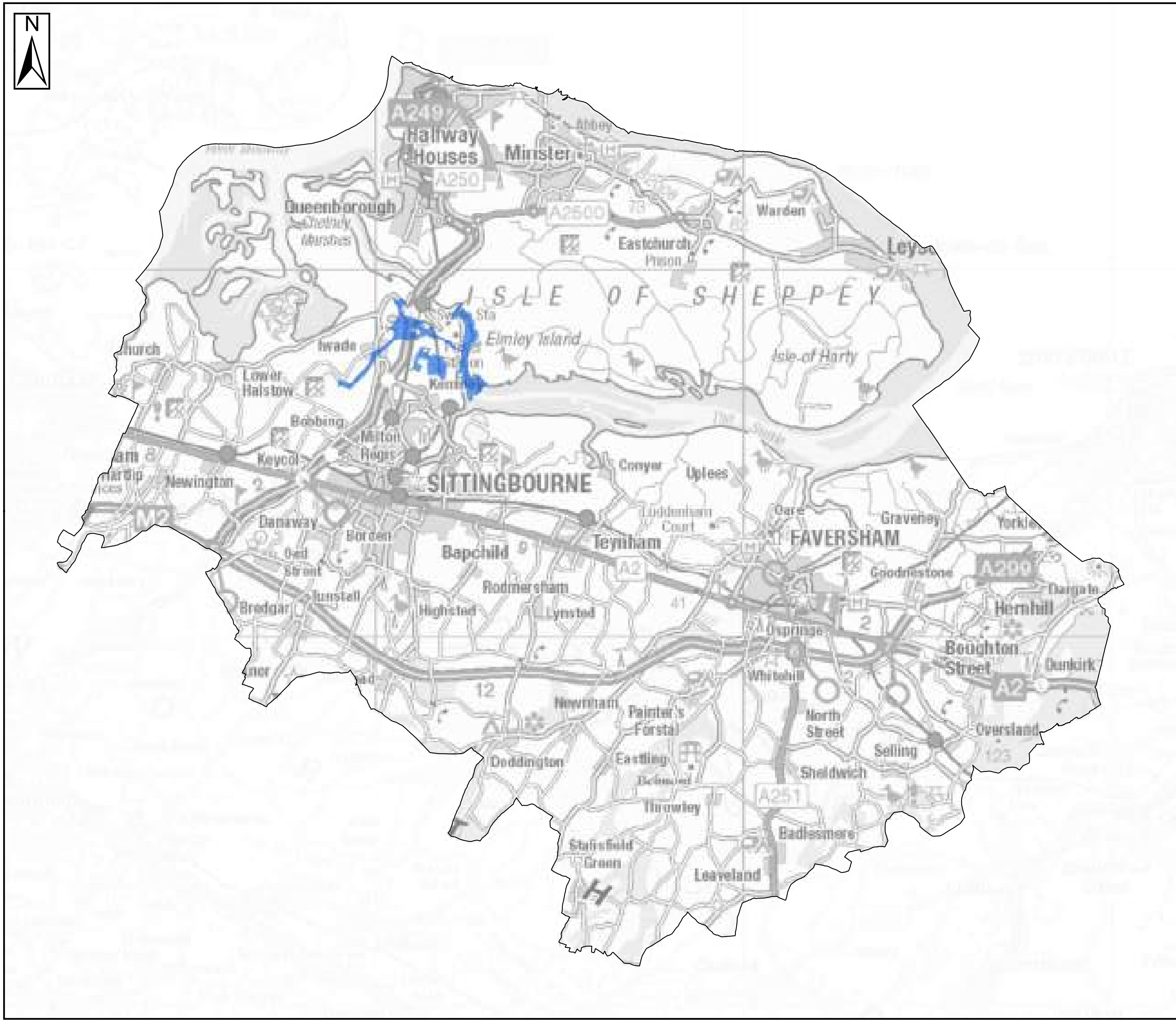
0 1.25 2.5 5 Kilometres

SWALE BOROUGH COUNCIL

SFRA: APPENDIX F

JBA GROUNDWATER FLOOD MAP

Making Swale a better place



Key Plan

Legend

- Swale Borough
- Environment Agency Reservoir Flood Extents

Notes

The risk of inundation due to reservoir breach or failure of reservoirs within the area has been mapped using the outlines available from the Risk of Flooding from Reservoir dataset, made available by the Environment Agency. An Environment Agency programme for updating and improving this mapping is in progress and is due to be completed by 2020.

0 1.25 2.5 5 Kilometres

SWALE BOROUGH COUNCIL

SFRA: APPENDIX G
RESERVOIR INUNDATION

APPENDIX G

Odyssey Fluvial Flood Study Report (Reference 15-347-01)

and Environment Agency Correspondence

Mr Gerald Guma
Odyssey Markides
Tuscany House White Hart Lane
BASINGSTOKE
Hampshire
RG21 4AF

Our ref: KT/2016/121301/01-L01
Your ref: Enquiry

Date: 20 June 2016

Dear Mr Guma

Hydraulic Model Review - Charged

Queen Court Farm Yard, Kent

Thank you for your enquiry. We have reviewed the submitted hydraulic modelling of the site.

We do not hold any detailed modelling of the watercourse affecting this site. Therefore we accept the submitted model outputs as the best available information for this proposed development.

We are satisfied with the methodology used and the results produced.

The modelling shows some areas of the site to be affected by the 1 in 20 year flood event, therefore potentially putting these areas in Flood Zone 3b (functional flood plain).

We would expect a detailed Flood Risk Assessment (FRA) to be submitted using the model results and flood levels / depths to proposed flood mitigation in order to satisfy the Exception Test as detailed in the National Planning Policy Framework (NPPF).

Please note that residential development is not appropriate in areas identified as Flood Zone 3b.

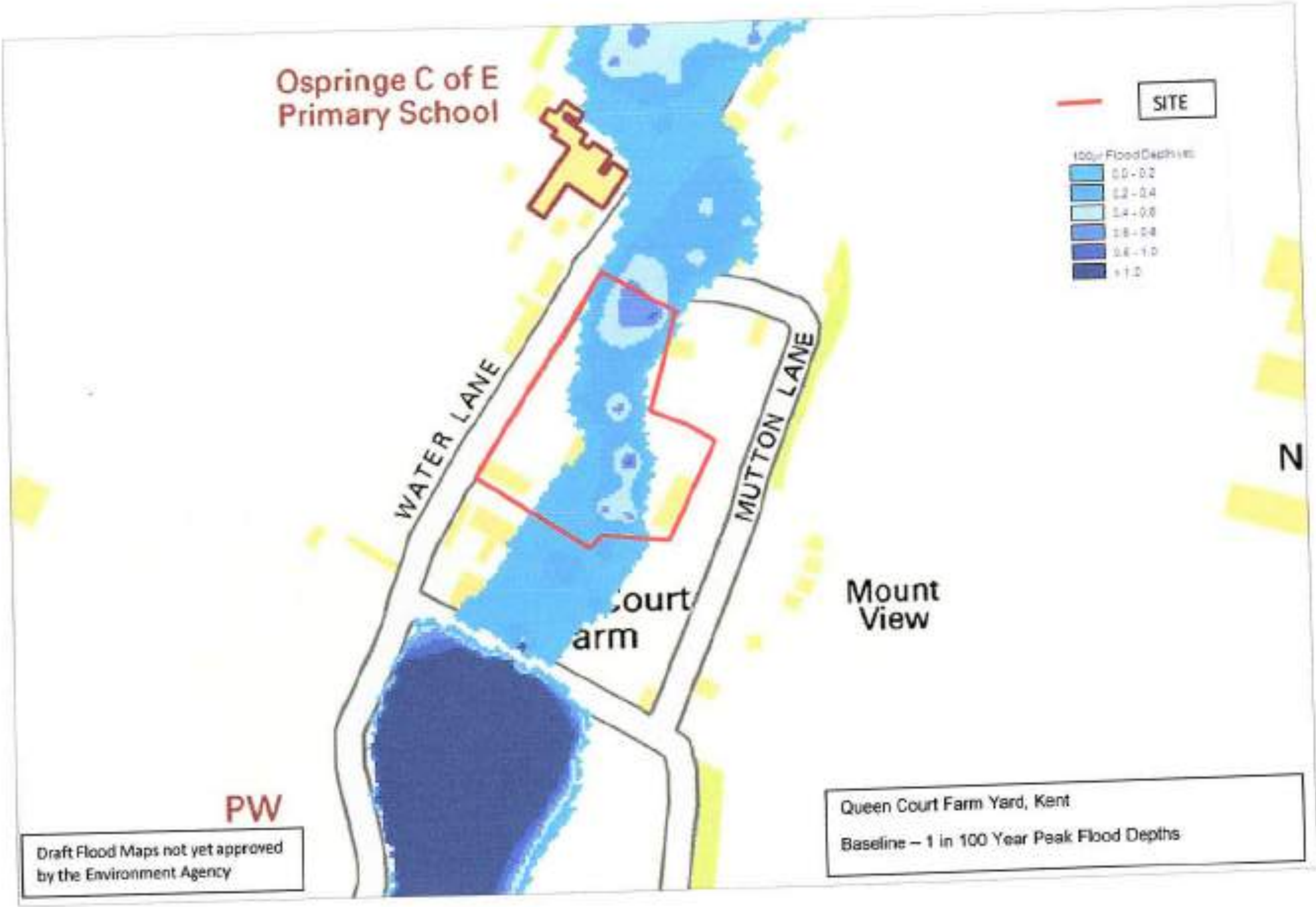
Please note that the view expressed in this letter by the Environment Agency is a response to a pre application enquiry only and does not represent our final view in relation to any future planning application made in relation to this site. We reserve the right to change our position in relation to any such application.

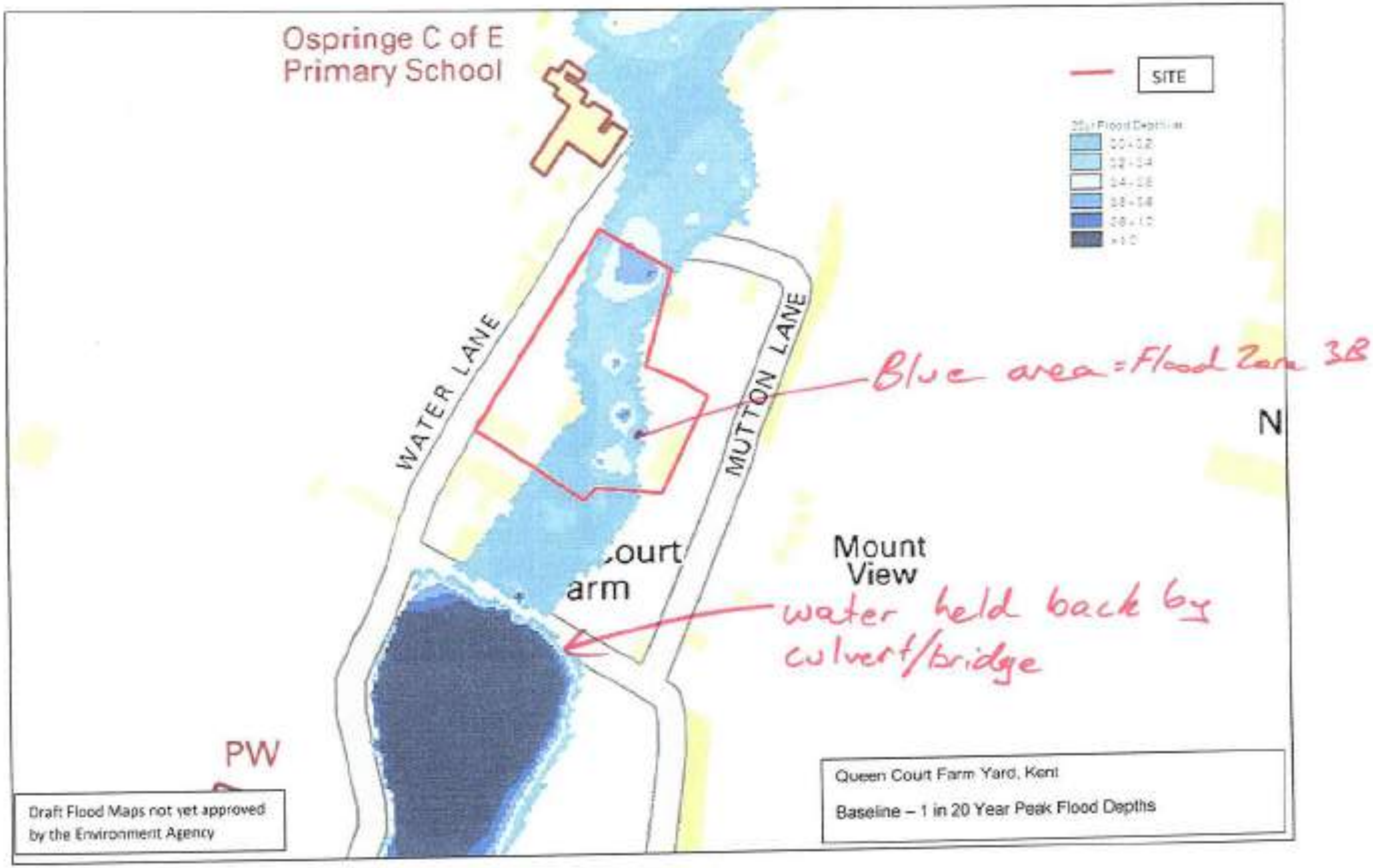
Yours sincerely

Pp Jennifer Wilson

Mrs Joanna Clemmence
Planning Advisor

Direct dial 0208 474 7773
Direct e-mail ksiplanning@environment-agency.gov.uk


Ospringe C of E
Primary School
SITE
WATER LANE
MUTTON LANE
Mount
View
N
PW
Draft Flood Maps not yet approved by the Environment Agency
Queen Court Farm Yard, Kent
Baseline – 1 in 100 Year Peak Flood Depths


Ospringe C of E
Primary School
SITE
WATER LANE
MUTTON LANE
Blue area = Flood Zone 3B
N
Mount
View
water held back by
culvert/bridge
PW
Draft Flood Maps not yet approved
by the Environment Agency
Queen Court Farm Yard, Kent
Baseline – 1 in 20 Year Peak Flood Depths

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
Hampshire
RG21 4AF
Tel: 01256 331144
Fax: 01256 331134
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.

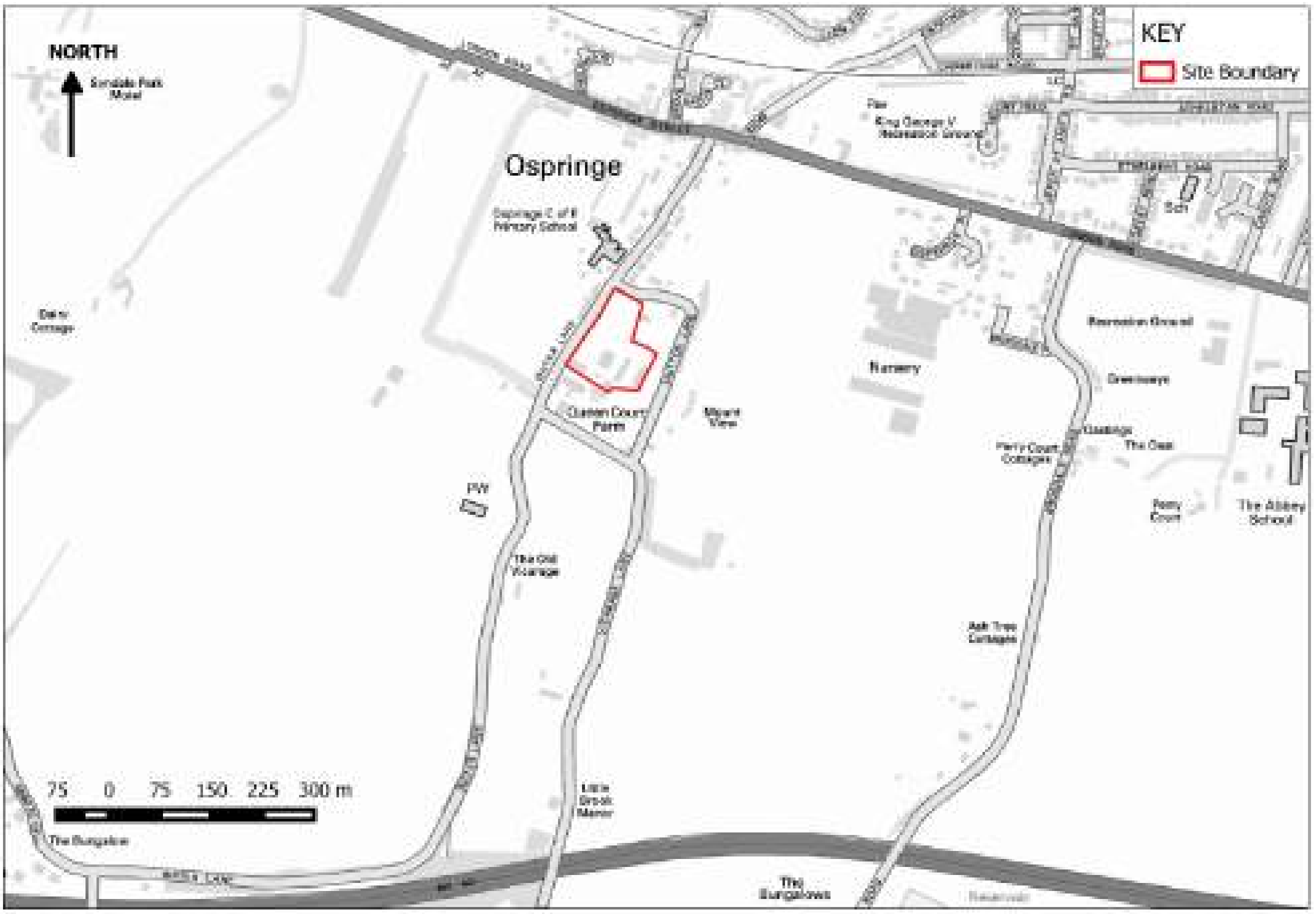


Figure 1:1 Site location

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

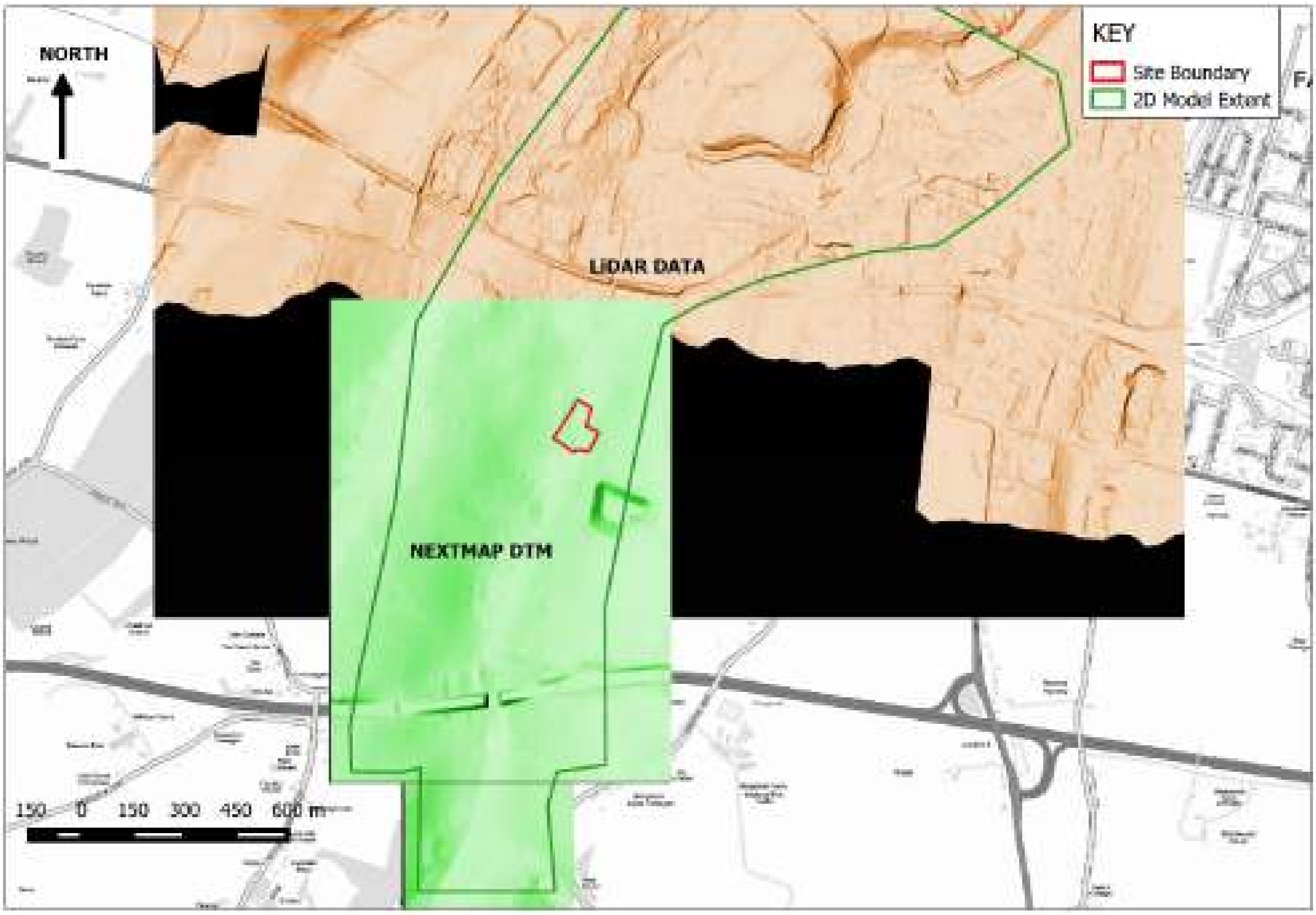


Figure 2:1 LiDAR and NEXTMap data coverage

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.

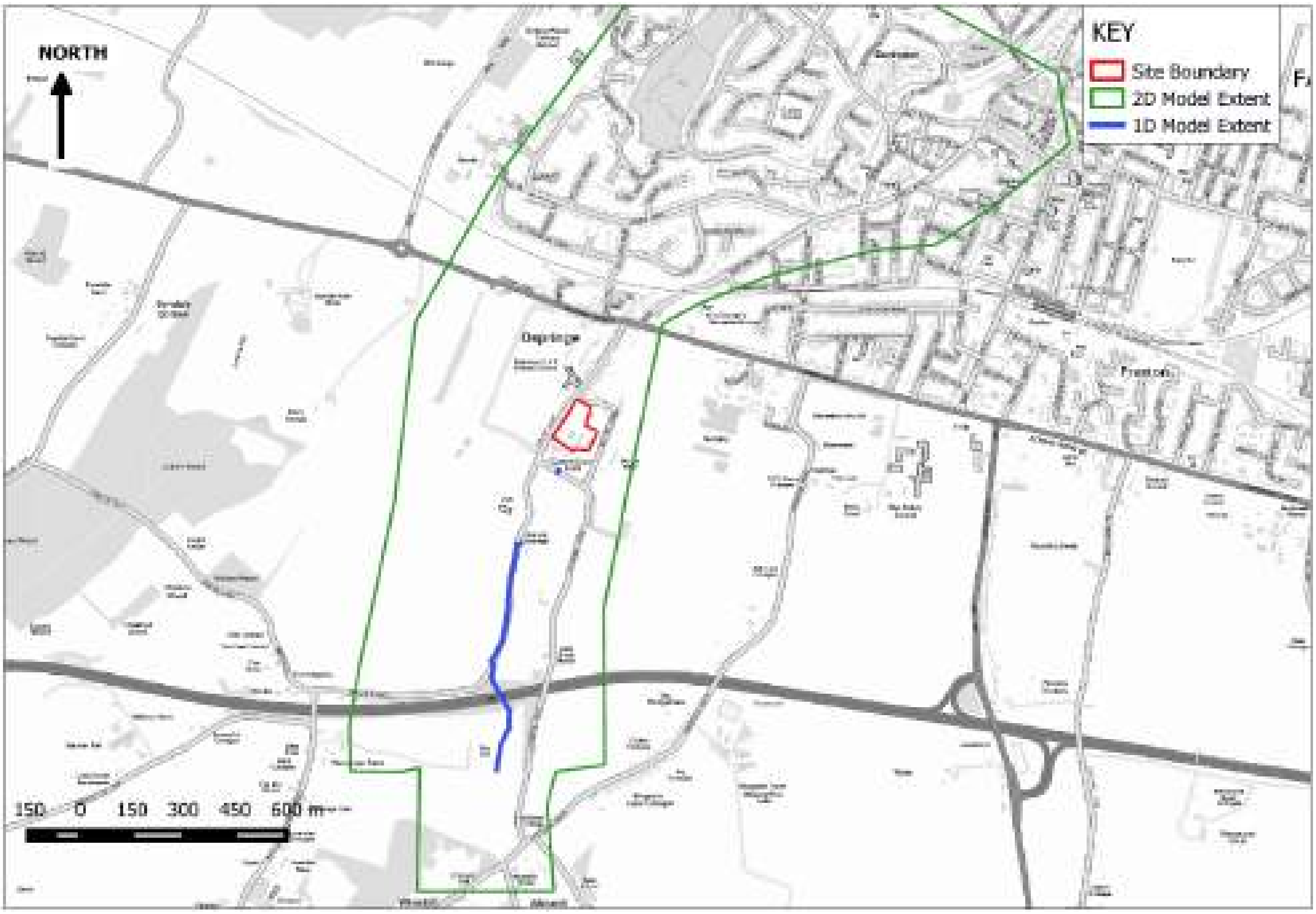


Figure 3:1 Hydraulic model schematic

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.

