



Inverness Terrace Ltd

Rudloe No.2, Box

Flood Risk Assessment & Drainage Strategy

132283-R1(1)-FRA



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NOVEMBER 2014

RSK GENERAL NOTES

Project No.: 132283-R1(1)-FRA

Site Name: Rudloe Site No.2, Box

Report Title: Flood Risk Assessment & Drainage Strategy

Client: Inverness Terrace Ltd

Date: November 2014

Office: Hemel Hempstead

Status: Final

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1 INTRODUCTION

RSK Land and Development Engineering Ltd were commissioned to carry out a Flood Risk Assessment (FRA) and Drainage Strategy for Inverness Terrace Ltd (Client). The assessment is in support of the planning submission for the site.

The assessment has been prepared in accordance with National Planning Policy Framework (NPPF) ^(Ref. 1) and its accompanying guidance document ^(Ref. 2), the Interim Code of Practice for Sustainable Drainage ^(Ref. 3) and BS 8533-2011 Assessing and managing flood risk in development Code of practice ^(Ref. 4), with site-specific advice from the Environment Agency (EA), the Local Planning Authority, the architect and the Client.

The NPPF sets out the criteria for development and flood risk by stating that inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk, but where development is necessary, making it safe without increasing flood risk elsewhere. The key definitions are:

- “Areas at risk of flooding” means land within Flood Zones 2 and 3; or land within Flood Zone 1 which has critical drainage problems and which has been notified to the local planning authority by the EA;
- “Flood risk” means risk from all sources of flooding - including from rivers and the sea, directly from rainfall on the ground surface and rising groundwater, overwhelmed sewers and drainage systems, and from reservoirs, canals and lakes and other artificial sources.

For this site, the key aspects that require the assessment are:

- The EA’s indicative flood map shows the site to be located in Flood Zone 1.
- The site area is in excess of 1ha.

The comments given in this report and opinions expressed are subject to RSK Group Service Constraints provided in **Appendix A**.

2 CONTEXT AND SCOPE OF WORK

A key element of project development is to prepare a Flood Risk Assessment to establish the risk associated with the proposed development and to propose suitable mitigation, if required, to reduce the risk to a more acceptable level.

The scope of work relating to a flood risk assessment is based on the guidance provided in Section 10 of NPPF ^(Ref. 1) and its accompanying guidance ^(Ref. 2).

A site-specific flood risk assessment must demonstrate that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall. The scope of this assessment therefore comprises the following elements:

- To obtain information on the hydrology and hydrological regime in and around the site.
- To obtain the views of the EA including scope, location and impacts.
- To determine the extent of new flooding provision and the influence on the site.
- To review site surface water drainage based on the proposed layout. To determine the extent of infrastructure required.
- To review architect plans and planning information and other studies to determine the existing site conditions.
- To assess the impact on the site from climate change effects and anticipated increases in rainfall over a 100 year period for residential uses and over a 60 year period for a commercial uses.
- Preparation of a report including calculations and summaries of the source information and elements reviewed.

Appendix B of this report provides clarity of the scope of site-specific FRA's and includes extracts from the NPPF technical guidance; the British Standard together with the Scope of a Drainage Impact Assessment as described in ICPSDS.

This report is supported by the following additional key reports and information:

- RSK Foul Drainage & Utilities Assessment ^(Ref. 5).
- RSK Preliminary Risk Assessment ^(Ref. 6).

3 SITE DESCRIPTION

3.1 Site Location

Site Name: Rudloe No.2

Site Address and Post Code: Westwells Road, Box, Wiltshire, SN13 9RA

Site National Grid Reference: 384747, 169128

The site is located to the south of Westwells Road in Box, Wiltshire. The site is a former Ministry of Defence site and comprises a number of existing buildings, roads and associated hardstanding areas. There is an existing fire station and circular concrete air shaft associated with the Box Tunnel within the site boundary that are not included as part of the site. The Box Tunnel (railway line) passes beneath the site and was constructed during the 1840s.

The site is bounded to the north by Westwells Road, to the west by Bradford Road, to the south by open space and light forest and to the east by a Ministry of Defence site.

A site location plan is shown in **Figure 1**.

3.2 Site Land use and Topography

The approximate land use of the existing Site is as follows:

- Total site area: 80,200m² (8.02ha)
- Existing building footprint: 9,560m² (0.96ha) = 11.9%
- Existing hardstanding area (car parking/paving/roads): 18,160m² (1.82ha) = 22.6%
- Total impermeable area: 27,720 (2.77ha) (34.6%)
- Existing permeable area (soft landscaping): 52,480m² (5.25ha) = 65.4%

The site existing levels varying from 146.3m above ordnance datum (mAOD) to 120.2mAOD. The land is generally falls from northwest to southeast along the line of Westwells Road.

Figure 2 shows the topographic survey and the existing site layout with land use highlighted.

3.3 Site Geology

Based on published geological records for the area (British Online Geological Survey Maps):

- Superficial Geology: Unknown

- Base rock Geology: Predominantly Forest Marble Formation - Mudstone with a small area to the east of Forest Marble Formation - Limestone

BGS Borehole data for the site shows made ground overlying firm Sandy Silty Clay and Weathered Forrest Marble Limestone.

There are indications of areas of worked ground and made ground within the vicinity of the area with suggestions that made ground may be present in areas of development.

The proposed buildings within the development are to be in some cases located over areas of existing buildings and therefore foundations and other buried features are likely to be encountered. The Box Tunnel (railway line) runs through the centre of the site at an approximate depth of 50m.

3.4 Site Hydrology

There are no springs, watercourses, drainage ditches or ponds located within the site boundary.

North of Spring Lane, approximately 600m to the east/northeast of site is an unnamed tributary of the River Avon. The tributary generally flows from west to east along the line of the railway and is classified as an ordinary watercourse. The watercourse is culverted through part of Corsham and becomes a Main River approximately 2.2km to the northeast of site.

The By Brook is designated by the EA as a Main River and flows north to south approximately 1.5km to the west of the site.

3.5 Site Hydrogeology

Hydrogeological information was obtained from the EA's online mapping service. The site is underlain by a Secondary A bedrock aquifer (permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers).

There is no superficial aquifer shown on the EA groundwater mapping.

The site is located within an Outer Zone (Zone 2) Groundwater Source Protection Zone.

3.6 Site History

With reference to www.old-maps.co.uk/ the site appears to have been open farmland up until 1956 when the Ministry of Defence buildings are shown on site. These buildings are still present. A number of disused MoD structures are present beneath parts of the site, this facility, whilst mostly disused, will be retained by the MoD. The Preliminary Risk Assessment ^(ref. 6) contains a full analysis of the site's former uses.

4 DEVELOPMENT PROPOSALS

The site development application proposes the demolition of the existing MoD buildings with a residential redevelopment comprising up to 180 residential units and 0.25 hectares for economic development.

The proposed total development areas equate approximately to the following (with the change from existing use in brackets):

- Proposed building footprint: 7,900m² (0.79ha) **(-1,660m²)**
- Proposed hard standing, driveways and roads: 16,000m² (1.60ha) **(-2,160m²)**
- Total proposed impermeable area: 23,900 (2.39ha) (29.9%) **(-3,820m²)**
- Total proposed permeable area: 56,300 (5.63ha) (70.1%) **(+3820m²)**

Figure 3 shows the proposed site layout.

5 LEGISLATION AND POLICY CONTEXT

5.1 National Policy

Table 5.1: National Legislation and Policy Context

Legislation	Key Provisions
National Planning Policy Framework (2012) ^(Ref. 1)	The aims of planning policy on development and flood risk are to ensure that flood risk is taken into account at all stages in the planning process to avoid inappropriate development in areas at risk of flooding, and to direct development away from areas at highest risk. Where new development is, exceptionally, necessary in such areas, policy aims to make it safe without increasing flood risk elsewhere and where possible, reducing flood risk overall.
Flood and Water Management Act 2010 ^(Ref. 7)	The Flood and Water Management Act aims to implement the findings of the 2007 Pitt Review and co-ordinate control of drainage and flood issues. There are a number of increased responsibilities within the Act that affect adoption of Sustainable Drainage Systems (SuDS) features and the role of the EA to expand on the mapping data they provide. The implementation of SuDS features has many beneficial impacts on the treatment of surface water during remediation works.
Water Resources Act 1991 ^(Ref. 8)	Section 24 - The EA is empowered under this Act to maintain and improve the quality of 'controlled' waters Section 85 - It is an offence to cause or knowingly permit pollution of controlled waters Section 88 - Discharge consents are required for discharges to controlled waters
Water Framework Directive (2000) ^(Ref. 9)	The Water Framework Directive (WFD) requires all inland and coastal waters to reach 'good' chemical and biological status by 2015. Flood risk management is unlikely to have a significant impact on chemical water quality except where maintenance works disturb sediment (such as de-silting) or where pollutants are mobilised from contaminated land by floodwaters. The main impact of the WFD on flood risk management, both now and in the future, relates to the ecological quality of water bodies. Channel works, such as straightening and deepening, or flood risk management schemes that modify geomorphological processes can change river morphology. The WFD aims to protect conservation sites identified by the EC Habitats Directive and Birds Directive that have water-related features, by designating them as 'protected sites'.

