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GROVE FARM, LITTLE BEALINGS

Flood Risk Assessment and Drainage Strategy – Volume 1 of 3

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GROVE FARM, LITTLE BEALINGS
Flood Risk Assessment and Drainage Strategy

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1.0 INTRODUCTION

Brief

1.1 This Flood Risk Assessment and Drainage Strategy has been prepared by Create Consulting Engineers Ltd on behalf of Brown & Co to undertake a Flood Risk Assessment and Foul and Surface Water Drainage Strategy for Land at Grove Farm, Little Bealings.

Project Context

1.2 The application site extends to 1.12 hectares (ha). It is generally rectangular in shape and comprises predominantly derelict agricultural buildings.

1.3 The site is bounded by agricultural land to the west and north (with the river Flynn to the north) and residential areas to the east and south. The Site is accesses via a private road from The Street which also serves other properties found immediately east of the Site. A public footpath also passes through the site in an east-west orientation.

1.4 An indicative architect's layout for the site is provided on Drawing 15/042/10H. The Ordnance Survey grid reference for the Site is 629900E, 247500N and the Site location is shown on Drawing 15/042/05A.

Planning Policy Context

1.5 The potential consequences of inappropriate development in a flood risk area for occupiers, either of the development or elsewhere, pose significant risks in terms of personal safety and damage to property.

<u>National Policy</u>

1.6 The National Planning Policy Framework[1] includes Government policy on development and flood risk stating that:

When determining planning applications, local planning authorities should ensure flood risk is not increased elsewhere and only consider development appropriate in areas at risk of flooding where, informed by a site-specific Flood Risk Assessment following the Sequential Test, and if required the Exception Test, 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; and*

[1] NPPF accessed online (May 2018) https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/6077/2116950.pdf

- *development is appropriately flood resilient and resistant, including safe access and escape routes where required, and that any residual risk can be safely managed, including my emergency planning; and it gives priority to the use of sustainable drainage systems.*

1.7 The Planning Practice Guidance to the NPPF[2] requires that at the planning stage, the developer should prepare and submit an appropriate FRA to demonstrate how flood risk from all sources of flooding to the development itself and flood risk to others will be managed now and when taking climate change into account.

1.8 To comply with the NPPF a FRA must be submitted for planning applications for developments within flood zones 2 and 3 (medium or high risk of fluvial or tidal flooding) and for all developments of 1 hectare or greater located in Flood Zone 1 (low risk).

1.9 A FRA should be appropriate to the scale, nature and location of the development and should identify and assess the risk from all sources of flooding to and from the development and demonstrate how any flood risks will be managed over the lifetime of the development.

1.10 An assessment of surface water and drainage is also required as part of the FRA in order to demonstrate how flood risk to others will be managed following development and taking climate change into account.

1.11 The Planning Practice Guidance (substantially revised in March 2015 in relation to drainage) requires that sustainable drainage systems should be considered and included where practicable, in line with DEFRA Technical Standards[3].

1.12 The Technical Standards are therefore a key reference document and should be used in the formulation of the surface water drainage strategy for a scheme of this nature. The standards include the following requirements:

"Flood risk outside the development

***S1** Where the drainage system discharges to a surface water body that can accommodate uncontrolled surface water discharges without any impact on flood risk from that surface water body (e.g. the sea or a large estuary) the peak flow control standards (**S2** and **S3** below) and volume control technical standards (**S4** and **S6** below) need not apply.*

[2] PPG accessed online (May 2018) http://planningguidance.planningportal.gov.uk/
[3] Technical Standards Accessed Online (May 2018)
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/415773/sustainable-drainage-technical-standards.pdf

Peak flow control

***S2** For greenfield developments, the peak runoff rate from the development to any highway drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event should never exceed the peak greenfield runoff rate for the same event.*

***S3** For developments which were previously developed, the peak runoff rate from the development to any drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event must be as close as reasonably practicable to the greenfield runoff rate from the development for the same rainfall event, but should never exceed the rate of discharge from the development prior to redevelopment for that event.*

Volume control

***S4** Where reasonably practicable, for greenfield development, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year 6 hour rainfall event should never exceed the greenfield runoff volume for the same event.*

***S5** Where reasonably practicable, for developments which have been previously developed, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event must be constrained to a value as close as is reasonably practicable to the greenfield runoff volume for the same event, but should never exceed the runoff volume from the development site prior to redevelopment for that event.*

***S6** Where it is not reasonably practicable to constrain the volume of runoff to any drain, sewer or surface water body in accordance with **S4** or **S5** above, the runoff volume must be discharged at a rate that does not adversely affect flood risk.*

Flood risk within the development

***S7** The drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur on any part of the Site for a 1 in 30 year rainfall event.*

***S8** The drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur during a 1 in 100 year rainfall event in any part of: a building (including a basement); or in any utility plant susceptible to water (e.g. pumping station or electricity substation) within the development.*

S9 *The design of the Site must ensure that, so far as is reasonably practicable, flows resulting from rainfall in excess of a 1 in 100 year rainfall event are managed in exceedance routes that minimise the risks to people and property.*

Structural Integrity

S10 *Components must be designed to ensure structural integrity of the drainage system and any adjacent structures or infrastructure under anticipated loading conditions over the design life of the development taking into account the requirements for reasonable levels of maintenance.*

S11 *The materials, including products, components, fittings or naturally occurring materials, which are specified by the designer must be of a suitable nature and quality for their intended use.*

Designing for Maintenance Considerations

S12 *Pumping should only be used to facilitate drainage for those parts of the Site where it is not reasonably practicable to drain water by gravity.*

Construction

S13 *The mode of construction of any communication with an existing sewer or drainage system must be such that the making of the communication would not be prejudicial to the structural integrity and functionality of the sewerage or drainage system.*

S14 *Damage to the drainage system resulting from associated construction activities must be minimised and must be rectified before the drainage system is considered to be completed."*

County Council Policy

1.13 Suffolk County Council act as Lead Local Flood Authority (LLFA) for the area and are a statutory consultee for all major developments, which includes the following:

- The winning and working of minerals or the use of land for mineral-working deposits;
- Waste development;
- The provision of dwelling houses where the number of dwelling houses to be provided is 10 or more; or the development is to be carried out on a site having an area of 0.5 hectares or more and it is not known whether the number of dwelling houses to be provided is 10 or more;

- The provision of a building or buildings where the floor space to be created by the development is 1,000 square metres or more;
- Development carried out on a site having an area of one hectare or more and
- Any minor applications in areas at risk of surface water flooding.

1.14 The LLFA have produced a local SUDS guidance document[4], which includes construction standards and provide assistance to developers in creating sustainable drainage systems on their sites as well as the LLFA's consenting policy and various protocols. Suffolk County Council also provide guidance within their Preliminary Flood Risk Assessment (PFRA)[5] and Flood Risk Management Strategy[6] on development and flood risk.

Local District Planning Policy

1.15 The Local Development Plan for the Suffolk Coastal area is the Suffolk Coastal District Local Plan, Core Strategy and Development Management Policies Development Plan Document (Suffolk Coastal District Council, 2013).

1.16 The relevant policies from the Local Plan are as follows:

- *Strategic Policy SP1 – Sustainable Development*
- *Strategic Policy SP12 – Climate Change*
- *Development Management Policy DM28 – Flood Risk*

1.17 The relevant policies from these local planning documents have been considered as part of this foul and surface water drainage strategy.

1.18 The Strategic Flood Risk Assessment (SFRA) for the Suffolk Coastal area (Scott Wilson, 2009), along with the Preliminary Flood Risk Assessment (PFRA) for Suffolk County (AECOM, 2011) provide a summary of the flood risks for the local area. These documents have been utilised as part of this assessment and are referenced where applicable throughout this report.

Climate Change

1.19 Climate change has important implications for the assessment and management of flood risk. The NPPF requires that climate change is considered when making an assessment of flood risk posed to future development.