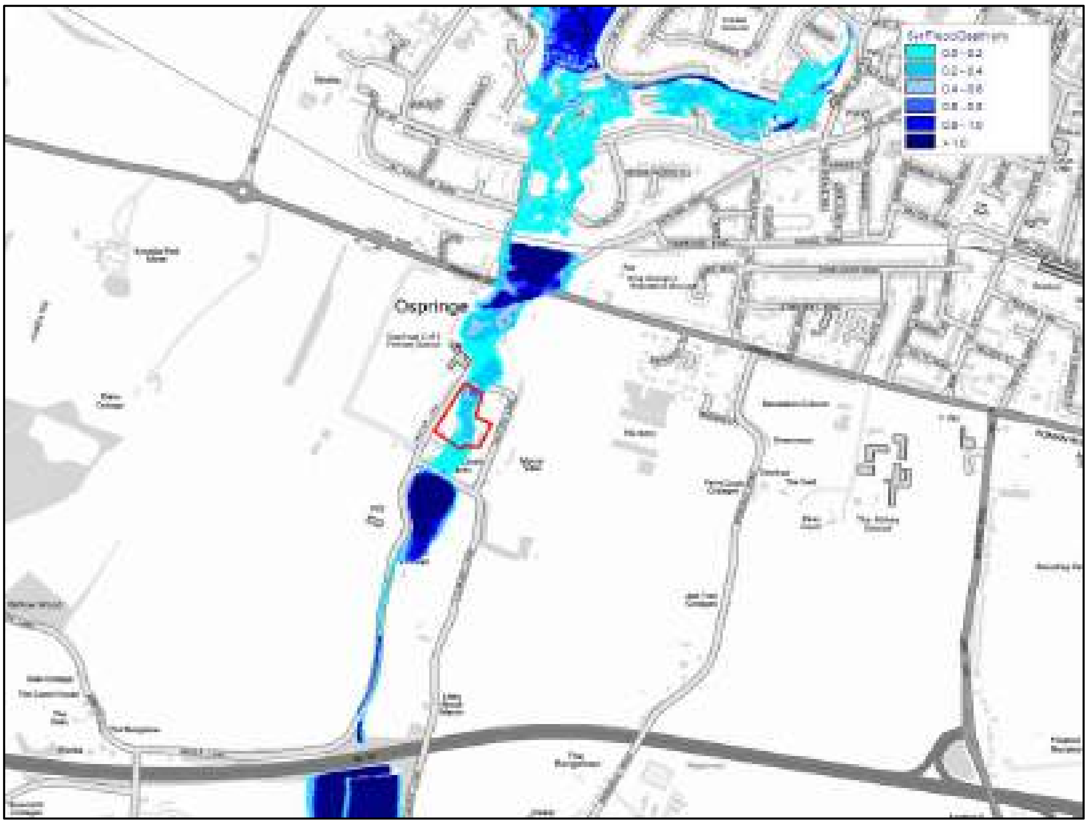


Figure 5:1 Baseline 1 in 5 year peak flood depths

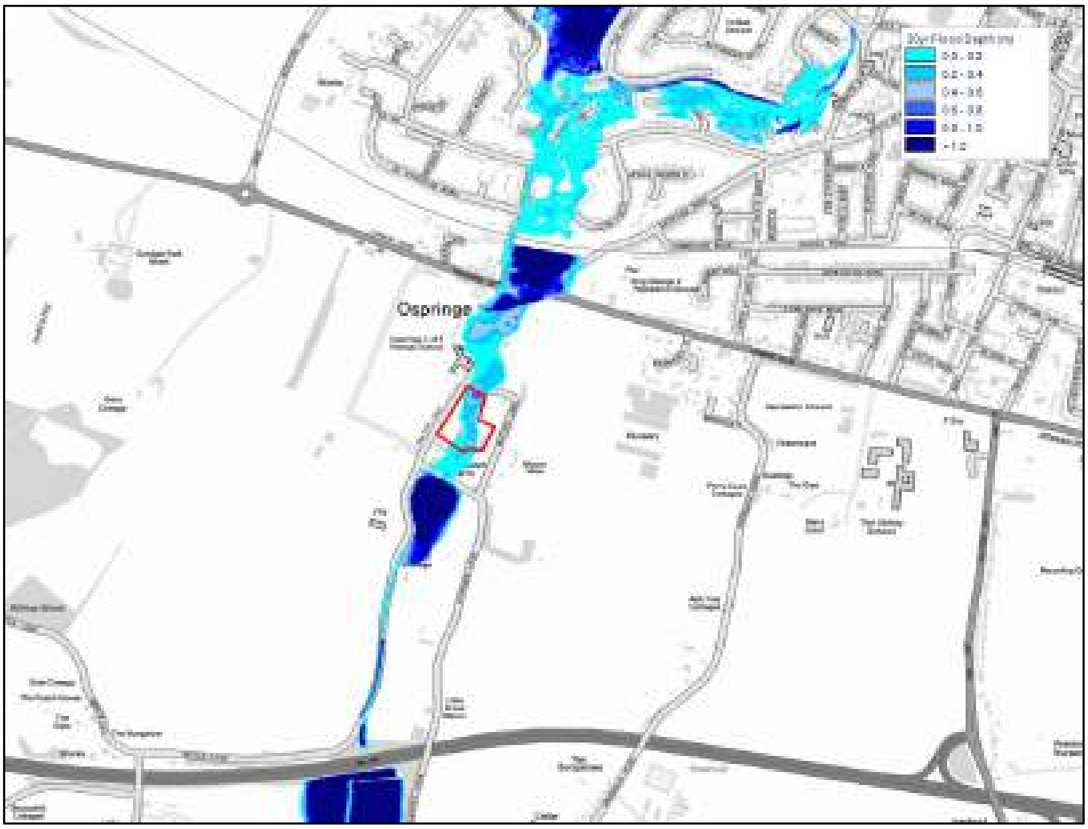


Figure 5:2 Baseline 1 in 20 year peak flood depths

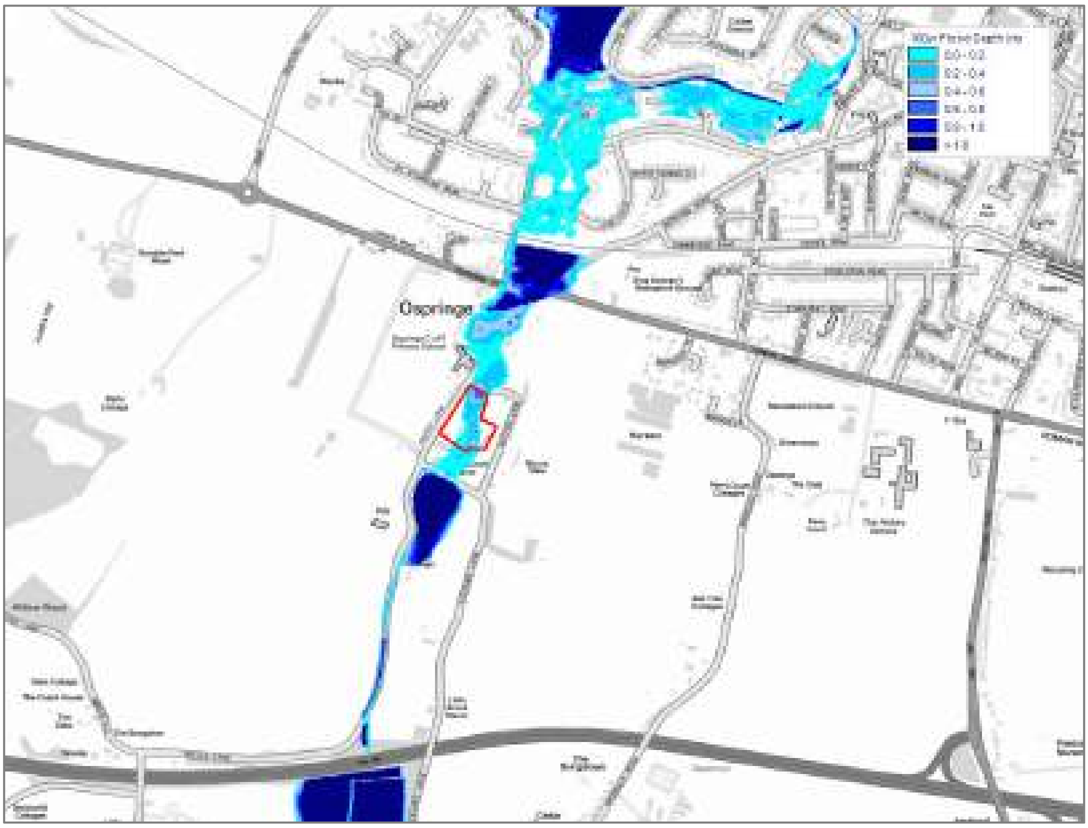


Figure 5:3 Baseline 1 in 100 year peak flood depths

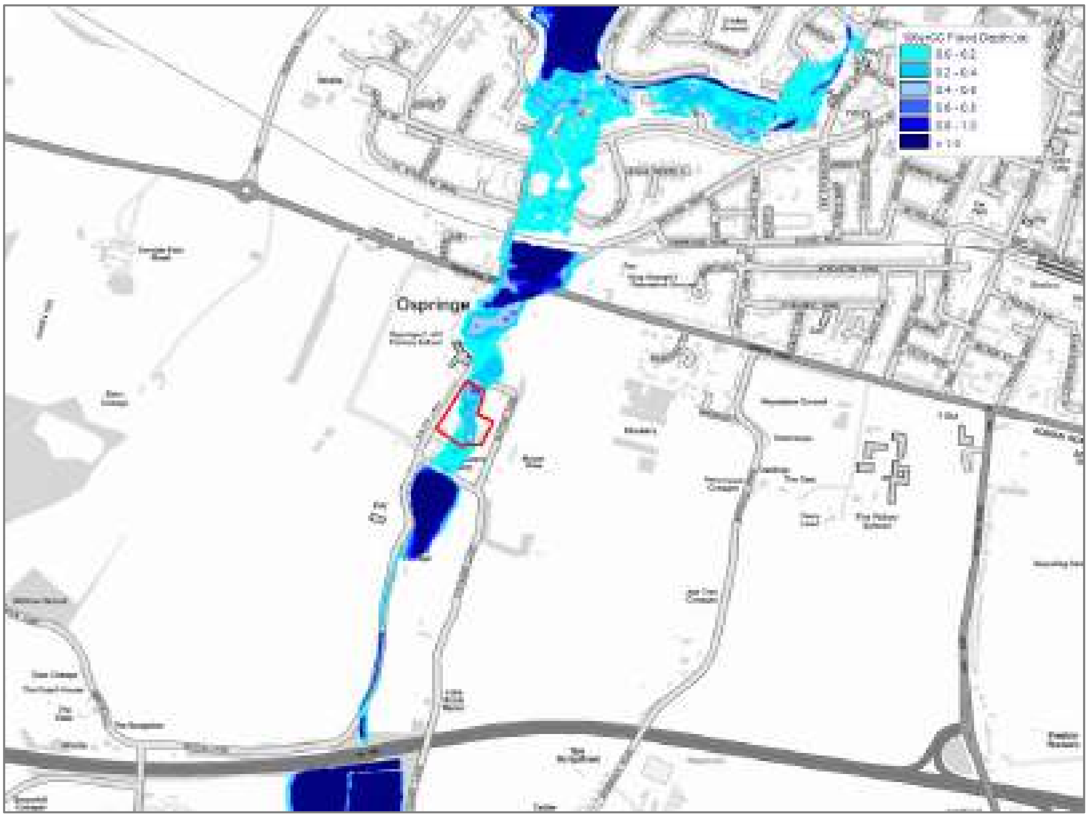


Figure 5:4 Baseline 1 in 100 year plus climate change peak flood depths

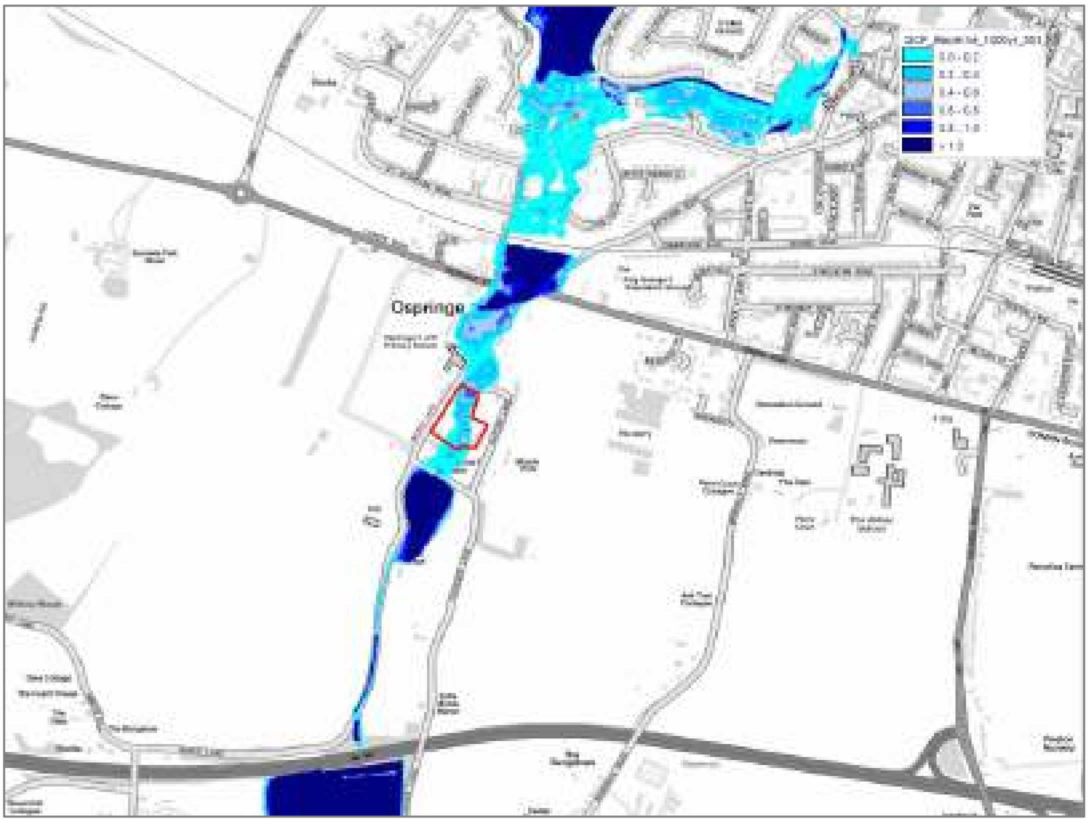


Figure 5:5 Baseline 1 in 1000 year peak flood depths

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

- FARL - a difference of no more than 0.05.
- BFIHOST - a difference of no more than 0.18
- SAAR - a factor of no more than 1.25
- SPRHOST - difference of no more than 15

1.1.7 A comparison of the catchment descriptors at the four potential donor gauging stations with the study reach (Table 3) suggests that the adjacent Great Stour gauges share similar characteristics of the study reach. However it is noted that the receiving catchments of all Great Stour gauges are classified as slightly urbanised ($0.030 \leq URBEXT_{2000} < 0.060$) whereas the catchment of the study reach is classified as essentially rural ($URBEXT_{2000} < 0.030$), these gauges may therefore not be suitable as a donor.

Table 3 Catchment Descriptors at Subject Sites and Donor Gauging Stations

Site	AREA	FARL	BFIHOST	SAAR	SPRHOST	URBEXT2000
Reach Nr A2	52.63	1.000	0.713	755	28.84	0.0042
Reach Nr M2	50.44	1.000	0.714	760	28.76	0.0032
40011	341.97	0.965	0.706	747	25.40	0.0321
40008	226.42	0.983	0.659	741	28.00	0.0452
40022	66.96	0.967	0.744	726	23.30	0.0348
40005	278.05	0.992	0.353	691	44.56	0.0148

1.1.8 Although the gauges may not be suitable as a donor due to the difference in urbanisation, as a check QMED is calculated from flow data and catchment descriptors at the gauge 40022 to confirm whether the QMED ratio is low or high in this area.

1.1.9 For stations with more than 13 years of flow data FEH recommends that QMED is calculated from annual maximum (AMAX) data.

Table 4 QMED Ratio at Donor Gauging Stations

Station	QMED-Catchment Descriptors (m^3/s)	QMED-Catchment Descriptors adjusted for urban influence (m^3/s)	QMED-AMAX (m^3/s)	Ratio
40022	3.648	3.961	5.123	1.293

1.1.10 This ratio between QMED from AMAX data and catchment descriptors suggests the QMED from catchment descriptors underestimates that from flow data with a ratio of 1.293. However the Revised Statistical method requires a further adjustment based on geographical proximity as detailed below.

1.1.4 Revised Donor Adjusted QMED

1.1.11 In addition to adjusting QMED based on the ratio of QMED estimates from catchment descriptors and flow data, the Revised Statistical method requires that the QMED ratio at a donor gauging station is also adjusted according to the distance between the catchment centroids using an exponent 'a'. Exponent 'a' is derived as the straight line distance between the centroid of the subject catchment and the donor gauging station, which in this case is 40022. This exponent in the ratio of QMED at this station gives a revised adjustment ratio at the site of interest of 1.101 (Table 5).

Table 5 Adjusted QMED Ratio at Donor Gauging Stations

Site	Centroid Easting	Centroid Northing	Centroid Distance (km)	Exponent 'a'	Unadjusted Ratio	Adjusted Ratio
Reach Near A2	598182	154399				
40022	604436	145695	10.718	0.374	1.293	1.101

1.1.5 Flood Frequency Curve

1.1.12 The calculation of a flood frequency curve and the peak flows at the flood estimation points requires the construction of a pooling group and the fitting of an extreme value distribution to the pooled group data.

1.1.13 Table 6 below gives details of the pooling group including any stations added or removed and reasons for this.

Table 6 Pooling Group Details

Station removed (with reasons)
203049 (Clady @ Clady Bridge) – Station in Ireland
41020 (Bevern Stream @ Clappers Bridge) – Low BFIHOST value (0.355)
25006 (Greta @ Rutherford Bridge) – Low BFIHOST value (0.241)
27010 (Hodge Beck @ Bransdale Weir) – Low BFIHOST value (0.341)
Final Pooling Group
53023 (Sherston Avon @ Fosseway)
43014 (East Avon @ Upavon)
84009 (Nethan @ Kirkmuirhill)
54025 (Dulas @ Rhos-y-pentref)
48803 (Carnon @ Bissoe)
47009 (Tiddy @ Tideford)
45008 (Otter @ Fenny Bridges)
43017 (West Avon @ Upavon)
55013 (Arrow @ Titley Mill)
72014 (Conder @ Galgate)
67005 (Ceiriog @ Brynkinalt Weir)
28061 (Churnet @ Basford Bridge)
12006 (Gairn @ Invergairn)
96003 (Strathy @ Strathy Bridge)
73008 (Bela @ Beetham)
53023 (Sherston Avon @ Fosseway)

1.1.14 The revised pooling group contains 15 stations with 509 station years of record. Guidance from the WINFAP Software indicates the pooling group is 'acceptably homogeneous and a review of the pooling group is not required' (H2 = -1.2640). There was no valid reason for the removal of any other of the component stations and the pooling group was considered acceptable. A 500 year record length is reasonable to calculate the 1 in 100 year peak flow and the 1 in 1000 year peak flow was extrapolated using ReFH. The pooling ground for the 1 in 1000 year event is likely to be inhomogeneous.

1.1.15 Two extreme value distributions are often used on the pooled group data (i) the Generalised Logistic (GL) and (ii) the General Extreme Value (GEV) distribution both fitted to the annual maximum data by the method of L-Moments. FEH indicates that the GL distribution can often provide the best fit to extreme value flood series and in this case WINFAP indicates that the GL provides an acceptable distribution for this site.

1.1.16 The results of the frequency analysis based on the QMED donor adjustment factor of 1.101 and on the basis that the GL distribution is recommended by WINFAP. Refer to Table 7 for the full range of results.

Table 7 Pooled Group Growth Curve and Flood Frequency Curves (m^3/s) for individual catchments

	Return periods	2	5	10	20	30	50	100	1000
	Growth Curve	1.000	1.323	1.542	1.767	1.905	2.088	2.354	3.435
Flood Frequency Curves (m^3/s)	Reach Near A2	4.662	6.167	7.188	8.237	8.880	9.733	10.973	16.013
	Reach Near M2	4.550	6.020	7.016	8.040	8.668	9.500	10.711	15.629

1.1.6 Extension to the 1 in 1000 Year Event

1.1.17 The FEH Statistical method was originally recommended for return periods only up to the 1 in 200 year event and noted as not suitable for extrapolating to very extreme events such as the 1 in 1000 year event. Flood estimates for longer return periods were historically derived using the FSR/FEH rainfall-runoff method as the rainfall growth curves for long return periods could be defined with much more confidence than flood growth curves. However the original FEH rainfall-runoff method was known to overestimate flows and more recently the extension of the Statistical method has been preferred.

1.1.18 The Environment Agency's Flood Estimation Guidelines provide two suggestions for calculating extreme floods up to the 1000 year event. Firstly using the Statistical method but the 1 in 1000 year pooling group is likely to be inhomogeneous with many component stations hence a simple extension of the 1 in 200 year and more recently the 1 in 100 year event has been proposed. A second approach is to derive the ReFH growth factor for the 1 in 100 year to 1 in 1000 year event which is then applied to the Statistical method 1 in 100 year peak flow.

1.1.19 The Statistical method flood frequency curve is extended to the 1 in 1000 year event using the ReFH growth factor as described above. (Table 8).

Table 8 Statistical Method Pooling Group Extended to 1 in 1000 year using ReFH

	Return periods	2	5	10	20	30	50	100	1000
Flood Frequency Curves (m^3/s)	Reach Near A2	4.662	6.167	7.188	8.237	8.880	9.733	10.973	20.282
	Reach Near M2	4.550	6.020	7.016	8.040	8.668	9.500	10.711	19.948

1.1.7 Hydrograph Shape

1.1.20 If a design hydrograph is required it is recommended that the hydrograph shape from the ReFH method is used and forced to fit the peak flows from the Statistical method, referred to as the hybrid method. This can be achieved in the WHS's ReFH 2 software suite.

1.1.21 The FEH Guidelines suggest two hybrid methods for ungauged sites:

1.1.22 Generating the hydrograph using ReFH method and scaling the ordinates so the peak flow matches the statistical estimate.

1.1.23 Adjusting the parameters of the ReFH model until the simulated peak flows match the preferred values. This might appear more elegant than option (a) but should be used with caution. It may prove difficult to match the statistical results over a range of return periods, because the ReFH method may give a different growth curve.

1.1.24 Option a) is the quickest method and often the best. The flood hydrographs from this method are provided in Figure 1-3 to Figure 1-4.

Figure 1-3 Hybrid Flood Hydrograph – Reach Near A2

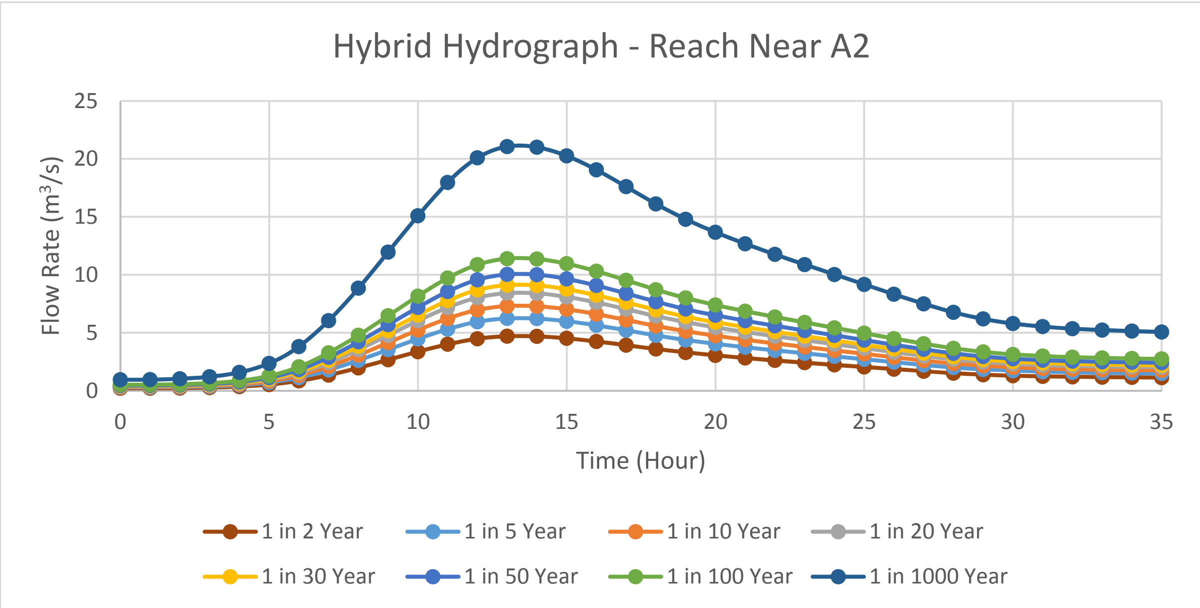
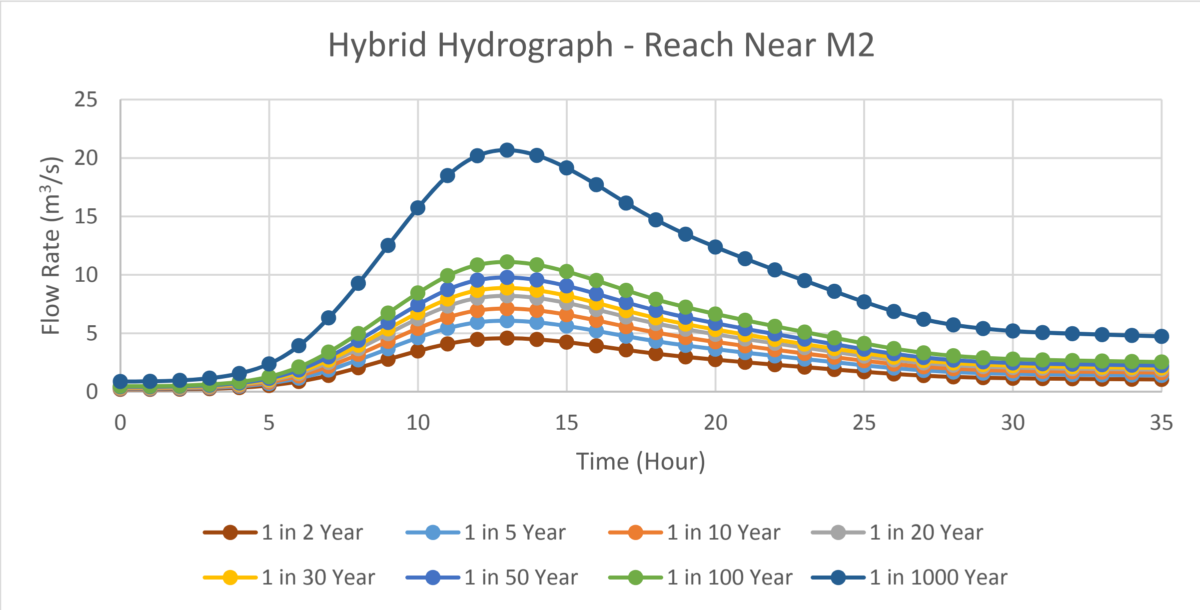


Figure 1-4 Hybrid Flood Hydrograph – Reach Near M2



UK Design Flood Estimation

Generated on 06 January 2016 09:35:13 by jho
Printed from the ReFH Flood Modelling software package, version 2.1.5798.30211

Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH)

Site details Checksum: 8C20-D687

Site name: Reach Nr A2

Easting: 600300

Northing: 160800

Country: England, Wales or Northern Ireland

Catchment Area (km²): 52.63

Using plotscale calculations: No

Site description: None

Model run: 5 year

Summary of results

Rainfall - FEH 1999 (mm):	42.75	Total runoff (ML):	232.28
Total Rainfall (mm):	29.04	Total flow (ML):	659.82
Peak Rainfall (mm):	6.60	Peak flow (m³/s):	7.01

Parameters

** Where the user has overriden a system-generated value, this original value is shown in square brackets after the value used.*

Rainfall parameters (Rainfall - FEH 1999 model)

Name	Value	User-defined?
Duration (hr)	11	No
Timestep (hr)	1	No
SCF(Seasonal correction factor)	0.72	No
ARF(Areal reduction factor)	0.94	No
Seasonality	Winter	n/a

Loss model parameters

Name	Value	User-defined?
Cini (mm)	92.68	No
Cmax (mm)	710.31	No
Use alpha correction factor	Yes	No
Alpha correction factor	1	No

Routing model parameters

Name	Value	User-defined?
Tp (hr)	6.33	No
Up	0.65	No
Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	1.26	No
BL (hr)	65.9	No
BR	1.86	No

Urbanisation parameters

Name	Value	User-defined?
Urban area (km^2)	0.35	No
Urbext 2000	0	No
Urban runoff factor	0.7	No
Imperviousness factor	0.3	No
Tp scaling factor	0.5	No
Sewered area (km^2)	0.00	Yes
Sewer capacity (m^3/s)	0.00	Yes

Time series data

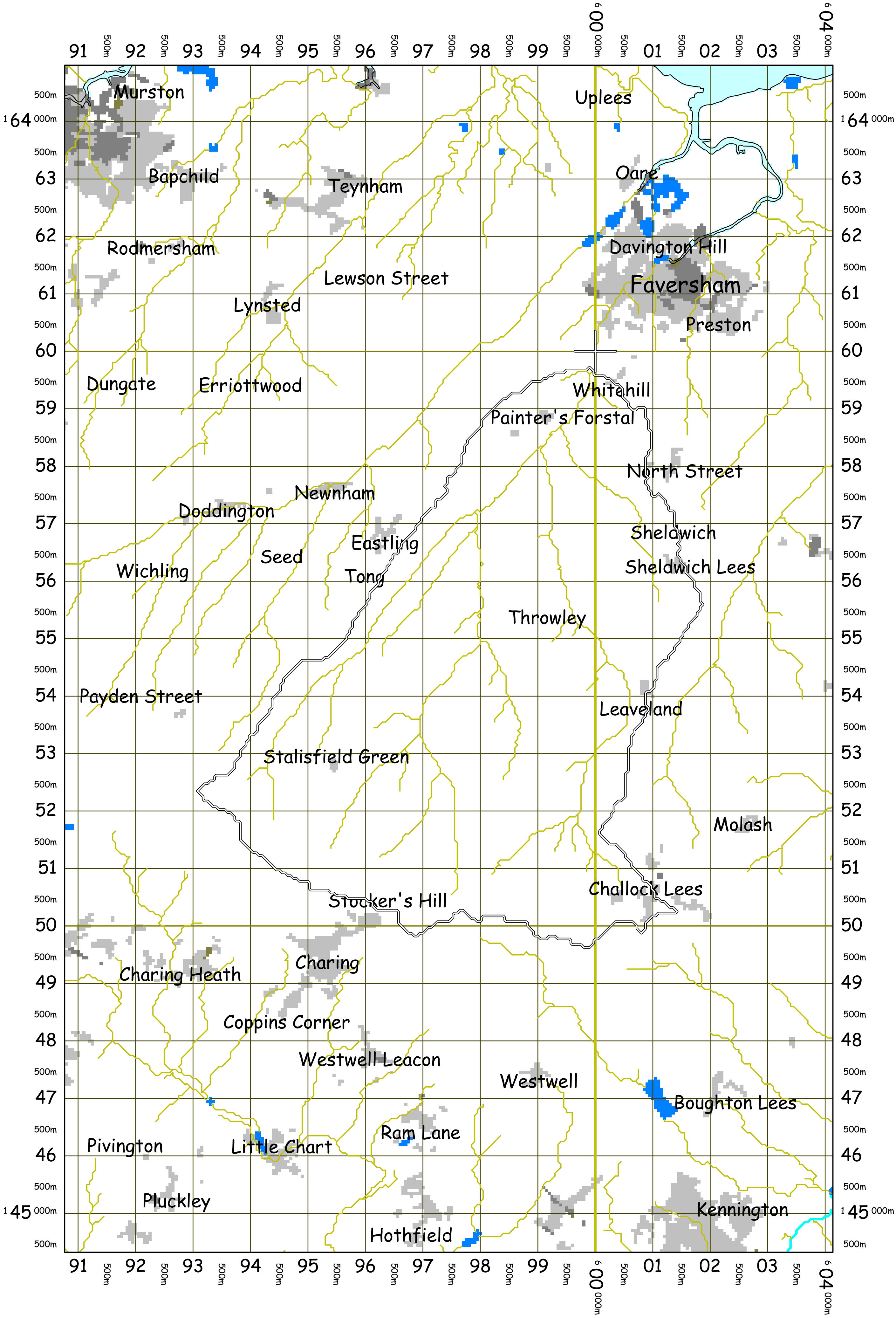
Time (hh:mm)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
00:00	0.638	0.000	0.084	0.000	1.258	1.258
01:00	1.068	0.000	0.142	0.010	1.239	1.249
02:00	1.780	0.000	0.241	0.049	1.221	1.270
03:00	2.943	0.000	0.408	0.135	1.205	1.340
04:00	4.790	0.000	0.690	0.300	1.192	1.493
05:00	6.598	0.000	1.003	0.599	1.186	1.785
06:00	4.790	0.000	0.766	1.102	1.191	2.293
07:00	2.943	0.000	0.487	1.810	1.212	3.023
08:00	1.780	0.000	0.300	2.628	1.254	3.882
09:00	1.068	0.000	0.182	3.467	1.317	4.784
10:00	0.638	0.000	0.110	4.248	1.402	5.650
11:00	0.000	0.000	0.000	4.882	1.506	6.388
12:00	0.000	0.000	0.000	5.250	1.622	6.872
13:00	0.000	0.000	0.000	5.272	1.743	7.014
14:00	0.000	0.000	0.000	5.033	1.859	6.892
15:00	0.000	0.000	0.000	4.635	1.965	6.600
16:00	0.000	0.000	0.000	4.152	2.057	6.210
17:00	0.000	0.000	0.000	3.637	2.135	5.772
18:00	0.000	0.000	0.000	3.142	2.197	5.339
19:00	0.000	0.000	0.000	2.717	2.246	4.963
20:00	0.000	0.000	0.000	2.354	2.283	4.637
21:00	0.000	0.000	0.000	2.033	2.310	4.343
22:00	0.000	0.000	0.000	1.738	2.328	4.066
23:00	0.000	0.000	0.000	1.459	2.337	3.797
24:00	0.000	0.000	0.000	1.193	2.339	3.532
25:00	0.000	0.000	0.000	0.937	2.334	3.271
26:00	0.000	0.000	0.000	0.693	2.322	3.015
27:00	0.000	0.000	0.000	0.472	2.303	2.775
28:00	0.000	0.000	0.000	0.288	2.279	2.566
29:00	0.000	0.000	0.000	0.158	2.251	2.409
30:00	0.000	0.000	0.000	0.079	2.220	2.299
31:00	0.000	0.000	0.000	0.035	2.188	2.223
32:00	0.000	0.000	0.000	0.012	2.156	2.168
33:00	0.000	0.000	0.000	0.002	2.124	2.126
34:00	0.000	0.000	0.000	0.000	2.092	2.092