5.2 Local Policy

Wiltshire Local Development Framework (2010)

The Wiltshire Local Development Framework (LDF) ^(Ref. 10) (July 2014) incorporates a number of Local Development Plan Documents (DPDs) and sets out the strategy for managing growth and development in the Region. Relevant policies contained within these documents are outlined in **Table 5.3** below.

Table 5.3: LDF policy context

LDF Policy	Key Provisions
Wiltshire Core Strategy (adopted July 2014) ^(Ref. 10)	Core Policy 37 Military establishments <i>New development and changes of use at operational facilities that help enhance or sustain their operational capability will be supported.</i> <i>Redevelopment, conversion or change of use of redundant MoD sites and buildings will be supported provided they are well related to an existing settlement in terms of both location and scale. Sites that are remote from settlements should only be considered where the existing buildings and infrastructure on the site are suitable for redevelopment, conversion or change of use. Redevelopment proposals will not exceed the existing building footprint and floorspace unless they are well located to an existing settlement. The focus will be on employment-led development and other uses should be determined through a masterplanning approach with the local community.</i> <i>Development at operational or redundant sites should enhance the overall character of the site. All development at operational or redundant sites should mitigate any adverse impacts on local infrastructure, and not erode the character of the surrounding area. All proposals must ensure that the cultural and historical significance of the military facilities located on the site are understood and inform the scope of future development of that site.</i> Core Policy 67 Flood Risk <i>Development proposed in Flood Zones 2 and 3 as identified within the Strategic Flood Risk Assessment will need to refer to the Strategic Housing Land Availability Assessment when providing evidence to the local planning authority in order to apply the Sequential Test in line with the requirements of national policy and established best practice.</i> <i>All new development will include measures to reduce the rate of rainwater run-off and improve rainwater infiltration to soil and ground (sustainable urban drainage) unless site or environmental conditions make these measures unsuitable.</i>

6 SOURCES OF INFORMATION

6.1 Environment Agency Consultation

6.1.1 Flood Zone Maps

The EA Flood Zone mapping study for England and Wales is available on their web site at, <http://www.environment-agency.gov.uk/homeandleisure/floods/>

The relevant guidance note from the EA is available online through the following link: <http://www.environment-agency.gov.uk/research/planning/93498.aspx>

The guidance note relevant to this site is Note 1 and relates to undertaking Flood Risk Assessment studies for all development in Flood Zone 1 where standing advice does not apply.

6.1.2 Site Specific Consultation

The EA was formally consulted as part of this assessment, with request for flood related information (including flood levels) included in the consultation. Their full response to both the pre-planning enquiry and the flood data request can be found in **Appendix C**.

The Product data request confirms the following points:

- The Flood Zone map is shown in **Figure 4** and indicates that the site lies in Flood Zone 1 with less than 1 in 1,000 annual probability of fluvial or tidal flooding (<0.1%) in any year. This indicates that there is a low flood risk from fluvial and tidal sources.

The pre-application response confirms the following points:

- The site falls within a groundwater Source Protection Zone (SPZ) 2.
- As the site is greater than 1 hectare in size any future planning application must be accompanied by a Flood Risk Assessment (FRA), which focuses on the sustainable management of surface water runoff.
- Any outflow from the site must be limited to the maximum allowable rate, so there is no increase in the rate and/or volume of run-off, and preferably it should be reduced.
- The surface water drainage system must deal with the surface water run-off from the site up to the critical 1% Annual Probability of Flooding (or 1 in a 100-year flood) event, including an allowance for climate change for the lifetime of the development. Drainage calculations must be included to demonstrate this (e.g. Windes or similar sewer modelling package calculations that include the necessary attenuation volume).
- If there is any surcharge and flooding from the system, overland flood flow routes and "collection" areas on site (e.g. car parks, landscaping) must be shown on a drawing. CIRIA good practice guide for designing for exceedance in urban drainage (C635) should be used.

- The adoption and maintenance of the drainage system must be addressed and clearly stated.
- A groundwater risk assessment should be undertaken for potential contamination for the Environment Agency's formal consideration.

6.2 Relevant Studies

Table 6.1: Relevant studies

Study	Comments
SFRA: North Wiltshire District Council Strategic Flood Risk Assessment Level 1 October 2007 (Ref. 11)	The principle aim of the SFRA was to map all forms of flood risk in order to provide an evidence base to locate new development. It also aims to provide appropriate policies for the management of flood risk, and identify the level of detail required for site-specific FRAs. The SFRA contains information and maps detailing flood sources and risks. The specific details for the area surrounding the site are given in Section 7.
SWMP: Wiltshire Council Surface Water Management Plan 2011 (Ref. 12)	The SWMP is focussed on Chippenham, Trowbridge and Salisbury. The site area is not addressed by the SWMP.

6.3 Drainage

6.3.1 Public Sewers

Sewer details have been referenced from sewer record plans obtained from Wessex Water (**Appendix D**) and from a site walkover. The plans indicate that there is a network of combined sewers around the Site.

The Surface Water in Westwells Road is collected and conveyed in pipe shown on the Wessex Water records as a 12" overflow pipe from the Fiveways Reservoir towards the low point in Westwells Road. From this low point (approximately 450m to the east of site) the surface water appears to enter the Highway drainage network. Wessex Water records show two separate Highways drains flowing from south to north beneath the residential properties to the north of Westwells Road and then open fields. These two pipes outfall to the watercourse on the northern side of Spring Lane approximately 430m north from Westwells Road.

There is a Foul Water network in Westwells Road that runs from the northeast corner of the adjacent MOD to the east site along Westwells Road.

6.3.2 Private Drainage

There is an existing onsite surface and foul water network serving the site.

The surface water from the site connects to the surrounding Wessex Water network in Westwells Road approximately 300m to the southeast of the site via a connection through the adjacent MoD and Spring Park sites.

The foul water connects to the surrounding Wessex Water network in Westwells Road via a connection running southwest to northeast across the adjacent MOD site.

7 SOURCES OF FLOOD RISK

7.1 Criteria

In accordance with NPPF ^(Ref. 1) and advice from the EA, a prediction of the flood sources and levels is required along with the effects of climate change from the present for the design life of the development (in this case assumed to be 100 years). To consider these effects of climate change, NPPF Technical Guidance Table 5 recommends consideration of a 30% increase in rainfall intensity and 20% increase in peak river flows over this timeframe.

The flood risk elements that need to be considered for any site are defined in BS 8533 as the “Forms of Flooding” and are listed as:

- Flooding from Rivers (fluvial flood risk).
- Flooding from the Sea (tidal flood risk).
- Flooding from the Land.
- Flooding from Groundwater.
- Flooding from Sewers (sewer and drain exceedance, pumping station failure etc).
- Flooding from Reservoirs, Canals and other Artificial Structures.

The following section reviews each of these in respect of the subject site.

7.2 Flooding from Rivers (Fluvial Flood Risk)

The latest EA published flood zone map (**Figure 4**) shows that the site lies within Flood Zone 1, representing a less than 1 in 1,000 year probability of flooding.

The SFRA also indicates that the site is located in Flood Zone 1.

The resultant fluvial flood risk is considered **low**.

7.2.1 Climate change

Fluvial flooding is likely to increase as a result of climate change. A greater intensity and frequency of precipitation is likely to raise river levels and increase the likelihood of a river overtopping its banks.

The overall risk of fluvial flooding is considered to be **low**.

7.3 Flooding from the Sea (Tidal Flood Risk)

The site is not considered to be at risk from tidal flooding due to its inland location.

The resultant tidal flood risk is considered **low**.

7.4 Flooding from the Land (Surface Water Flood Risk)

Intense rainfall can create conditions where the local infiltration and drainage capacity is insufficient to cope with the volume of water and so water flows overland. Surface water flooding can also occur due to a reduction in the capacity of a drainage system due to some form of blockage.

Figure 5 shows the EA's surface water flood map. This indicated that the majority of the site is not at risk of surface water flooding with a few small areas indicated to be at low risk. Westwells Road to the north of the site is shown to be at medium risk of surface water flooding in the vicinity of the site.

SFRA mapping indicates some historic highway flood events to the north of the site along Westwells Road. Incidents are shown at the northwest corner of the site at the intersection of Bradford Road and Westwells Road as well as further east along Westwells Road at the intersection with Park Lane. A further incident was recorded at the northeast corner of the site on Westwells Road.

Surface water flooding in Westwells Road is likely to continue within kerb and channel systems and flow west to east along Westwells Road, away from the site.

The surrounding topography east of Bradford Road generally falls from west to east. The topography on site generally falls from northeast to southwest.

The resultant overland flood risk is considered **low** to **moderate**.

7.4.1 Climate Change

Surface water flooding is likely to increase as a result of climate change in a similar ratio to fluvial flooding. Increased intensity and frequency of precipitation is likely to lead to reduced infiltration and increased overland flow.