[4] SuDS Adoption Policy (Accessed May 2018) https://www.suffolk.gov.uk/assets/Roads-and-transport/Flooding-and-drainage/Strategy-Apendicies/2016-04-SuDS-Guidance-Appendix-A-v12.pdf
[5] Suffolk County Council Preliminary Flood Risk Assessment (Accessed May 2018) https://www.suffolk.gov.uk/assets/suffolk.gov.uk/Emergency%20and%20Safety/Civil%20Emergencies/SUFFOLKPFRAREPORTFINAL.pdf
[6] Suffolk County Council Flood Risk Management Strategy (Accessed May 2018) http://www.greensuffolk.org/assets/Greenest-County/Water--Coast/Suffolk-Flood-Partnership/19431A-Flood-Risk-Management-Strategy-v12.pdfications/Documents/Local_Flood_Risk_Management_strategy.pdf

1.20 Climate change has the potential to affect all identified sources of flooding at the Site. The likely impacts of climate change include increased severity of rainfall events as well as wetter winters leading to higher groundwater levels and increased frequency and severity of surface water flooding.

1.21 The influence of climate change on rainfall intensity has been taken into account by the surface water drainage strategy outlined in Chapter 6 as an inclusion of 40% has been made for climate change for all rainfall events up to and including the 1 in 100 year event in accordance with NPPF requirements, and 'Flood Risk Assessments: Climate Change Allowances'[7].

Objectives

1.22 The following specific objectives were set by Create Consulting Engineers Ltd after a review of the available data:

- To assess the suitability of the scheme in relation to all sources of flooding;
- To assess the flood risk posed by the scheme once it is complete and operational;
- To suggest mitigation measures in order to reduce any residual risks to acceptable levels.

Constraints and Limitations

1.23 The copyright of this report is vested in Create Consulting Engineers Ltd and the Client, Brown & Co. The Client, or their appointed representatives, may copy the report for purposes in connection with the development described herein. It shall not be copied by any other party or used for any other purposes without the written consent of Create Consulting Engineers Ltd or the Client.

1.24 Create Consulting Engineers Ltd accepts no responsibility whatsoever to other parties to whom this report, or any part thereof, is made known. Any such other parties rely upon the report at their own risk.

1.25 This Flood Risk Assessment addresses the flood risk posed to and from the proposed development, the extent of which is shown by the Site boundary, as indicated Drawing 15/042/05A.

1.26 This report has been undertaken with the assumption that the Site will be developed in accordance with the above proposals without significant change. The conclusions resulting from this study are not necessarily indicative of future conditions or operating practices at or adjacent to the Site.

[7] Environment Agency (2016) *Flood Risk Assessments: Climate Change Allowances*.

1.27 Create Consulting Engineers Ltd has endeavoured to assess all information provided to them during this appraisal. The report summarises information from a number of external sources and cannot offer any guarantees or warranties for the completeness or accuracy or information relied upon. Information from third parties has not been verified by Create Consulting Engineers Ltd unless otherwise stated in this report.

2.0 SOURCES OF INFORMATION

2.1 The information contained in this report is based on a review of existing information and consultation with interested parties.

Records Review

2.2 Key reports and websites reviewed as part of this study are listed in Table 2.1 below.

Document/Website	Author/Publisher	Date
Fluvial/Tidal Flood Maps, Groundwater Mapping – environment-agency.gov.uk	Environment Agency (EA)	Accessed May 2018
Surface Water and Reservoir Flood Mapping – flood-warning-information.service.gov.uk	GOV.UK	Accessed May 2018
BGS GeoIndex – Geology and borehole records - www.bgs.ac.uk/geoindex	British Geological Survey	Accessed May 2018
Suffolk County Council Preliminary Flood Risk Assessment	AECOM	2011
Suffolk County Council Local Flood Risk Management Strategy	Suffolk County Council	2016
Suffolk Coastal and Waveney District Council Strategic Flood Risk Assessment	Scott Wilson	2009
Proposed Site Layout Plans (Drawing 15/042/10/H)	Brown and Co.	January 2018
Existing Site Layout (Topographic Survey) Drawing 1196se/01 to 1196se/04	Survey Solutions	February 2017
Anglian Water Clean and Waste Water Asset Plans (included as Appendix A)	Anglian Water	February 2017

Table 2.1: Key Information Sources

Consultation

2.3 The agencies and individuals consulted as part of this exercise to obtain records or seek input to the proposals as part of this FRA are listed in Table 2.2 and key records are included in the appendices.

Consultee	Form of Consultation	Topics Discussed and Actions Agreed
Anglian Water Developer Services Team	Online request for Asset Plans on 29 March 2016.	Asset plans received on 22 February 2017 (Appendix A). These show no foul assets within or neighbouring the site. The nearest foul water asset shown on the plans is found 450 m to the north west of the site within Sandy Lane. These also show no potable mains within the site with the nearest being a 180 mm potable water main that runs within The Street to the site entrance

Consultee	Form of Consultation	Topics Discussed and Actions Agreed
Environment Agency Customers and Engagement Team	Email Request for Product 4 flood levels data on 22 February 2017	A response dated 16 March 2017 noted that no modelled flood level data was available for the nearby River Flynn so basic mapping was provided (Appendix B). This is discussed in full in Section 3.

Table 2.2: List of Parties Consulted

Site Walkover and Site Investigation

2.4 A site walkover survey was conducted by Create Consulting Engineers on the 2nd of March 2017. A visual examination of the Site as well as an assessment its hydrological context within the surrounding area was carried out.

2.5 No site investigation has been carried out for the purposes of this assessment.

3.0 SITE SETTING

Site Location

3.1 The Site is located on The Street in the village Little Bealings 7.5 km north east of Ipswich town centre and lies at grid reference 629900E, 247500N and Postcode IP13 6LT as shown on Site Location Plan 15/042/05A.

Description of Site and Surroundings

3.2 The site comprises a parcel of brownfield land bounded by agricultural land to the west and north (with the river Flynn to the north) and residential areas to the east and south. The Site is accessed via a private road from The Street which also serves other properties found immediately east of the Site. A public footpath also passes through the site in an east-west orientation.

3.3 The Site itself is formed of nine derelict agricultural buildings (formerly used for the rearing of pigs) as well as ancillary structures, access and concreted muck pads.

3.4 The site slopes towards the River Flynn to the north with levels falling from approximately 11.0 mAOD along the southern boundary to 7.5 mAOD along the northern boundary. Full level information for the site can be found on Drawings 19116se-01 – 19116se-04.

Geological/Hydrological Setting

Ground Conditions and Infiltration Capacity

3.5 BGS mapping (accessed online at www.bgs.ac.uk/geoindex, May 2018) shows bedrock geology at the site to be comprised of the Thames Group (clay and silt), overlying the Red Crag formation (sands), whilst superficial deposits are made up of Alluvium (clays and silts) associated with the River Flynn to the north.

3.6 A local BGS borehole located immediately east of The Street adjacent to the site shows a variety of clays to its maximum depth (25.6 mbgl) with little evidence of Alluvium, potentially suggesting these deposits are more tightly bound to the river corridor than shown by the BGS mapping.

Surface Watercourses

3.7 The nearest surface watercourse to the Site is The River Fynn, located approximately 22.0 m to the north of the site boundary. The River drains agricultural land to the north-west, flowing eastwards to join with The River Deben at Martelsham approximately 5.0 km to the south-east.

Groundwater

3.8 The site does not lie within a Groundwater Source Protection Zone, as identified by the online Environment Agency mapping.

3.9 This mapping does however show the superficial alluvial deposits are classified as a Secondary A aquifer, and are therefore potentially capable of supplying water at a local, non-strategic scale.

3.10 According to the borehole located close to the east of the site groundwater is encountered at a depth of 2.28 mbgl which is deemed reasonable given the presence of the nearby River Flynn.

Artificial Water Bodies

3.11 There are no artificial waterbodies on the site or within its immediate vicinity.

Public Sewers and Water Supply Mains

3.12 Anglian Water Asset records (Appendix A) show no public sewers that cross the site boundary. The nearest foul water asset shown on the plans is found 450 m to the north west of the site and comprises of a gravity network draining properties from the northern part of Little Bealings to a small sewage treatment works. There are no other public sewers in the vicinity of the site.

3.13 Anglian Water potable water supply records (included in Appendix A) show a 180 mm potable water main that runs along The Street as well as an abandoned main running parallel to it. No other clean water assets are shown in the vicinity of the site, although it is assumed a private supply connects to the site via the access route.