Time (hh:mm)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
35:00	0.000	0.000	0.000	0.000	2.060	2.060
36:00	0.000	0.000	0.000	0.000	2.029	2.029
37:00	0.000	0.000	0.000	0.000	1.999	1.999
38:00	0.000	0.000	0.000	0.000	1.969	1.969
39:00	0.000	0.000	0.000	0.000	1.939	1.939
40:00	0.000	0.000	0.000	0.000	1.910	1.910
41:00	0.000	0.000	0.000	0.000	1.881	1.881
42:00	0.000	0.000	0.000	0.000	1.853	1.853
43:00	0.000	0.000	0.000	0.000	1.825	1.825
44:00	0.000	0.000	0.000	0.000	1.797	1.797
45:00	0.000	0.000	0.000	0.000	1.770	1.770
46:00	0.000	0.000	0.000	0.000	1.744	1.744
47:00	0.000	0.000	0.000	0.000	1.717	1.717
48:00	0.000	0.000	0.000	0.000	1.691	1.691
49:00	0.000	0.000	0.000	0.000	1.666	1.666
50:00	0.000	0.000	0.000	0.000	1.641	1.641
51:00	0.000	0.000	0.000	0.000	1.616	1.616
52:00	0.000	0.000	0.000	0.000	1.592	1.592
53:00	0.000	0.000	0.000	0.000	1.568	1.568
54:00	0.000	0.000	0.000	0.000	1.544	1.544
55:00	0.000	0.000	0.000	0.000	1.521	1.521
56:00	0.000	0.000	0.000	0.000	1.498	1.498
57:00	0.000	0.000	0.000	0.000	1.475	1.475
58:00	0.000	0.000	0.000	0.000	1.453	1.453
59:00	0.000	0.000	0.000	0.000	1.431	1.431
60:00	0.000	0.000	0.000	0.000	1.410	1.410
61:00	0.000	0.000	0.000	0.000	1.389	1.389
62:00	0.000	0.000	0.000	0.000	1.368	1.368
63:00	0.000	0.000	0.000	0.000	1.347	1.347
64:00	0.000	0.000	0.000	0.000	1.327	1.327
65:00	0.000	0.000	0.000	0.000	1.307	1.307
66:00	0.000	0.000	0.000	0.000	1.287	1.287
67:00	0.000	0.000	0.000	0.000	1.268	1.268

Appendix

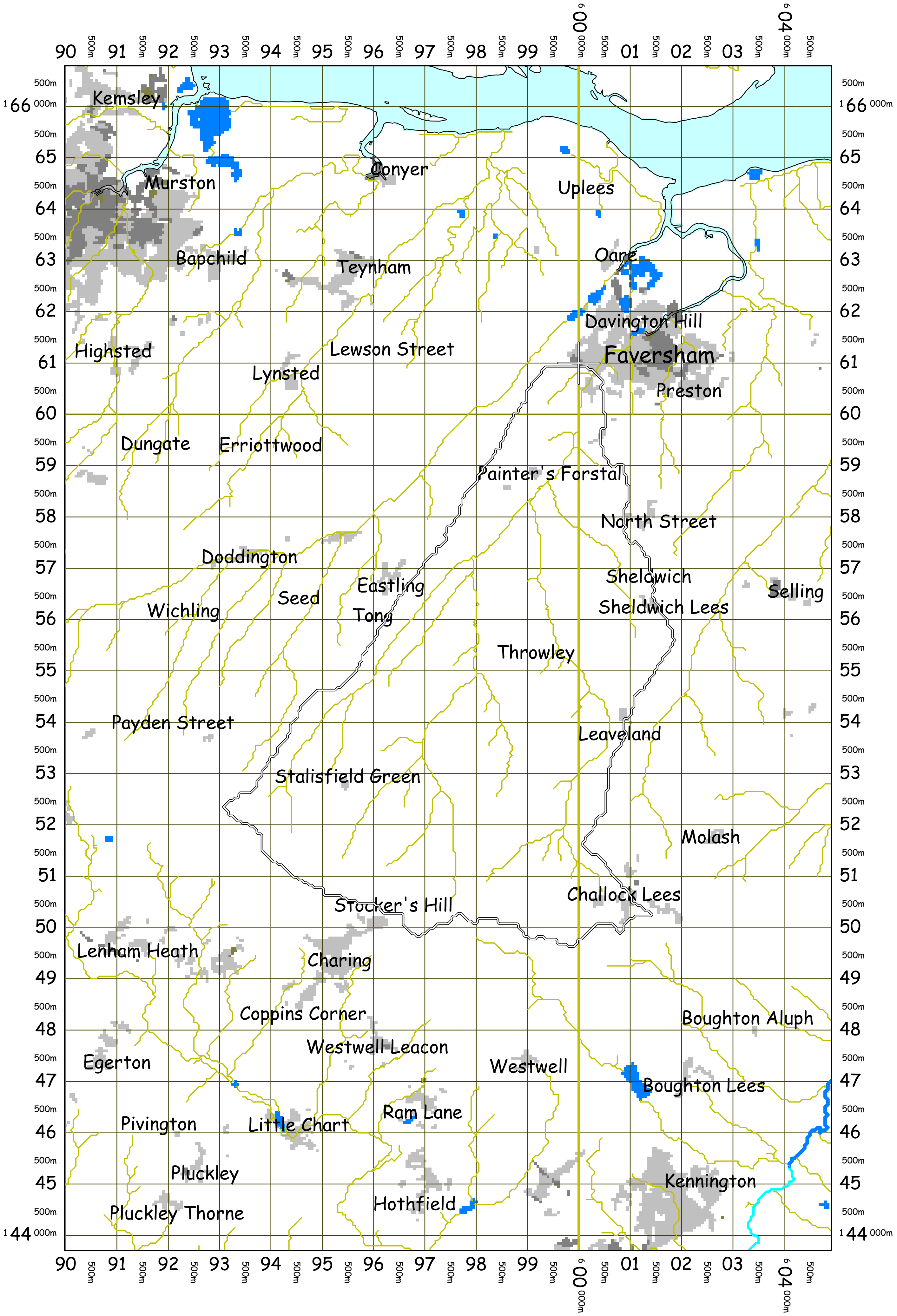
Catchment descriptors

Name	Value	User-defined value used?
Area (km^2)	52.63	No
ALTBAR	112	No
ASPBAR	27	No
ASPVAR	0.46	No
BFIHOST	0.71	No
DPLBAR (km)	8.46	No
DPSBAR (mkm^{-1})	52.2	No
FARL	1	No
LDP	14.11	No
PROPWET (mm)	0.34	No
RMED1H	12.3	No
RMED1D	35.3	No
RMED2D	43.1	No
SAAR (mm)	755	No
SAAR4170 (mm)	775	No
SPRHOST	28.84	No
Urbext2000	0	No
Urbext1990	0	No
URBCONC	0	No
URBLOC	0	No
Urban Area (km^2)	0.35	No
DDF parameter C	-0.02	No
DDF parameter D1	0.35	No
DDF parameter D2	0.35	No
DDF parameter D3	0.3	No
DDF parameter E	0.31	No
DDF parameter F	2.53	No
DDF parameter C (1km grid value)	-0.02	No
DDF parameter D1 (1km grid value)	0.32	No
DDF parameter D2 (1km grid value)	0.36	No
DDF parameter D3 (1km grid value)	0.31	No
DDF parameter E (1km grid value)	0.32	No
DDF parameter F (1km grid value)	2.52	No



599950 159650 [TQ 99950 59650]

0 0.5 1
Kilometres



600300 160800 [TR 00300 60800]

Kilometres 0 2.5 5

UK Design Flood Estimation

Generated on 06 January 2016 09:39:44 by jho
Printed from the ReFH Flood Modelling software package, version 2.1.5798.30211

Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH)

Site details Checksum: 8C20-D687

Site name: Reach Nr A2

Easting: 600300

Northing: 160800

Country: England, Wales or Northern Ireland

Catchment Area (km²): 52.63

Using plotscale calculations: No

Site description: None

Model run: 1000 year

Summary of results

Rainfall - FEH 1999 (mm):	172.12	Total runoff (ML):	1045.81
Total Rainfall (mm):	116.91	Total flow (ML):	2965.22
Peak Rainfall (mm):	26.57	Peak flow (m³/s):	28.00

Parameters

** Where the user has overriden a system-generated value, this original value is shown in square brackets after the value used.*

Rainfall parameters (Rainfall - FEH 1999 model)

Name	Value	User-defined?
Duration (hr)	11	No
Timestep (hr)	1	No
SCF(Seasonal correction factor)	0.72	No
ARF(Areal reduction factor)	0.94	No
Seasonality	Winter	n/a

Loss model parameters

Name	Value	User-defined?
Cini (mm)	92.68	No
Cmax (mm)	710.31	No
Use alpha correction factor	Yes	No
Alpha correction factor	0.66	No

Routing model parameters

Name	Value	User-defined?
Tp (hr)	6.33	No
Up	0.65	No
Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	1.26	No
BL (hr)	65.9	No
BR	1.86	No

Urbanisation parameters

Name	Value	User-defined?
Urban area (km^2)	0.35	No
Urbext 2000	0	No
Urban runoff factor	0.7	No
Imperviousness factor	0.3	No
Tp scaling factor	0.5	No
Sewered area (km^2)	0.00	Yes
Sewer capacity (m^3/s)	0.00	Yes

Time series data

Time (hh:mm)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
00:00	2.567	0.000	0.230	0.000	1.258	1.258
01:00	4.300	0.000	0.406	0.029	1.239	1.268
02:00	7.167	0.000	0.735	0.138	1.222	1.360
03:00	11.851	0.000	1.373	0.389	1.211	1.600
04:00	19.286	0.000	2.657	0.900	1.209	2.109
05:00	26.567	0.000	4.516	1.902	1.228	3.130
06:00	19.286	0.000	3.899	3.773	1.285	5.058
07:00	11.851	0.000	2.655	6.634	1.404	8.038
08:00	7.167	0.000	1.702	10.162	1.608	11.769
09:00	4.300	0.000	1.056	13.984	1.909	15.893
10:00	2.567	0.000	0.642	17.753	2.311	20.064
11:00	0.000	0.000	0.000	21.078	2.807	23.884
12:00	0.000	0.000	0.000	23.347	3.375	26.722
13:00	0.000	0.000	0.000	24.026	3.978	28.004
14:00	0.000	0.000	0.000	23.363	4.573	27.936
15:00	0.000	0.000	0.000	21.801	5.131	26.932
16:00	0.000	0.000	0.000	19.704	5.630	25.335
17:00	0.000	0.000	0.000	17.348	6.062	23.409
18:00	0.000	0.000	0.000	14.999	6.421	21.421
19:00	0.000	0.000	0.000	12.958	6.715	19.673
20:00	0.000	0.000	0.000	11.225	6.951	18.177
21:00	0.000	0.000	0.000	9.716	7.139	16.856
22:00	0.000	0.000	0.000	8.353	7.285	15.637
23:00	0.000	0.000	0.000	7.081	7.391	14.472
24:00	0.000	0.000	0.000	5.873	7.460	13.333
25:00	0.000	0.000	0.000	4.697	7.496	12.193
26:00	0.000	0.000	0.000	3.561	7.498	11.060
27:00	0.000	0.000	0.000	2.498	7.470	9.968
28:00	0.000	0.000	0.000	1.576	7.415	8.990
29:00	0.000	0.000	0.000	0.893	7.337	8.230
30:00	0.000	0.000	0.000	0.456	7.246	7.702
31:00	0.000	0.000	0.000	0.203	7.146	7.348
32:00	0.000	0.000	0.000	0.069	7.042	7.111
33:00	0.000	0.000	0.000	0.012	6.937	6.949
34:00	0.000	0.000	0.000	0.000	6.833	6.833

Time (hh:mm)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
35:00	0.000	0.000	0.000	0.000	6.730	6.730
36:00	0.000	0.000	0.000	0.000	6.629	6.629
37:00	0.000	0.000	0.000	0.000	6.529	6.529
38:00	0.000	0.000	0.000	0.000	6.430	6.430
39:00	0.000	0.000	0.000	0.000	6.334	6.334
40:00	0.000	0.000	0.000	0.000	6.238	6.238
41:00	0.000	0.000	0.000	0.000	6.144	6.144
42:00	0.000	0.000	0.000	0.000	6.052	6.052
43:00	0.000	0.000	0.000	0.000	5.961	5.961
44:00	0.000	0.000	0.000	0.000	5.871	5.871
45:00	0.000	0.000	0.000	0.000	5.782	5.782
46:00	0.000	0.000	0.000	0.000	5.695	5.695
47:00	0.000	0.000	0.000	0.000	5.610	5.610
48:00	0.000	0.000	0.000	0.000	5.525	5.525
49:00	0.000	0.000	0.000	0.000	5.442	5.442
50:00	0.000	0.000	0.000	0.000	5.360	5.360
51:00	0.000	0.000	0.000	0.000	5.279	5.279
52:00	0.000	0.000	0.000	0.000	5.200	5.200
53:00	0.000	0.000	0.000	0.000	5.121	5.121
54:00	0.000	0.000	0.000	0.000	5.044	5.044
55:00	0.000	0.000	0.000	0.000	4.968	4.968
56:00	0.000	0.000	0.000	0.000	4.893	4.893
57:00	0.000	0.000	0.000	0.000	4.820	4.820
58:00	0.000	0.000	0.000	0.000	4.747	4.747
59:00	0.000	0.000	0.000	0.000	4.676	4.676
60:00	0.000	0.000	0.000	0.000	4.605	4.605
61:00	0.000	0.000	0.000	0.000	4.536	4.536
62:00	0.000	0.000	0.000	0.000	4.468	4.468
63:00	0.000	0.000	0.000	0.000	4.400	4.400
64:00	0.000	0.000	0.000	0.000	4.334	4.334
65:00	0.000	0.000	0.000	0.000	4.269	4.269
66:00	0.000	0.000	0.000	0.000	4.204	4.204
67:00	0.000	0.000	0.000	0.000	4.141	4.141
68:00	0.000	0.000	0.000	0.000	4.079	4.079
69:00	0.000	0.000	0.000	0.000	4.017	4.017
70:00	0.000	0.000	0.000	0.000	3.957	3.957

Time (hh:mm)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
71:00	0.000	0.000	0.000	0.000	3.897	3.897
72:00	0.000	0.000	0.000	0.000	3.839	3.839
73:00	0.000	0.000	0.000	0.000	3.781	3.781
74:00	0.000	0.000	0.000	0.000	3.724	3.724
75:00	0.000	0.000	0.000	0.000	3.668	3.668
76:00	0.000	0.000	0.000	0.000	3.613	3.613
77:00	0.000	0.000	0.000	0.000	3.558	3.558
78:00	0.000	0.000	0.000	0.000	3.505	3.505
79:00	0.000	0.000	0.000	0.000	3.452	3.452
80:00	0.000	0.000	0.000	0.000	3.400	3.400
81:00	0.000	0.000	0.000	0.000	3.349	3.349
82:00	0.000	0.000	0.000	0.000	3.298	3.298
83:00	0.000	0.000	0.000	0.000	3.248	3.248
84:00	0.000	0.000	0.000	0.000	3.200	3.200
85:00	0.000	0.000	0.000	0.000	3.151	3.151
86:00	0.000	0.000	0.000	0.000	3.104	3.104
87:00	0.000	0.000	0.000	0.000	3.057	3.057
88:00	0.000	0.000	0.000	0.000	3.011	3.011
89:00	0.000	0.000	0.000	0.000	2.966	2.966
90:00	0.000	0.000	0.000	0.000	2.921	2.921
91:00	0.000	0.000	0.000	0.000	2.877	2.877
92:00	0.000	0.000	0.000	0.000	2.834	2.834
93:00	0.000	0.000	0.000	0.000	2.791	2.791
94:00	0.000	0.000	0.000	0.000	2.749	2.749
95:00	0.000	0.000	0.000	0.000	2.708	2.708
96:00	0.000	0.000	0.000	0.000	2.667	2.667
97:00	0.000	0.000	0.000	0.000	2.627	2.627
98:00	0.000	0.000	0.000	0.000	2.587	2.587
99:00	0.000	0.000	0.000	0.000	2.548	2.548
100:00	0.000	0.000	0.000	0.000	2.510	2.510
101:00	0.000	0.000	0.000	0.000	2.472	2.472
102:00	0.000	0.000	0.000	0.000	2.435	2.435
103:00	0.000	0.000	0.000	0.000	2.398	2.398
104:00	0.000	0.000	0.000	0.000	2.362	2.362
105:00	0.000	0.000	0.000	0.000	2.326	2.326
106:00	0.000	0.000	0.000	0.000	2.291	2.291

Time (hh:mm)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
107:00	0.000	0.000	0.000	0.000	2.257	2.257
108:00	0.000	0.000	0.000	0.000	2.223	2.223
109:00	0.000	0.000	0.000	0.000	2.189	2.189
110:00	0.000	0.000	0.000	0.000	2.156	2.156
111:00	0.000	0.000	0.000	0.000	2.124	2.124
112:00	0.000	0.000	0.000	0.000	2.092	2.092
113:00	0.000	0.000	0.000	0.000	2.061	2.061
114:00	0.000	0.000	0.000	0.000	2.029	2.029
115:00	0.000	0.000	0.000	0.000	1.999	1.999
116:00	0.000	0.000	0.000	0.000	1.969	1.969
117:00	0.000	0.000	0.000	0.000	1.939	1.939
118:00	0.000	0.000	0.000	0.000	1.910	1.910
119:00	0.000	0.000	0.000	0.000	1.881	1.881
120:00	0.000	0.000	0.000	0.000	1.853	1.853
121:00	0.000	0.000	0.000	0.000	1.825	1.825
122:00	0.000	0.000	0.000	0.000	1.797	1.797
123:00	0.000	0.000	0.000	0.000	1.770	1.770
124:00	0.000	0.000	0.000	0.000	1.744	1.744
125:00	0.000	0.000	0.000	0.000	1.717	1.717
126:00	0.000	0.000	0.000	0.000	1.692	1.692
127:00	0.000	0.000	0.000	0.000	1.666	1.666
128:00	0.000	0.000	0.000	0.000	1.641	1.641
129:00	0.000	0.000	0.000	0.000	1.616	1.616
130:00	0.000	0.000	0.000	0.000	1.592	1.592
131:00	0.000	0.000	0.000	0.000	1.568	1.568
132:00	0.000	0.000	0.000	0.000	1.544	1.544
133:00	0.000	0.000	0.000	0.000	1.521	1.521
134:00	0.000	0.000	0.000	0.000	1.498	1.498
135:00	0.000	0.000	0.000	0.000	1.476	1.476
136:00	0.000	0.000	0.000	0.000	1.453	1.453
137:00	0.000	0.000	0.000	0.000	1.432	1.432
138:00	0.000	0.000	0.000	0.000	1.410	1.410
139:00	0.000	0.000	0.000	0.000	1.389	1.389
140:00	0.000	0.000	0.000	0.000	1.368	1.368
141:00	0.000	0.000	0.000	0.000	1.347	1.347
142:00	0.000	0.000	0.000	0.000	1.327	1.327

Time (hh:mm)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
143:00	0.000	0.000	0.000	0.000	1.307	1.307
144:00	0.000	0.000	0.000	0.000	1.287	1.287
145:00	0.000	0.000	0.000	0.000	1.268	1.268

Appendix

Catchment descriptors

Name	Value	User-defined value used?
Area (km^2)	52.63	No
ALTBAR	112	No
ASPBAR	27	No
ASPVAR	0.46	No
BFIHOST	0.71	No
DPLBAR (km)	8.46	No
DPSBAR (mkm^{-1})	52.2	No
FARL	1	No
LDP	14.11	No
PROPWET (mm)	0.34	No
RMED1H	12.3	No
RMED1D	35.3	No
RMED2D	43.1	No
SAAR (mm)	755	No
SAAR4170 (mm)	775	No
SPRHOST	28.84	No
Urbext2000	0	No
Urbext1990	0	No
URBCONC	0	No
URBLOC	0	No
Urban Area (km^2)	0.35	No
DDF parameter C	-0.02	No
DDF parameter D1	0.35	No
DDF parameter D2	0.35	No
DDF parameter D3	0.3	No
DDF parameter E	0.31	No
DDF parameter F	2.53	No
DDF parameter C (1km grid value)	-0.02	No
DDF parameter D1 (1km grid value)	0.32	No
DDF parameter D2 (1km grid value)	0.36	No
DDF parameter D3 (1km grid value)	0.31	No
DDF parameter E (1km grid value)	0.32	No
DDF parameter F (1km grid value)	2.52	No

UK Design Flood Estimation

Generated on 06 January 2016 09:39:20 by jho
Printed from the ReFH Flood Modelling software package, version 2.1.5798.30211

Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH)

Site details

Checksum: 8C20-D687

Site name: Reach Nr A2

Easting: 600300

Northing: 160800

Country: England, Wales or Northern Ireland

Catchment Area (km^2): 52.63

Using plotscale calculations: No

Site description: None

Model run: 100 year

Summary of results

Rainfall - FEH 1999 (mm):	95.01	Total runoff (ML):	547.89
Total Rainfall (mm):	64.53	Total flow (ML):	1551.96
Peak Rainfall (mm):	14.66	Peak flow (m^3/s):	15.15

Parameters

** Where the user has overriden a system-generated value, this original value is shown in square brackets after the value used.*

Rainfall parameters (Rainfall - FEH 1999 model)

Name	Value	User-defined?
Duration (hr)	11	No
Timestep (hr)	1	No
SCF(Seasonal correction factor)	0.72	No
ARF(Areal reduction factor)	0.94	No
Seasonality	Winter	n/a

Loss model parameters

Name	Value	User-defined?
Cini (mm)	92.68	No
Cmax (mm)	710.31	No
Use alpha correction factor	Yes	No
Alpha correction factor	0.88	No

Routing model parameters

Name	Value	User-defined?
Tp (hr)	6.33	No
Up	0.65	No
Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	1.26	No
BL (hr)	65.9	No
BR	1.86	No

Urbanisation parameters

Name	Value	User-defined?
Urban area (km^2)	0.35	No
Urbext 2000	0	No
Urban runoff factor	0.7	No
Imperviousness factor	0.3	No
Tp scaling factor	0.5	No
Sewered area (km^2)	0.00	Yes
Sewer capacity (m^3/s)	0.00	Yes

Time series data

Time (hh:mm)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
00:00	1.417	0.000	0.166	0.000	1.258	1.258
01:00	2.374	0.000	0.284	0.021	1.239	1.259
02:00	3.956	0.000	0.491	0.097	1.222	1.319
03:00	6.541	0.000	0.860	0.270	1.208	1.478
04:00	10.645	0.000	1.528	0.608	1.202	1.810
05:00	14.664	0.000	2.366	1.237	1.208	2.445
06:00	10.645	0.000	1.907	2.337	1.237	3.574
07:00	6.541	0.000	1.251	3.935	1.302	5.237
08:00	3.956	0.000	0.785	5.830	1.414	7.243
09:00	2.374	0.000	0.482	7.819	1.577	9.395
10:00	1.417	0.000	0.291	9.716	1.791	11.507
11:00	0.000	0.000	0.000	11.316	2.052	13.368
12:00	0.000	0.000	0.000	12.319	2.345	14.665
13:00	0.000	0.000	0.000	12.499	2.652	15.151
14:00	0.000	0.000	0.000	12.027	2.952	14.979
15:00	0.000	0.000	0.000	11.140	3.228	14.368
16:00	0.000	0.000	0.000	10.017	3.474	13.491
17:00	0.000	0.000	0.000	8.795	3.683	12.478
18:00	0.000	0.000	0.000	7.600	3.857	11.457
19:00	0.000	0.000	0.000	6.569	3.996	10.565
20:00	0.000	0.000	0.000	5.691	4.107	9.798
21:00	0.000	0.000	0.000	4.920	4.194	9.114
22:00	0.000	0.000	0.000	4.216	4.258	8.475
23:00	0.000	0.000	0.000	3.555	4.303	7.858
24:00	0.000	0.000	0.000	2.925	4.329	7.254
25:00	0.000	0.000	0.000	2.315	4.337	6.652
26:00	0.000	0.000	0.000	1.732	4.328	6.060
27:00	0.000	0.000	0.000	1.196	4.304	5.499
28:00	0.000	0.000	0.000	0.740	4.266	5.006
29:00	0.000	0.000	0.000	0.413	4.218	4.631
30:00	0.000	0.000	0.000	0.209	4.163	4.372
31:00	0.000	0.000	0.000	0.092	4.105	4.197
32:00	0.000	0.000	0.000	0.032	4.044	4.076
33:00	0.000	0.000	0.000	0.005	3.984	3.989
34:00	0.000	0.000	0.000	0.000	3.924	3.924

Time (hh:mm)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
35:00	0.000	0.000	0.000	0.000	3.865	3.865
36:00	0.000	0.000	0.000	0.000	3.807	3.807
37:00	0.000	0.000	0.000	0.000	3.749	3.749
38:00	0.000	0.000	0.000	0.000	3.693	3.693
39:00	0.000	0.000	0.000	0.000	3.637	3.637
40:00	0.000	0.000	0.000	0.000	3.583	3.583
41:00	0.000	0.000	0.000	0.000	3.529	3.529
42:00	0.000	0.000	0.000	0.000	3.476	3.476
43:00	0.000	0.000	0.000	0.000	3.423	3.423
44:00	0.000	0.000	0.000	0.000	3.372	3.372
45:00	0.000	0.000	0.000	0.000	3.321	3.321
46:00	0.000	0.000	0.000	0.000	3.271	3.271
47:00	0.000	0.000	0.000	0.000	3.222	3.222
48:00	0.000	0.000	0.000	0.000	3.173	3.173
49:00	0.000	0.000	0.000	0.000	3.125	3.125
50:00	0.000	0.000	0.000	0.000	3.078	3.078
51:00	0.000	0.000	0.000	0.000	3.032	3.032
52:00	0.000	0.000	0.000	0.000	2.986	2.986
53:00	0.000	0.000	0.000	0.000	2.941	2.941
54:00	0.000	0.000	0.000	0.000	2.897	2.897
55:00	0.000	0.000	0.000	0.000	2.853	2.853
56:00	0.000	0.000	0.000	0.000	2.810	2.810
57:00	0.000	0.000	0.000	0.000	2.768	2.768
58:00	0.000	0.000	0.000	0.000	2.726	2.726
59:00	0.000	0.000	0.000	0.000	2.685	2.685
60:00	0.000	0.000	0.000	0.000	2.645	2.645
61:00	0.000	0.000	0.000	0.000	2.605	2.605
62:00	0.000	0.000	0.000	0.000	2.566	2.566
63:00	0.000	0.000	0.000	0.000	2.527	2.527
64:00	0.000	0.000	0.000	0.000	2.489	2.489
65:00	0.000	0.000	0.000	0.000	2.452	2.452
66:00	0.000	0.000	0.000	0.000	2.415	2.415
67:00	0.000	0.000	0.000	0.000	2.378	2.378
68:00	0.000	0.000	0.000	0.000	2.342	2.342
69:00	0.000	0.000	0.000	0.000	2.307	2.307
70:00	0.000	0.000	0.000	0.000	2.272	2.272