7.5 Flooding from Groundwater

Groundwater flooding occurs when the water held underground rises to a level where it breaks the surface in areas away from usual channels and drainage pathways. Groundwater flooding typically occurs following long periods of sustained intense rainfall and is typically associated with low-lying areas underlain by permeable aquifers.

Available groundwater mapping indicates the site is underlain by Secondary A bedrock aquifer.

The SFRA does not indicate any historic groundwater flooding incidents in the areas surrounding the site.

The resultant groundwater flood risk is considered **low**.

7.5.1 Climate Change

Climate change could increase the risk of groundwater flooding as a result of increased precipitation filtering into the groundwater body. If winter rainfall becomes more frequent

and heavier, groundwater levels may increase. Higher winter recharge may however be balanced by lower recharge during the predicted hotter and drier summers. This is less likely to cause a significant change to flood risk than from other sources, since groundwater flow is not as confined. It is probable that any locally perched aquifers may be more affected, but these are likely to be isolated. The change in flood risk is likely to be low.

7.6 Flooding from Sewers

Flood events occur when the capacity of a sewer is exceeded either due to a blockage in the sewer system or excess surface water runoff entering the system.

The SFRA mapping does not indicate an historic sewerage flood events that are likely to have affected the site.

Most adopted surface water drainage networks are designed to the criteria set out in Sewers for Adoption ^(Ref. 13). One of the design parameters of which is, that sewer systems be designed such that no flooding of any part of the site occurs in a 1 in 30 year rainfall event. By definition, a 1 in 100 year event could exceed the capacity of the surrounding sewer network as well as any proposed drainage system.

When exceeded, the surcharged pipe work will lead to flooding from backed up manholes and gully connections. This will lead to immediate flooding within highways surrounding the site. Surface floodwater would most likely follow the road levels and flow away from the site to the east along Westwells Road. Due to the presence of the combined sewer running to the north of the site and the local topography, the risk of sewer flooding is considered to be **low** for the site.

7.6.1 Climate Change

The impact of climate change is likely to be negative regarding flooding from sewers. Increased rainfall and more frequent flooding put existing sewer and drainage systems under additional pressure resulting in the potential for more frequent surcharging and potential flooding. This would increase the frequency of local sewer flooding but not significant in terms of the proposed development.

7.7 Other Sources of Flooding

7.7.1 Reservoirs

Flood events can occur from a sudden release of large volumes of water from reservoirs, canals and artificial structures.

Figure 6 has been reproduced from the Reservoir Flood Risk Map on the EA website. The map provides a worst case scenario of the maximum extent of flooding that would occur in the event that a reservoir were to fail and release the water it holds. The map indicates that the site is not at risk of reservoir flooding.

The resultant flood risk is considered **low**.

Reservoirs can be managed over time, controlling inflow/outflow of water and therefore there is the capacity to control the effects of climate change. Increased rainfall has the potential to increase base flow, but this should be minimal. It is unlikely that there will be a substantial change to the risk of flooding for this site.

7.7.2 Canals

There are no Canal & River Trust owned canals within the site area.

7.7.3 Blockages of Artificial Drainage Systems

There are no known culverts in close proximity to the Site.

There is a possibility that flooding may result due to culverts and/or sewers being blocked by debris or structural failure. This can cause water to backup and result in localised flooding, as well as placing areas with lower ground levels at risk.

The risk of flooding from artificial drainage systems is considered to be **low**.

Climate change is unlikely to affect the flooding risk to the site from such blockages.

8 PLANNING CONTEXT

8.1 Application of Planning Policy

NPPF includes (Section 10) measures specifically dealing with development planning and flood risk using a sequential characterisation of risk based on planning zones and the EA Flood Map. The main study requirement is to identify the flood zones and vulnerability classification relevant to the proposed development, based on an assessment of current and future conditions.

8.2 Land Use Vulnerability

Within NPPF Technical Guidance each Flood Zone has a list of appropriate land uses dependent on vulnerability to flooding.

In applying the Sequential Test, reference is made to the following table (reproduced from Table 3 contained within NPPF):

Table 8.1: Flood Risk Vulnerability and Flood Zone ‘Compatibility’

Flood Risk Vulnerability Classification (Table D2)		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone (Table D1)	Zone 1	Appropriate	Appropriate	Appropriate	Appropriate	Appropriate
	Zone 2	Appropriate	Appropriate	Exception Test Required	Appropriate	Appropriate
	Zone 3a	Exception Test Required	Appropriate	Should not be permitted	Exception Test Required	Appropriate
	Zone 3b functional floodplain	Exception Test Required	Appropriate	Should not be permitted	Should not be permitted	Should not be permitted

With reference to Table 2 of NPPF Technical Guidance, the proposed residential development on site is classed as "Less Vulnerable" and therefore considered appropriate in Flood Zone 1.

8.3 Sequential and Exception Tests

The Sequential Test is required to assess flood risk and NPPF Technical Guidance recommends that the test be applied at all stages of the planning process to direct new development to areas with the lowest probability of flooding (Flood Zone 1).

The development proposal includes ‘more vulnerable’ residential uses to be developed on this site. With reference to Table 8.1 above, this development would be appropriate for areas within Flood Zone 1, passing the Sequential Test.

As the development satisfies the Sequential Test, the Exception Test is not required.

9 SURFACE WATER DRAINAGE ASSESSMENT

9.1 Scope

NPPF states that Sustainable Drainage Systems (SuDS) should be considered wherever practical. The use of SuDS is also encouraged by regional and local policy (see **Section 5**).

The EA confirm in their pre-application enquiry response that:

“Any outflow from the site must be limited to the maximum allowable rate, so there is no increase in the rate and/or volume of run-off, and preferably it should be reduced.

The surface water drainage system must deal with the surface water run-off from the site up to the critical 1% Annual Probability of Flooding (or 1 in a 100-year flood) event, including an allowance for climate change for the lifetime of the development. Drainage calculations must be included to demonstrate this (e.g. Windes or similar sewer modelling package calculations that include the necessary attenuation volume)”.

9.2 Pre-development Situation

As the site is predominately developed, the Modified Rational Method has been used to calculate the existing surface water runoff discharges from the site. Table 9.1 below gives the discharge values for the site:

Modified Rational Method:

$$Q = 2.78 C_v C_r i A$$

where

- 2.78 - Coefficient which accounts for the differences in units used for the inputs and the outputs of the equation
- C_v - Volumetric Runoff Coefficient - a co-efficient that describes the proportion of rainfall appearing in the surface water drainage system, assumed to be 0.95 for impermeable areas.
- C_r - Routing Coefficient - a routing co-efficient added to the Rational Method to represent runoff characteristics of a particular site or area in a more accurate manner, assumed to be 1.3 for urban areas.
- i - Rainfall Intensity (mm/h) based on a 1 hour rainfall event (taken from the Flood Estimation Handbook).
- A - is the site area (Ha).

Table 9.1 Existing Site Discharge Based upon the Rational Method

Catchment Area (m ²)	Impermeable Area (m ²)	Impermeable Percentage	Q (l/s)			
			Qbar	Q1	Q30	Q100
80,200	27,720	34.6%	125.6	65.7	280.7	397.8

As outlined in the SuDS Manual, it is appropriate to use the Modified Rational Method assumption of 100% of runoff from impermeable areas and 0% from permeable areas

9.3 Limiting Discharge for Design

Whilst the current guidelines suggest a reduction of off site discharge would be sufficient, because of the sensitive nature of the surrounding infrastructure, and also the pressures on the surrounding surface water drainage network, it is proposed to limit the post-development discharges from site to greenfield rates, in accordance with the very best industry practice, this will ensure, through the use of SuDS, that a significant reduction in off site surface water discharges will be achieved.

In terms of estimating the greenfield runoff from the site, the pro-rated IOH 124 method (Ref. 14) has been used.

In addition to this, guidance given in the Code for Sustainable Homes Technical Guide, November 2010 (Ref. 15) states:

“Where this calculation results in a peak flow rate of less than 5l/s, the limiting discharge rate may be increased up to a level of no more than 5l/s at the point of discharge from the site to reduce the risk of blockage”.

Table 9.2 Greenfield Runoff from site using the IOH124 Method

Catchment	Area (ha)	Q (l/s)			
		Qbar	Q1	Q30	Q100
Total	8.0	34.1	26.6	65.0	82.5
Per ha	1.0	4.3	3.3	8.1	10.3

Table 9.3: Limiting Discharge

Catchment	Area (ha)	Impermeable Area (ha)	Equivalent Greenfield Qbar rate (l/s)	Limiting Discharge (l/s)
Northern Area	2.1	0.7	3.0	5.0*
Southern Area	5.9	1.7	7.3	7.3
Total	8.0	2.4	10.3	12.3

**Where the calculated discharge is less than 5l/s the limit will default to a minimum of 5l/s outlined above.*

9.4 Post-Development Situation

The total impermeable area of the proposed site is estimated to be around 23,896m² (29.9% of the site), which in itself represents a decrease of 3,820m² over the existing impermeable area, and therefore a reduction in runoff rates, however, as stated above, calculations have been undertaken using greenfield runoff rates to follow best practice.