Existing Site Drainage

3.14 It is understood that there is no formal drainage network serving the Site, therefore it is assumed that at present rainfall either infiltrates or runs off overland towards the north.

4.0 SCHEME DESCRIPTION

The Scheme

4.1 The Client intends to submit a Planning Application (all matters reserved except access and structural landscaping) for a residential development comprising up to eight dwellings (Use Class C3), vehicular access, public open space, sustainable drainage systems and all other associated hard/soft landscaping and infrastructure.

4.2 The proposed scheme is shown on Drawing 15-042-10H appended with this report.

Proposed Land Use Vulnerability Classification

4.3 The development is proposed to include residential dwellings which is defined as a ‘more vulnerable’ use according to the NPPF.

4.4 Given the proposed land use classification and the location of the Site within Flood Zone 1 (as noted in Chapter 5 below), the Sequential and Exception Tests will not need to be undertaken for the purposes of the proposed development.

5.0 FLOOD RISK ASSESSMENT

Scope of Work

5.1 The scope of this FRA was refined to meet the brief outlined in Chapter 1 of this report and considers the following:

- Flood risk to the development from all sources;
- Potential for the design, construction and operation of the Site to increase the risk of flooding to neighbouring properties;
- Any necessary mitigation measures to mitigate identified potential flood risks;
- Climate change;
- Residual flood risks.

5.2 The approach is consistent with the NPPF[1] and its associated Technical Guidance[2] along with the requirements of local planning policy.

Flood Risk to the Proposed Development

Flood Risk from Fluvial/Tidal Sources

5.3 The Site is located within the Environment Agency's Flood Zone 1, as shown in Figure 5.1, which is described within the NPPF Technical Guidance as having less than 1 in 1000 (<0.1%) annual probability of flooding from rivers or the sea. This figure is based on mapping provided by the Environment Agency (included in Appendix B)

5.4 The boundary of Flood Zones 2 and 3 associated with the River Flynn to the north remain tight to the watercourse, most likely due to the significant change in level between the watercourse and site boundary and also due to the fact the land to the north remains largely at the same level as the bank tops for some distance from the watercourse, allow flood waters to spill north.

5.5 The Site is therefore considered to be at a low risk of fluvial/tidal flooding and this source is not considered further in this report.

Flood Risk from Surface Water

5.6 The EA Surface Water Flood Maps (Figure 5.1) suggest that the majority of the Site is at a 'very low' risk of surface water flooding from extreme rainfall, which is defined as having a less than 1 in 1000 (0.1%) annual probability of flooding from extreme rainfall.

5.7 There is a small area of the Site to the northern boundary, which is at low risk (0.1 to 1%) of surface water flooding, due to local topography.

Flood Risk from Groundwater

5.8 The presence of water has been noted a depth of 2.28 mbgl which is deemed reasonable given the presence of the nearby River Flynn. This was recorded in a borehole close to the eastern boundary of the Site. It is anticipated the River Flynn acts as a major control on groundwater and therefore it is unlikely groundwater levels will raise significantly above this level. Perched/shallow groundwater however, remains a residual risk and appropriate mitigation measures are included in Table 7.1.

5.9 Strategic scale Flood Risk Assessments prepared by Suffolk Coastal and Waveney District Council (2009) shows no record of groundwater flooding affecting the site or surrounding area.

Flood Risk from Artificial Water bodies

5.10 The Site is not in an area at risk from flooding during a reservoir breach event and therefore flooding from this source will not be considered further in this report.

Flood Risk from Public Sewers

5.11 The Suffolk Coastal and Waveney District Council SFRA (2009) shows no records of sewer flooding. No issues have been identified at the Site, and the risk of sewer flooding is considered to be low.

5.12 Sewer flooding from blockage of private site and building drainage is, however, a residual risk managed by the design of the Site drainage and regular inspection and maintenance of the public and private sewer network. The flood risk associated with this source may also increase over time due to the effects of climate change. Appropriate mitigation measures are included in Table 7.1 of this report.

Flood Risk from Water Mains

5.13 Flood risk from this source is considered to be a residual risk with the main threat being from internal pipe work during any building works. Flooding from this source poses a residual risk to the proposed development with appropriate mitigation measures discussed in Table 7.1

Flood History

5.14 A review of the SFRA shows no records of flooding within Little Bealings.

Flood Risk Summary

5.15 In summary, the risk of flooding from all sources is generally considered to be low however, a number of mitigation measures are recommended in Table 7.1 to address and manage the residual risks from these forms of flooding.

6.0 FOUL AND SURFACE WATER DRAINAGE AND FLOOD RISK FROM THE DEVELOPMENT

Existing Foul Water Drainage

6.1 There are currently no foul flows from the Site due to its derelict nature.

Proposed Foul Water Drainage Strategy

6.2 Foul water from the eight residential dwellings will be designed to drain via gravity to a private treatment plant located within public open space to the west of the proposed dwellings. This will subsequently drain to a positive outfall to the river Flynn to the north (though land within the ownership of the Client).

6.3 The positioning of the foul water treatment plant and associated outfall is included on Drawing 1196/02/001.

6.4 Any treatment plant will be installed in line with BS EN 12566 for septic tanks and small sewage treatment plants. In addition the plant will be installed in accordance with the governments General Binding Rules[8].

6.5 An appropriate maintenance plan for the plant will be put in place ensuring the tank is de-sludged and serviced in line with manufacturer requirements.

6.6 Based on the Guidance in Flows and Loads 4 (British Water, 2013) the outflow from any treatment plant installed on this site will quite likely be in excess of 2.0 m^3/day, therefore a suitable permit application be obtained from the Environment Agency prior to installation.

Existing Surface Water Drainage

6.7 Calculations included in Appendix B estimate the current runoff rates from the greenfield area of the Site as shown in Table 6.1.

Storm Event	Existing Greenfield Runoff Rates (l/s)
1 year	1.00
30 year	2.70
100 year	4.00

Table 6.1. Existing Greenfield Runoff Rates

6.8 Existing brownfield runoff rates for the developed area of the site (0.34 ha) are summarised in Table 3.2 with calculations also shown in Appendix B.

[8] General Binding Rules on Small Sewage Discharge to the Ground (March 2018) https://www.gov.uk/guidance/general-binding-rules-small-sewage-discharge-to-the-ground

Storm Event	Existing Brownfield Runoff Rates (l/s)
1 year	38.40
30 year	94.75
100 year	120.76

Table 6.2. Existing Brownfield Runoff Rates

6.9 Observations during the site walkover noted the existing buildings appeared to have formal rainwater guttering taking flows below ground. Given the existing geology it is assumed flows are then discharged direct to the River Flynn or to the ditch to the west, although no outfalls were noted.

Proposed Surface Water Drainage Strategy

6.10 The following provides a summary of the proposed method of management and disposal of surface water runoff from the Site:

- Surface water flows will be attenuated using SUDS such that flows are fully retained within the Site boundaries (with an allowance for an increase in rainfall intensity of 40% due to climate change).
- As part of the initial design process sustainable drainage methods have been included where practicable, to provide the required attenuation in accordance with the SUDS hierarchy (see Table 4.1).
- Surface water flows will be attenuated using SUDS such that flows from the site are restricted (with an allowance for an increase in rainfall intensity of 40% due to climate change).
- Infiltration forms of SUDS (i.e. soakaways) are considered unlikely to be viable due to the generally cohesive nature of the soils beneath the site and potential for shallow groundwater.
- On the basis that infiltration systems are not viable the following forms of SUDS are proposed:
    - All dwellings and adoptable roadways will drain to an attenuation basin, positioned within the western side of the site (Drawing 1196/02/001);
    - A single surface water outfall is proposed using a gravity connection flowing from the western side of the site towards an outfall to the River Flynn, through land under the control of the client;
    - An upstream vortex separator device is proposed to provide treatment in the form of sediment/debris removal before outfall to The River Flynn.
- Micro Drainage calculations included in Appendix C indicate that a basin with 165.9 m^3 of storage is required. The calculations assume a maximum basin depth of approximately 1.3 m (with a maximum water depth of 1.0 m and a 0.3 m allowance for freeboard) with 1 in 3 side slopes, which equates to an approximate surface area of 328.3 m^2. This allows for drainage from the site to reach the basin with an appropriate cover, whilst a suitable gradient can be achieved for the outfall to the

River Flynn. The area should be considered to be approximate at this stage, calculations undertaken as part of the detailed design will confirm the exact pond area and levels as the design progresses.