Time (hh:mm)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
71:00	0.000	0.000	0.000	0.000	2.238	2.238
72:00	0.000	0.000	0.000	0.000	2.205	2.205
73:00	0.000	0.000	0.000	0.000	2.171	2.171
74:00	0.000	0.000	0.000	0.000	2.139	2.139
75:00	0.000	0.000	0.000	0.000	2.106	2.106
76:00	0.000	0.000	0.000	0.000	2.075	2.075
77:00	0.000	0.000	0.000	0.000	2.043	2.043
78:00	0.000	0.000	0.000	0.000	2.013	2.013
79:00	0.000	0.000	0.000	0.000	1.982	1.982
80:00	0.000	0.000	0.000	0.000	1.953	1.953
81:00	0.000	0.000	0.000	0.000	1.923	1.923
82:00	0.000	0.000	0.000	0.000	1.894	1.894
83:00	0.000	0.000	0.000	0.000	1.866	1.866
84:00	0.000	0.000	0.000	0.000	1.838	1.838
85:00	0.000	0.000	0.000	0.000	1.810	1.810
86:00	0.000	0.000	0.000	0.000	1.783	1.783
87:00	0.000	0.000	0.000	0.000	1.756	1.756
88:00	0.000	0.000	0.000	0.000	1.729	1.729
89:00	0.000	0.000	0.000	0.000	1.703	1.703
90:00	0.000	0.000	0.000	0.000	1.678	1.678
91:00	0.000	0.000	0.000	0.000	1.652	1.652
92:00	0.000	0.000	0.000	0.000	1.627	1.627
93:00	0.000	0.000	0.000	0.000	1.603	1.603
94:00	0.000	0.000	0.000	0.000	1.579	1.579
95:00	0.000	0.000	0.000	0.000	1.555	1.555
96:00	0.000	0.000	0.000	0.000	1.532	1.532
97:00	0.000	0.000	0.000	0.000	1.509	1.509
98:00	0.000	0.000	0.000	0.000	1.486	1.486
99:00	0.000	0.000	0.000	0.000	1.463	1.463
100:00	0.000	0.000	0.000	0.000	1.441	1.441
101:00	0.000	0.000	0.000	0.000	1.420	1.420
102:00	0.000	0.000	0.000	0.000	1.398	1.398
103:00	0.000	0.000	0.000	0.000	1.377	1.377
104:00	0.000	0.000	0.000	0.000	1.357	1.357
105:00	0.000	0.000	0.000	0.000	1.336	1.336
106:00	0.000	0.000	0.000	0.000	1.316	1.316

Time (hh:mm)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
107:00	0.000	0.000	0.000	0.000	1.296	1.296
108:00	0.000	0.000	0.000	0.000	1.277	1.277

Appendix

Catchment descriptors

Name	Value	User-defined value used?
Area (km^2)	52.63	No
ALTBAR	112	No
ASPBAR	27	No
ASPVAR	0.46	No
BFIHOST	0.71	No
DPLBAR (km)	8.46	No
DPSBAR (mkm^{-1})	52.2	No
FARL	1	No
LDP	14.11	No
PROPWET (mm)	0.34	No
RMED1H	12.3	No
RMED1D	35.3	No
RMED2D	43.1	No
SAAR (mm)	755	No
SAAR4170 (mm)	775	No
SPRHOST	28.84	No
Urbext2000	0	No
Urbext1990	0	No
URBCONC	0	No
URBLOC	0	No
Urban Area (km^2)	0.35	No
DDF parameter C	-0.02	No
DDF parameter D1	0.35	No
DDF parameter D2	0.35	No
DDF parameter D3	0.3	No
DDF parameter E	0.31	No
DDF parameter F	2.53	No
DDF parameter C (1km grid value)	-0.02	No
DDF parameter D1 (1km grid value)	0.32	No
DDF parameter D2 (1km grid value)	0.36	No
DDF parameter D3 (1km grid value)	0.31	No
DDF parameter E (1km grid value)	0.32	No
DDF parameter F (1km grid value)	2.52	No

UK Design Flood Estimation

Generated on 06 January 2016 09:36:51 by jho
Printed from the ReFH Flood Modelling software package, version 2.1.5798.30211

Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH)

Site details Checksum: 8C20-D687

Site name: Reach Nr A2

Easting: 600300

Northing: 160800

Country: England, Wales or Northern Ireland

Catchment Area (km²): 52.63

Using plotscale calculations: No

Site description: None

Model run: 20 year

Summary of results

Rainfall - FEH 1999 (mm):	62.43	Total runoff (ML):	349.99
Total Rainfall (mm):	42.40	Total flow (ML):	990.58
Peak Rainfall (mm):	9.64	Peak flow (m³/s):	10.05

Parameters

** Where the user has overriden a system-generated value, this original value is shown in square brackets after the value used.*

Rainfall parameters (Rainfall - FEH 1999 model)

Name	Value	User-defined?
Duration (hr)	11	No
Timestep (hr)	1	No
SCF(Seasonal correction factor)	0.72	No
ARF(Areal reduction factor)	0.94	No
Seasonality	Winter	n/a

Loss model parameters

Name	Value	User-defined?
Cini (mm)	92.68	No
Cmax (mm)	710.31	No
Use alpha correction factor	Yes	No
Alpha correction factor	0.96	No

Routing model parameters

Name	Value	User-defined?
Tp (hr)	6.33	No
Up	0.65	No
Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	1.26	No
BL (hr)	65.9	No
BR	1.86	No

Urbanisation parameters

Name	Value	User-defined?
Urban area (km^2)	0.35	No
Urbext 2000	0	No
Urban runoff factor	0.7	No
Imperviousness factor	0.3	No
Tp scaling factor	0.5	No
Sewered area (km^2)	0.00	Yes
Sewer capacity (m^3/s)	0.00	Yes

Time series data

Time (hh:mm)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
00:00	0.931	0.000	0.119	0.000	1.258	1.258
01:00	1.560	0.000	0.202	0.015	1.239	1.253
02:00	2.600	0.000	0.344	0.069	1.221	1.290
03:00	4.298	0.000	0.590	0.191	1.206	1.397
04:00	6.995	0.000	1.015	0.428	1.196	1.624
05:00	9.636	0.000	1.511	0.859	1.195	2.055
06:00	6.995	0.000	1.179	1.597	1.210	2.807
07:00	4.298	0.000	0.758	2.646	1.249	3.894
08:00	2.600	0.000	0.471	3.870	1.317	5.187
09:00	1.560	0.000	0.287	5.137	1.419	6.556
10:00	0.931	0.000	0.173	6.326	1.553	7.880
11:00	0.000	0.000	0.000	7.308	1.716	9.024
12:00	0.000	0.000	0.000	7.895	1.899	9.794
13:00	0.000	0.000	0.000	7.959	2.089	10.048
14:00	0.000	0.000	0.000	7.622	2.273	9.895
15:00	0.000	0.000	0.000	7.035	2.442	9.477
16:00	0.000	0.000	0.000	6.311	2.591	8.902
17:00	0.000	0.000	0.000	5.533	2.717	8.250
18:00	0.000	0.000	0.000	4.780	2.820	7.600
19:00	0.000	0.000	0.000	4.133	2.902	7.034
20:00	0.000	0.000	0.000	3.581	2.966	6.546
21:00	0.000	0.000	0.000	3.094	3.014	6.108
22:00	0.000	0.000	0.000	2.647	3.049	5.697
23:00	0.000	0.000	0.000	2.226	3.071	5.298
24:00	0.000	0.000	0.000	1.825	3.082	4.907
25:00	0.000	0.000	0.000	1.437	3.081	4.518
26:00	0.000	0.000	0.000	1.068	3.070	4.138
27:00	0.000	0.000	0.000	0.731	3.049	3.780
28:00	0.000	0.000	0.000	0.449	3.019	3.468
29:00	0.000	0.000	0.000	0.248	2.983	3.231
30:00	0.000	0.000	0.000	0.125	2.944	3.068
31:00	0.000	0.000	0.000	0.055	2.902	2.957
32:00	0.000	0.000	0.000	0.019	2.859	2.878
33:00	0.000	0.000	0.000	0.003	2.816	2.820
34:00	0.000	0.000	0.000	0.000	2.774	2.774

Time (hh:mm)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
35:00	0.000	0.000	0.000	0.000	2.732	2.732
36:00	0.000	0.000	0.000	0.000	2.691	2.691
37:00	0.000	0.000	0.000	0.000	2.651	2.651
38:00	0.000	0.000	0.000	0.000	2.611	2.611
39:00	0.000	0.000	0.000	0.000	2.571	2.571
40:00	0.000	0.000	0.000	0.000	2.533	2.533
41:00	0.000	0.000	0.000	0.000	2.494	2.494
42:00	0.000	0.000	0.000	0.000	2.457	2.457
43:00	0.000	0.000	0.000	0.000	2.420	2.420
44:00	0.000	0.000	0.000	0.000	2.383	2.383
45:00	0.000	0.000	0.000	0.000	2.348	2.348
46:00	0.000	0.000	0.000	0.000	2.312	2.312
47:00	0.000	0.000	0.000	0.000	2.277	2.277
48:00	0.000	0.000	0.000	0.000	2.243	2.243
49:00	0.000	0.000	0.000	0.000	2.209	2.209
50:00	0.000	0.000	0.000	0.000	2.176	2.176
51:00	0.000	0.000	0.000	0.000	2.143	2.143
52:00	0.000	0.000	0.000	0.000	2.111	2.111
53:00	0.000	0.000	0.000	0.000	2.079	2.079
54:00	0.000	0.000	0.000	0.000	2.048	2.048
55:00	0.000	0.000	0.000	0.000	2.017	2.017
56:00	0.000	0.000	0.000	0.000	1.987	1.987
57:00	0.000	0.000	0.000	0.000	1.957	1.957
58:00	0.000	0.000	0.000	0.000	1.927	1.927
59:00	0.000	0.000	0.000	0.000	1.898	1.898
60:00	0.000	0.000	0.000	0.000	1.870	1.870
61:00	0.000	0.000	0.000	0.000	1.842	1.842
62:00	0.000	0.000	0.000	0.000	1.814	1.814
63:00	0.000	0.000	0.000	0.000	1.786	1.786
64:00	0.000	0.000	0.000	0.000	1.760	1.760
65:00	0.000	0.000	0.000	0.000	1.733	1.733
66:00	0.000	0.000	0.000	0.000	1.707	1.707
67:00	0.000	0.000	0.000	0.000	1.681	1.681
68:00	0.000	0.000	0.000	0.000	1.656	1.656
69:00	0.000	0.000	0.000	0.000	1.631	1.631
70:00	0.000	0.000	0.000	0.000	1.606	1.606

Time (hh:mm)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
71:00	0.000	0.000	0.000	0.000	1.582	1.582
72:00	0.000	0.000	0.000	0.000	1.558	1.558
73:00	0.000	0.000	0.000	0.000	1.535	1.535
74:00	0.000	0.000	0.000	0.000	1.512	1.512
75:00	0.000	0.000	0.000	0.000	1.489	1.489
76:00	0.000	0.000	0.000	0.000	1.467	1.467
77:00	0.000	0.000	0.000	0.000	1.445	1.445
78:00	0.000	0.000	0.000	0.000	1.423	1.423
79:00	0.000	0.000	0.000	0.000	1.401	1.401
80:00	0.000	0.000	0.000	0.000	1.380	1.380
81:00	0.000	0.000	0.000	0.000	1.359	1.359
82:00	0.000	0.000	0.000	0.000	1.339	1.339
83:00	0.000	0.000	0.000	0.000	1.319	1.319
84:00	0.000	0.000	0.000	0.000	1.299	1.299
85:00	0.000	0.000	0.000	0.000	1.279	1.279

Printed from the ReFH Flood Modelling software package, version 2.1.5798.30211

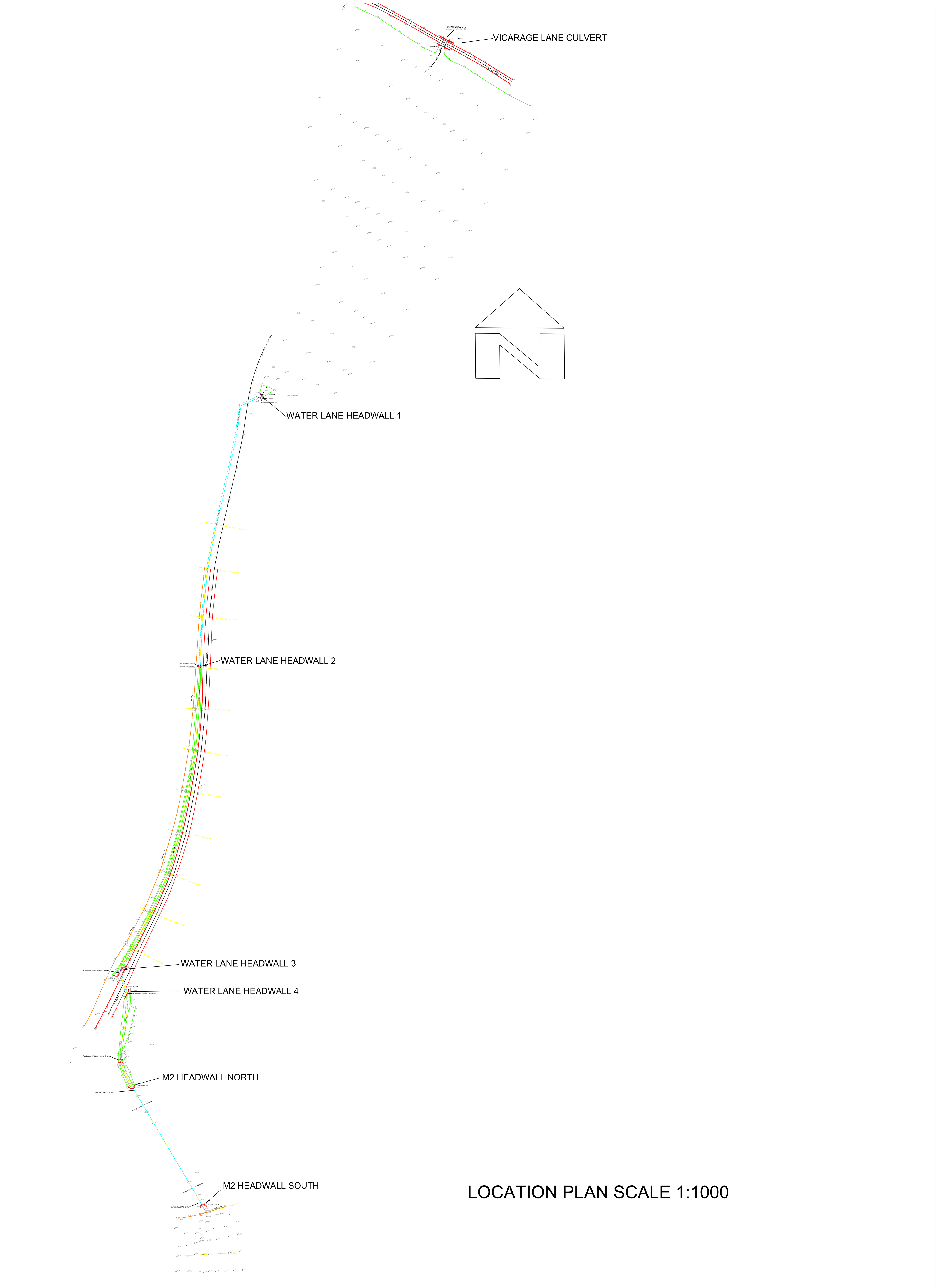
Appendix

Catchment descriptors

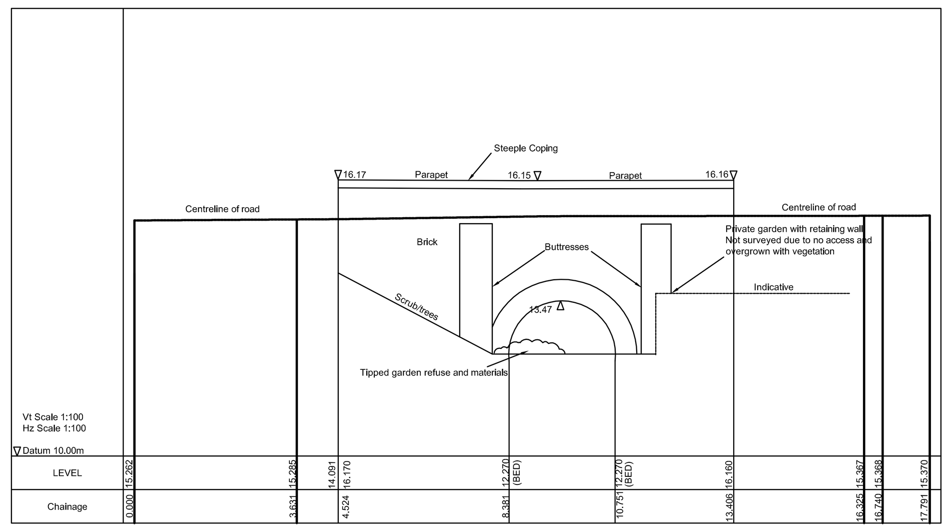
Name	Value	User-defined value used?
Area (km^2)	52.63	No
ALTBAR	112	No
ASPBAR	27	No
ASPVAR	0.46	No
BFIHOST	0.71	No
DPLBAR (km)	8.46	No
DPSBAR (mkm^{-1})	52.2	No
FARL	1	No
LDP	14.11	No
PROPWET (mm)	0.34	No
RMED1H	12.3	No
RMED1D	35.3	No
RMED2D	43.1	No
SAAR (mm)	755	No
SAAR4170 (mm)	775	No
SPRHOST	28.84	No
Urbext2000	0	No
Urbext1990	0	No
URBCONC	0	No
URBLOC	0	No
Urban Area (km^2)	0.35	No
DDF parameter C	-0.02	No
DDF parameter D1	0.35	No
DDF parameter D2	0.35	No
DDF parameter D3	0.3	No
DDF parameter E	0.31	No
DDF parameter F	2.53	No
DDF parameter C (1km grid value)	-0.02	No
DDF parameter D1 (1km grid value)	0.32	No
DDF parameter D2 (1km grid value)	0.36	No
DDF parameter D3 (1km grid value)	0.31	No
DDF parameter E (1km grid value)	0.32	No
DDF parameter F (1km grid value)	2.52	No

APPENDIX B

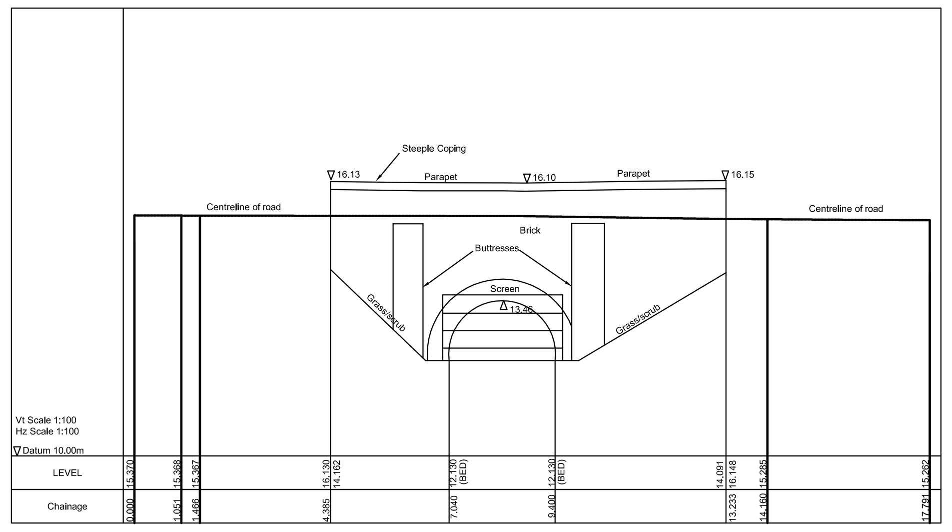
DVD with Hydraulic Models and Channel Survey



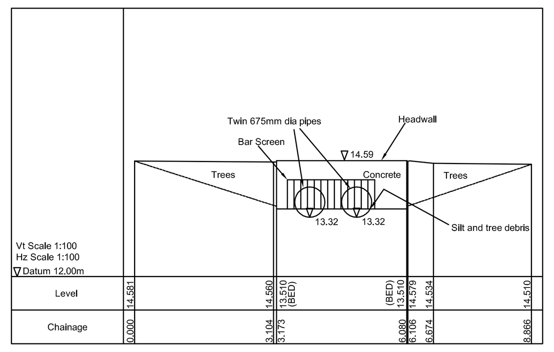
LOCATION PLAN SCALE 1:1000



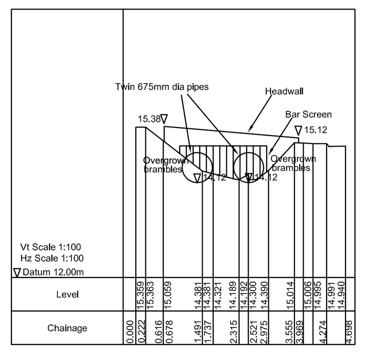
SECTIONAL ELEVATION, VICARAGE LANE CULVERT, NORTH HEADWALL



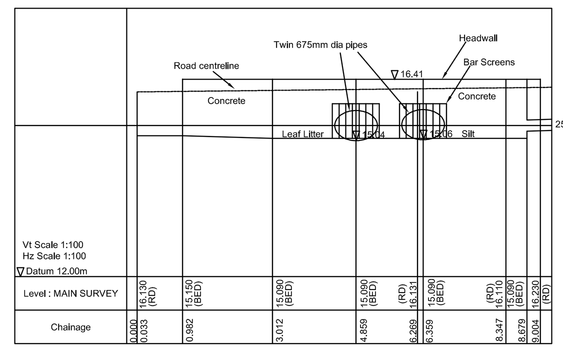
SECTIONAL ELEVATION, VICARAGE LANE CULVERT, SOUTH HEADWALL



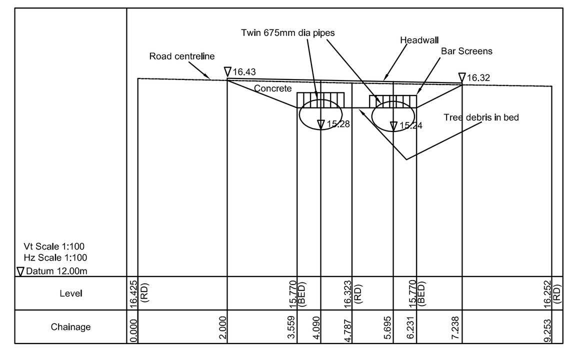
SECTIONAL ELEVATION, WATER LANE HEADWALL 1



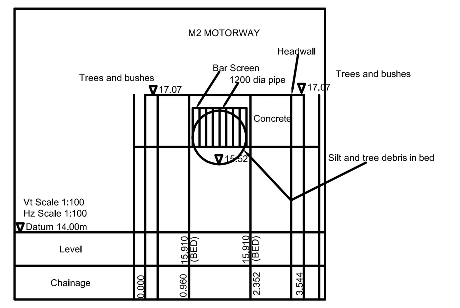
SECTIONAL ELEVATION, WATER LANE HEADWALL 2



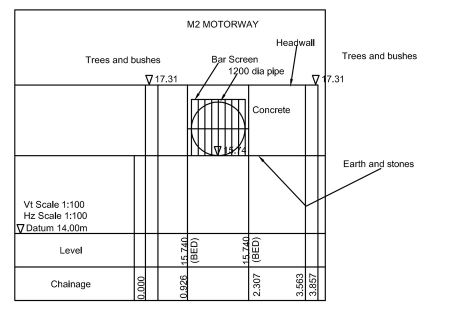
SECTIONAL ELEVATION, WATER LANE HEADWALL 3



SECTIONAL ELEVATION, WATER LANE HEADWALL 4



SECTIONAL ELEVATION, M2 HEADWALL NORTH



SECTIONAL ELEVATION, M2 HEADWALL SOUTH

C:\Users\vsnook\Desktop\surveyandinvest b.jpg

1. This spot level survey has been orientated to the Ordnance Survey National Grid (OSGB36) via GNSS/GLONASS RTK observations. Survey scale factor approximately 1.00009.
2. All levels are orthometric heights related to the OSGB36 datum, computed using the Leica Smart Net RTK Network.
3. Surveyed boundary features are indicative only and not necessarily legal boundaries.
4. Dimensions should not be scaled. All dimensions should be checked on site before any fabrication / construction.
5. Copyright of all data produced by Trigon Survey & Investigation Ltd shall remain with Trigon Survey & Investigation Ltd unless otherwise specifically agreed.
6. Information provided should not be altered or modified in any way. It should not be used for any purpose other than for which it was intended and should not be issued to other parties without prior agreement of Trigon Survey & Investigation Ltd
7. If the AutoCAD drawing is being read by any system other than AutoCAD it should be checked against a hard copy. Trigon Survey & Investigation Ltd cannot accept liability for omissions.
8. No trees, street furniture, drainage, above or underground services, covers, storage tanks etc. have been surveyed.

Rev A:

Trigon Survey & Investigation Ltd
Basingstoke, Hants, RG24 7AS
Tel. 01256 352794 Mob.07864 269005
email: admin@trigonsurvey.co.uk
Web:www.trigonsurvey.co.uk

QUEEN'S COURT YARD, OSPRINGE WATERCOURSE SURVEY, WATER LANE :HEADWALL DETAILS

Client: Odyssey Markides

Drg. No:	16-187/04
Date:	15/02/16
Scale:	As shown
Sheet:	1 of 1
Surveyed:	V.Snook
Drawn:	V.Snook
Checked:	V.Snook
Sheet size:	A0

APPENDIX H

Updated Fluvial Flood Study Report (Reference 18-120-02C)

ODYSSEY

DEVELOPING JOURNEYS

PROPOSED RESIDENTIAL DEVELOPMENT AT SHEPHERD NEAME, QUEEN COURT FARMYARD SITE, OSPRINGE, FAVERSHAM

FLUVIAL FLOOD MODELLING STUDY

PROPOSED RESIDENTIAL DEVELOPMENT AT SHEPHERD NEAME, QUEEN COURT FARMYARD SITE, OSPRINGE, FAVERSHAM

FLUVIAL FLOOD MODELLINGSTUDY
ON BEHALF OF SHEPHERD NEAME LTD

Prepared by

Odyssey

Tuscany House

White Hart Lane

Basingstoke

Hampshire

RG21 4AF

Tel: 01256 331144

August 2022

DOCUMENT CONTROL SHEET

Project Name Shepherd Neame, Queen Court Farmyard Site, Ospringe, Faversham

Project No. 18-120

Rev	Issue Purpose	Author	Checked	Reviewed	Approved	Date
-	Draft for comment	ES	JH	GG	RS	March 2020
A	Revised flood mitigation strategy	JH	GG	JH	GG	February 2021
B	Minor amendments	JH	GG	JH	GG	February 2021
C	Updated proposed model to include access road and updated layout	SZ	LCS	RA	GG	August 2022

CONTENTS

APPENDICES

1.0 INTRODUCTION

1.1 Appointment and Brief

1.1.1 Odyssey has been commissioned by Shepherd Neame Ltd to carry out site-specific hydraulic modelling of the Nailbourne for the development of nine barn style residential units at Queen Court Farmyard Site, Water Lane, Ospringe, Faversham. Refer to **Figure 1.1** for the site location plan.

1.1.2 According to the current Environment Agency (EA) Flood Map for Planning, a large part of the site is shown to fall within the Flood Zone 3. It was also confirmed that the EA do not hold suitable flood level data for the site area to inform a site-specific Flood Risk Assessment for the site.

1.1.3 The east part of the site, which is subject to the development proposals, currently sits on gently rising land outside of Flood Zones 2 & 3. However, due to the close proximity of the proposed development to the floodplain area and other proposed access and landscaping works that are within the floodplain area, it was necessary to carry out site-specific river (fluvial) modelling for the site to accurately determine flood extents and levels at the site.