Due to the EA requirement to control surface water drainage, additional methods of surface water attenuation will be required to retain the surface volumes on site to meet EA, Code of Sustainable Drainage and planning policy guidance. In order to further improve the existing drainage regime, SuDS should be used where possible.

To calculate the potential storage requirement that would be needed on this site, the site has been assessed using the WINDES “QuickStore” calculation. Full calculations can be found in **Appendix E**. This is an approximation of the storage requirement and as such provides a range of storage volumes. These volumes can be later revised at detail design stage by the introduction of specific flow control methods.

Following the guidance from the EA and Code for Sustainable Homes technical Guidance (as for the existing site), the assumed discharge limits have been included within the quick store calculations. The site has been split into two separate catchments with the storage requirements and proposed SuDS storage for each catchment outlined below in Table 9.4

The proposed SuDS for the site include a combination of swales, permeable pavement and detention basins. The proposed SuDS features are designed to provide adequate storage to retain the 1 in 100 plus 30% climate change event. Additional areas of permeable paving and storage can potentially be provided in private parking areas and estate roads, which will potentially reduce the size of the basin features further. The proposed indicative surface water strategy is shown as **Figure 7**.

Table 9.4: SUDS Features and their Provided Volumes

Catchment	Required SuDS Storage (1 in 100 year + CC) (m ³)	Proposed SuDS Storage (m ³)
Northern Area	541	580
Southern Area	1,599	1,660
Total	2,140	2,240

The Northern Area is proposed to have a gravity discharge to 12" reservoir overflow pipe running along Westwells Road via the site entrance. The reservoir overflow pipe is known to be the primary surface water conveyance sewer in Westwells Road.

The Southern Area is proposed to be pumped from the detention basin to Westwells Road via the southern site entrance to the same 12" reservoir overflow pipe.

At full (detailed) planning/detailed design there may be an opportunity to drain a greater proportion of the site via gravity and minimise the surface water pumping requirements.

There may also be an option to drain the site via the MoD land and the Spring Park sites via gravity, however, this option has not explored in detail due to potential constraints with crossing adjacent MoD land.

10 FLOOD MITIGATION MEASURES

10.1 Overview

The proposal comprises of the demolition of the existing MoD buildings with a residential redevelopment comprising up to 180 residential units and 0.25 hectares of commercial space in Flood Zone 1, and therefore the consideration of appropriate flood mitigation measures are focused on any potential surface water flooding.

10.2 Overland Flood Flow

Overland flow is not expected to enter the site during large rainfall events as Bradford Road and Westwells Road will collect and convey surface water flows away from the site.

The use of the SuDS features as outlined in Section 9.4 will be designed to control surface water onsite for up to a 1 in 100 year plus climate change rainfall event. The proposed SuDS will also reduce any potential downstream sewer flooding associated with the site, by limiting off site discharges to mimic greenfield runoff rates.

11 SUMMARY AND CONCLUSIONS

A FRA has been undertaken for a proposed development of up to 180 residential units and 0.25 hectares of commercial space, at a site known as Rudloe No.2 located in Box, near Corsham.

This FRA complies with the NPPF and its Technical Guidance and demonstrates that flood risk from all sources has been considered in the proposed development. It is also consistent with the Local Planning Authority requirements with regard to flood risk.

The proposed development site lies in an area designated by the Environment Agency as Flood Zone 1, and is outlined to have a chance of flooding of less than 1 in 1,000 (<0.1%) in any year.

NPPF sets out a Sequential Test, which states that preference should be given to development located within Flood Zone 1. This flood risk assessment demonstrates that the requirements of the Sequential Test have been met, with the location of the site within Flood Zone 1 and 'Less Vulnerable' classification of the development.

The proposed development will decrease the amount of impermeable area on site, resulting in a decrease in the off site flood risk from surface water runoff. Additionally, on site SuDS storage is provided for all storm events up and including the 1 in 100 year climate change storm and off site surface water discharges are limited to greenfield runoff rates.

This flood risk assessment has concluded that:

- The location at which the proposed development is located within Flood Zone 1, and as such is at a very risk of flooding from fluvial sources;
- The site is far enough inland not to be at risk of any tidal flooding event;
- Flood risk from surface water is considered low at the site;
- Flood risk from other sources (groundwater, sewers, reservoirs and artificial sources) is demonstrated to be low;
- The surface water drainage strategy will incorporate SuDS features including detention basins, permeable paving and swales that will significantly reduce surface water discharge rates from the site. This will reduce the loading on existing surface water network and consequently the risk of surface water flooding downstream of the site will be reduced.

Overall, taking into account the above points, the development of the site should not be precluded on flood risk grounds.

The following conclusions and key recommendations have been taken from this FRA.

Table 11.1: Flood Risk Assessment Summary

1.	Development description and location
1a	What type of development is proposed and where will it be located? Redevelopment of the MOD Rudloe No.2 site in Box for residential and commercial use.
1b	What is its vulnerability classification? 'More vulnerable' and 'less vulnerable'.
1c	Is the proposed development consistent with the Local Development Documents? Core Policy 37: Redevelopment, conversion or change of use of redundant MoD sites
1d	Provide evidence that the Sequential Test or Exception Test has been applied in the selection of this site for this type of development? Development satisfies Sequential and Exception Tests (brownfield land, safe without increasing flood risk to adjacent properties).
2.	Definition of the flood hazard
2a	What source of flooding could affect the site? Surface Water
2b	Describe how flooding could occur? Onsite surface water flows.
2c	What are the existing surface water drainage arrangements for the site? Existing surface network draining to Westwells Road through the MOD and Spring Park sites.
3.	Probability
3a	Which flood zone is the site within? Flood Zone 1.
3b	If there is a Strategic Flood Risk Assessment covering this site, what does it show? - The SFRA confirms: - The site lies within Flood Zone 1 - Historic Highways flooding events have been recorded on Westwells Road at the intersection with Bradford Road, to the east of the intersection with Park Land and at the low point in Westwells Road.
3c	What is the probability of the site flooding taking account of the contents of the SFRA of any further site-specific assessment? Greater than a 1 in 100 year plus climate change event.
3d	What are the existing rates and volumes of run-off generated by the site? See Section 9.2.
4.	Climate Change
4a	How is flood risk at the site likely to be affected by climate change? Climate change will increase rainfall by 30%, which may result in increased surface water flows.

5.	Detailed development proposals
5a	Demonstrate, where appropriate; how land uses most sensitive to flood damage have been placed within the site that are at least risk of flooding. The entire site is located in Flood Zone 1.
6.	Flood risk management measures
6a	How will the site be protected from flooding, including the potential of climate change, over the development's lifetime? SuDS features will be designed to attenuate surface water flow on site.
7.	Off site impacts
7a	How will it be ensured that the proposed development and the measures to protect the site from flooding will not increase flood risk elsewhere? There will be a substantial reduction of impermeable area of the site and controlled discharges limited to greenfield rates. Therefore the risk of flooding is reduced even accounting for climate change effects.
8.	Residual risks
8a	What flood related risks will remain after the implementation of measures to protect the site from flooding? Any blockage of on site local sewers.
8b	How, and by whom, will these risks be managed over the lifetime of the development? - Wessex Water and Wiltshire County Council to manage public surface and foul water sewers in the surrounding areas. - Management teams to maintain on-site private drains

12 REFERENCES

1. Communities and Local Government “National Planning Policy Framework” NPPF, March 2012.
2. Communities and Local Government “Technical Guidance to the National Planning Policy Framework”, March 2012.
3. DEFRA “Interim Code of Practice for Sustainable Drainage Systems” National SUDS Working Group, July 2004.
4. BS 8533-2011 Assessing and managing flood risk in development Code of practice, November 2011.
5. RSK “Foul Drainage & Utilities Assessment”, November 2014.
6. RSK “Preliminary Risk Assessment”, May 2014.
7. Flood and Water Management Act 2010
8. Water Resources Act, 1991.
9. EU Water Framework Directive, 2000
10. Wiltshire Council “Wiltshire Core Strategy”, 2014.
11. Scott Wilson “North Wiltshire – Strategic Flood Risk Assessment Level 1” October 2007.
12. URS & Scott Wilson “Wiltshire Council - Surface Water Management Plan - Focussed on Chippenham, Trowbridge and Salisbury”, November 2011.
13. WRC “Sewers for Adoption” 7th Edition, 2012.
14. Institute of Hydrology (IoH) “Flood Estimation for small catchments” Report 124, 1994.
15. Communities and Local Government “The Code for Sustainable Homes: Setting the standard in sustainability for new homes”, February 2008.