- The surface water drainage proposals are included on Drawing 1196/02/001.
- A flow control, Hydro brake or similar, will restrict discharge rates from the Site to 1.0 l/s prior to the discharge offsite. This will restrict flows to this level for all events up to and including the 1 in 100 year plus 40% climate change event.
- The 1.0 l/s restricting flow rate is the design minimum rate at which the proposed outflow control device can operate. The equivalent 1 in 1 year greenfield runoff rate for the calculated 0.35ha impermeable area of the Site is shown by the calculations included in Appendix C.
- The design calculations for the basin are based on an impermeable area of 0.226 ha, this includes the measured new roof and driveway areas of dwellings and garages along with the road area as shown on the attached layout plan (Drawing 15/042/10H);
- The proposed surface water drainage strategy is included in Drawing 1196/02/001 appended to this report.

6.11 A summary of the potential SUDS options which led to the above drainage strategy is included in Table 6.3. This drainage strategy however is in compliance with both local and national policy as outlined in Section 1 of this report.

SUDS Option	Suitability/Included in the Scheme?	Comments
Soakaways and porous paving	X	Due to underlying geology soakaways have been deemed to be unviable, therefore this form of drainage cannot be utilised.
Porous paving (storage)	*	Not included in the client and architect design proposal at present.
Rainwater Harvesting	*	Not included in the client and architect design proposal at present.
Swales	*	Not included in the client and architect design proposal at present.
Attenuation Ponds (above ground storage)	✓	A basin of 165.9 m^3 (328.3 m^2) is included within the scheme.
Below ground storage in cellular systems	*	Not included in the client and architect design proposal at present.
Flow control devices	✓	A flow control device will be used to restrict flows to 1.0 l/s for all events up to and including the 1 in 100 year plus 40% climate change storm.
Green Roofs/Brown Roofs/Blue Roofs	*	Not included in the client and architect design proposal at present.

Table 6.3: SUDS Options

Key:

✓ *Suitable for use and included in the scheme*

* *Possibly suitable for use – not included in the client and architect design proposal at present – should be considered further as part of the detailed design*

X *Unlikely to be suitable for use*

<u>Exceedance Flow Routes</u>

6.12 Given the indicative nature of the attached site layout and the fact this report supports an outline planning application exceedance flow routes cannot be fully confirmed at this stage. These will be developed at the detailed design stage in line with the following principles:

- Surcharged flows from highways, private drives and roof areas will be retained within kerb lines and channelled towards the attenuation basin;
- External ground levels will be profiled such that no ponding occurs against buildings, with flows directed as above;
- All flows in excess of the drainage network design standard (1 in 30 year) will be channelled to the attenuation basins which have been sized to accommodate the 1 in 100 year plus climate change event whilst also allowing a suitable freeboard.

<u>Management and Maintenance of Drainage Assets</u>

6.13 Again due to the outline nature of the application it is difficult to confirm the exact management and maintenance procedures. However the following principles will be incorporated as part of the detailed design:

- The attenuation basin will be managed by a private company (or its successor in title) as part of its duties in managing the various areas of public open space, this will include regular seasonal mowing and debris removal as well as re-profiling as required due to siltation;
- All surface and foul water drainage assets will, where possible, be offered to Suffolk County Council Highways and Anglian Water for adoption and management;
- All remaining private drainage within individual property curtilages will be maintained by individual property owners.

Flood Risk from the Development

6.14 As the development of the Site will introduce new hard surfacing, the runoff characteristics will be potentially altered. Therefore an assessment of the proposed surface and foul water drainage scheme is required to ensure the scheme does not increase flood risk to the surrounding area.

6.15 The following sections provide a drainage assessment of the scheme and appropriate mitigation measures are presented in Table 7.1

Effects on the Public Foul Sewer Network

6.16 As the site will not connect to the public sewer network there will be no impacts.

Effects on Local Watercourses

6.17 As the majority of the Site is currently brownfield, it is assumed that under current conditions, any surface water will currently be directed to existing below ground drainage with surrounding scrub areas allowed to pond or runoff overland during extreme rainfall events. Following development, the surface water drainage strategy set out above ensures that sufficient sustainable drainage systems will be included to make sure that there are no significant changes in surface water runoff from the Site compared to the existing situation (for all rainfall events up to the 1 in 100 year plus climate change), whilst there is likely to be an improvement over the existing scenario. Calculations in Appendix C confirm this.

6.18 For all events beyond the 1 in 100 year plus climate change rainfall event, the situation will be no worse than existing, as long as a consideration of exceedance flows is made as part of the detailed drainage design, to ensure that any excess surface water runoff would continue to overflow away from the existing and proposed residential properties.

7.0 MITIGATION MEASURES

7.1 Flood Risk Mitigation measures are proposed in Table 7.1 in order to both mitigate flood risk posed to the development and to ensure the development poses no risk to the surrounding area.

Type of Flooding	Issue	Mitigation Measures	Justification	Residual Risk *
Flooding from surface and foul water – sewer blockage/surcharging and intense rainfall	Blockages or surcharges in the site drainage or the private sewer network on the vicinity may result in flooding.	• Ensure an appropriate management regime is put in place for the proposed private foul water treatment plant including routine inspection and maintenance by the site management. • Monitor flood risk throughout the life of the development in order to confirm the risk posed to the scheme over time. • Consider opportunities for flood resilient design. • At the detailed design stage consideration will be given to flood flow routes in the event of a system surcharge/blockage, these will ensure any surcharged water is kept within kerb line and away from properties.	These measures will ensure flood risk from these sources is minimised.	Low
Flooding from Water mains.	Flooding of the water supply and distribution system may result in flooding of the internal building.	• Routine inspection of the Site and public water supply and distribution system by the Site owner and Anglian Water.	Will ensure the risk of flooding is minimised.	Low
Flooding from surface water runoff – overland flow/ponding	Risk of flooding from rainfall events in exceedance of the drainage design may result in on-site property flooding.	• The detailed design of the development will make an allowance for flow routing from rainfall events in exceedance of the drainage design capacity (i.e. the 100 year plus 40% climate change) in accordance with best practice guidance; • External areas will also be profiled so as any runoff will be directed away from dwellings and into the roads; • Floor levels of all units will be raised above the surrounding area (as per Building Regulations standards).	In the event of this extreme rainfall event dwellings will not be inundated whilst flooding of the surrounding area is also prohibited.	Low
Flooding from perched/shallow groundwater	Shallow groundwater may be present which may pose a threat to the scheme	• Where surface and foul water drainage networks are to be placed within any water bearing strata they should be constructed such that water ingress cannot occur. • Consider lining of the attenuation basin to ensure the storage volume is not hindered by any standing groundwater. • Consider the need for dewatering during construction and the inclusion of waterproofing for various substructures.	Will ensure the risk of flooding is minimised.	Low
Increased flood risk to surrounding properties as a result of the scheme.	The scheme has potential to change surface water run-off rates and patterns which may increase risk of flooding to neighbouring land or property.	• Inclusion of sustainable drainage to ensure the Site or surrounding area does not flood during the 100 year plus 40% climate change event; • A management plan for the maintenance of drainage assets should be prepared and agreed with appropriate authorities as part of the detailed design. This should ensure routine inspection and maintenance of both the foul and surface water drainage systems by the Site management and/or any adopting body and Anglian Water; • At the detailed design stage consideration will be given to flood flow routes in the event of a system surcharge/blockage, these will ensure any surcharged water is kept within kerb line and away from properties.	These measures will ensure the scheme does not increase flood risk elsewhere, in line with local and national policy requirements.	Low

Table 7.1. Mitigation Measures

*Following adoption of the mitigation measures

8.0 RESIDUAL FLOOD RISKS AND IMPACTS TO SURROUNDING AREAS

Residual Risks

8.1 A number of residual risks have been identified, associated with private sewers, site drainage, water supply pipes and intense rainfall.

8.2 As long as the public sewer networks, site drainage/water supply infrastructure are regularly inspected by maintained by Anglian Water and site management respectively then the residual risks will be minimised.