1.1.4 Please see **Table 1.1** below for the project summary.

Table 1.1: Project Summary

Project name:	Queen Court Farmyard site, Ospringe, Faversham
Project type:	Hydraulic modelling of the mainly fluvial 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 5%, 1%, 1% plus climate change Annual Exceedance Probability (AEP) and 0.1% scenarios.

1.2 Scope of Works

1.2.1 The primary aim of the modelling study is to identify and quantify the fluvial flood risk associated with the fluvial flows generated by the local catchment.

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

- 20% AEP (1 in 5 year);
- 5% AEP (1 in 20 year);
- 1% AEP (1 in 100 year);
- 1% AEP plus 22% climate change allowance (1 in 100 year + 22%CC);
- 0.1% AEP (1 in 1000 year).

1.3 Project Limitations

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

1.3.2 The baseline modelling assesses flood risk for an existing site/area in its current state.

1.3.3 The modelling undertaken is based on the interpretation and assessment of data provided by third parties. Odyssey 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 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.

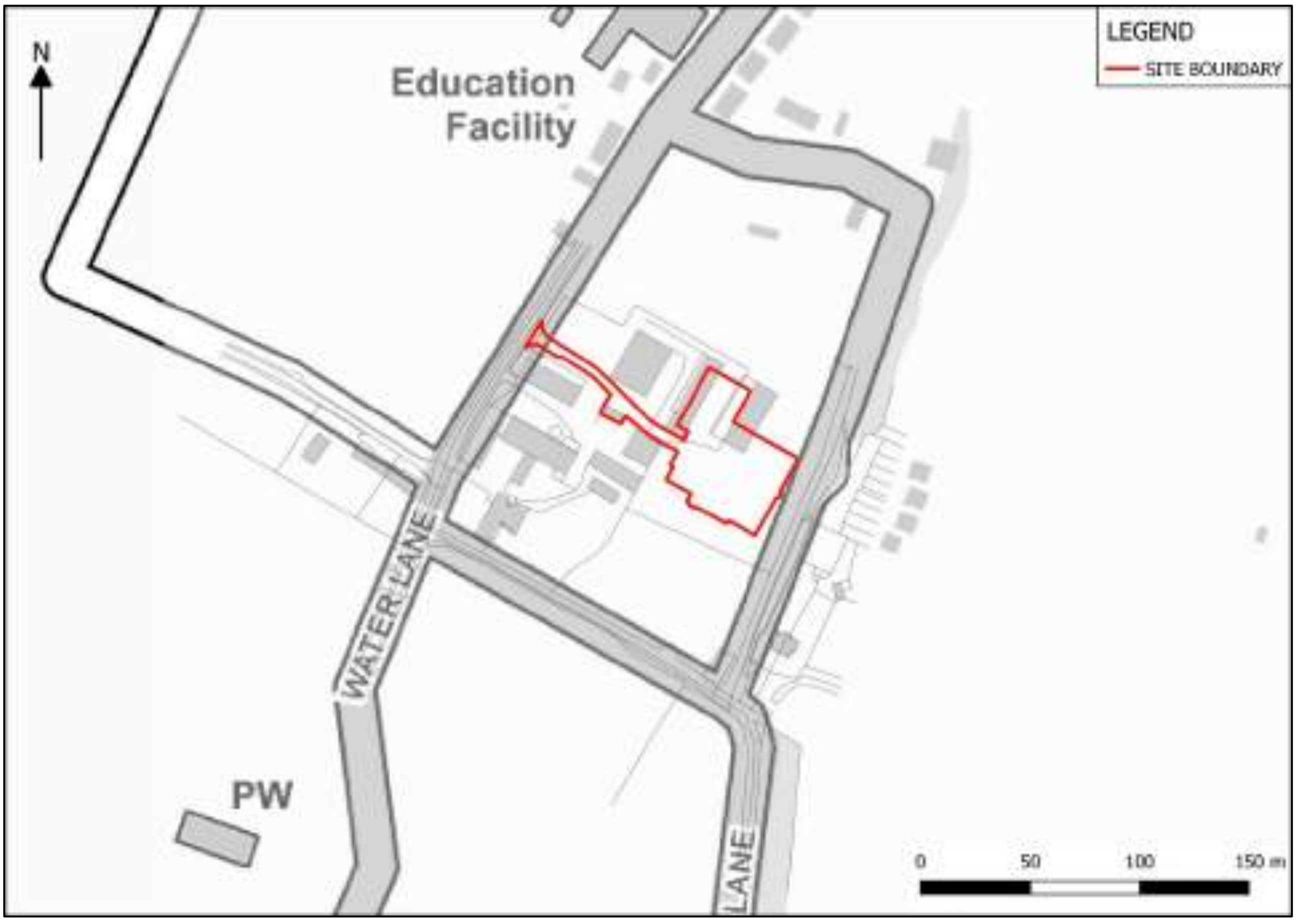
1.4 Site Description

1.4.1 The site is located in Ospringe, Faversham, Kent. 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 (600161E, 160488N).
Site area:	The total site area is approximately 1.5 hectares (ha), and the proposals are to erect barn style dwellings within the former farmyard area with associated parking areas infrastructure.
Current use:	The site currently comprises of existing residential buildings. There are large sections of concrete hardstanding and open green space at the site.
Wider setting:	The site is bounded by Water Lane to the 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 years. 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



2.0 INPUT DATA

2.1 Key Input Data

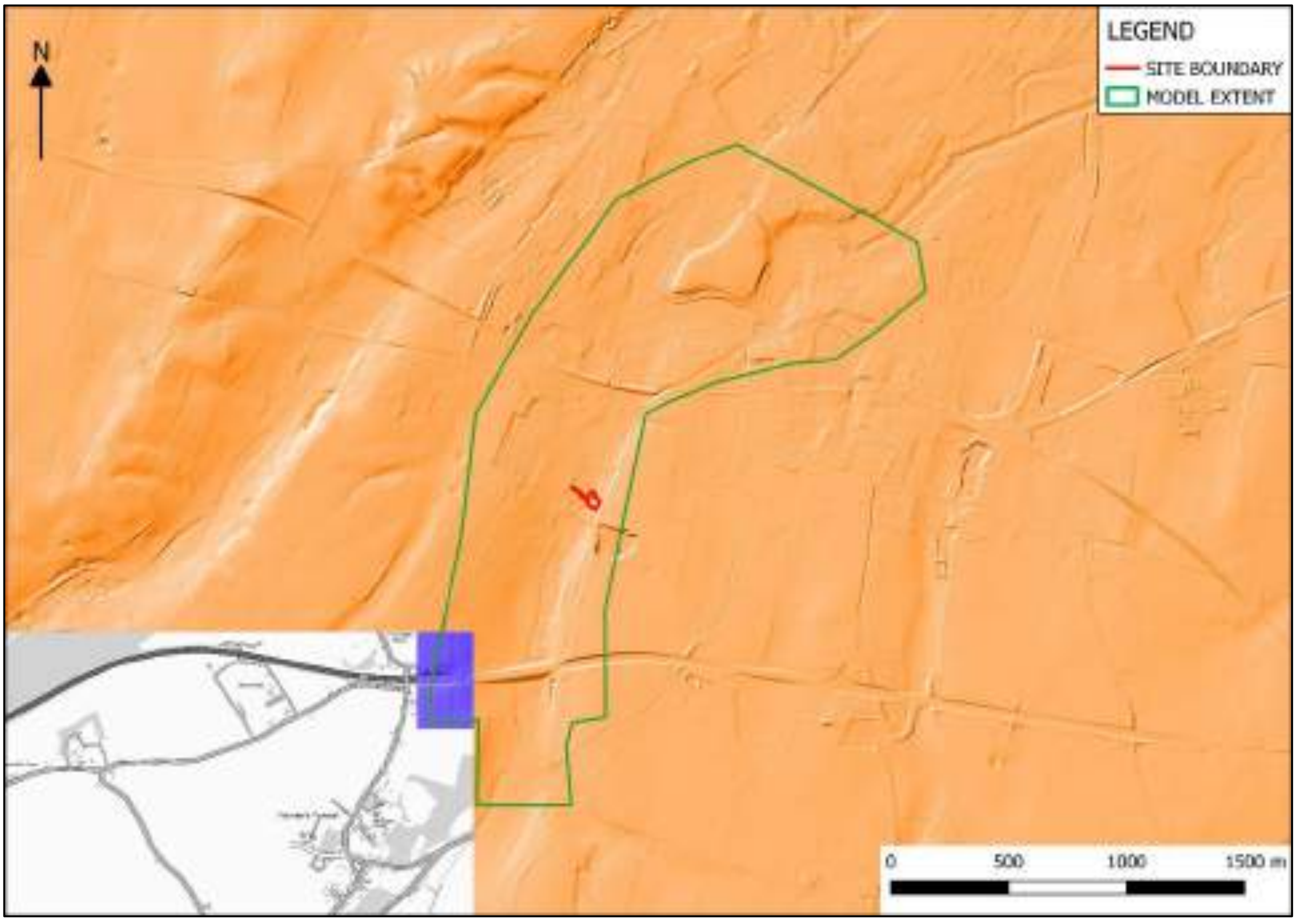
2.1.1 Various sources of information have been utilised for this project with some of the relevant data sets listed in **Table 2.1** below.

Table 2.1: Datasets 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 fluvial key flood routes. Also forms basis of ground level data for the site. Refer to Appendix B.	1
LiDAR (Light Detection and Ranging)	Environment Agency LiDAR	Flown in 2019, 2011 and 2004. Latest data downloaded in February 2021	Forms the basis of ground level data for the 2D component of the hydraulic model.	1-2
NextMap DTM	NextMap	2012	A small area at the upstream do not have LiDAR coverage. NextMap DTM data has been utilised in the model build. Refer to Figure 2.1 below for coverage.	2

[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: EA LiDAR DTM (orange area) and NEXTMap DTM (blue area) Data Coverage



3.0 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 22%.
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**.

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
LDP (km):	7.42	8.46
DPLBAR (km):	52.7	52.2
DPSBAR (m/km):	760	755
SAAR (mm):	28.76	28.84
SPRHOST:	0.0035	0.0048
URBEXT1990	0.0032	0.0042
URBEXT2000	0.023	0.0241
FPEXT:	No	No
Pumped watercourse?		
Any unusual catchment features? In particular is BFIHOST>0.65, SPRHOST<0.20, URBEXT>0.125, FARL<0.90 or high FPEXT?		

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**. The FEH catchment plans are shown in **Figure 3.1** and **Figure 3.2** 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
0.1% AEP (1 in 1000 year)	19.95	20.28

Figure 3.1 FEH Catchment near the M2

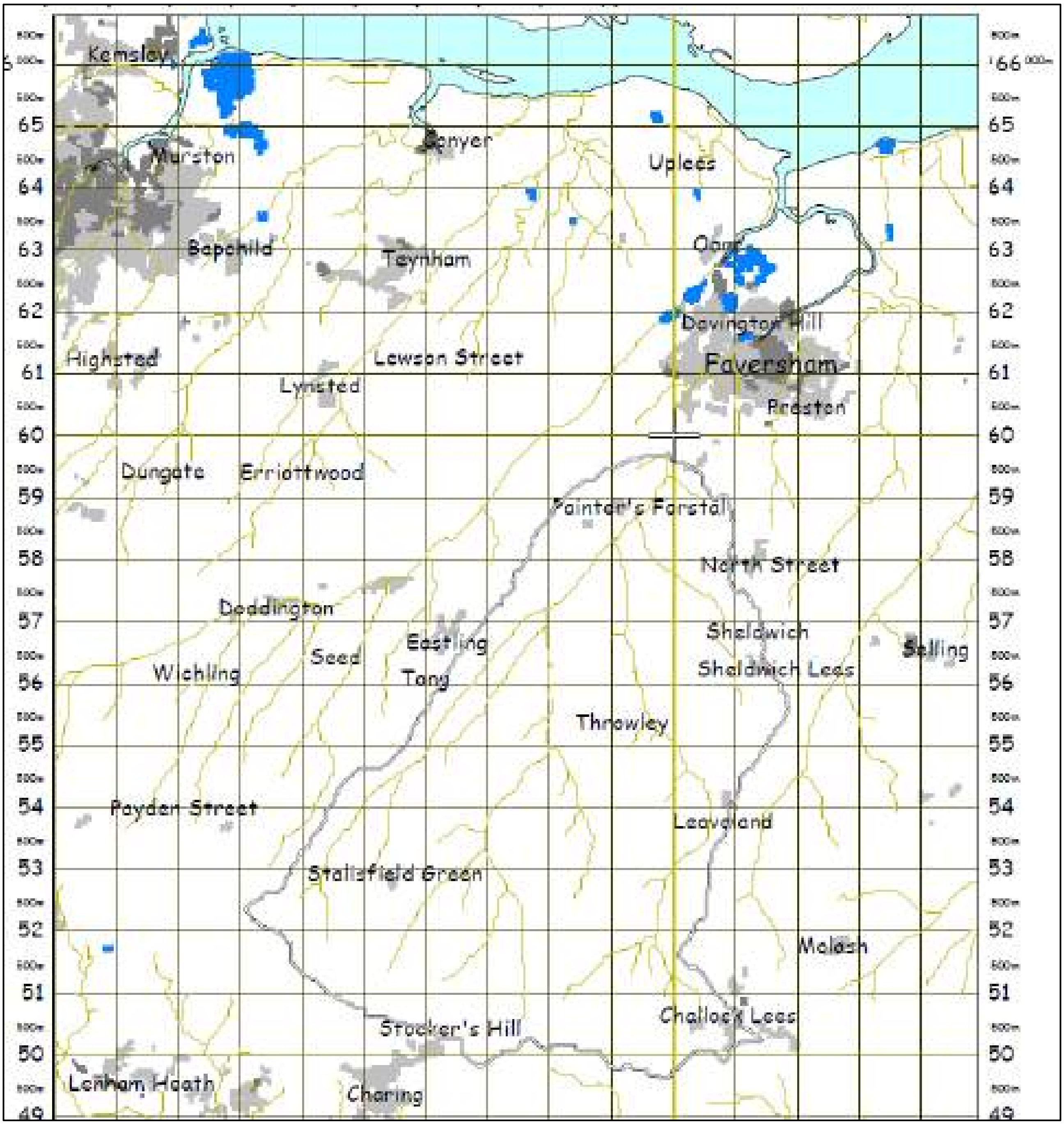
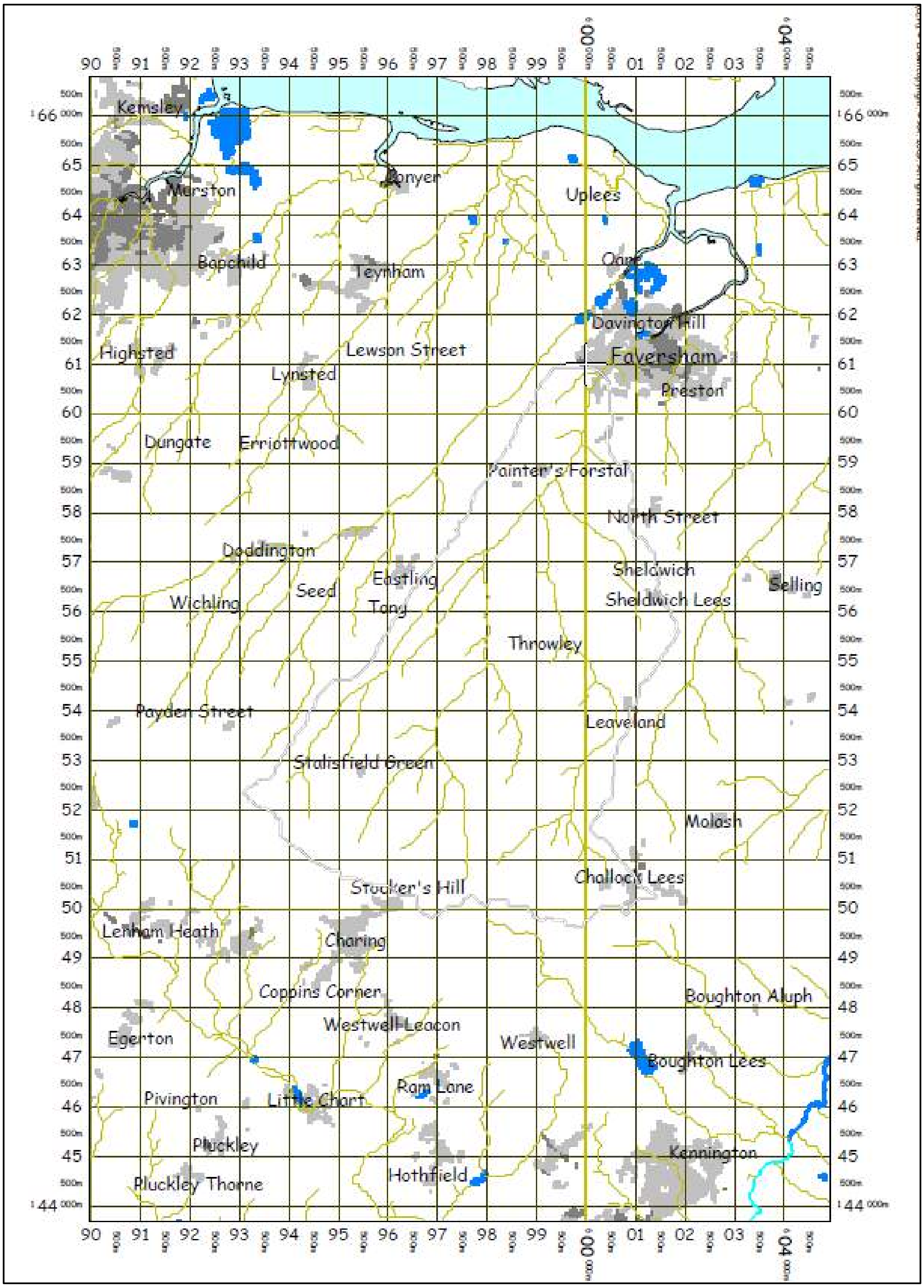


Figure 3.2 FEH Catchment near the A2



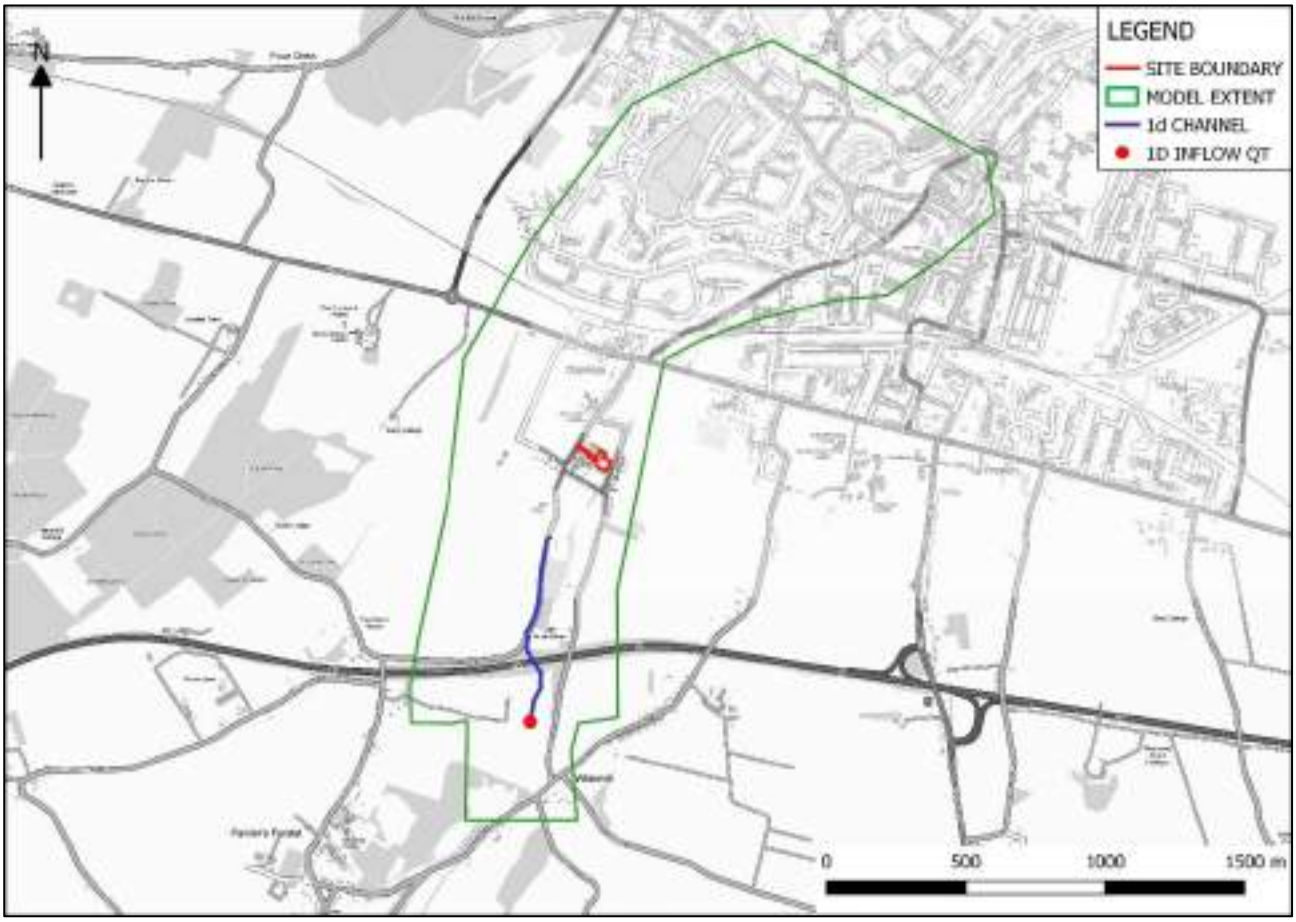
3.1.4 The process in the baseline hydraulic modelling is detailed in **Table 3.4** below.

Table 3.4: Hydrological Analysis *(continued overleaf)*

Summary of hydrological analysis required:	Design flow hydrographs.
What 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 – 2020-10-AA-iDP-w64 Double Precision modelling is necessary as the model is direct rainfall and is modelled on a relatively small 2d grid/time step combination.
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 3.4** below for the hydraulic model schematic.
How have watercourse channel structures been represented?	The culverts within the model domain have all been modelled as per the recommendations in TUFLOW.
How have sewer networks been represented?	No sewer networks were modelled as part of the above proposals.
How has the floodplain/ground surface been represented?	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 fluvial flow paths. Refer to **Figure 3.4** below for the hydraulic model schematic.
How have different models been linked?	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.
Have any adjustments to the raw DTM been made?	The site topographical survey was incorporated into the hydraulic model. 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.
How have flood defences been represented?	There are no known formal flood defences along the modelled watercourses.

What boundary conditions have been used?	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.	
What roughness values have been used?	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.	
	TUFLOW	**Manning's n**
	Grass	0.04
	Woodland	0.06
	Roads	0.02
	Buildings	1.00
	Water	0.03
	Roadside	0.02
	Manmade Surface	0.03
	Stability	1.00
	Railway Track	0.03
Are there any changes to default model or run parameters? Why?	No changes to default parameters.	
What timestep has been used?	A 1.5 second 2D TUFLOW time step was used for different model runs. This is in accordance with the recommendations that the 2D time step should be no smaller than a quarter of the 2D grid size.	

Figure 3.4: Hydraulic Model Schematic



4.0 MODEL PROVING

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?	Not applicable.

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** +20% Roughness – fairly minor differences. Approximately 0.07m maximum increase in peak water level at the site for +20% roughness for a localised area but generally less than 0.001m. -20% Roughness - fairly minor differences. Approximately 0.07m maximum decrease in peak water level at the site for -20% roughness for a localised area but generally less than 0.001m. **Culvert Coefficient** 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 not sensitive to changes in roughness. **Culvert Coefficient –** On average generally not sensitive to changes in roughness.

4.3 Blockage Analysis

Table 4.3: 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 0.03m 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 4.4: Run Performance

Is the model stable?	Yes, very little fluctuation in model results.
Is the mass balance error sensible?	Yes, the final cumulative mass balance is less than 1% for all model runs. It is less than 3% in accordance with the recommended value as stated in the TUFLOW manual.
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

5.0 MODEL RESULTS

5.1 Baseline Design Runs

5.1.1 The primary purpose of the hydraulic modelling study is to identify the pre-development fluvial flood flow routes in order to determine the land available for development purposes and mitigation strategy. The model was used to predict fluvial 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 22% climate change (1 in 100 year plus 22% climate change);
- 0.1% AEP (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 act as a hydrological boundary 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 fluvial 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.

5.1.4 The baseline modelling results are shown in **Figures 5.1** to **5.5**. The results show a flow path through the centre of the site.