FIGURES

Figure 1 – Site Location Map

Figure 2 – Topographic Survey and Existing Site Layout

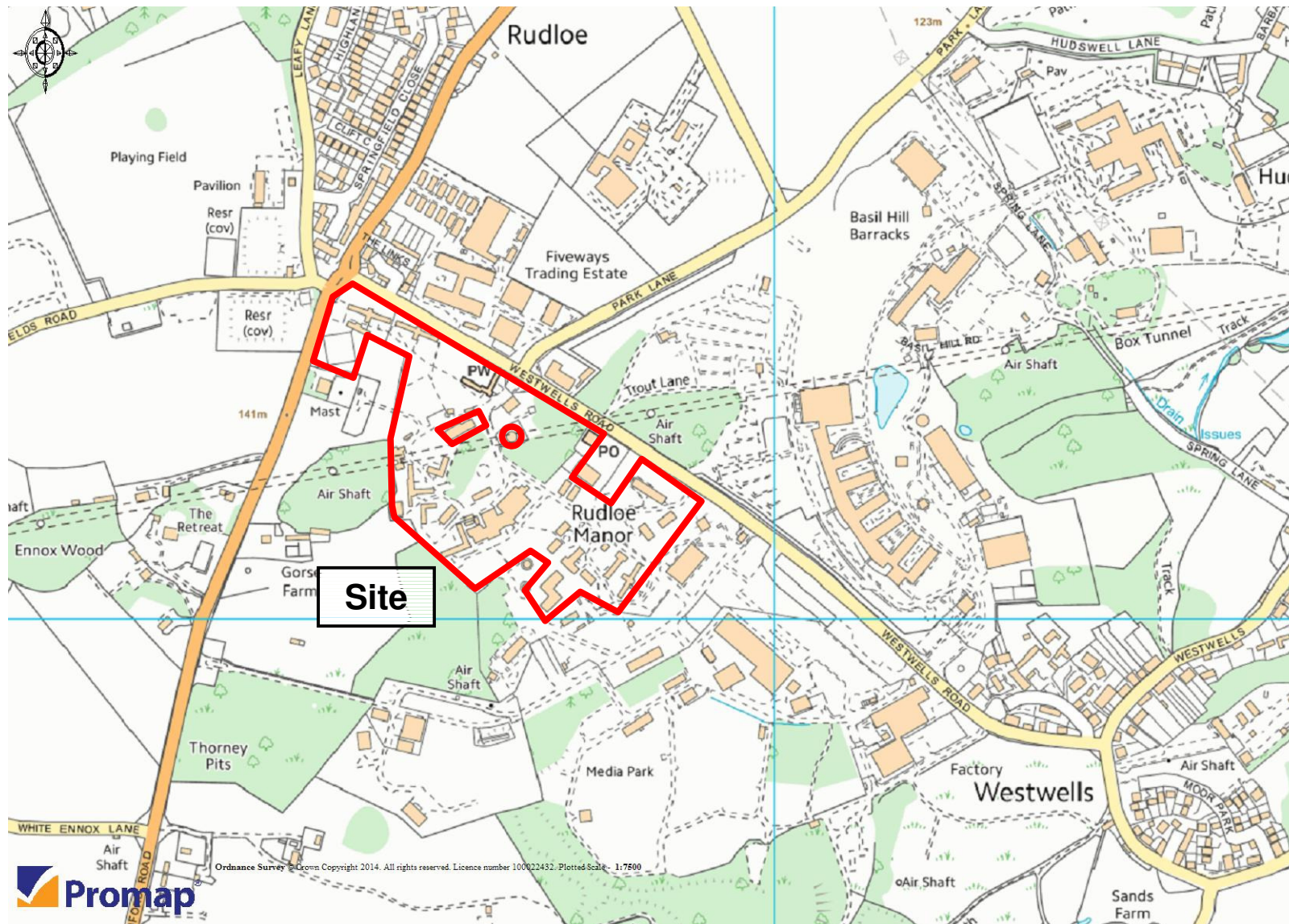
Figure 3 – Proposed Site Layout

Figure 4 – Environment Agency River and Sea Flood Map

Figure 5 – Environment Agency Surface Water Flood Map

Figure 6 – Environment Agency Reservoir Flood Map

Figure 7 – Proposed Surface Water Drainage Strategy



SITE LOCATION PLAN

Client: Inverness Terrace Ltd

Figure No: 1

Site: Rudloe Site No.2, Corsham

Job No: 132283

Scale: NTS

Source: Promap

Abnormal or unusual residual risks associated with the design outcomes shown on this drawing are:-

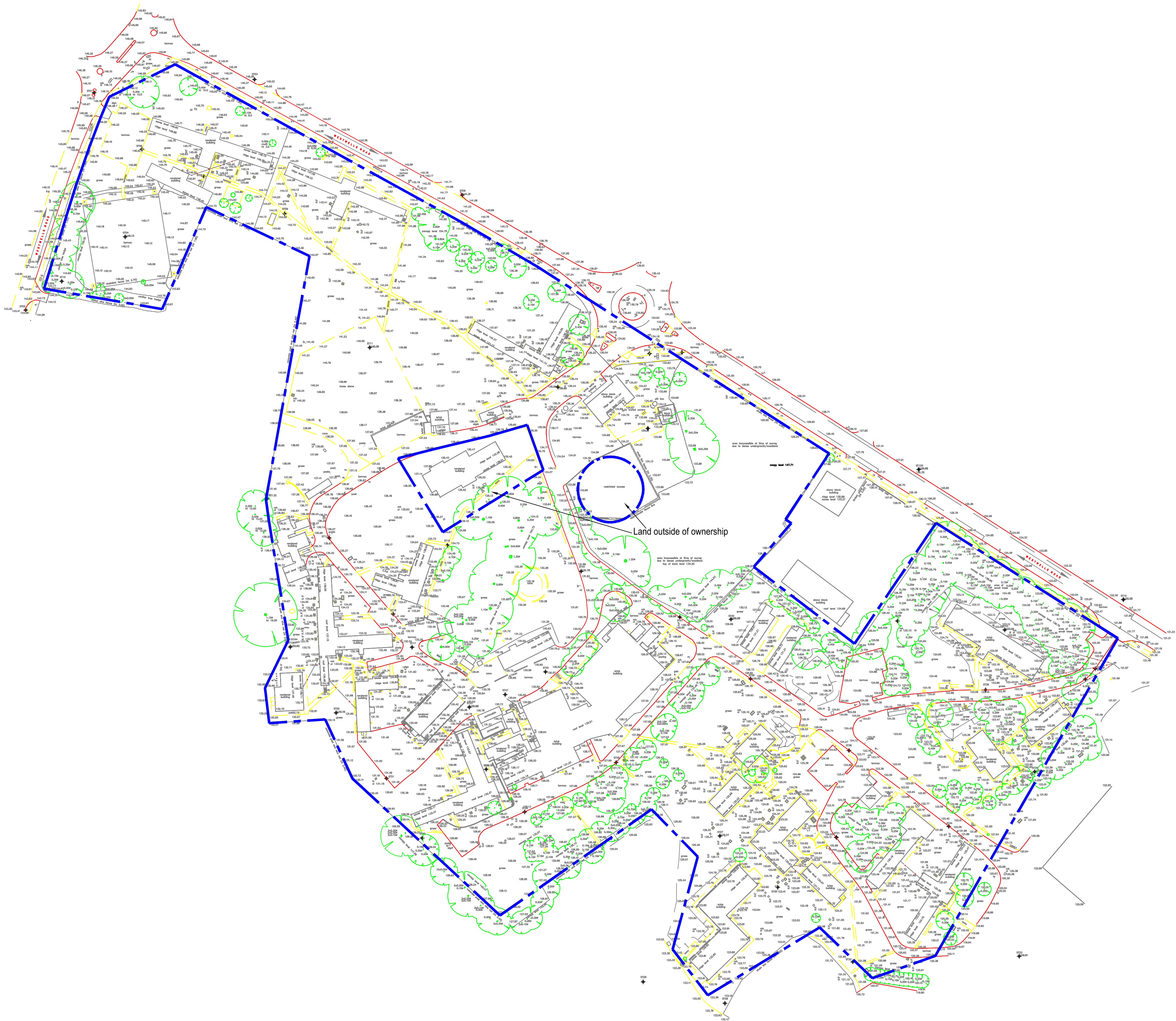
RSK LDE LTD has followed its Design Risk Management process for Hazard Elimination and Risk reduction in developing the designs shown on this drawing.
Abnormal or unusual residual risks may be shown above where it is considered that such risk may not normally be expected by competent persons engaged on work of this nature or type.

LEGEND

 SITE BOUNDARY

NOTES

TOPOGRAPHIC SURVEY CARRIED OUT BY
MIDLAND SURVEY LTD JUNE 2014



Rev.	Date	Amendment	Drawn	Chkd.	Appd.