Impact on Flood Risk of Surrounding Areas

8.3 Given the low flood risk present on site and the drainage strategy proposed, it is considered that the development of the Site will not increase the risk of flooding in other areas, surrounding the Site, assuming the measures proposed in Table 7.1 are implemented.

9.0 CONCLUSIONS AND RECOMMENDATIONS

9.1 Based on our understanding of the Site setting and the development proposals, it is considered that the risk of flooding from all sources is generally low, and the development can be operated safely and without significantly increasing flood risk elsewhere. However a number of residual risks have been identified, associated with private sewers, site drainage and water supply pipes and intense rainfall. Appropriate mitigation measures have been provided in Table 7.1 to address and manage the residual risk from these forms of flooding.

9.2 We recommend that the assessment of residual risks should be reviewed by site owners as new flood risk information becomes available, and the flood risk associated with adjacent sewers may also increase over time in the area due to climate change.

10.0 REFERENCES

i. British Geological Survey GeoIndex. Available at: www.bgs.ac.uk/geoindex (Accessed online March 2018). BGS, Wallingford.

ii. British Water (2013) *Flows and Loads 4.* British water, London.

iii. Environment Agency Fluvial Flood Maps, Surface Water Flood Maps, Groundwater Maps and Reservoir Flood Maps Available at: http://maps.environment-agency.gov.uk/wiyby/wiybyController?x=514500.0&y=188500.0&topic=floodmap&ep=map&scale=8&location=Harrow,%20Harrow&lang=_e&layerGroups=default&textonly=off (Accessed May 2018).

iv. Suffolk Coastal and Waveney District Councils (2009) *Suffolk Coastal and Waveney District Strategic Flood Risk Assessment, Main Report.* Scott Wilson, London.

v. Suffolk County Council (2011) *Preliminary Flood Risk Assessment*. AECOM, London.

vi. Suffolk Coastal District Council (2013) *Suffolk Coastal District Local Plan Core Strategy and Development Management Policies Development Plan document*. Suffolk Coastal District Council.

vii. Water UK/WRc plc (2012) Sewers for Adoption – 7th Edition. WRc plc, Swindon.

viii. Woods-Ballard., et al. (2015) *The SUDS Manual.* Report C753. CIRIA, London.

FIGURES

Figure 5.1: Fluvial/Tidal Flood Map

Source: Environment Agency data (Appendix B) and Google mapping 2018

Figure 5.2: Surface Water Flood Map

Source: Data.Gov Website (www.environment-agency.gov.uk)

APPENDICES

APPENDIX A

(c) Crown copyright and database rights 2017 Ordnance Survey 100022432

Date: 22/02/17

Scale: 1:1250

Map Centre: 622969,247822

Data updated: 24/10/16

Our Ref: 214318 - 2

Wastewater Plan A0

Foul Sewer
Surface Sewer
Combined Sewer
Final Effluent
Rising Main (Colour denotes effluent type)
Private Sewer (Colour denotes effluent type)
Decommissioned Sewer (Colour denotes effluent type)

Outfall (Colour denotes effluent type)
Inlet (Colour denotes effluent type)
Manhole (Colour denotes effluent type)
Sewage Treatment Works
Pumping Station

charlotte.catchpole@createconsultingengineers.co.uk

P17-1196 Grove Farm

love every drop
anglianwater

Manhole Reference	Easting	Northing	Liquid Type	Cover Level	Invert Level	Depth to Invert
5101	622598	248123	F	27.316	25.78	1.536
5201	622543	248236	F	31.611	29.529	2.082
5202	622520	248220	F	30.221	29.489	0.732
6001	622660	248014	F	24.44	21.86	2.58
6002	622602	248041	F	23.649	22.552	1.097
6003	622667	248072	F	-	-	-
6004	622679	248025	F	-	-	-
6005	622674	248029	F	-	-	-
6006	622659	248039	F	-	-	-
6007	622630	248065	F	-	-	-
6101	622609	248134	F	29.846	-	-
6102	622602	248171	F	30.684	28.474	2.21
6301	622612	248302	F	32.842	31.19	1.652
6801	622622	247890	F	-	-	-
6901	622686	247955	F	-	-	-
6902	622673	247962	F	19.936	18.806	1.13
7001	622725	248015	F	-	-	-
7002	622721	248003	F	-	-	-
7003	622731	248019	F	-	-	-
7004	622727	248032	F	-	-	-
7005	622757	248053	F	-	-	-
7006	622773	248056	F	-	-	-
7007	622704	248056	F	-	-	-
7901	622711	247961	F	-	-	-
7902	622736	247965	F	-	-	-
7903	622738	247974	F	-	-	-
7904	622730	247996	F	-	-	-
7905	622748	247968	F	-	-	-
7906	622761	247963	F	-	-	-
7907	622765	247975	F	-	-	-
7908	622788	247982	F	-	-	-
8001	622800	248019	F	-	-	-
8002	622823	248012	F	-	-	-

Manhole Reference	Easting	Northing	Liquid Type	Cover Level	Invert Level	Depth to Invert

Manhole Reference	Easting	Northing	Liquid Type	Cover Level	Invert Level	Depth to Invert

Manhole Reference	Easting	Northing	Liquid Type	Cover Level	Invert Level	Depth to Invert

Manhole Reference	Easting	Northing	Liquid Type	Cover Level	Invert Level	Depth to Invert

Manhole Reference	Easting	Northing	Liquid Type	Cover Level	Invert Level	Depth to Invert

(c) Crown copyright and database rights 2017 Ordnance Survey 100022432 | Date: 22/02/17 | Scale: 1:1250 | Map Centre: 622969,247822 | Data updated: 24/10/16 | Our Ref: 214318 - 1 | Clean Water Plan A0

This plan is provided by Anglian Water pursuant its obligations under the Water Industry Act 1991 sections 198 or 199. It must be used in conjunction with any search results attached. The information on this plan is based on data currently recorded but position must be regarded as approximate. Service pipes, private sewers and drains are generally not shown. Users of this map are strongly advised to commission their own survey of the area shown on the plan before carrying out any works. The actual position of all apparatus MUST be established by trial holes. No liability whatsoever, including liability for negligence, is accepted by Anglian Water for any error or inaccuracy or omission, including the failure to accurately record, or record at all, the location of any water main, discharge pipe, sewer or disposal main or any item of apparatus. This information is valid for the date printed. This plan is produced by Anglian Water Services Limited (c) Crown copyright and database rights 2017 Ordnance Survey 100022432.This map is to be used for the purposes of viewing the location of Anglian Water plant only. Any other uses of the map data or further copies is not permitted. This notice is not intended to exclude or restrict liability for death or personal injury resulting from negligence.

Potable Water		Fitting	
Raw Water	RAW		
Decommissioned Water		Hydrant	

charlotte.catchpole@createconsultingengineers.co.uk

P17-1196 Grove Farm

love every drop anglianwater

APPENDIX B

Reference: EAn/2017/38921
Site Address: Little Bealings IP13 6LT
Date: 06/03/2017

Included:

- Flood Map

Important information to note with your Product:

Flood Risk Assessments (FRAs)
If you are obtaining this information for use within a Flood Risk Assessment (FRA) required for a planning application, please include our unaltered Product 4 data within an appendix of your FRA.

Flood Zones
Please see the attached map showing the Flood Zones (outlines) for the area of the site. Our maps show the site is located in fluvial Flood Zone 3.

JFLOW
The Flood Zone maps in this area are formed of national generalised modelling, which was used in 2004 to create fluvial floodplain maps on a national scale. This modelling is not a detailed local assessment, it is used to give an indication of areas at risk from flooding.

JFLOW outputs are not suitable for detailed decision making, however, you can still request this data if necessary. JFLOW is not to be used in a Flood Risk Assessment (FRA) and normally, in these circumstances, a FRA will instead need to undertake a modelling exercise in order to derive flood levels and extents, both with and without allowances for climate change, for the watercourse, in order to inform the design for the site. Without this information, the risk to the development from fluvial flooding associated with the main watercourse is unknown.