Figure 5.1: Baseline 1 in 5 Year Peak Flood Depths

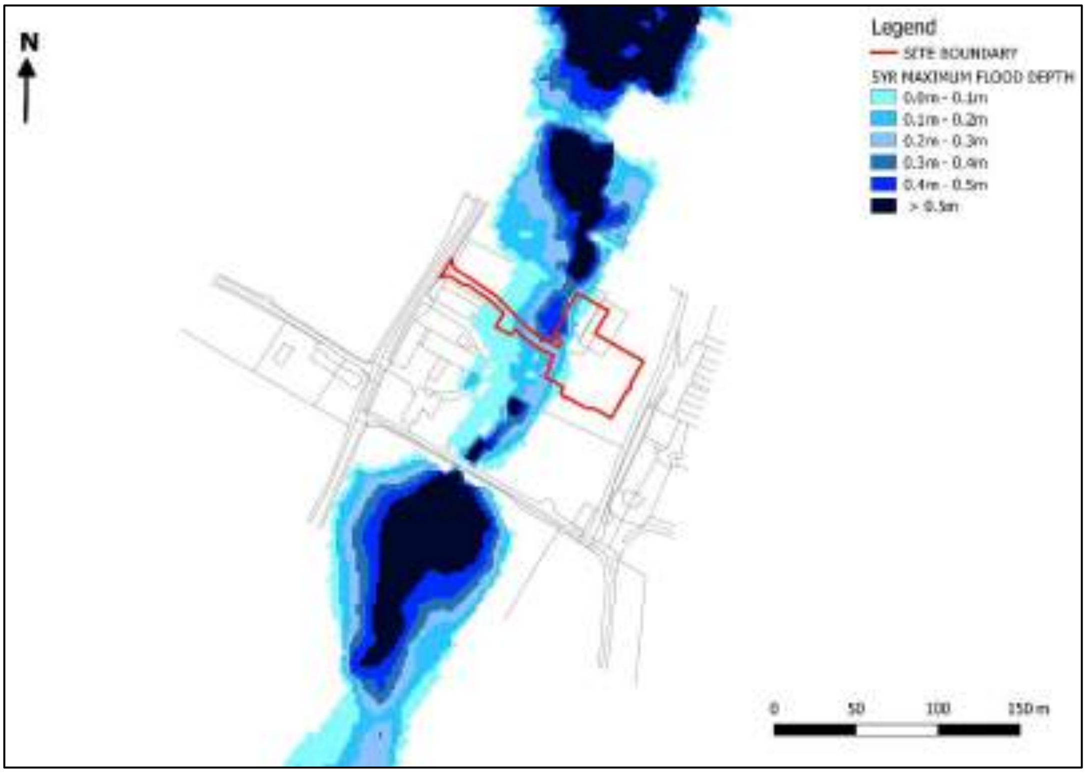


Figure 5.2: Baseline 1 in 20 Year Peak Flood Depths

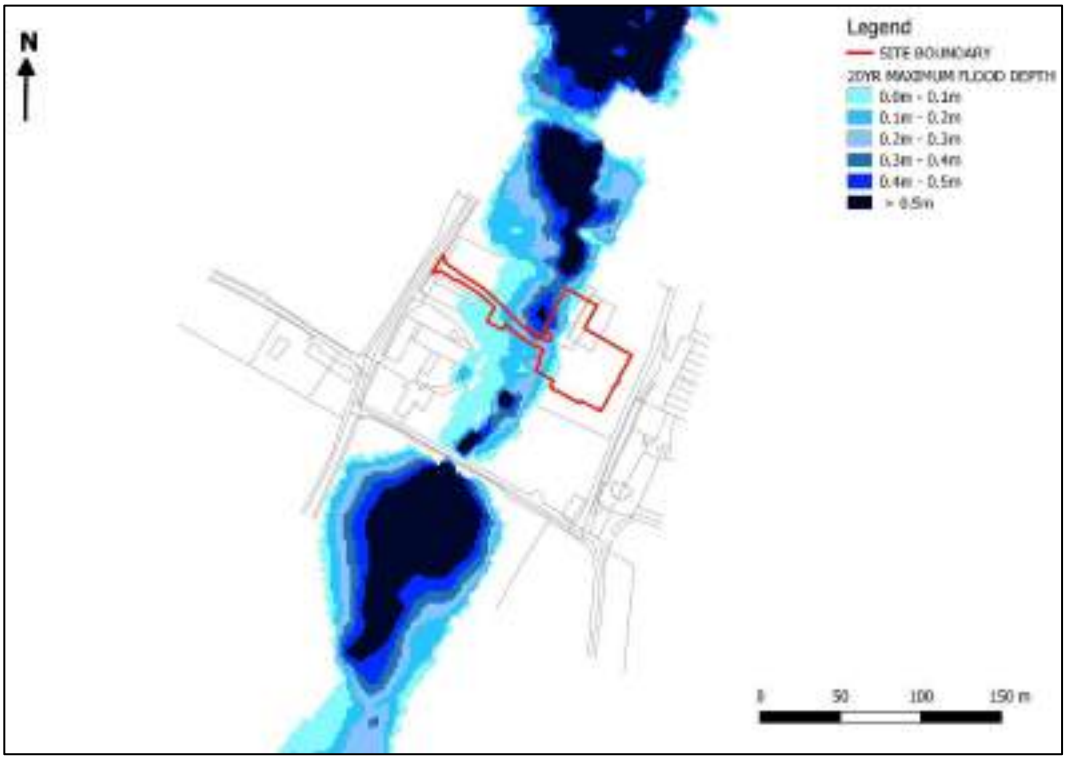


Figure 5.3: Baseline 1 in 100 Year Peak Flood Depths

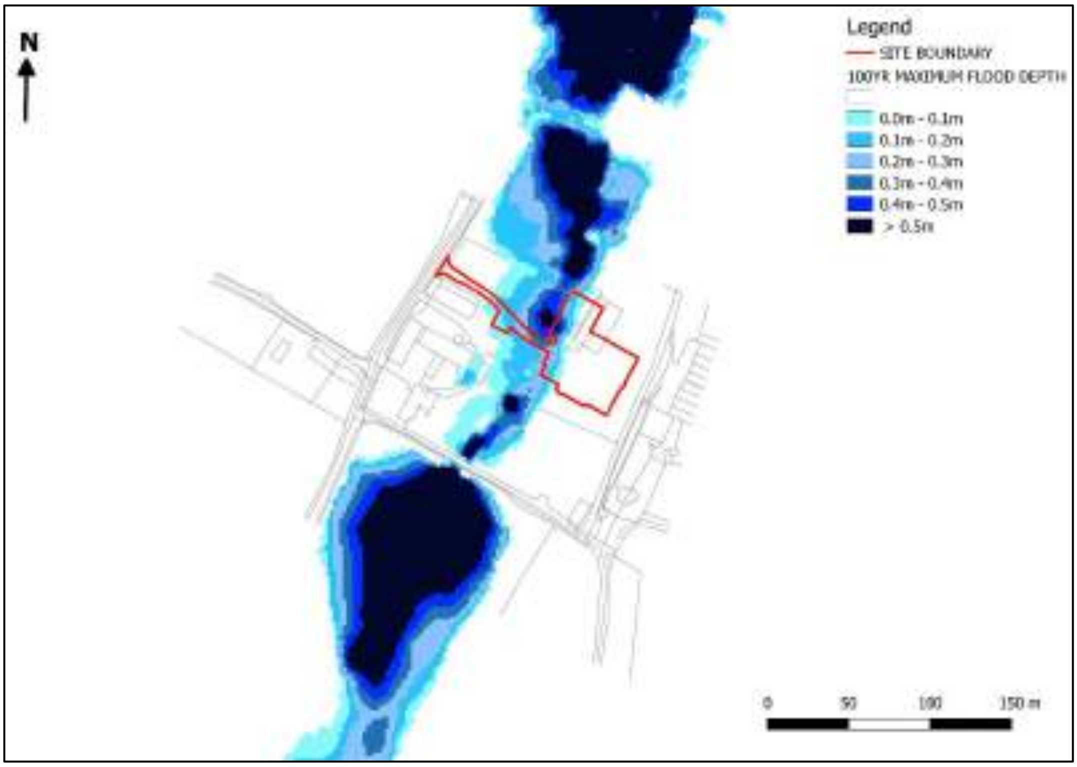


Figure 5.4: Baseline 1 in 100 Year Plus Climate Change (22%) Peak Flood Depths

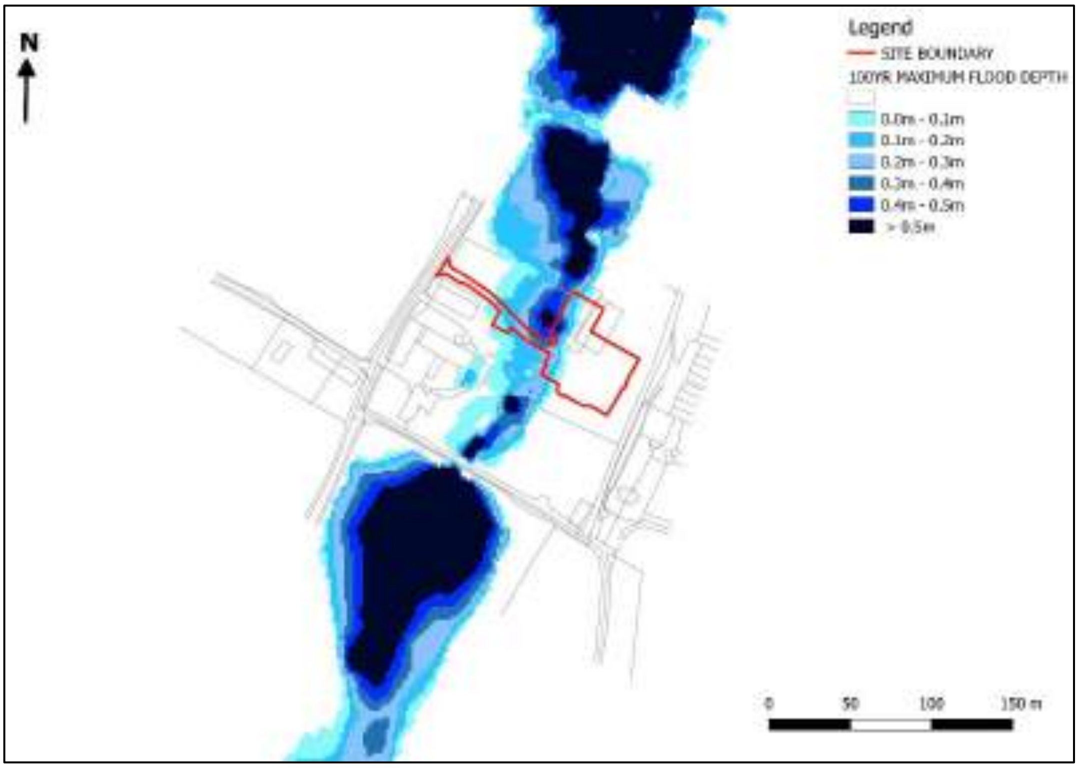
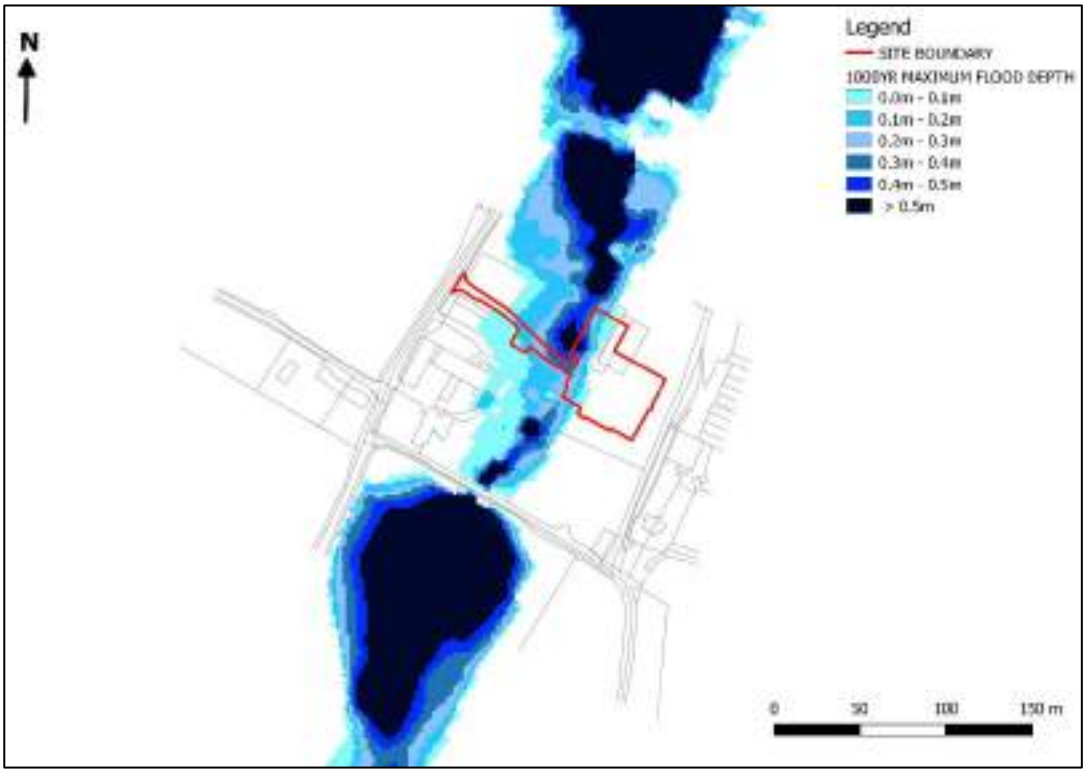


Figure 5.5: Baseline 1 in 1000 Year Plus Climate Change



5.2 Proposed Design Runs

5.2.1 A proposed swale network will be built along the centre of the site which will capture the flows from the critical culvert along Vicarage Lane. A safe access and egress route is required as part of the proposed development. Culverts have been proposed to allow for continuation of flow through the access road. This includes two 0.9mm diameter circular culverts at the location of the access road over the swale and three 0.45m diameter flood relief culverts two to the west of the main culvert and one to the east. A schematic of the proposed swale, access road, culverts and recommended finish floor levels is shown in **Figure 5.6**.

5.2.2 The post development modelled flood depths and levels for the 1% AEP plus 22% climate change scenario are shown in **Figure 5.7** and **5.8**.

5.2.3 The development proposal will not pose an impact to the downstream flood flow and water level. The inclusion of the access road poses a minimal increase in water levels off site. However, an increase of up to 0.15m above the original proposed flood levels is predicted to a section of the garages of the Phase 1 development in the south-west. This is shown in **Figure 5.9** below.

Figure 5.6: Proposed Development Schematic

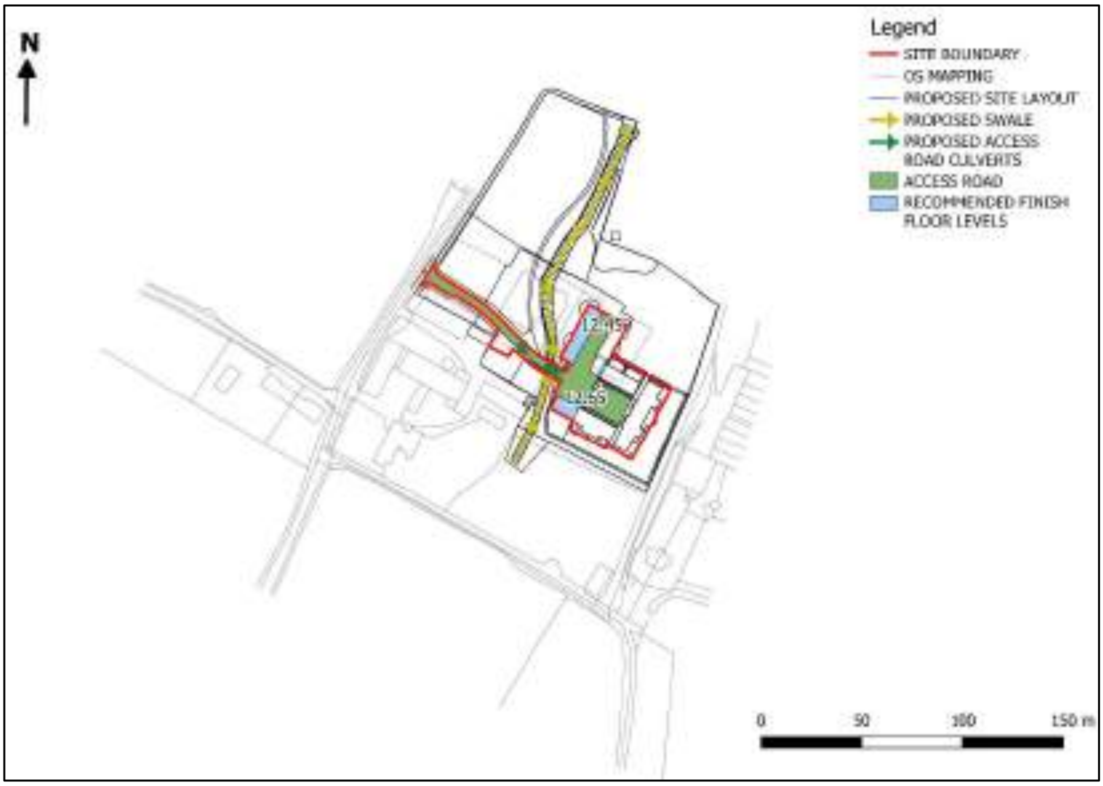


Figure 5.7: Post 1 in 100 Year Plus Climate Change (22%) Peak Flood Depths

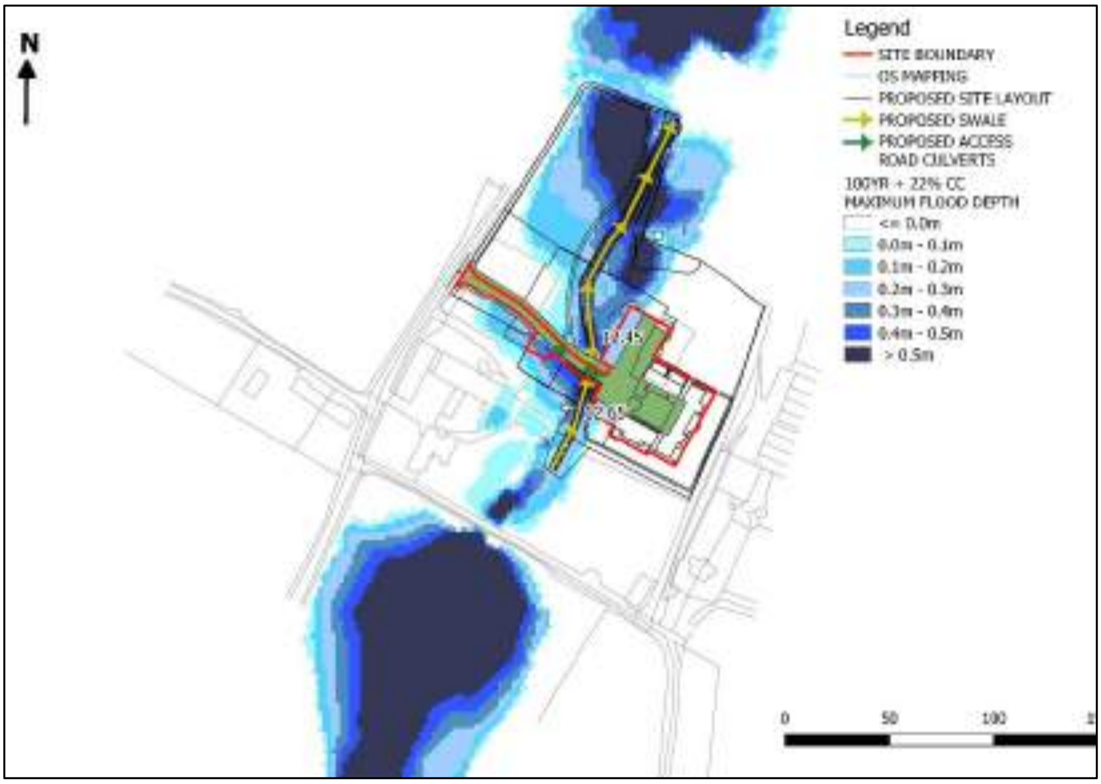


Figure 5.8: Post 1 in 100 Year Plus 22%CC Peak Flood Levels with Access Road

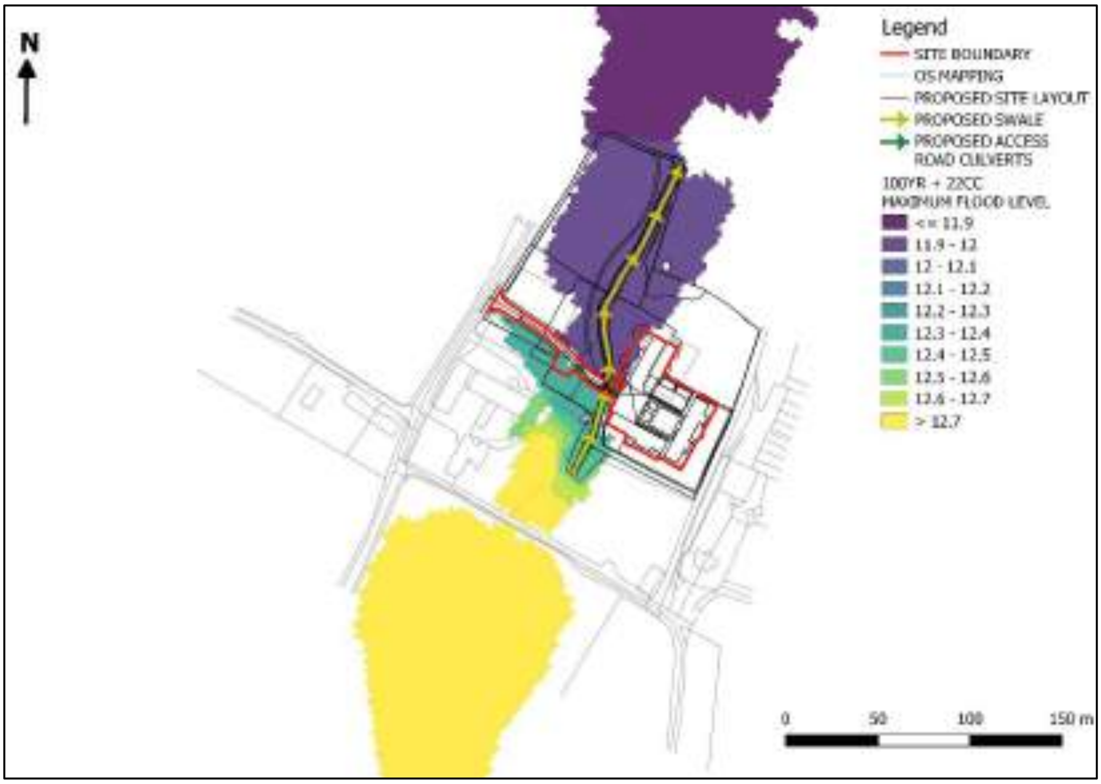
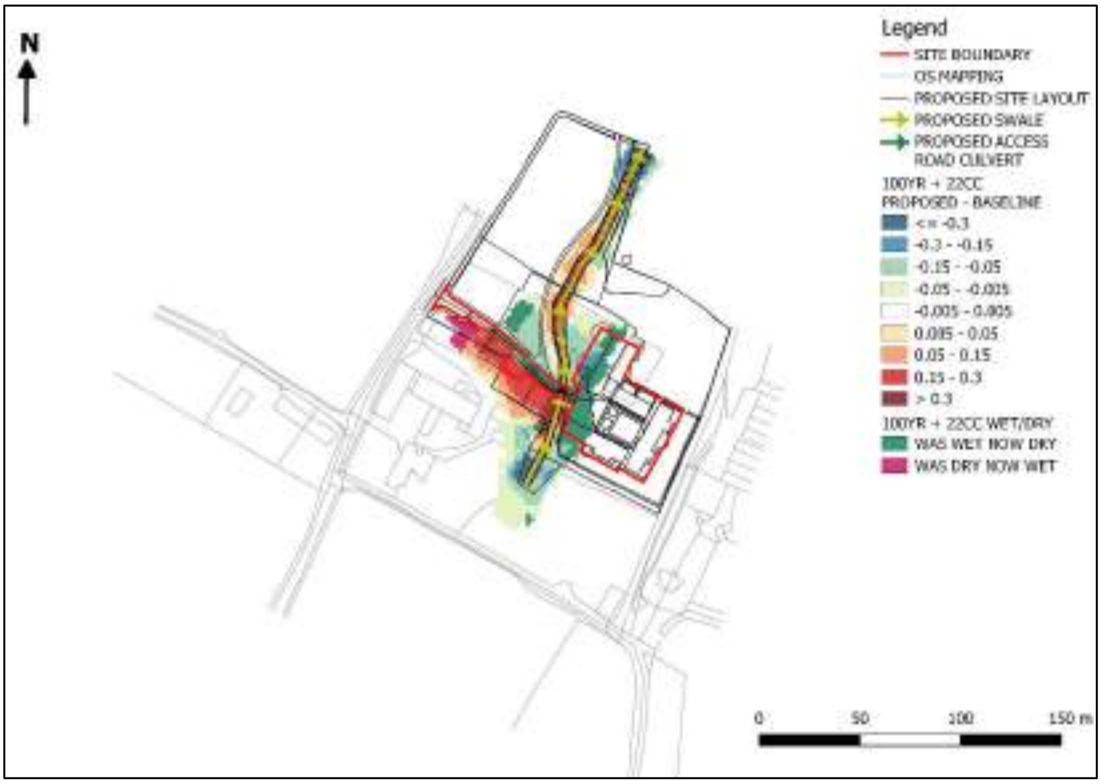


Figure 5.9: Peak Flood Depth Comparison Map



5.2.4 The minimum recommended finished floor levels are shown in **Figure 5.6** which are based on an increase of 300mm above the flood levels of 12.3mAOD to 12.4mAOD upstream of the access road and 11.9mAOD to 12.2mAOD downstream of the access road associated with the 1% AEP plus 22% climate change design event. The recommended minimum level for the access road is 12.6mAOD which is based on an increase of 300mm above the design flood level of 12.3mAOD. However, the proposed access road is required to be higher (13.3mAOD) in some locations to allow for suitable cover of 1.2m above the proposed swale culvert.

6.0 CONCLUSIONS & RECOMMENDATIONS

6.1.1 Odyssey has been commissioned by Shepherd Neame Ltd to carry out a site-specific fluvial modelling of the Nailbourne for the development of nine barn style residential units at Queen Court Farmyard Site, Water Lane, Ospringe, Faversham.

6.1.2 According to the current Environment Agency (EA) Flood Map for Planning, a large part of the site falls within Flood Zone 3, excluding the east part of the Queen Court Farmyard area which comprises gently rising land subject to the development proposals for barn style residential units.

6.1.3 The predicted peak water levels for the watercourse and ditches indicate that water levels are generally, out of bank at the modelled ditch adjacent to Water Lane. It was also observed that the floodplain is significantly wider at the upstream end of the M2 Motorway.

6.1.4 The fluvial flood extents show a flow path through the centre of the site.

6.1.5 It is proposed to build a swale network along the centre of the site to capture the flows from the critical culvert underneath Vicarage Lane. A safe access and egress route is required as part of the proposed development.

6.1.6 The proposed development sits outside of the floodplain and remains dry during the 1% AEP plus 22% climate change scenario assuming the recommended finish floor levels are accommodated.

6.1.7 The sensitivity analysis has shown that the flood levels are not sensitive to variation in roughness and downstream boundary but are sensitive to culvert blockages.

6.1.8 It is recommended that the hydraulic assessment is accepted as best available source of information and the modelling results should be used to inform the following for a Flood Risk Assessment:

- Confirmation of the above flood mitigation option to ensure that the proposals do not exacerbate flooding in all areas upstream and downstream of the site.
- Finished floor levels of buildings adjacent to the flood flow path and level of the access road to ensure it forms a safe access and egress route.

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

- FARL - a difference of no more than 0.05.
- BFIHOST - a difference of no more than 0.18
- SAAR - a factor of no more than 1.25
- SPRHOST - difference of no more than 15

1.1.7 A comparison of the catchment descriptors at the four potential donor gauging stations with the study reach (Table 3) suggests that the adjacent Great Stour gauges share similar characteristics of the study reach. However it is noted that the receiving catchments of all Great Stour gauges are classified as slightly urbanised ($0.030 \leq URBEXT_{2000} < 0.060$) whereas the catchment of the study reach is classified as essentially rural ($URBEXT_{2000} < 0.030$), these gauges may therefore not be suitable as a donor.

Table 3 Catchment Descriptors at Subject Sites and Donor Gauging Stations

Site	AREA	FARL	BFIHOST	SAAR	SPRHOST	URBEXT2000
Reach Nr A2	52.63	1.000	0.713	755	28.84	0.0042
Reach Nr M2	50.44	1.000	0.714	760	28.76	0.0032
40011	341.97	0.965	0.706	747	25.40	0.0321
40008	226.42	0.983	0.659	741	28.00	0.0452
40022	66.96	0.967	0.744	726	23.30	0.0348
40005	278.05	0.992	0.353	691	44.56	0.0148

1.1.8 Although the gauges may not be suitable as a donor due to the difference in urbanisation, as a check QMED is calculated from flow data and catchment descriptors at the gauge 40022 to confirm whether the QMED ratio is low or high in this area.

1.1.9 For stations with more than 13 years of flow data FEH recommends that QMED is calculated from annual maximum (AMAX) data.

Table 4 QMED Ratio at Donor Gauging Stations

Station	QMED-Catchment Descriptors (m^3/s)	QMED-Catchment Descriptors adjusted for urban influence (m^3/s)	QMED-AMAX (m^3/s)	Ratio
40022	3.648	3.961	5.123	1.293

1.1.10 This ratio between QMED from AMAX data and catchment descriptors suggests the QMED from catchment descriptors underestimates that from flow data with a ratio of 1.293. However the Revised Statistical method requires a further adjustment based on geographical proximity as detailed below.

1.1.4 Revised Donor Adjusted QMED

1.1.11 In addition to adjusting QMED based on the ratio of QMED estimates from catchment descriptors and flow data, the Revised Statistical method requires that the QMED ratio at a donor gauging station is also adjusted according to the distance between the catchment centroids using an exponent 'a'. Exponent 'a' is derived as the straight line distance between the centroid of the subject catchment and the donor gauging station, which in this case is 40022. This exponent in the ratio of QMED at this station gives a revised adjustment ratio at the site of interest of 1.101 (Table 5).

Table 5 Adjusted QMED Ratio at Donor Gauging Stations

Site	Centroid Easting	Centroid Northing	Centroid Distance (km)	Exponent 'a'	Unadjusted Ratio	Adjusted Ratio
Reach Near A2	598182	154399				
40022	604436	145695	10.718	0.374	1.293	1.101

1.1.5 Flood Frequency Curve

1.1.12 The calculation of a flood frequency curve and the peak flows at the flood estimation points requires the construction of a pooling group and the fitting of an extreme value distribution to the pooled group data.

1.1.13 Table 6 below gives details of the pooling group including any stations added or removed and reasons for this.

Table 6 Pooling Group Details

Station removed (with reasons)
203049 (Clady @ Clady Bridge) – Station in Ireland
41020 (Bevern Stream @ Clappers Bridge) – Low BFIHOST value (0.355)
25006 (Greta @ Rutherford Bridge) – Low BFIHOST value (0.241)
27010 (Hodge Beck @ Bransdale Weir) – Low BFIHOST value (0.341)
Final Pooling Group
53023 (Sherston Avon @ Fosseway)
43014 (East Avon @ Upavon)
84009 (Nethan @ Kirkmuirhill)
54025 (Dulas @ Rhos-y-pentref)
48803 (Carnon @ Bissoe)
47009 (Tiddy @ Tideford)
45008 (Otter @ Fenny Bridges)
43017 (West Avon @ Upavon)
55013 (Arrow @ Titley Mill)
72014 (Conder @ Galgate)
67005 (Ceiriog @ Brynkinalt Weir)
28061 (Churnet @ Basford Bridge)
12006 (Gairn @ Invergairn)
96003 (Strathy @ Strathy Bridge)
73008 (Bela @ Beetham)
53023 (Sherston Avon @ Fosseway)

1.1.14 The revised pooling group contains 15 stations with 509 station years of record. Guidance from the WINFAP Software indicates the pooling group is 'acceptably homogeneous and a review of the pooling group is not required' (H2 = -1.2640). There was no valid reason for the removal of any other of the component stations and the pooling group was considered acceptable. A 500 year record length is reasonable to calculate the 1 in 100 year peak flow and the 1 in 1000 year peak flow was extrapolated using ReFH. The pooling ground for the 1 in 1000 year event is likely to be inhomogeneous.

1.1.15 Two extreme value distributions are often used on the pooled group data (i) the Generalised Logistic (GL) and (ii) the General Extreme Value (GEV) distribution both fitted to the annual maximum data by the method of L-Moments. FEH indicates that the GL distribution can often provide the best fit to extreme value flood series and in this case WINFAP indicates that the GL provides an acceptable distribution for this site.

1.1.16 The results of the frequency analysis based on the QMED donor adjustment factor of 1.101 and on the basis that the GL distribution is recommended by WINFAP. Refer to Table 7 for the full range of results.