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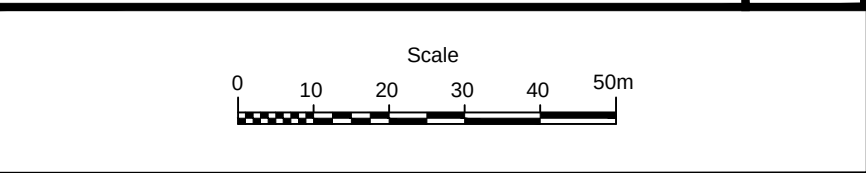
Client
INVERNESS TERRACE LTD

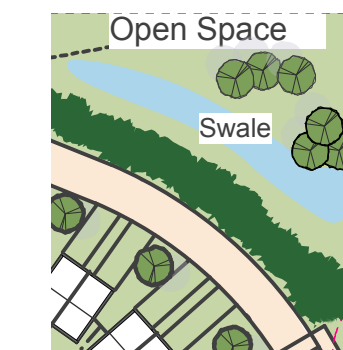
Project Title
**RUDLOE SITE NO.2
CORSHAM**

Drawing Title
**TOPOGRAPHIC SURVEY &
EXISTING SITE LAYOUT**

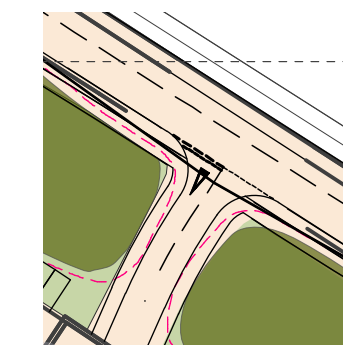
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Scale 1:1000	Orig Size A1	Dimensions M	Project No. 132283	Drawing File	

Project No. 132283	Drawing File	Rev. P2
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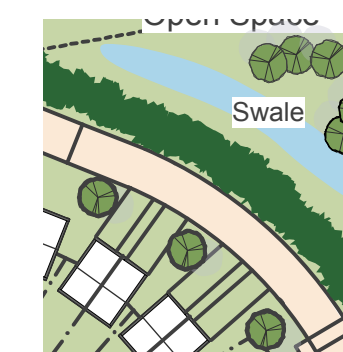




Open space provided through the design with plots overlooking to provide surveillance where required.



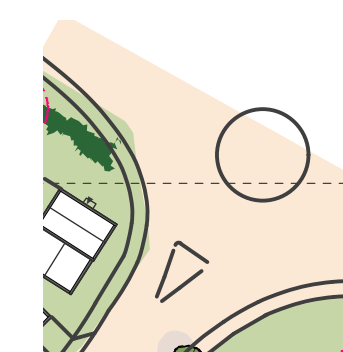
Southern site access point to be read in conjunction with WSP plans



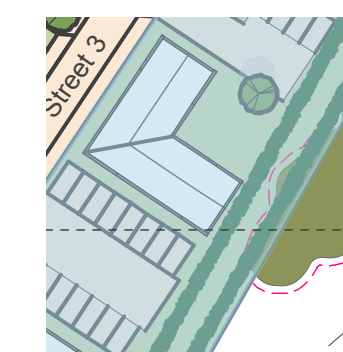
Proposed Hedgrow planting. This provides additional planting for the Bat flight paths and also provides a buffer to the development.



Low density housing proposed within the existing Greenbelt area. The total foot print of the proposed buildings does not exceed the area of the existing buildings. (Greenbelt limit identified on plan using dashed line)



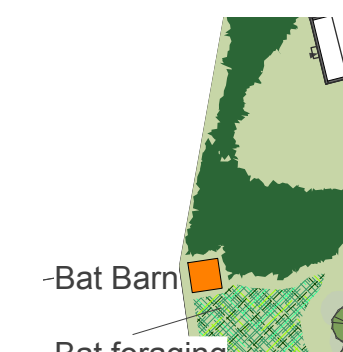
Northern Site Access Point, to be read in conjunction with WSP plans



Proposed Employment use Area (Approx 0.6 acre)
2 Storey B1 use buildings, equating to 1,100 m2



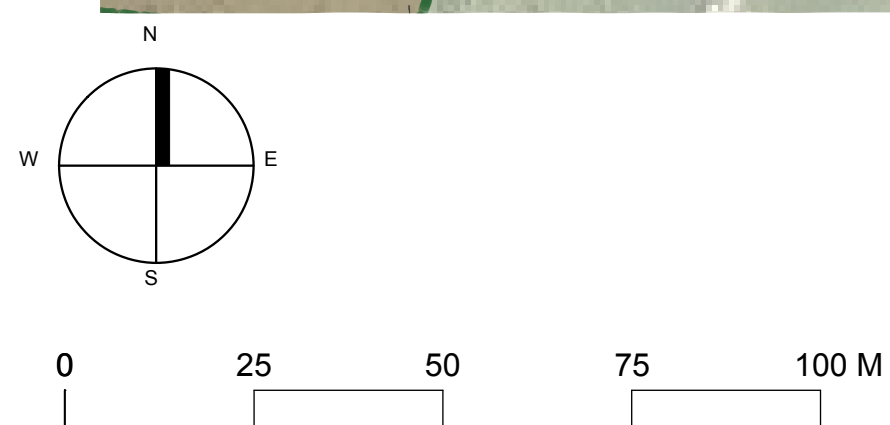
Existing Fire Building and Air Shaft to be retained. New access point provided for fire building. Boundary to fire building to be erected at approx 2m in height.



Bat Barns to be located within the central open space

Figure 3 - Proposed Site Layout

RUDLOE No 2 - Figure 2 - Indicative Masterplan Pegasus Urban Design



Map legend

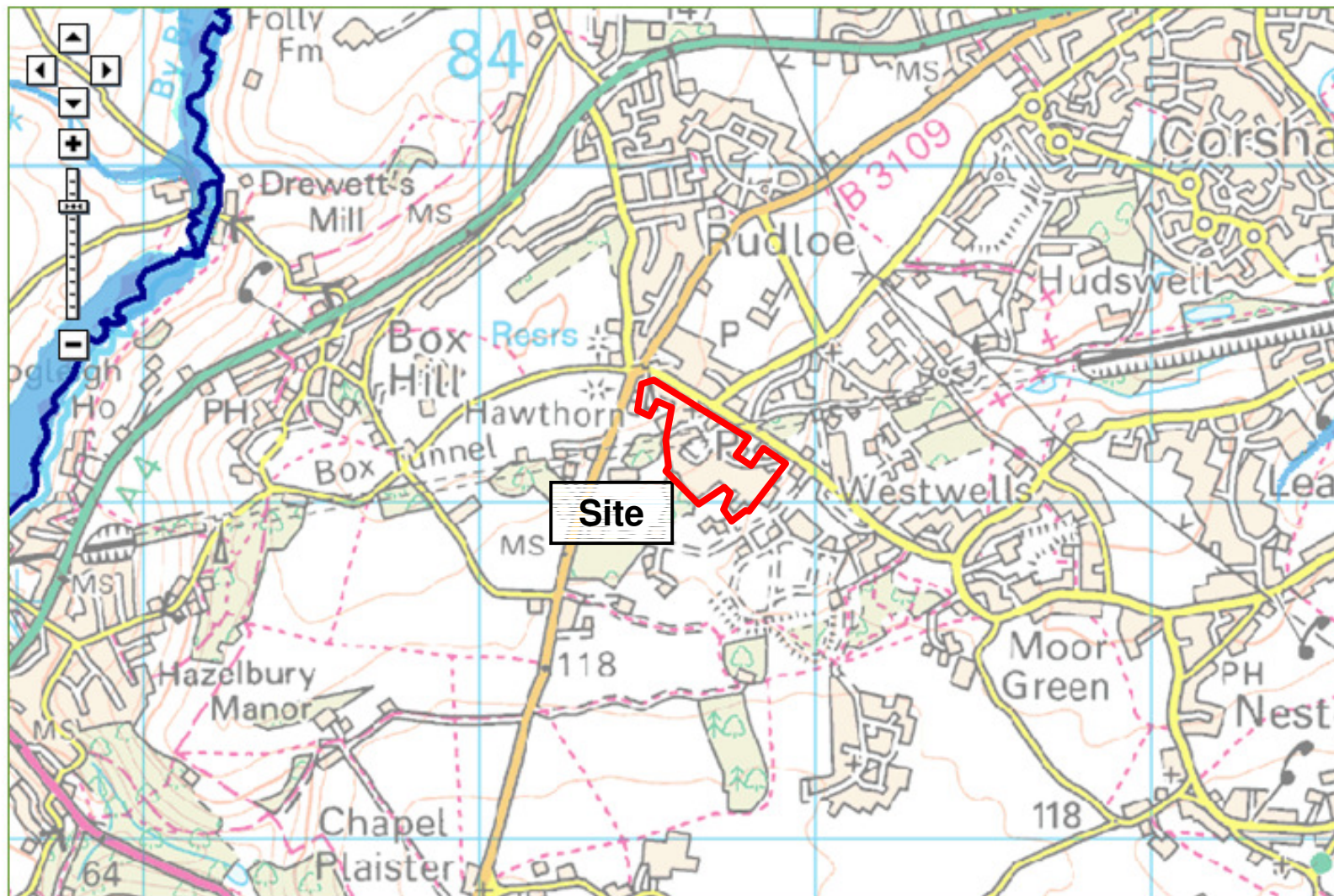
Click on the map to see what Flood Zone (National Planning Policy Guidance definitions) the proposed development is in.