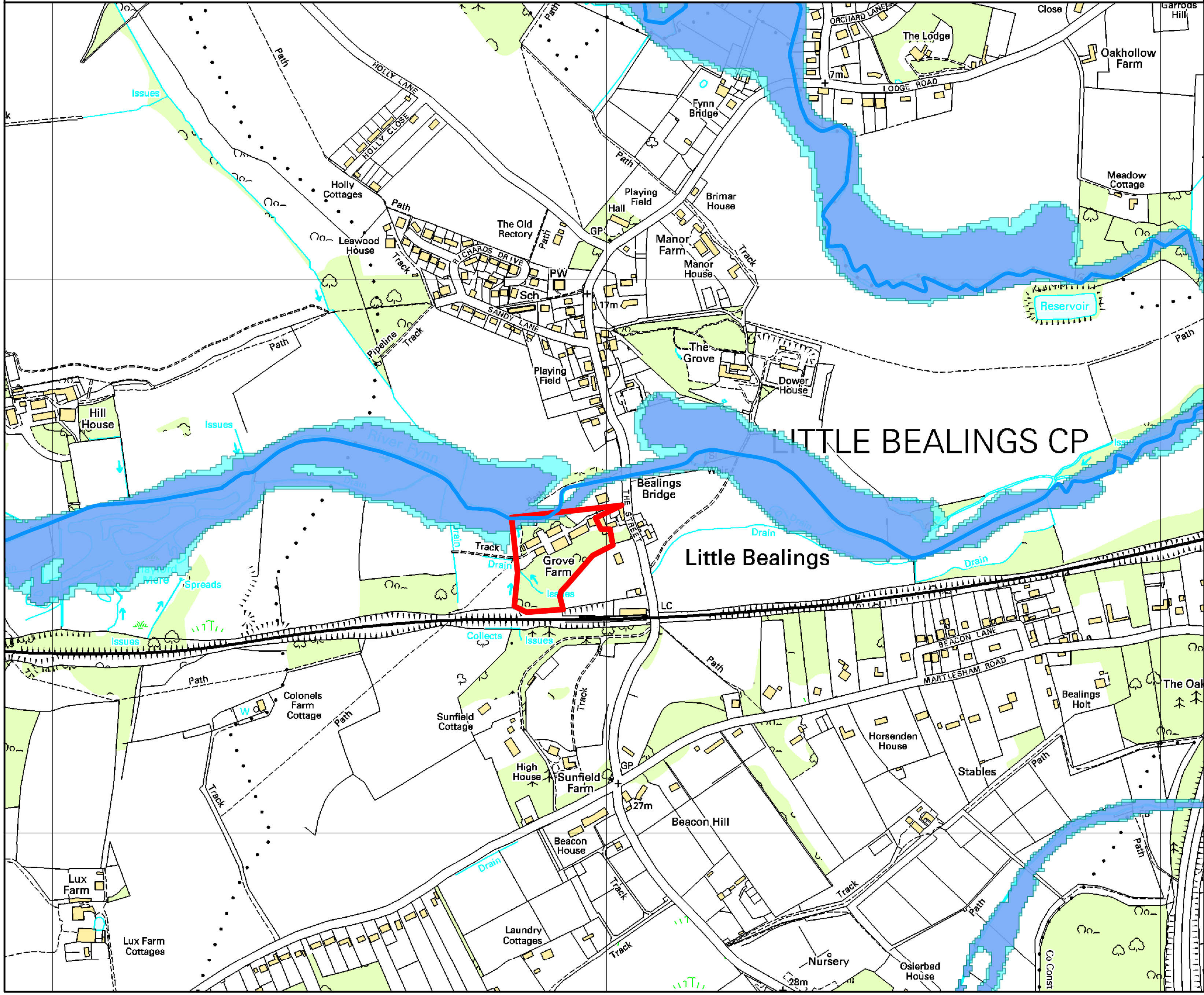
For any further guidance with regards to Flood Risk Assessments and JFLOW, please contact the Sustainable Places Team on planning.ipswich@environment-agency.gov.uk

Historic Flood Events
We have checked our historic flooding database and have found no record of flooding in this area. This does not mean that the site has never flooded, only that no flooding has been reported to us in this location.

Surface Water
Please be aware that in recent years, there has been an increase in flood damage caused by surface water flooding or drainage systems that have been overwhelmed. We have worked with Lead local Flood Authorities (LLFAs) to develop a map which incorporates the best local and national scale information on surface water flood risk. These maps can be viewed on our website at the following:-
http://maps.environment-agency.gov.uk/wiyby/wiybyController?ep=maptopics&lang=_e

Reservoir Flooding
You can obtain a map which shows the extent of flooding if a reservoir was to fail and release the water that it holds. The map shows the worst case scenario. These maps can be viewed on our website at the following:-
http://maps.environment-agency.gov.uk/wiyby/wiybyController?ep=maptopics&lang=_e

Flood Map for Planning centred on IP13 6LT
Created 06/03/2017 - Ref: EAn/2017/38921



Environment Agency
Iceni House
Cobham Road
Ipswich
Suffolk
IP3 9JD

0 135 270 540
Metres

Legend

- Main Rivers
- Site Location
- Flood Zone 3
- Flood Zone 2

Flood Map for Planning (assuming no defences)

Flood Zone 3 shows the area that could be affected by flooding:
- from the sea with a 1 in 200 or greater chance of happening each year
- or from a river with a 1 in 100 or greater chance of happening each year.

Flood Zone 2 shows the extent of an extreme flood from rivers or the sea with up to a 1 in 1000 chance of occurring each year.

Contact Us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 03708 506 506 (Mon-Fri 8-6). Email: enquiries@environment-agency.gov.uk

Produced by: Partnership & Strategic Overview
East Anglia: Essex, Norfolk & Suffolk

APPENDIX C

Location : **Grove Farm, Little Bealings**
M5-60 : 20 mm

Wallingford Method - maps

r : 0.4

For different durations,

From Table 1

Duration, D	Z1			
15 min	0.63	**M5-15:**	Z1 x M5-60	12.60 mm
30 min	0.81	**M5-30:**	Z1 x M5-60	16.20 mm
60 min	1	**M5-60:**	Z1 x M5-60	20.00 mm
6hr	1.6	**M5-360:**	Z1 x M5-60	32.00 mm

For different return intervals,

From Table 2*

	Z2		
Duration, D	M1	M30	M100
15 min	0.62	1.53	1.95
30 min	0.62	1.53	2.00
60 min	0.64	1.54	2.03
6 hr	0.68	1.50	1.95

Average point intensity, API = I/(D/60)

	D min	Calculation	I mm	API mm/hr
M 1-15	15	M5-15*Z2(M1)	7.81	31.25
M 1-30	30	M5-30*Z2(M1)	10.04	20.09
M 1-60	30	M5-360*Z2(M1)	12.80	25.60
M1-360	360	M5-360*Z2(M1)	21.76	3.63
M 30-15	15	M5-15*Z2(M30)	19.28	77.11
M 30-30	30	M5-30*Z2(M30)	24.79	49.57
M 30-60	60	M5-60*Z2(M30)	30.80	30.80
M30-360	360	M5-360*Z2(M30)	48.00	8.00
M 100-15	15	M5-15*Z2(M100)	24.57	98.28
M 100-30	30	M5-30*Z2(M100)	32.40	64.80
M100-60	60	M5-60*Z2(M100)	40.60	40.60
M100-360	360	M5-360*Z2(M100)	62.40	10.40

Table 1

Rainfall Duration D

Minutes					Hours					
r	5	10	15	30	1	2	4	6	10	24
0.12	0.22	0.34	0.45	0.67	1.00	1.48	2.17	2.75	3.70	6.00
0.15	0.25	0.38	0.48	0.69	1.00	1.42	2.02	2.46	3.32	4.90
0.18	0.27	0.41	0.51	0.71	1.00	1.36	1.86	2.25	2.86	4.30
0.21	0.29	0.43	0.54	0.73	1.00	1.33	1.77	2.12	2.62	3.60
0.24	0.31	0.46	0.56	0.75	1.00	1.30	1.71	2.00	2.40	3.35
0.27	0.33	0.48	0.58	0.76	1.00	1.27	1.64	1.88	2.24	3.10
0.30	0.34	0.49	0.59	0.77	1.00	1.25	1.57	1.78	2.12	2.84
0.33	0.35	0.50	0.61	0.78	1.00	1.23	1.53	1.73	2.04	2.60
0.36	0.36	0.51	0.62	0.79	1.00	1.22	1.48	1.67	1.90	2.42
0.39	0.37	0.52	0.63	0.80	1.00	1.21	1.46	1.62	1.82	2.28
0.42	0.38	0.53	0.64	0.81	1.00	1.20	1.42	1.57	1.74	2.16
0.45	0.39	0.54	0.65	0.82	1.00	1.19	1.38	1.51	1.68	2.03