Table 7 Pooled Group Growth Curve and Flood Frequency Curves (m^3/s) for individual catchments

	Return periods	**2**	**5**	**10**	**20**	**30**	**50**	**100**	**1000**
	Growth Curve	1.000	1.323	1.542	1.767	1.905	2.088	2.354	3.435
Flood Frequency Curves (m^3/s)	Reach Near A2	4.662	6.167	7.188	8.237	8.880	9.733	10.973	16.013
	Reach Near M2	4.550	6.020	7.016	8.040	8.668	9.500	10.711	15.629

1.1.6 Extension to the 1 in 1000 Year Event

1.1.17 The FEH Statistical method was originally recommended for return periods only up to the 1 in 200 year event and noted as not suitable for extrapolating to very extreme events such as the 1 in 1000 year event. Flood estimates for longer return periods were historically derived using the FSR/FEH rainfall-runoff method as the rainfall growth curves for long return periods could be defined with much more confidence than flood growth curves. However the original FEH rainfall-runoff method was known to overestimate flows and more recently the extension of the Statistical method has been preferred.

1.1.18 The Environment Agency's Flood Estimation Guidelines provide two suggestions for calculating extreme floods up to the 1000 year event. Firstly using the Statistical method but the 1 in 1000 year pooling group is likely to be inhomogeneous with many component stations hence a simple extension of the 1 in 200 year and more recently the 1 in 100 year event has been proposed. A second approach is to derive the ReFH growth factor for the 1 in 100 year to 1 in 1000 year event which is then applied to the Statistical method 1 in 100 year peak flow.

1.1.19 The Statistical method flood frequency curve is extended to the 1 in 1000 year event using the ReFH growth factor as described above. (Table 8).

Table 8 Statistical Method Pooling Group Extended to 1 in 1000 year using ReFH

	Return periods	**2**	**5**	**10**	**20**	**30**	**50**	**100**	**1000**
Flood Frequency Curves (m^3/s)	Reach Near A2	4.662	6.167	7.188	8.237	8.880	9.733	10.973	20.282
	Reach Near M2	4.550	6.020	7.016	8.040	8.668	9.500	10.711	19.948

1.1.7 Hydrograph Shape

1.1.20 If a design hydrograph is required it is recommended that the hydrograph shape from the ReFH method is used and forced to fit the peak flows from the Statistical method, referred to as the hybrid method. This can be achieved in the WHS's ReFH 2 software suite.

1.1.21 The FEH Guidelines suggest two hybrid methods for ungauged sites:

1.1.22 Generating the hydrograph using ReFH method and scaling the ordinates so the peak flow matches the statistical estimate.

1.1.23 Adjusting the parameters of the ReFH model until the simulated peak flows match the preferred values. This might appear more elegant than option (a) but should be used with caution. It may prove difficult to match the statistical results over a range of return periods, because the ReFH method may give a different growth curve.

1.1.24 Option a) is the quickest method and often the best. The flood hydrographs from this method are provided in Figure 1-3 to Figure 1-4.

Figure 1-3 Hybrid Flood Hydrograph – Reach Near A2

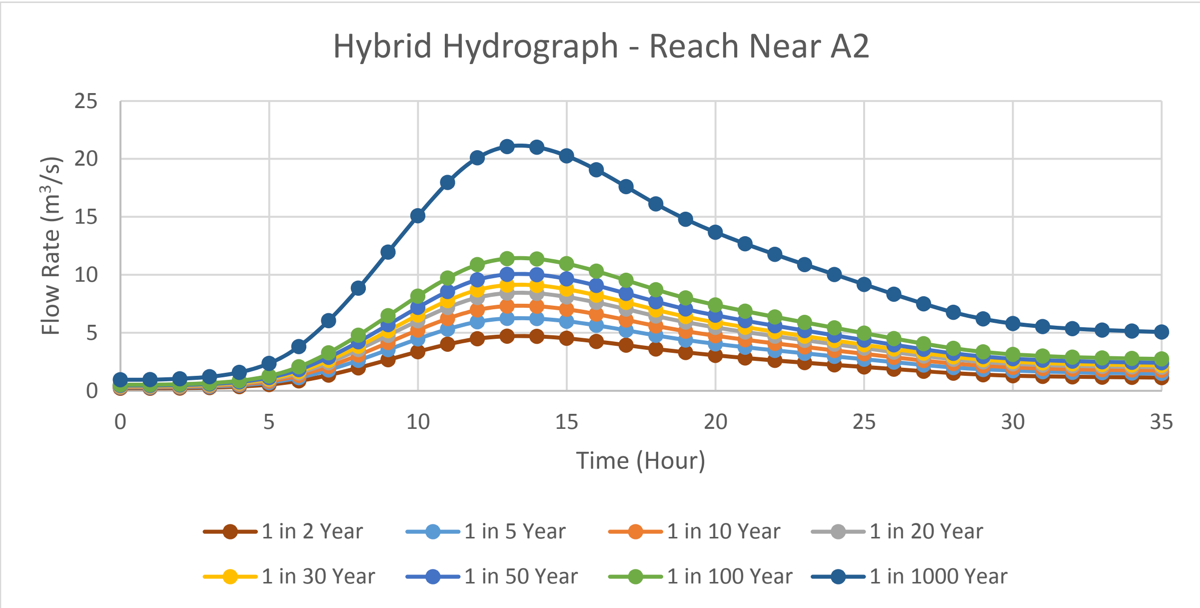
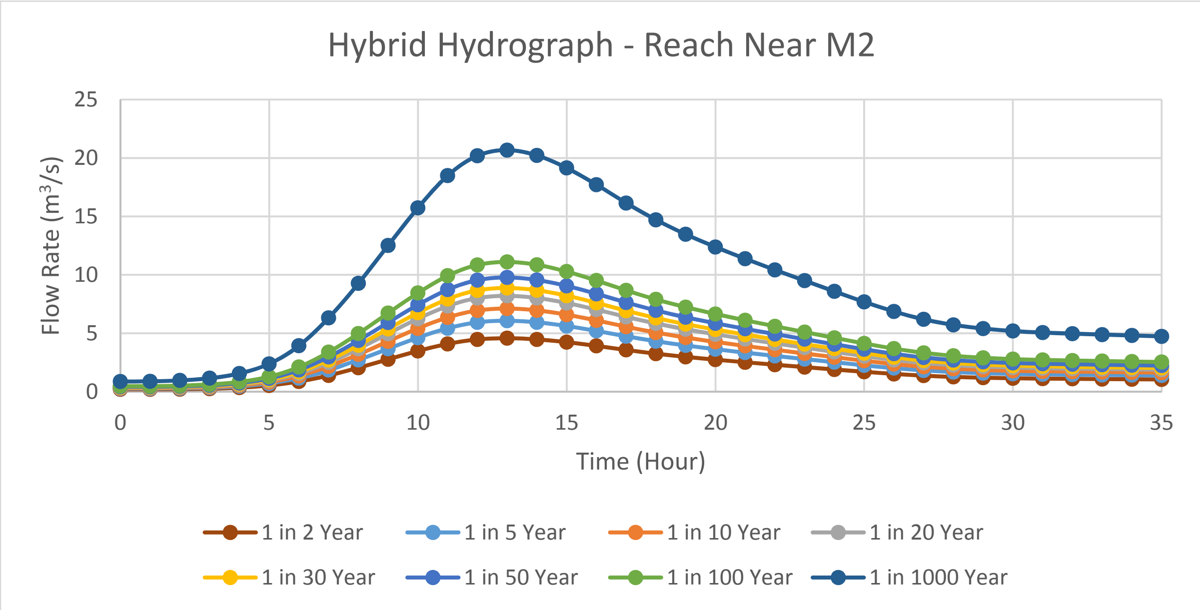


Figure 1-4 Hybrid Flood Hydrograph – Reach Near M2



UK Design Flood Estimation

Generated on 06 January 2016 09:35:13 by jho
Printed from the ReFH Flood Modelling software package, version 2.1.5798.30211

Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH)

Site details Checksum: 8C20-D687

Site name: Reach Nr A2

Easting: 600300

Northing: 160800

Country: England, Wales or Northern Ireland

Catchment Area (km²): 52.63

Using plotscale calculations: No

Site description: None

Model run: 5 year

Summary of results

Rainfall - FEH 1999 (mm):	42.75	Total runoff (ML):	232.28
Total Rainfall (mm):	29.04	Total flow (ML):	659.82
Peak Rainfall (mm):	6.60	Peak flow (m³/s):	7.01

Parameters

** Where the user has overriden a system-generated value, this original value is shown in square brackets after the value used.*

Rainfall parameters (Rainfall - FEH 1999 model)

Name	Value	User-defined?
Duration (hr)	11	No
Timestep (hr)	1	No
SCF(Seasonal correction factor)	0.72	No
ARF(Areal reduction factor)	0.94	No
Seasonality	Winter	n/a

Loss model parameters

Name	Value	User-defined?
Cini (mm)	92.68	No
Cmax (mm)	710.31	No
Use alpha correction factor	Yes	No
Alpha correction factor	1	No

Routing model parameters

Name	Value	User-defined?
Tp (hr)	6.33	No
Up	0.65	No
Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	1.26	No
BL (hr)	65.9	No
BR	1.86	No

Urbanisation parameters

Name	Value	User-defined?
Urban area (km^2)	0.35	No
Urbext 2000	0	No
Urban runoff factor	0.7	No
Imperviousness factor	0.3	No
Tp scaling factor	0.5	No
Sewered area (km^2)	0.00	Yes
Sewer capacity (m^3/s)	0.00	Yes

Time series data

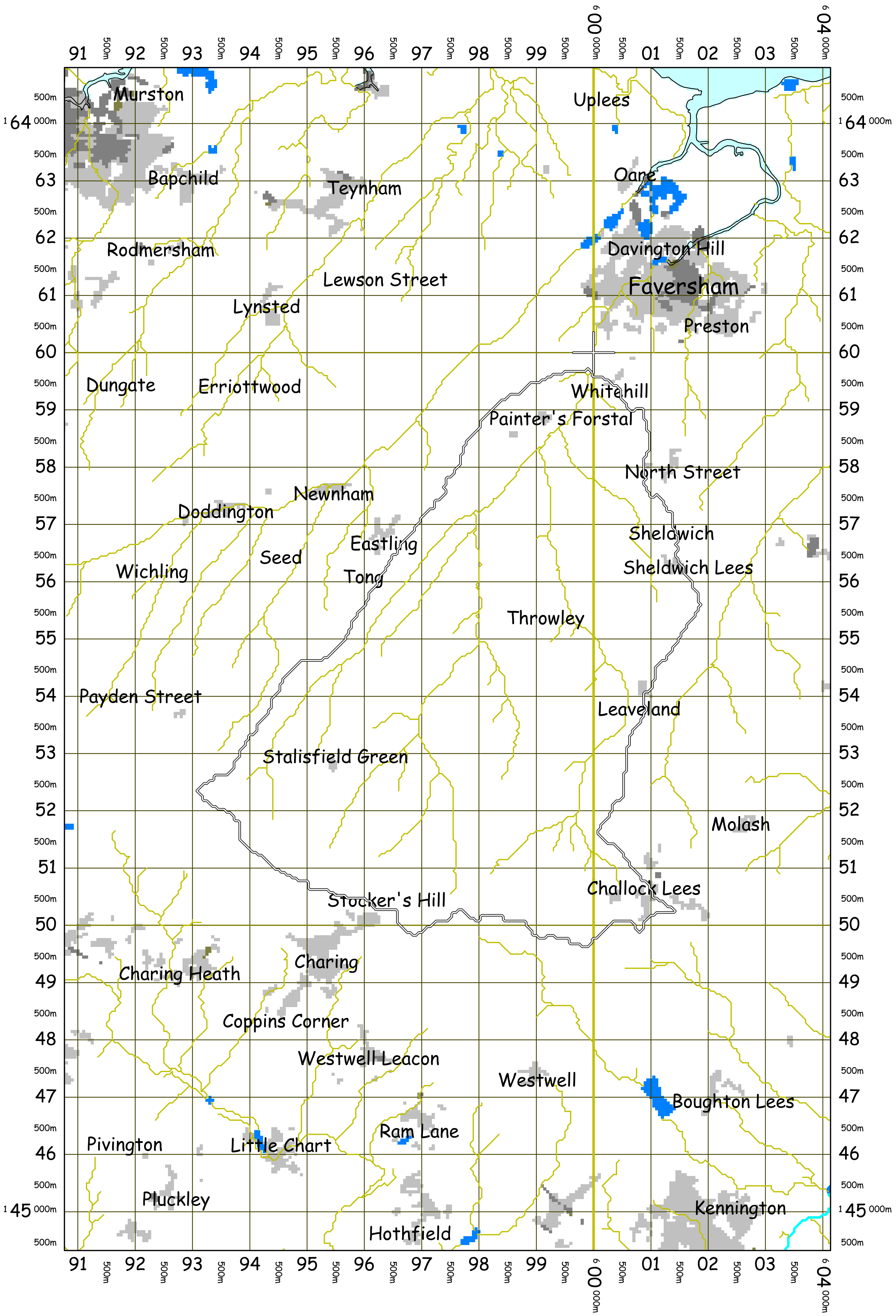
Time (hh:mm)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
00:00	0.638	0.000	0.084	0.000	1.258	1.258
01:00	1.068	0.000	0.142	0.010	1.239	1.249
02:00	1.780	0.000	0.241	0.049	1.221	1.270
03:00	2.943	0.000	0.408	0.135	1.205	1.340
04:00	4.790	0.000	0.690	0.300	1.192	1.493
05:00	6.598	0.000	1.003	0.599	1.186	1.785
06:00	4.790	0.000	0.766	1.102	1.191	2.293
07:00	2.943	0.000	0.487	1.810	1.212	3.023
08:00	1.780	0.000	0.300	2.628	1.254	3.882
09:00	1.068	0.000	0.182	3.467	1.317	4.784
10:00	0.638	0.000	0.110	4.248	1.402	5.650
11:00	0.000	0.000	0.000	4.882	1.506	6.388
12:00	0.000	0.000	0.000	5.250	1.622	6.872
13:00	0.000	0.000	0.000	5.272	1.743	7.014
14:00	0.000	0.000	0.000	5.033	1.859	6.892
15:00	0.000	0.000	0.000	4.635	1.965	6.600
16:00	0.000	0.000	0.000	4.152	2.057	6.210
17:00	0.000	0.000	0.000	3.637	2.135	5.772
18:00	0.000	0.000	0.000	3.142	2.197	5.339
19:00	0.000	0.000	0.000	2.717	2.246	4.963
20:00	0.000	0.000	0.000	2.354	2.283	4.637
21:00	0.000	0.000	0.000	2.033	2.310	4.343
22:00	0.000	0.000	0.000	1.738	2.328	4.066
23:00	0.000	0.000	0.000	1.459	2.337	3.797
24:00	0.000	0.000	0.000	1.193	2.339	3.532
25:00	0.000	0.000	0.000	0.937	2.334	3.271
26:00	0.000	0.000	0.000	0.693	2.322	3.015
27:00	0.000	0.000	0.000	0.472	2.303	2.775
28:00	0.000	0.000	0.000	0.288	2.279	2.566
29:00	0.000	0.000	0.000	0.158	2.251	2.409
30:00	0.000	0.000	0.000	0.079	2.220	2.299
31:00	0.000	0.000	0.000	0.035	2.188	2.223
32:00	0.000	0.000	0.000	0.012	2.156	2.168
33:00	0.000	0.000	0.000	0.002	2.124	2.126
34:00	0.000	0.000	0.000	0.000	2.092	2.092

Time (hh:mm)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
35:00	0.000	0.000	0.000	0.000	2.060	2.060
36:00	0.000	0.000	0.000	0.000	2.029	2.029
37:00	0.000	0.000	0.000	0.000	1.999	1.999
38:00	0.000	0.000	0.000	0.000	1.969	1.969
39:00	0.000	0.000	0.000	0.000	1.939	1.939
40:00	0.000	0.000	0.000	0.000	1.910	1.910
41:00	0.000	0.000	0.000	0.000	1.881	1.881
42:00	0.000	0.000	0.000	0.000	1.853	1.853
43:00	0.000	0.000	0.000	0.000	1.825	1.825
44:00	0.000	0.000	0.000	0.000	1.797	1.797
45:00	0.000	0.000	0.000	0.000	1.770	1.770
46:00	0.000	0.000	0.000	0.000	1.744	1.744
47:00	0.000	0.000	0.000	0.000	1.717	1.717
48:00	0.000	0.000	0.000	0.000	1.691	1.691
49:00	0.000	0.000	0.000	0.000	1.666	1.666
50:00	0.000	0.000	0.000	0.000	1.641	1.641
51:00	0.000	0.000	0.000	0.000	1.616	1.616
52:00	0.000	0.000	0.000	0.000	1.592	1.592
53:00	0.000	0.000	0.000	0.000	1.568	1.568
54:00	0.000	0.000	0.000	0.000	1.544	1.544
55:00	0.000	0.000	0.000	0.000	1.521	1.521
56:00	0.000	0.000	0.000	0.000	1.498	1.498
57:00	0.000	0.000	0.000	0.000	1.475	1.475
58:00	0.000	0.000	0.000	0.000	1.453	1.453
59:00	0.000	0.000	0.000	0.000	1.431	1.431
60:00	0.000	0.000	0.000	0.000	1.410	1.410
61:00	0.000	0.000	0.000	0.000	1.389	1.389
62:00	0.000	0.000	0.000	0.000	1.368	1.368
63:00	0.000	0.000	0.000	0.000	1.347	1.347
64:00	0.000	0.000	0.000	0.000	1.327	1.327
65:00	0.000	0.000	0.000	0.000	1.307	1.307
66:00	0.000	0.000	0.000	0.000	1.287	1.287
67:00	0.000	0.000	0.000	0.000	1.268	1.268

Appendix

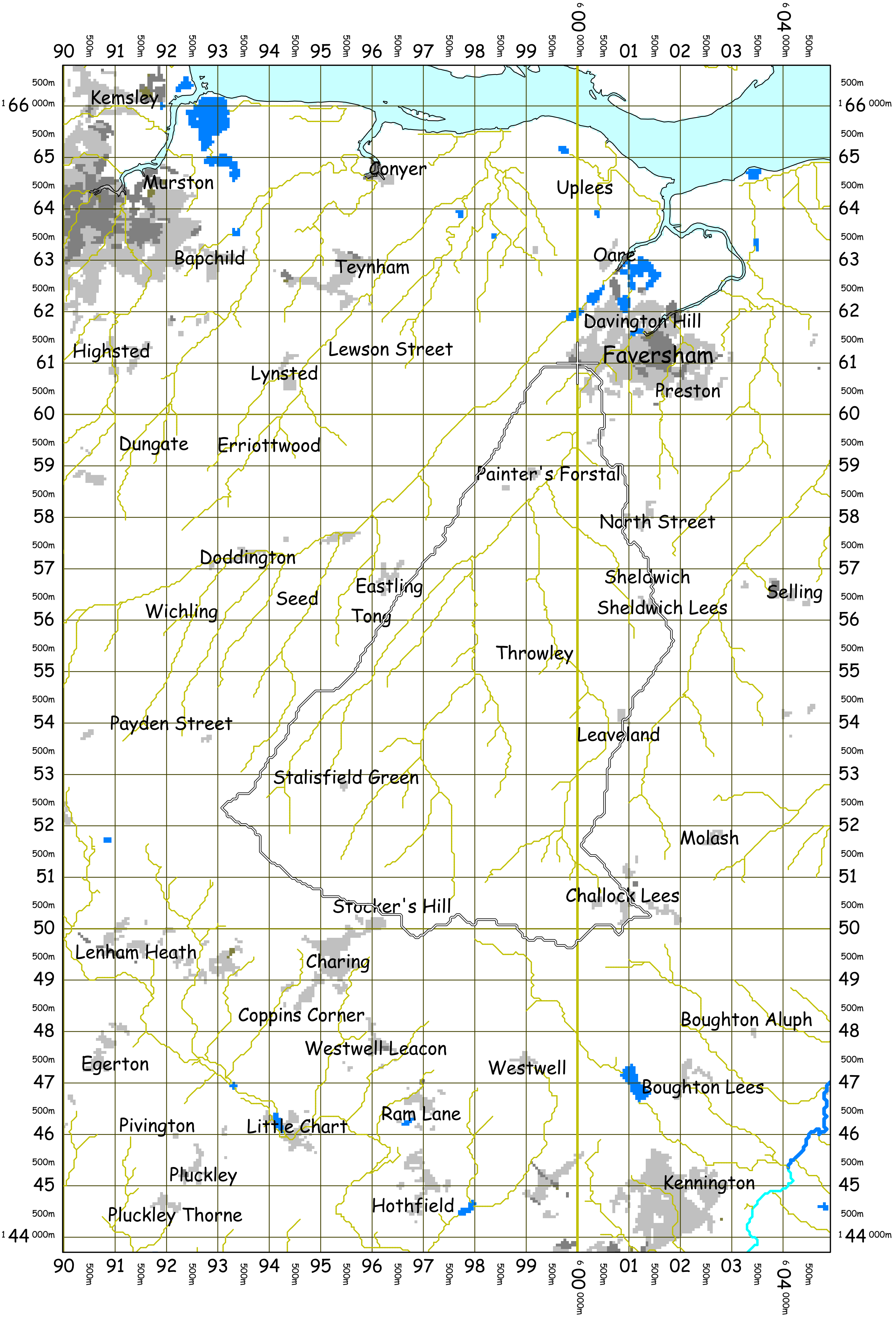
Catchment descriptors

Name	Value	User-defined value used?
Area (km^2)	52.63	No
ALTBAR	112	No
ASPBAR	27	No
ASPVAR	0.46	No
BFIHOST	0.71	No
DPLBAR (km)	8.46	No
DPSBAR (mkm^{-1})	52.2	No
FARL	1	No
LDP	14.11	No
PROPWET (mm)	0.34	No
RMED1H	12.3	No
RMED1D	35.3	No
RMED2D	43.1	No
SAAR (mm)	755	No
SAAR4170 (mm)	775	No
SPRHOST	28.84	No
Urbext2000	0	No
Urbext1990	0	No
URBCONC	0	No
URBLOC	0	No
Urban Area (km^2)	0.35	No
DDF parameter C	-0.02	No
DDF parameter D1	0.35	No
DDF parameter D2	0.35	No
DDF parameter D3	0.3	No
DDF parameter E	0.31	No
DDF parameter F	2.53	No
DDF parameter C (1km grid value)	-0.02	No
DDF parameter D1 (1km grid value)	0.32	No
DDF parameter D2 (1km grid value)	0.36	No
DDF parameter D3 (1km grid value)	0.31	No
DDF parameter E (1km grid value)	0.32	No
DDF parameter F (1km grid value)	2.52	No



599950 159650 [TQ 99950 59650]

0 0.5 1
Kilometres



600300 160800 [TR 00300 60800]

0 2.5 5
Kilometres

UK Design Flood Estimation

Generated on 06 January 2016 09:39:44 by jho
Printed from the ReFH Flood Modelling software package, version 2.1.5798.30211

Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH)

Site details Checksum: 8C20-D687

Site name: Reach Nr A2

Easting: 600300

Northing: 160800

Country: England, Wales or Northern Ireland

Catchment Area (km^2): 52.63

Using plotscale calculations: No

Site description: None

Model run: 1000 year

Summary of results

Rainfall - FEH 1999 (mm):	172.12	Total runoff (ML):	1045.81
Total Rainfall (mm):	116.91	Total flow (ML):	2965.22
Peak Rainfall (mm):	26.57	Peak flow (m^3/s):	28.00

Parameters

** Where the user has overriden a system-generated value, this original value is shown in square brackets after the value used.*

Rainfall parameters (Rainfall - FEH 1999 model)

Name	Value	User-defined?
Duration (hr)	11	No
Timestep (hr)	1	No
SCF(Seasonal correction factor)	0.72	No
ARF(Areal reduction factor)	0.94	No
Seasonality	Winter	n/a

Loss model parameters

Name	Value	User-defined?
Cini (mm)	92.68	No
Cmax (mm)	710.31	No
Use alpha correction factor	Yes	No
Alpha correction factor	0.66	No

Routing model parameters

Name	Value	User-defined?
Tp (hr)	6.33	No
Up	0.65	No
Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	1.26	No
BL (hr)	65.9	No
BR	1.86	No

Urbanisation parameters

Name	Value	User-defined?
Urban area (km^2)	0.35	No
Urbext 2000	0	No
Urban runoff factor	0.7	No
Imperviousness factor	0.3	No
Tp scaling factor	0.5	No
Sewered area (km^2)	0.00	Yes
Sewer capacity (m^3/s)	0.00	Yes

Time series data

Time (hh:mm)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
00:00	2.567	0.000	0.230	0.000	1.258	1.258
01:00	4.300	0.000	0.406	0.029	1.239	1.268
02:00	7.167	0.000	0.735	0.138	1.222	1.360
03:00	11.851	0.000	1.373	0.389	1.211	1.600
04:00	19.286	0.000	2.657	0.900	1.209	2.109
05:00	26.567	0.000	4.516	1.902	1.228	3.130
06:00	19.286	0.000	3.899	3.773	1.285	5.058
07:00	11.851	0.000	2.655	6.634	1.404	8.038
08:00	7.167	0.000	1.702	10.162	1.608	11.769
09:00	4.300	0.000	1.056	13.984	1.909	15.893
10:00	2.567	0.000	0.642	17.753	2.311	20.064
11:00	0.000	0.000	0.000	21.078	2.807	23.884
12:00	0.000	0.000	0.000	23.347	3.375	26.722
13:00	0.000	0.000	0.000	24.026	3.978	28.004
14:00	0.000	0.000	0.000	23.363	4.573	27.936
15:00	0.000	0.000	0.000	21.801	5.131	26.932
16:00	0.000	0.000	0.000	19.704	5.630	25.335
17:00	0.000	0.000	0.000	17.348	6.062	23.409
18:00	0.000	0.000	0.000	14.999	6.421	21.421
19:00	0.000	0.000	0.000	12.958	6.715	19.673
20:00	0.000	0.000	0.000	11.225	6.951	18.177
21:00	0.000	0.000	0.000	9.716	7.139	16.856
22:00	0.000	0.000	0.000	8.353	7.285	15.637
23:00	0.000	0.000	0.000	7.081	7.391	14.472
24:00	0.000	0.000	0.000	5.873	7.460	13.333
25:00	0.000	0.000	0.000	4.697	7.496	12.193
26:00	0.000	0.000	0.000	3.561	7.498	11.060
27:00	0.000	0.000	0.000	2.498	7.470	9.968
28:00	0.000	0.000	0.000	1.576	7.415	8.990
29:00	0.000	0.000	0.000	0.893	7.337	8.230
30:00	0.000	0.000	0.000	0.456	7.246	7.702
31:00	0.000	0.000	0.000	0.203	7.146	7.348
32:00	0.000	0.000	0.000	0.069	7.042	7.111
33:00	0.000	0.000	0.000	0.012	6.937	6.949
34:00	0.000	0.000	0.000	0.000	6.833	6.833

Time (hh:mm)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
35:00	0.000	0.000	0.000	0.000	6.730	6.730
36:00	0.000	0.000	0.000	0.000	6.629	6.629
37:00	0.000	0.000	0.000	0.000	6.529	6.529
38:00	0.000	0.000	0.000	0.000	6.430	6.430
39:00	0.000	0.000	0.000	0.000	6.334	6.334
40:00	0.000	0.000	0.000	0.000	6.238	6.238
41:00	0.000	0.000	0.000	0.000	6.144	6.144
42:00	0.000	0.000	0.000	0.000	6.052	6.052
43:00	0.000	0.000	0.000	0.000	5.961	5.961
44:00	0.000	0.000	0.000	0.000	5.871	5.871
45:00	0.000	0.000	0.000	0.000	5.782	5.782
46:00	0.000	0.000	0.000	0.000	5.695	5.695
47:00	0.000	0.000	0.000	0.000	5.610	5.610
48:00	0.000	0.000	0.000	0.000	5.525	5.525
49:00	0.000	0.000	0.000	0.000	5.442	5.442
50:00	0.000	0.000	0.000	0.000	5.360	5.360
51:00	0.000	0.000	0.000	0.000	5.279	5.279
52:00	0.000	0.000	0.000	0.000	5.200	5.200
53:00	0.000	0.000	0.000	0.000	5.121	5.121
54:00	0.000	0.000	0.000	0.000	5.044	5.044
55:00	0.000	0.000	0.000	0.000	4.968	4.968
56:00	0.000	0.000	0.000	0.000	4.893	4.893
57:00	0.000	0.000	0.000	0.000	4.820	4.820
58:00	0.000	0.000	0.000	0.000	4.747	4.747
59:00	0.000	0.000	0.000	0.000	4.676	4.676
60:00	0.000	0.000	0.000	0.000	4.605	4.605
61:00	0.000	0.000	0.000	0.000	4.536	4.536
62:00	0.000	0.000	0.000	0.000	4.468	4.468
63:00	0.000	0.000	0.000	0.000	4.400	4.400
64:00	0.000	0.000	0.000	0.000	4.334	4.334
65:00	0.000	0.000	0.000	0.000	4.269	4.269
66:00	0.000	0.000	0.000	0.000	4.204	4.204
67:00	0.000	0.000	0.000	0.000	4.141	4.141
68:00	0.000	0.000	0.000	0.000	4.079	4.079
69:00	0.000	0.000	0.000	0.000	4.017	4.017
70:00	0.000	0.000	0.000	0.000	3.957	3.957