☐ Flood Map for Planning (Rivers and Sea) 

-  Flood Zone 3
-  Flood Zone 2
-  Flood defences (Not all may be shown*)
-  Areas benefiting from flood defences (Not all may be shown*)
-  Main rivers

SN13 9RA at scale 1:20,000

[Other maps](#)  [Data search](#)  [Text only version](#) 



Environment Agency River and Sea Flood Map

Client: Inverness Terrace Ltd

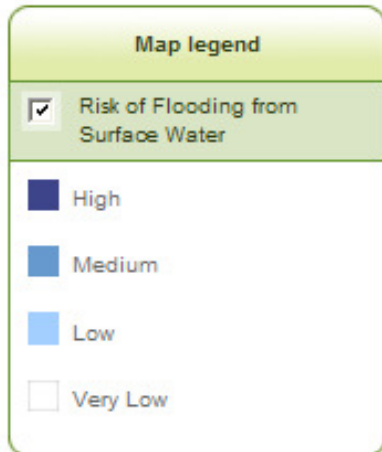
Figure No: 4

Site: Rudloe Site No.2, Corsham

Job No: 132283

Scale: NTS

Source: EA website

Data search 

Environment Agency Surface Water Flood Map

Client: Inverness Terrace Ltd

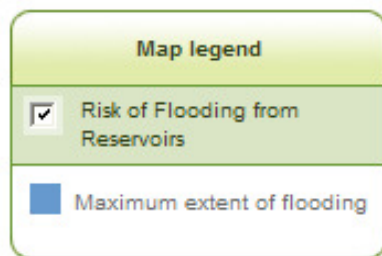
Figure No: 5

Site: Rudloe Site No.2, Corsham

Job No: 132283

Scale: NTS

Source: EA website



Map of X: 384,505; Y: 168,979 at scale 1:10,000

Data search 

Environment Agency Reservoir Flood Map

Client: Inverness Terrace Ltd

Figure No: 6

Site: Rudloe Site No.2, Corsham

Job No: 132283

Scale: NTS

Source: EA website

Abnormal or unusual residual risks associated with the design outcomes shown on this drawing are:-

RSK LDE LTD has followed its Design Risk Management process for Hazard Elimination and Risk reduction in developing the designs shown on this drawing. Abnormal or unusual residual risks may be shown above where it is considered that such risk may not normally be expected by competent persons engaged on work of this nature or type.

LEGEND

- SITE BOUNDARY
- PROPOSED SURFACE WATER SEWER
- PROPOSED SURFACE WATER RISING MAIN

NOTES

ARCHITECTURAL LAYOUT - PEGASUS
DRAWING YOR.2233_11 REVISION G

SURFACE WATER DESIGN IS INDICATIVE ONLY AND IS SUBJECT TO DETAILED DESIGN

Rev.	Date	Amendment	Drawn	Chkd.	Appd.



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Client

INVERNESS TERRACE LTD

Project Title

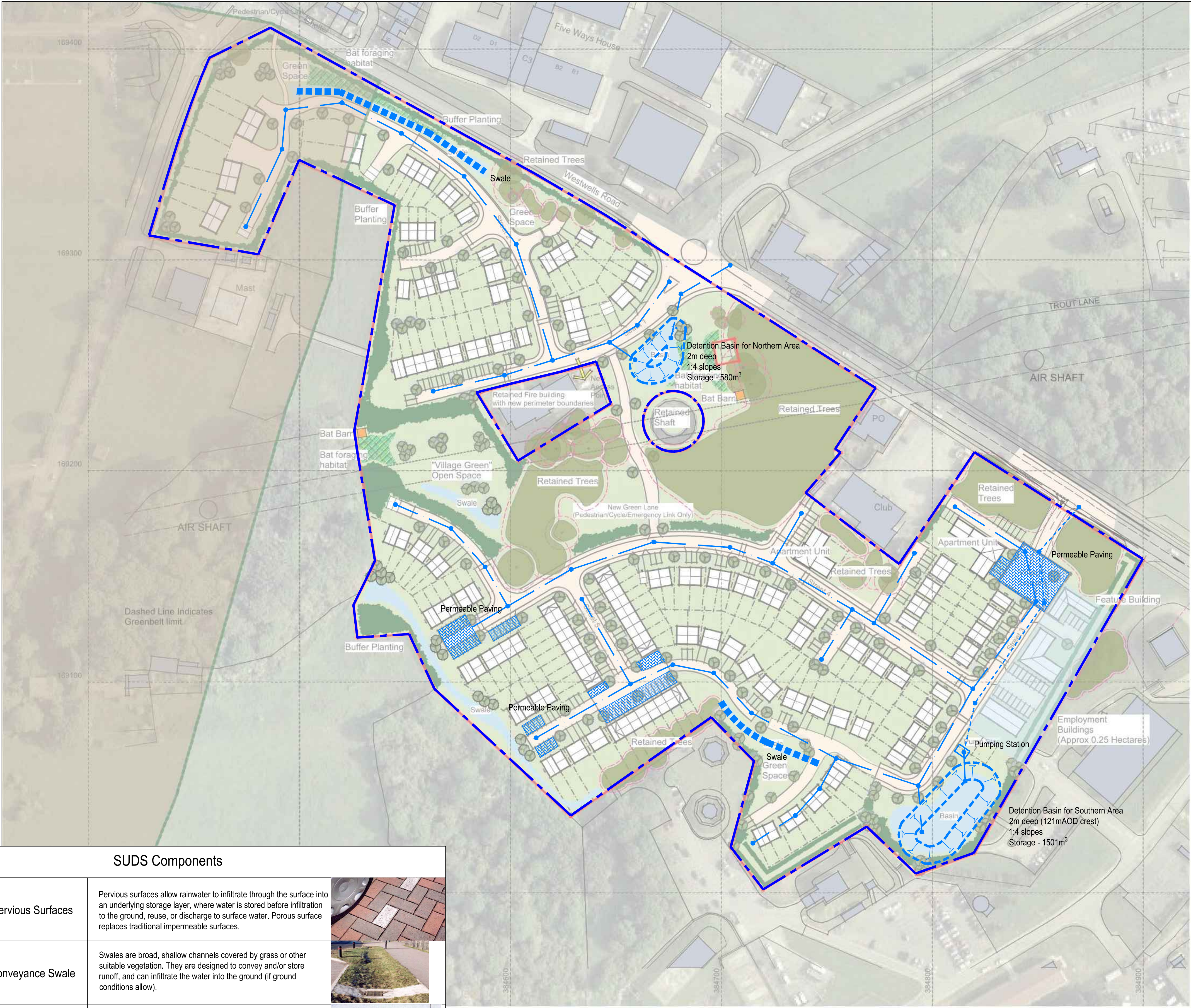
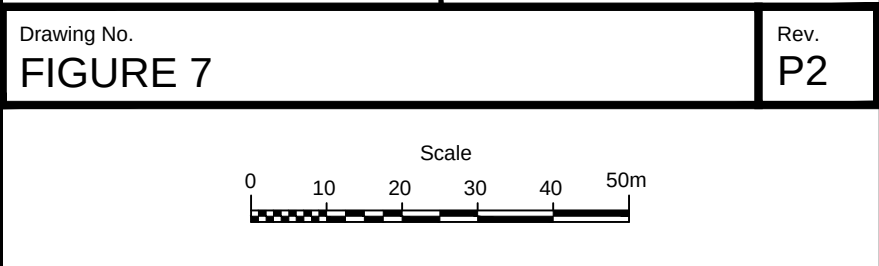
RUDLOE SITE NO.2
CORSHAM

Drawing Title

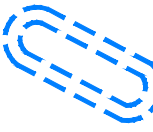
INDICATIVE SURFACE WATER
DRAINAGE STRATEGY

Drawn	Date	Checked	Date	Approved	Date
SR	24/11/14	MC	25/11/14	MC	25/11/14
Scale	1:1000	Orig Size	A1	Dimensions	m

Project No. 132283	Drawing File
Drawing No. FIGURE 7	Rev. P2



SUDS Components

1		Pervious Surfaces	Pervious surfaces allow rainwater to infiltrate through the surface into an underlying storage layer, where water is stored before infiltration to the ground, reuse, or discharge to surface water. Porous surface replaces traditional impermeable surfaces.	
2		Conveyance Swale	Swales are broad, shallow channels covered by grass or other suitable vegetation. They are designed to convey and/or store runoff, and can infiltrate the water into the ground (if ground conditions allow).	
3		Detention Basin	Dry, vegetated surface basins that attenuate stormwater by providing temporary storage and controlled release of detained runoff.	