Table 2 - England and Wales

Growth Factor Z2

M5 rainfall	M1	M2	M3	M4	M5	M10	M20	M50	M100	M30 interpolated
5.00	0.62	0.79	0.89	0.97	1.02	1.19	1.36	1.56	1.79	1.25
10.00	0.61	0.79	0.90	0.97	1.03	1.22	1.41	1.65	1.91	1.49
15.00	0.62	0.80	0.90	0.97	1.03	1.24	1.44	1.70	1.99	1.53
20.00	0.64	0.81	0.90	0.97	1.03	1.24	1.45	1.73	2.03	1.54
25.00	0.66	0.82	0.91	0.97	1.03	1.24	1.44	1.72	2.01	1.53
30.00	0.68	0.83	0.91	0.97	1.03	1.22	1.42	1.70	1.97	1.51
40.00	0.70	0.84	0.92	0.97	1.02	1.19	1.38	1.64	1.89	1.47
50.00	0.72	0.85	0.93	0.98	1.02	1.17	1.34	1.58	1.81	1.42
75.00	0.76	0.87	0.93	0.98	1.02	1.14	1.28	1.47	1.64	1.34
100.00	0.78	0.88	0.94	0.98	1.02	1.13	1.25	1.40	1.54	1.30
150.00	0.78	0.88	0.94	0.98	1.01	1.12	1.21	1.33	1.45	1.25
200.00	0.78	0.88	0.94	0.98	1.01	1.11	1.19	1.30	1.40	1.23

Peak Runoff

Q=2.78CiA Rational Method, SUDS Manual Section 4.3.3

where: (1) C = Cv Cr

Cv = 1 **

Cr = 1.3 constant value for design purposes

therefore , C = 1.3

* The rainfall depths from cells E8-E11 are compared with the depths given in cells J29-J40 and Z2 interpolated accordingly for each return period

** Cv varies between 0.6 (rapidly draining soils) and 0.9 (heavy clay) with an average of 0.75 taken if ground conditions not known.

2.78*C= **3.614**

(2) i = API, defined above

Q=2.78CiA

(3) A = areas measured for subcatchments

	i	Contributing Impermeable Area Ha	
		Site	Per hectare
	mm/hr	0.34	1
M 1-15	31.25	**38.40**	112.93
M 1-30	20.09	24.68	72.60
M 1-60	25.60	31.46	72.60
M1-360	3.63	4.46	13.11
M 30-15	77.11	**94.75**	278.68
M 30-30	49.57	60.91	179.15

	i	Contributing Impermeable Area Ha	
		Site	Per hectare
	mm/hr	0.34	1
M 30-60	30.80	37.85	179.15
M30-360	8.00	9.83	28.91
M 100-15	98.28	**120.76**	355.18
M 100-30	64.80	79.62	234.19
M 100-60	40.60	49.89	234.19
M100-360	10.40	12.78	37.59

IoH 124 Calculation of Greenfield Runoff Rate

Date: 07-Mar-17
By: GS

OS Location 629900E 247500N

SAAR	587 mm	See Wallingford Map
Site area =	50 ha	Always assume 50ha and prorata for specific site
	0.5 km^2	
Soil WRA Class	3	See Wallingford Map
Soil Type SPR Value	0.4	Conversion to SPR

$Qbar_{rural} = 0.00108 \times (AREA)^{0.89} X (SAAR)^{1.17} X (SOIL)^{2.17}$

Qbar-50ha = 0.138 m^3/s

From Regional Growth Curve Factor

Region: 5

Return period	1	2	5	10	25	30	50	100	500
Growth Factor	0.85	0.89	1.29	1.65	2.25	2.37	2.83	3.56	5.02

Q_1 50ha =	0.118 m^3/s	=	117.68 l/s	=	2.354 l/s/ha
Q_2 50ha =	0.123 m^3/s	=	123.22 l/s	=	2.464 l/s/ha
Q_5 50ha =	0.179 m^3/s	=	178.60 l/s	=	3.572 l/s/ha
Q_{10} 50ha =	0.228 m^3/s	=	228.44 l/s	=	4.569 l/s/ha
Q_{25} 50ha =	0.312 m^3/s	=	311.51 l/s	=	6.230 l/s/ha
Q_{30} 50ha =	0.328 m^3/s	=	328.12 l/s	=	6.562 l/s/ha
Q_{50} 50ha =	0.392 m^3/s	=	391.81 l/s	=	7.836 l/s/ha
Q_{100} 50ha =	0.493 m^3/s	=	492.87 l/s	=	9.857 l/s/ha
Q_{500} 50ha =	0.695 m^3/s	=	695.00 l/s	=	13.900 l/s/ha

Factored for Development Impermeable Area

Site area = 0.1954 ha Impermeable area

Q_{bar} site =	0.001 m^3/s	=	0.5 l/s	=	2.8 l/s/ha
Q_1 site =	0.000 m^3/s	=	0.5 l/s	=	2.4 l/s/ha
Q_2site =	0.000 m^3/s	=	0.5 l/s	=	2.5 l/s/ha
Q_5site =	0.001 m^3/s	=	0.7 l/s	=	3.6 l/s/ha
Q_{10} site =	0.001 m^3/s	=	0.9 l/s	=	4.6 l/s/ha
Q_{25} site =	0.001 m^3/s	=	1.2 l/s	=	6.2 l/s/ha
Q_{30} site =	0.001 m^3/s	=	1.3 l/s	=	6.6 l/s/ha
Q_{50} site =	0.002 m^3/s	=	1.5 l/s	=	7.8 l/s/ha
Q_{100} site =	0.002 m^3/s	=	1.9 l/s	=	9.9 l/s/ha
Q_{500} site =	0.003 m^3/s	=	2.7 l/s	=	13.9 l/s/ha

Note: For greenfield site, the critical duration is generally not relevant and the prediction of the peak rate of runoff using IH124 does not require consideration of storm duration.

IoH 124 Calculation of Greenfield Runoff Rate

Date: 07-Mar-17
By: GS

OS Location 629900E 247500N

SAAR	587	mm	See Wallingford Map
Site area =	50	ha	Always assume 50ha and prorata for specific site
	0.5	km^2	
Soil WRA Class	3		See Wallingford Map
Soil Type SPR Value	0.4		Conversion to SPR

$$Qbar_{rural} = 0.00108 \times (AREA)^{0.89} \times (SAAR)^{1.17} \times (SOIL)^{2.17}$$

Qbar-50ha = 0.138 m^3/s

From Regional Growth Curve Factor

Region: 5

Return period	1	2	5	10	25	30	50	100	500
Growth Factor	0.85	0.89	1.29	1.65	2.25	2.37	2.83	3.56	5.02

Q_1 50ha =	0.118 m^3/s	=	117.68 l/s	=	2.354 l/s/ha
Q_2 50ha =	0.123 m^3/s	=	123.22 l/s	=	2.464 l/s/ha
Q_5 50ha =	0.179 m^3/s	=	178.60 l/s	=	3.572 l/s/ha
Q_{10} 50ha =	0.228 m^3/s	=	228.44 l/s	=	4.569 l/s/ha
Q_{25} 50ha =	0.312 m^3/s	=	311.51 l/s	=	6.230 l/s/ha
Q_{30} 50ha =	0.328 m^3/s	=	328.12 l/s	=	6.562 l/s/ha
Q_{50} 50ha =	0.392 m^3/s	=	391.81 l/s	=	7.836 l/s/ha
Q_{100} 50ha =	0.493 m^3/s	=	492.87 l/s	=	9.857 l/s/ha
Q_{500} 50ha =	0.695 m^3/s	=	695.00 l/s	=	13.900 l/s/ha

Factored for Development Impermeable Area

Site area = 0.41 ha

Q_{bar} site =	0.001 m^3/s	=	1.1 l/s	=	2.8 l/s/ha
Q_1 site =	0.001 m^3/s	=	1.0 l/s	=	2.4 l/s/ha
Q_2site =	0.001 m^3/s	=	1.0 l/s	=	2.5 l/s/ha
Q_5site =	0.001 m^3/s	=	1.5 l/s	=	3.6 l/s/ha
Q_{10} site =	0.002 m^3/s	=	1.9 l/s	=	4.6 l/s/ha
Q_{25} site =	0.003 m^3/s	=	2.6 l/s	=	6.2 l/s/ha
Q_{30} site =	0.003 m^3/s	=	2.7 l/s	=	6.6 l/s/ha
Q_{50} site =	0.003 m^3/s	=	3.2 l/s	=	7.8 l/s/ha
Q_{100} site =	0.004 m^3/s	=	4.0 l/s	=	9.9 l/s/ha
Q_{500} site =	0.006 m^3/s	=	5.7 l/s	=	13.9 l/s/ha

Note: For greenfield site, the critical duration is generally not relevant and the prediction of the peak rate of runoff using IH124 does not require consideration of storm duration.