Time (hh:mm)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
71:00	0.000	0.000	0.000	0.000	3.897	3.897
72:00	0.000	0.000	0.000	0.000	3.839	3.839
73:00	0.000	0.000	0.000	0.000	3.781	3.781
74:00	0.000	0.000	0.000	0.000	3.724	3.724
75:00	0.000	0.000	0.000	0.000	3.668	3.668
76:00	0.000	0.000	0.000	0.000	3.613	3.613
77:00	0.000	0.000	0.000	0.000	3.558	3.558
78:00	0.000	0.000	0.000	0.000	3.505	3.505
79:00	0.000	0.000	0.000	0.000	3.452	3.452
80:00	0.000	0.000	0.000	0.000	3.400	3.400
81:00	0.000	0.000	0.000	0.000	3.349	3.349
82:00	0.000	0.000	0.000	0.000	3.298	3.298
83:00	0.000	0.000	0.000	0.000	3.248	3.248
84:00	0.000	0.000	0.000	0.000	3.200	3.200
85:00	0.000	0.000	0.000	0.000	3.151	3.151
86:00	0.000	0.000	0.000	0.000	3.104	3.104
87:00	0.000	0.000	0.000	0.000	3.057	3.057
88:00	0.000	0.000	0.000	0.000	3.011	3.011
89:00	0.000	0.000	0.000	0.000	2.966	2.966
90:00	0.000	0.000	0.000	0.000	2.921	2.921
91:00	0.000	0.000	0.000	0.000	2.877	2.877
92:00	0.000	0.000	0.000	0.000	2.834	2.834
93:00	0.000	0.000	0.000	0.000	2.791	2.791
94:00	0.000	0.000	0.000	0.000	2.749	2.749
95:00	0.000	0.000	0.000	0.000	2.708	2.708
96:00	0.000	0.000	0.000	0.000	2.667	2.667
97:00	0.000	0.000	0.000	0.000	2.627	2.627
98:00	0.000	0.000	0.000	0.000	2.587	2.587
99:00	0.000	0.000	0.000	0.000	2.548	2.548
100:00	0.000	0.000	0.000	0.000	2.510	2.510
101:00	0.000	0.000	0.000	0.000	2.472	2.472
102:00	0.000	0.000	0.000	0.000	2.435	2.435
103:00	0.000	0.000	0.000	0.000	2.398	2.398
104:00	0.000	0.000	0.000	0.000	2.362	2.362
105:00	0.000	0.000	0.000	0.000	2.326	2.326
106:00	0.000	0.000	0.000	0.000	2.291	2.291

Time (hh:mm)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
107:00	0.000	0.000	0.000	0.000	2.257	2.257
108:00	0.000	0.000	0.000	0.000	2.223	2.223
109:00	0.000	0.000	0.000	0.000	2.189	2.189
110:00	0.000	0.000	0.000	0.000	2.156	2.156
111:00	0.000	0.000	0.000	0.000	2.124	2.124
112:00	0.000	0.000	0.000	0.000	2.092	2.092
113:00	0.000	0.000	0.000	0.000	2.061	2.061
114:00	0.000	0.000	0.000	0.000	2.029	2.029
115:00	0.000	0.000	0.000	0.000	1.999	1.999
116:00	0.000	0.000	0.000	0.000	1.969	1.969
117:00	0.000	0.000	0.000	0.000	1.939	1.939
118:00	0.000	0.000	0.000	0.000	1.910	1.910
119:00	0.000	0.000	0.000	0.000	1.881	1.881
120:00	0.000	0.000	0.000	0.000	1.853	1.853
121:00	0.000	0.000	0.000	0.000	1.825	1.825
122:00	0.000	0.000	0.000	0.000	1.797	1.797
123:00	0.000	0.000	0.000	0.000	1.770	1.770
124:00	0.000	0.000	0.000	0.000	1.744	1.744
125:00	0.000	0.000	0.000	0.000	1.717	1.717
126:00	0.000	0.000	0.000	0.000	1.692	1.692
127:00	0.000	0.000	0.000	0.000	1.666	1.666
128:00	0.000	0.000	0.000	0.000	1.641	1.641
129:00	0.000	0.000	0.000	0.000	1.616	1.616
130:00	0.000	0.000	0.000	0.000	1.592	1.592
131:00	0.000	0.000	0.000	0.000	1.568	1.568
132:00	0.000	0.000	0.000	0.000	1.544	1.544
133:00	0.000	0.000	0.000	0.000	1.521	1.521
134:00	0.000	0.000	0.000	0.000	1.498	1.498
135:00	0.000	0.000	0.000	0.000	1.476	1.476
136:00	0.000	0.000	0.000	0.000	1.453	1.453
137:00	0.000	0.000	0.000	0.000	1.432	1.432
138:00	0.000	0.000	0.000	0.000	1.410	1.410
139:00	0.000	0.000	0.000	0.000	1.389	1.389
140:00	0.000	0.000	0.000	0.000	1.368	1.368
141:00	0.000	0.000	0.000	0.000	1.347	1.347
142:00	0.000	0.000	0.000	0.000	1.327	1.327

Time (hh:mm)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
143:00	0.000	0.000	0.000	0.000	1.307	1.307
144:00	0.000	0.000	0.000	0.000	1.287	1.287
145:00	0.000	0.000	0.000	0.000	1.268	1.268

Appendix

Catchment descriptors

Name	Value	User-defined value used?
Area (km^2)	52.63	No
ALTBAR	112	No
ASPBAR	27	No
ASPVAR	0.46	No
BFIHOST	0.71	No
DPLBAR (km)	8.46	No
DPSBAR (mkm^{-1})	52.2	No
FARL	1	No
LDP	14.11	No
PROPWET (mm)	0.34	No
RMED1H	12.3	No
RMED1D	35.3	No
RMED2D	43.1	No
SAAR (mm)	755	No
SAAR4170 (mm)	775	No
SPRHOST	28.84	No
Urbext2000	0	No
Urbext1990	0	No
URBCONC	0	No
URBLOC	0	No
Urban Area (km^2)	0.35	No
DDF parameter C	-0.02	No
DDF parameter D1	0.35	No
DDF parameter D2	0.35	No
DDF parameter D3	0.3	No
DDF parameter E	0.31	No
DDF parameter F	2.53	No
DDF parameter C (1km grid value)	-0.02	No
DDF parameter D1 (1km grid value)	0.32	No
DDF parameter D2 (1km grid value)	0.36	No
DDF parameter D3 (1km grid value)	0.31	No
DDF parameter E (1km grid value)	0.32	No
DDF parameter F (1km grid value)	2.52	No

UK Design Flood Estimation

Generated on 06 January 2016 09:39:20 by jho
Printed from the ReFH Flood Modelling software package, version 2.1.5798.30211

Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH)

Site details Checksum: 8C20-D687

Site name: Reach Nr A2

Easting: 600300

Northing: 160800

Country: England, Wales or Northern Ireland

Catchment Area (km²): 52.63

Using plotscale calculations: No

Site description: None

Model run: 100 year

Summary of results

Rainfall - FEH 1999 (mm):	95.01	Total runoff (ML):	547.89
Total Rainfall (mm):	64.53	Total flow (ML):	1551.96
Peak Rainfall (mm):	14.66	Peak flow (m³/s):	15.15

Parameters

** Where the user has overriden a system-generated value, this original value is shown in square brackets after the value used.*

Rainfall parameters (Rainfall - FEH 1999 model)

Name	Value	User-defined?
Duration (hr)	11	No
Timestep (hr)	1	No
SCF(Seasonal correction factor)	0.72	No
ARF(Areal reduction factor)	0.94	No
Seasonality	Winter	n/a

Loss model parameters

Name	Value	User-defined?
Cini (mm)	92.68	No
Cmax (mm)	710.31	No
Use alpha correction factor	Yes	No
Alpha correction factor	0.88	No

Routing model parameters

Name	Value	User-defined?
Tp (hr)	6.33	No
Up	0.65	No
Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	1.26	No
BL (hr)	65.9	No
BR	1.86	No

Urbanisation parameters

Name	Value	User-defined?
Urban area (km^2)	0.35	No
Urbext 2000	0	No
Urban runoff factor	0.7	No
Imperviousness factor	0.3	No
Tp scaling factor	0.5	No
Sewered area (km^2)	0.00	Yes
Sewer capacity (m^3/s)	0.00	Yes

Time series data

Time (hh:mm)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
00:00	1.417	0.000	0.166	0.000	1.258	1.258
01:00	2.374	0.000	0.284	0.021	1.239	1.259
02:00	3.956	0.000	0.491	0.097	1.222	1.319
03:00	6.541	0.000	0.860	0.270	1.208	1.478
04:00	10.645	0.000	1.528	0.608	1.202	1.810
05:00	14.664	0.000	2.366	1.237	1.208	2.445
06:00	10.645	0.000	1.907	2.337	1.237	3.574
07:00	6.541	0.000	1.251	3.935	1.302	5.237
08:00	3.956	0.000	0.785	5.830	1.414	7.243
09:00	2.374	0.000	0.482	7.819	1.577	9.395
10:00	1.417	0.000	0.291	9.716	1.791	11.507
11:00	0.000	0.000	0.000	11.316	2.052	13.368
12:00	0.000	0.000	0.000	12.319	2.345	14.665
13:00	0.000	0.000	0.000	12.499	2.652	15.151
14:00	0.000	0.000	0.000	12.027	2.952	14.979
15:00	0.000	0.000	0.000	11.140	3.228	14.368
16:00	0.000	0.000	0.000	10.017	3.474	13.491
17:00	0.000	0.000	0.000	8.795	3.683	12.478
18:00	0.000	0.000	0.000	7.600	3.857	11.457
19:00	0.000	0.000	0.000	6.569	3.996	10.565
20:00	0.000	0.000	0.000	5.691	4.107	9.798
21:00	0.000	0.000	0.000	4.920	4.194	9.114
22:00	0.000	0.000	0.000	4.216	4.258	8.475
23:00	0.000	0.000	0.000	3.555	4.303	7.858
24:00	0.000	0.000	0.000	2.925	4.329	7.254
25:00	0.000	0.000	0.000	2.315	4.337	6.652
26:00	0.000	0.000	0.000	1.732	4.328	6.060
27:00	0.000	0.000	0.000	1.196	4.304	5.499
28:00	0.000	0.000	0.000	0.740	4.266	5.006
29:00	0.000	0.000	0.000	0.413	4.218	4.631
30:00	0.000	0.000	0.000	0.209	4.163	4.372
31:00	0.000	0.000	0.000	0.092	4.105	4.197
32:00	0.000	0.000	0.000	0.032	4.044	4.076
33:00	0.000	0.000	0.000	0.005	3.984	3.989
34:00	0.000	0.000	0.000	0.000	3.924	3.924

Time (hh:mm)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
35:00	0.000	0.000	0.000	0.000	3.865	3.865
36:00	0.000	0.000	0.000	0.000	3.807	3.807
37:00	0.000	0.000	0.000	0.000	3.749	3.749
38:00	0.000	0.000	0.000	0.000	3.693	3.693
39:00	0.000	0.000	0.000	0.000	3.637	3.637
40:00	0.000	0.000	0.000	0.000	3.583	3.583
41:00	0.000	0.000	0.000	0.000	3.529	3.529
42:00	0.000	0.000	0.000	0.000	3.476	3.476
43:00	0.000	0.000	0.000	0.000	3.423	3.423
44:00	0.000	0.000	0.000	0.000	3.372	3.372
45:00	0.000	0.000	0.000	0.000	3.321	3.321
46:00	0.000	0.000	0.000	0.000	3.271	3.271
47:00	0.000	0.000	0.000	0.000	3.222	3.222
48:00	0.000	0.000	0.000	0.000	3.173	3.173
49:00	0.000	0.000	0.000	0.000	3.125	3.125
50:00	0.000	0.000	0.000	0.000	3.078	3.078
51:00	0.000	0.000	0.000	0.000	3.032	3.032
52:00	0.000	0.000	0.000	0.000	2.986	2.986
53:00	0.000	0.000	0.000	0.000	2.941	2.941
54:00	0.000	0.000	0.000	0.000	2.897	2.897
55:00	0.000	0.000	0.000	0.000	2.853	2.853
56:00	0.000	0.000	0.000	0.000	2.810	2.810
57:00	0.000	0.000	0.000	0.000	2.768	2.768
58:00	0.000	0.000	0.000	0.000	2.726	2.726
59:00	0.000	0.000	0.000	0.000	2.685	2.685
60:00	0.000	0.000	0.000	0.000	2.645	2.645
61:00	0.000	0.000	0.000	0.000	2.605	2.605
62:00	0.000	0.000	0.000	0.000	2.566	2.566
63:00	0.000	0.000	0.000	0.000	2.527	2.527
64:00	0.000	0.000	0.000	0.000	2.489	2.489
65:00	0.000	0.000	0.000	0.000	2.452	2.452
66:00	0.000	0.000	0.000	0.000	2.415	2.415
67:00	0.000	0.000	0.000	0.000	2.378	2.378
68:00	0.000	0.000	0.000	0.000	2.342	2.342
69:00	0.000	0.000	0.000	0.000	2.307	2.307
70:00	0.000	0.000	0.000	0.000	2.272	2.272

Time (hh:mm)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
71:00	0.000	0.000	0.000	0.000	2.238	2.238
72:00	0.000	0.000	0.000	0.000	2.205	2.205
73:00	0.000	0.000	0.000	0.000	2.171	2.171
74:00	0.000	0.000	0.000	0.000	2.139	2.139
75:00	0.000	0.000	0.000	0.000	2.106	2.106
76:00	0.000	0.000	0.000	0.000	2.075	2.075
77:00	0.000	0.000	0.000	0.000	2.043	2.043
78:00	0.000	0.000	0.000	0.000	2.013	2.013
79:00	0.000	0.000	0.000	0.000	1.982	1.982
80:00	0.000	0.000	0.000	0.000	1.953	1.953
81:00	0.000	0.000	0.000	0.000	1.923	1.923
82:00	0.000	0.000	0.000	0.000	1.894	1.894
83:00	0.000	0.000	0.000	0.000	1.866	1.866
84:00	0.000	0.000	0.000	0.000	1.838	1.838
85:00	0.000	0.000	0.000	0.000	1.810	1.810
86:00	0.000	0.000	0.000	0.000	1.783	1.783
87:00	0.000	0.000	0.000	0.000	1.756	1.756
88:00	0.000	0.000	0.000	0.000	1.729	1.729
89:00	0.000	0.000	0.000	0.000	1.703	1.703
90:00	0.000	0.000	0.000	0.000	1.678	1.678
91:00	0.000	0.000	0.000	0.000	1.652	1.652
92:00	0.000	0.000	0.000	0.000	1.627	1.627
93:00	0.000	0.000	0.000	0.000	1.603	1.603
94:00	0.000	0.000	0.000	0.000	1.579	1.579
95:00	0.000	0.000	0.000	0.000	1.555	1.555
96:00	0.000	0.000	0.000	0.000	1.532	1.532
97:00	0.000	0.000	0.000	0.000	1.509	1.509
98:00	0.000	0.000	0.000	0.000	1.486	1.486
99:00	0.000	0.000	0.000	0.000	1.463	1.463
100:00	0.000	0.000	0.000	0.000	1.441	1.441
101:00	0.000	0.000	0.000	0.000	1.420	1.420
102:00	0.000	0.000	0.000	0.000	1.398	1.398
103:00	0.000	0.000	0.000	0.000	1.377	1.377
104:00	0.000	0.000	0.000	0.000	1.357	1.357
105:00	0.000	0.000	0.000	0.000	1.336	1.336
106:00	0.000	0.000	0.000	0.000	1.316	1.316

Time (hh:mm)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
107:00	0.000	0.000	0.000	0.000	1.296	1.296
108:00	0.000	0.000	0.000	0.000	1.277	1.277

Appendix

Catchment descriptors

Name	Value	User-defined value used?
Area (km^2)	52.63	No
ALTBAR	112	No
ASPBAR	27	No
ASPVAR	0.46	No
BFIHOST	0.71	No
DPLBAR (km)	8.46	No
DPSBAR (mkm^{-1})	52.2	No
FARL	1	No
LDP	14.11	No
PROPWET (mm)	0.34	No
RMED1H	12.3	No
RMED1D	35.3	No
RMED2D	43.1	No
SAAR (mm)	755	No
SAAR4170 (mm)	775	No
SPRHOST	28.84	No
Urbext2000	0	No
Urbext1990	0	No
URBCONC	0	No
URBLOC	0	No
Urban Area (km^2)	0.35	No
DDF parameter C	-0.02	No
DDF parameter D1	0.35	No
DDF parameter D2	0.35	No
DDF parameter D3	0.3	No
DDF parameter E	0.31	No
DDF parameter F	2.53	No
DDF parameter C (1km grid value)	-0.02	No
DDF parameter D1 (1km grid value)	0.32	No
DDF parameter D2 (1km grid value)	0.36	No
DDF parameter D3 (1km grid value)	0.31	No
DDF parameter E (1km grid value)	0.32	No
DDF parameter F (1km grid value)	2.52	No

UK Design Flood Estimation

Generated on 06 January 2016 09:36:51 by jho
Printed from the ReFH Flood Modelling software package, version 2.1.5798.30211

Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH)

Site details Checksum: 8C20-D687

Site name: Reach Nr A2

Easting: 600300

Northing: 160800

Country: England, Wales or Northern Ireland

Catchment Area (km^2): 52.63

Using plotscale calculations: No

Site description: None

Model run: 20 year

Summary of results

Rainfall - FEH 1999 (mm):	62.43	Total runoff (ML):	349.99
Total Rainfall (mm):	42.40	Total flow (ML):	990.58
Peak Rainfall (mm):	9.64	Peak flow (m^3/s):	10.05

Parameters

** Where the user has overriden a system-generated value, this original value is shown in square brackets after the value used.*

Rainfall parameters (Rainfall - FEH 1999 model)

Name	Value	User-defined?
Duration (hr)	11	No
Timestep (hr)	1	No
SCF(Seasonal correction factor)	0.72	No
ARF(Areal reduction factor)	0.94	No
Seasonality	Winter	n/a

Loss model parameters

Name	Value	User-defined?
Cini (mm)	92.68	No
Cmax (mm)	710.31	No
Use alpha correction factor	Yes	No
Alpha correction factor	0.96	No

Routing model parameters

Name	Value	User-defined?
Tp (hr)	6.33	No
Up	0.65	No
Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	1.26	No
BL (hr)	65.9	No
BR	1.86	No

Urbanisation parameters

Name	Value	User-defined?
Urban area (km^2)	0.35	No
Urbext 2000	0	No
Urban runoff factor	0.7	No
Imperviousness factor	0.3	No
Tp scaling factor	0.5	No
Sewered area (km^2)	0.00	Yes
Sewer capacity (m^3/s)	0.00	Yes

Time series data

Time (hh:mm)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
00:00	0.931	0.000	0.119	0.000	1.258	1.258
01:00	1.560	0.000	0.202	0.015	1.239	1.253
02:00	2.600	0.000	0.344	0.069	1.221	1.290
03:00	4.298	0.000	0.590	0.191	1.206	1.397
04:00	6.995	0.000	1.015	0.428	1.196	1.624
05:00	9.636	0.000	1.511	0.859	1.195	2.055
06:00	6.995	0.000	1.179	1.597	1.210	2.807
07:00	4.298	0.000	0.758	2.646	1.249	3.894
08:00	2.600	0.000	0.471	3.870	1.317	5.187
09:00	1.560	0.000	0.287	5.137	1.419	6.556
10:00	0.931	0.000	0.173	6.326	1.553	7.880
11:00	0.000	0.000	0.000	7.308	1.716	9.024
12:00	0.000	0.000	0.000	7.895	1.899	9.794
13:00	0.000	0.000	0.000	7.959	2.089	10.048
14:00	0.000	0.000	0.000	7.622	2.273	9.895
15:00	0.000	0.000	0.000	7.035	2.442	9.477
16:00	0.000	0.000	0.000	6.311	2.591	8.902
17:00	0.000	0.000	0.000	5.533	2.717	8.250
18:00	0.000	0.000	0.000	4.780	2.820	7.600
19:00	0.000	0.000	0.000	4.133	2.902	7.034
20:00	0.000	0.000	0.000	3.581	2.966	6.546
21:00	0.000	0.000	0.000	3.094	3.014	6.108
22:00	0.000	0.000	0.000	2.647	3.049	5.697
23:00	0.000	0.000	0.000	2.226	3.071	5.298
24:00	0.000	0.000	0.000	1.825	3.082	4.907
25:00	0.000	0.000	0.000	1.437	3.081	4.518
26:00	0.000	0.000	0.000	1.068	3.070	4.138
27:00	0.000	0.000	0.000	0.731	3.049	3.780
28:00	0.000	0.000	0.000	0.449	3.019	3.468
29:00	0.000	0.000	0.000	0.248	2.983	3.231
30:00	0.000	0.000	0.000	0.125	2.944	3.068
31:00	0.000	0.000	0.000	0.055	2.902	2.957
32:00	0.000	0.000	0.000	0.019	2.859	2.878
33:00	0.000	0.000	0.000	0.003	2.816	2.820
34:00	0.000	0.000	0.000	0.000	2.774	2.774

Time (hh:mm)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
35:00	0.000	0.000	0.000	0.000	2.732	2.732
36:00	0.000	0.000	0.000	0.000	2.691	2.691
37:00	0.000	0.000	0.000	0.000	2.651	2.651
38:00	0.000	0.000	0.000	0.000	2.611	2.611
39:00	0.000	0.000	0.000	0.000	2.571	2.571
40:00	0.000	0.000	0.000	0.000	2.533	2.533
41:00	0.000	0.000	0.000	0.000	2.494	2.494
42:00	0.000	0.000	0.000	0.000	2.457	2.457
43:00	0.000	0.000	0.000	0.000	2.420	2.420
44:00	0.000	0.000	0.000	0.000	2.383	2.383
45:00	0.000	0.000	0.000	0.000	2.348	2.348
46:00	0.000	0.000	0.000	0.000	2.312	2.312
47:00	0.000	0.000	0.000	0.000	2.277	2.277
48:00	0.000	0.000	0.000	0.000	2.243	2.243
49:00	0.000	0.000	0.000	0.000	2.209	2.209
50:00	0.000	0.000	0.000	0.000	2.176	2.176
51:00	0.000	0.000	0.000	0.000	2.143	2.143
52:00	0.000	0.000	0.000	0.000	2.111	2.111
53:00	0.000	0.000	0.000	0.000	2.079	2.079
54:00	0.000	0.000	0.000	0.000	2.048	2.048
55:00	0.000	0.000	0.000	0.000	2.017	2.017
56:00	0.000	0.000	0.000	0.000	1.987	1.987
57:00	0.000	0.000	0.000	0.000	1.957	1.957
58:00	0.000	0.000	0.000	0.000	1.927	1.927
59:00	0.000	0.000	0.000	0.000	1.898	1.898
60:00	0.000	0.000	0.000	0.000	1.870	1.870
61:00	0.000	0.000	0.000	0.000	1.842	1.842
62:00	0.000	0.000	0.000	0.000	1.814	1.814
63:00	0.000	0.000	0.000	0.000	1.786	1.786
64:00	0.000	0.000	0.000	0.000	1.760	1.760
65:00	0.000	0.000	0.000	0.000	1.733	1.733
66:00	0.000	0.000	0.000	0.000	1.707	1.707
67:00	0.000	0.000	0.000	0.000	1.681	1.681
68:00	0.000	0.000	0.000	0.000	1.656	1.656
69:00	0.000	0.000	0.000	0.000	1.631	1.631
70:00	0.000	0.000	0.000	0.000	1.606	1.606

Time (hh:mm)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
71:00	0.000	0.000	0.000	0.000	1.582	1.582
72:00	0.000	0.000	0.000	0.000	1.558	1.558
73:00	0.000	0.000	0.000	0.000	1.535	1.535
74:00	0.000	0.000	0.000	0.000	1.512	1.512
75:00	0.000	0.000	0.000	0.000	1.489	1.489
76:00	0.000	0.000	0.000	0.000	1.467	1.467
77:00	0.000	0.000	0.000	0.000	1.445	1.445
78:00	0.000	0.000	0.000	0.000	1.423	1.423
79:00	0.000	0.000	0.000	0.000	1.401	1.401
80:00	0.000	0.000	0.000	0.000	1.380	1.380
81:00	0.000	0.000	0.000	0.000	1.359	1.359
82:00	0.000	0.000	0.000	0.000	1.339	1.339
83:00	0.000	0.000	0.000	0.000	1.319	1.319
84:00	0.000	0.000	0.000	0.000	1.299	1.299
85:00	0.000	0.000	0.000	0.000	1.279	1.279

Appendix

Catchment descriptors

Name	Value	User-defined value used?
Area (km^2)	52.63	No
ALTBAR	112	No
ASPBAR	27	No
ASPVAR	0.46	No
BFIHOST	0.71	No
DPLBAR (km)	8.46	No
DPSBAR (mkm^{-1})	52.2	No
FARL	1	No
LDP	14.11	No
PROPWET (mm)	0.34	No
RMED1H	12.3	No
RMED1D	35.3	No
RMED2D	43.1	No
SAAR (mm)	755	No
SAAR4170 (mm)	775	No
SPRHOST	28.84	No
Urbext2000	0	No
Urbext1990	0	No
URBCONC	0	No
URBLOC	0	No
Urban Area (km^2)	0.35	No
DDF parameter C	-0.02	No
DDF parameter D1	0.35	No
DDF parameter D2	0.35	No
DDF parameter D3	0.3	No
DDF parameter E	0.31	No
DDF parameter F	2.53	No
DDF parameter C (1km grid value)	-0.02	No
DDF parameter D1 (1km grid value)	0.32	No
DDF parameter D2 (1km grid value)	0.36	No
DDF parameter D3 (1km grid value)	0.31	No
DDF parameter E (1km grid value)	0.32	No
DDF parameter F (1km grid value)	2.52	No

APPENDIX B

Link to Hydraulic Model Files

https://odysseymarkides.sharepoint.com/:f:/g/EuoJdDQxFWRJtpLAcWAbv1QBom3Oqy0IMr7LQWZ-dIy4Yw?e=QGNfBi

APPENDIX I

Maintenance Schedules

TABLE 13.1 Operation and maintenance requirements for soakaways

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Inspect for sediment and debris in pre-treatment components and floor of inspection tube or chamber and inside of concrete manhole rings	Annually
	Cleaning of gutters and any filters on downpipes	Annually (or as required based on inspections)
	Trimming any roots that may be causing blockages	Annually (or as required)
Occasional maintenance	Remove sediment and debris from pre-treatment components and floor of inspection tube or chamber and inside of concrete manhole rings	As required, based on inspections
Remedial actions	Reconstruct soakaway and/or replace or clean void fill, if performance deteriorates or failure occurs	As required
	Replacement of clogged geotextile (will require reconstruction of soakaway)	As required
Monitoring	Inspect silt traps and note rate of sediment accumulation	Monthly in the first year and then annually
	Check soakaway to ensure emptying is occurring	Annually

Maintenance will usually be carried out manually, although a suction tanker can be used for sediment/debris removal for large systems. If maintenance is not undertaken for long periods, deposits can become hard-packed and require considerable effort to remove.

Replacement of the aggregate or geocellular units will be necessary if the system becomes blocked with silt. Effective monitoring will give information on changes in infiltration rate and provide a warning of potential failure in the long term.

Roads and/or parking areas draining to infiltration components should be regularly swept to prevent silt being washed off the surface. This will minimise the need for maintenance.

Maintenance responsibility should be placed with an appropriate organisation, and maintenance schedules should be developed during the design phase.

▶ Generic health and safety guidance is presented in **Chapter 36**.

CDM 2015 requires designers to ensure that all maintenance risks have been identified and eliminated/reduced and/or controlled where appropriate. This information will be required as part of the health and safety file.

13.12.2 Infiltration basins

Regular inspection and maintenance is important for the effective operation of infiltration basins as designed. Maintenance responsibility for an infiltration basin and its surrounding area should be placed with a responsible organisation.

Regular mowing in and around infiltration basins is only required along maintenance access routes, amenity areas (eg footpaths), across embankments and across the main storage area. The remaining areas can be managed as “meadow” or other appropriate vegetation, unless additional management is required for landscaping purposes. Grass cutting may need to accommodate specific sward mixes and specialist seed or turf supplier recommendations. As described earlier in this chapter, deep-rooting vegetation can maintain infiltration rates and minimise the need for remedial maintenance. All vegetation management activities should take account of the need to maximise biosecurity and prevent the spread of invasive species.