APPENDIX D

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	6.163	0.463	0.8	61.3	O K
30 min Summer	6.268	0.568	0.8	79.9	O K
60 min Summer	6.365	0.665	0.8	98.4	O K
120 min Summer	6.449	0.749	0.9	116.0	O K
180 min Summer	6.490	0.790	0.9	125.0	O K
240 min Summer	6.514	0.814	0.9	130.4	O K
360 min Summer	6.545	0.845	0.9	137.5	O K
480 min Summer	6.561	0.861	0.9	141.3	O K
600 min Summer	6.569	0.869	0.9	143.2	O K
720 min Summer	6.572	0.872	0.9	144.0	O K
960 min Summer	6.569	0.869	0.9	143.2	O K
1440 min Summer	6.547	0.847	0.9	138.1	O K
2160 min Summer	6.514	0.814	0.9	130.4	O K
2880 min Summer	6.483	0.783	0.9	123.5	O K
4320 min Summer	6.427	0.727	0.9	111.3	O K
5760 min Summer	6.374	0.674	0.8	100.3	O K
7200 min Summer	6.324	0.624	0.8	90.3	O K
8640 min Summer	6.275	0.575	0.8	81.0	O K
10080 min Summer	6.226	0.526	0.8	72.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	146.239	0.0	60.0	19
30 min Summer	95.739	0.0	65.5	34
60 min Summer	59.609	0.0	100.5	64
120 min Summer	35.790	0.0	120.2	124
180 min Summer	26.173	0.0	130.8	184
240 min Summer	20.847	0.0	135.9	242
360 min Summer	15.148	0.0	137.8	362
480 min Summer	12.059	0.0	138.1	482
600 min Summer	10.096	0.0	138.1	602
720 min Summer	8.728	0.0	138.1	722
960 min Summer	6.931	0.0	138.2	960
1440 min Summer	5.001	0.0	138.2	1240
2160 min Summer	3.602	0.0	219.4	1620
2880 min Summer	2.851	0.0	231.3	2016
4320 min Summer	2.048	0.0	237.6	2852
5760 min Summer	1.618	0.0	263.2	3680
7200 min Summer	1.347	0.0	273.9	4472
8640 min Summer	1.159	0.0	282.8	5272
10080 min Summer	1.021	0.0	290.4	6056

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Winter	6.206	0.506	0.8	68.7	O K
30 min Winter	6.320	0.620	0.8	89.6	O K
60 min Winter	6.423	0.723	0.9	110.5	O K
120 min Winter	6.515	0.815	0.9	130.5	O K
180 min Winter	6.559	0.859	0.9	140.9	O K
240 min Winter	6.586	0.886	0.9	147.4	O K
360 min Winter	6.621	0.921	1.0	155.9	O K
480 min Winter	6.641	0.941	1.0	160.9	O K
600 min Winter	6.652	0.952	1.0	163.7	O K
720 min Winter	6.658	0.958	1.0	165.3	O K
960 min Winter	6.660	0.960	1.0	165.9	O K
1440 min Winter	6.644	0.944	1.0	161.7	O K
2160 min Winter	6.605	0.905	1.0	152.0	O K
2880 min Winter	6.568	0.868	0.9	143.0	O K
4320 min Winter	6.493	0.793	0.9	125.8	O K
5760 min Winter	6.420	0.720	0.9	109.7	O K
7200 min Winter	6.347	0.647	0.8	94.9	O K
8640 min Winter	6.275	0.575	0.8	81.2	O K
10080 min Winter	6.202	0.502	0.8	68.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Winter	146.239	0.0	64.7	19
30 min Winter	95.739	0.0	65.2	34
60 min Winter	59.609	0.0	112.4	64
120 min Winter	35.790	0.0	133.1	122
180 min Winter	26.173	0.0	138.5	180
240 min Winter	20.847	0.0	139.4	240
360 min Winter	15.148	0.0	140.5	356
480 min Winter	12.059	0.0	141.4	474
600 min Winter	10.096	0.0	142.4	590
720 min Winter	8.728	0.0	143.5	702
960 min Winter	6.931	0.0	144.9	930
1440 min Winter	5.001	0.0	144.4	1356
2160 min Winter	3.602	0.0	245.5	1708
2880 min Winter	2.851	0.0	258.2	2164
4320 min Winter	2.048	0.0	248.7	3072
5760 min Winter	1.618	0.0	294.8	3976
7200 min Winter	1.347	0.0	306.7	4824
8640 min Winter	1.159	0.0	316.7	5704
10080 min Winter	1.021	0.0	325.3	6552

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	21.000	Shortest Storm (mins)	15
Ratio R	0.404	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.226

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.226

Model Details

Storage is Online Cover Level (m) 7.000

Tank or Pond Structure

Invert Level (m) 5.700

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	100.9	1.300	328.3

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0047-1000-1000-1000
Design Head (m)	1.000
Design Flow (l/s)	1.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	47
Invert Level (m)	5.700
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	1.0	Kick-Flo®	0.415	0.7
Flush-Flo™	0.205	0.8	Mean Flow over Head Range	-	0.8

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.8	1.200	1.1	3.000	1.6	7.000	2.4
0.200	0.8	1.400	1.2	3.500	1.8	7.500	2.5
0.300	0.8	1.600	1.2	4.000	1.9	8.000	2.6
0.400	0.7	1.800	1.3	4.500	2.0	8.500	2.7
0.500	0.7	2.000	1.4	5.000	2.1	9.000	2.7
0.600	0.8	2.200	1.4	5.500	2.2	9.500	2.8
0.800	0.9	2.400	1.5	6.000	2.3		
1.000	1.0	2.600	1.5	6.500	2.3		

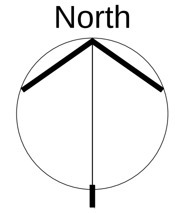
PLANS

Red line Boundary Area= 1.12 ha

Blue line Boundary Area= 2.08 ha

revision

A	Boundaries revised	DMW	23.3.18



Issue Status: Planning Application

10m 0 10 20 30 40 50 60
1:1250

client
R & P Baker

project
Residential Development
Grove Farm, Little Bealings
Woodbridge

drawing
Site Location Plan

date	Jan' 18	scale	1:1250 @ A3
drawn	DMW	checked by	STL

BROWN & CO
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Registration no: OC302092. Registered in England & Wales. T: 01603 620326.

15	042	05	A

revision

A	Turning head added to plan as per highways comments	DMW	17-08-17
B	Road widened to 4m as per highways comments.	DMW	23-08-17
C	Turning head and entrance widths revised as per highway consultant recommendation.	DMW	15-01-18
D	Road widened to 5m as per highways comments.	DMW	30-01-18
E	Plot boundaries revised	DMW	31-01-18
F	Site boundaries revised	DMW	05-02-18
G	Site layout revised	DMW	21-02-18
H	Site layout revised	DMW	23-03-18

North

Issue Status: Planning Application

10m 0 10 20 30

1:500

client
R & P Baker

project
Residential Development
Grove Farm, Little Bealings
Woodbridge

drawing
Propsoed
Site Plan

date Jan' 18

scale 1:500 @ A2

drawn DMW

checked by STL

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15	042	10	H