APPENDIX A

Service constraints



RSK GROUP
SERVICE CONSTRAINTS

1. This report and the Drainage design carried out in connection with the report (together the "Services") were compiled and carried out by RSK LDE Ltd (RSK) for Inverness Terrace Ltd (the "client") in accordance with the terms of a contract between RSK and the "client" dated May 2014. The Services were performed by RSK with the skill and care ordinarily exercised by a reasonable Civil Engineer at the time the Services were performed. Further, and in particular, the Services were performed by RSK taking into account the limits of the scope of works required by the client, the time scale involved and the resources, including financial and manpower resources, agreed between RSK and the client.
2. Other than that expressly contained in paragraph 1 above, RSK provides no other representation or warranty whether express or implied, in relation to the Services.
3. Unless otherwise agreed the Services were performed by RSK exclusively for the purposes of the client. RSK is not aware of any interest of or reliance by any party other than the client in or on the Services. Unless expressly provided in writing, RSK does not authorise, consent or condone any party other than the client relying upon the Services. Should this report or any part of this report, or otherwise details of the Services or any part of the Services be made known to any such party, and such party relies thereon that party does so wholly at its own and sole risk and RSK disclaims any liability to such parties. Any such party would be well advised to seek independent advice from a competent environmental consultant and/or lawyer.
4. It is RSK's understanding that this report is to be used for the purpose described in the introduction to the report. That purpose was a significant factor in determining the scope and level of the Services. Should the purpose for which the report is used, or the proposed use of the site change, this report may no longer be valid and any further use of or reliance upon the report in those circumstances by the client without RSK's review and advice shall be at the client's sole and own risk. Should RSK be requested to review the report after the date hereof, RSK shall be entitled to additional payment at the then existing rates or such other terms as agreed between RSK and the client.
5. The passage of time may result in changes in site conditions, regulatory or other legal provisions, technology or economic conditions which could render the report inaccurate or unreliable. The information and conclusions contained in this report should not be relied upon in the future without the written advice of RSK. In the absence of such written advice of RSK, reliance on the report in the future shall be at the client's own and sole risk. Should RSK be requested to review the report in the future, RSK shall be entitled to additional payment at the then existing rate or such other terms as may be agreed between RSK and the client.
6. The observations and conclusions described in this report are based solely upon the Services, which were provided pursuant to the agreement between the client and RSK. RSK has not performed any observations, investigations, studies or testing not specifically set out or required by the contract between the client and RSK. RSK is not liable for the existence of any condition, the discovery of which would require performance of services not otherwise contained in the Services. For the avoidance of doubt, unless otherwise expressly referred to in the introduction to this report, RSK did not seek to evaluate the presence on or off the site of asbestos, electromagnetic fields, lead paint, heavy metals, radon gas or other radioactive or hazardous materials.
7. The Services are based upon RSK's observations of existing physical conditions at the Site gained from a walk-over survey of the site together with RSK's interpretation of information including documentation, obtained from third parties and from the client on the history and usage of the site. The Services are also based on information and/or analysis provided by independent testing and information services or laboratories upon which RSK was reasonably entitled to rely. The Services clearly are limited by the accuracy of the information, including documentation, reviewed by RSK and the observations possible at the time of the walk-over survey. Further RSK was not authorised and did not attempt to independently verify the accuracy or completeness of information, documentation or materials received from the client or third parties, including laboratories and information services, during the performance of the Services. RSK is not liable for any inaccurate information or conclusions, the discovery of which inaccuracies required the doing of any act including the gathering of any information which was not reasonably available to RSK and including the doing of any independent investigation of the information provided to RSK save as otherwise provided in the terms of the contract between the client and RSK.

8. The phase II or intrusive environmental site investigation aspects of the Services is a limited sampling of the site at pre-determined borehole and soil vapour locations based on the operational configuration of the site. The conclusions given in this report are based on information gathered at the specific test locations and can only be extrapolated to an undefined limited area around those locations. The extent of the limited area depends on the soil and groundwater conditions, together with the position of any current structures and underground facilities and natural and other activities on site. In addition chemical analysis was carried out for a limited number of parameters [as stipulated in the contract between the client and RSK] [based on an understanding of the available operational and historical information,] and it should not be inferred that other chemical species are not present.

9. Any site drawing(s) provided in this report is (are) not meant to be an accurate base plan, but is (are) used to present the general relative locations of features on, and surrounding, the site.

APPENDIX B

NPPF Technical Guidance Note

Site-specific Flood Risk Assessments (FRAs)

As set out in the National Planning Policy Framework, local planning authorities should only consider development in flood risk areas appropriate where informed by a site-specific flood risk assessment. This should identify and assess the risks of all forms of flooding to and from the development and demonstrate how these flood risks will be managed so that the development remains safe throughout its lifetime, taking climate change into account. Those proposing developments should take advice from the emergency services when producing an evacuation plan for the development as part of the flood risk assessment.

BS 8533-2011 Assessing and managing flood risk in development Code of practice, Nov 2011

Assessing the risk of flooding

4.1 General

A detailed, development-based flooding investigation should be undertaken to determine:

- a) the likelihood and consequence of flooding in and around the development, from all sources,
- b) how the development might alter the existing flooding regime, potentially increasing the risk of flooding elsewhere; and
- c) the design measures needed to manage the risk of flooding in and around the development.

NOTE a detailed, development-based flooding investigation to be prepared and submitted to the planning authority as part of the planning application. By producing the flood investigation at such an early stage, it can be used to influence the conceptual layout and design of the development and reduce (or avoid) the risk of flooding.

4.2 Site information

Before undertaking a detailed assessment of the risk of flooding, information about the site and surroundings should be obtained, including:

- a) details of existing infrastructure (e.g. reservoirs, canals, culverts, flood risk management infrastructure and/or drainage infrastructure);
- b) details of existing raised flood risk management infrastructure (e.g. the level of protection afforded by them and their condition);
- c) evidence of historical flooding;
- d) topographic mapping including local features (e.g. boundary walls and hedges);
- e) information on site ground conditions.

Assessing the risk of flooding to the development site and beyond

The risk of flooding associated with a proposed development should be assessed as the combination of the likelihood of flooding and its consequence. The following factors should be assessed:

- a) how likely, and to what extent, the site might flood and the nature of that flood hazard;
- b) the consequence of flooding (e.g. damage to property, injury to people or loss of life); and
- c) the impact that the development could have on flooding elsewhere.

The assessment of flood risk should quantify the risk of flooding, both to and from the site, from the following:

- 1) tidal and fluvial flooding
- 2) surface water flooding
- 3) flooding due to surcharging of sewers and drains
- 4) groundwater flooding
- 5) flooding caused by the failure of infrastructure

Interim Code of Practice for Sustainable Drainage Systems

Drainage impact assessments

The drainage impact assessment (DIA) or drainage assessment (DA) will ensure that consideration is given to the impact of the proposed development on the catchment. It should be submitted with the first planning application for developments that require waste or surface water to be drained.

The DIA is site-specific, and guidance on the completion of the assessment recommends the implementation of a drainage system that provides the best environmental protection and states that SUDS is the preferred method of surface water drainage.

The basic requirements for a drainage impact assessment include:

- an examination of drainage patterns including overland flood pathways during extreme events
- concept drawing of the development proposal
- brief summary of how the drainage design provides SUDS techniques (in accordance with CIRIA guidance)
- summary of SUDS to be incorporated
- soil classification for the site
- evidence of soil porosity sites (where possible at site of infiltration devices)
- consideration of ground and groundwater conditions
- calculation for runoff flow for the range of critical rainfall events
- attenuation and treatment designed for a relevant return period rainfall events
- wastewater drainage proposals
- confirmation of maintenance responsibility
- copy of letter from sewerage undertaker giving location of nearest public sewer and confirmation of their availability for servicing the site.

APPENDIX C

Environment Agency Correspondence

Mr. Sam Reed
RSK
18 Frogmore Road Industrial Estate
Frogmore Road
Hemel Hempstead
Hertfordshire
HP3 9RT

Our ref: WX/2014/125995/01-L01
Your ref: Westwells Road, Corsham
Date: 10 June 2014

Dear Mr. Reed

DEVELOPMENT OF APPROXIMATELY 200 DWELLINGS WESTWELLS ROAD, CORSHAM, WILTS

Thank you for your email of 20 May requesting a preliminary opinion on the above proposed development. I can offer the following advice.

Groundwater Protection

The site falls within a groundwater Source Protection Zone 2 (SPZ2). This is a zone of protection surrounding a nearby drinking water borehole, which is vulnerable to pollution. It therefore requires careful protection from contamination. Further information on SPZs can be found at <http://www.environment-agency.gov.uk/homeandleisure/37833.aspx>

Groundwater Protection / Contaminated Land

We note that historic use of the site may have caused contamination.

National Planning Policy Framework (NPPF) paragraph 109 states that the planning system should contribute to and enhance the natural and local environment by preventing both new and existing development from contributing to, or being put at risk from unacceptable levels of water pollution. Government policy also states that planning policies and decisions should ensure that adequate site investigation information, prepared by a competent person, is presented.

Therefore, we advise you to consult with the Local Authority's Environmental Health Department in accordance with National Planning Policy Framework Paragraphs 109 & 120. You should also undertake a groundwater risk assessment of the potential for contamination, for the Environment Agency's formal consideration. Further guidance on what should be contained in the assessment and issues associated with groundwater protection can be found in our Groundwater Protection Policy document (GP3) which can be found at: <https://www.gov.uk/government/publications/groundwater-protection-principles-and-practice-gp3>

GP3 is intended to be used by anyone interested in groundwater and in particular those wanting to undertake activities which have the potential to impact on groundwater.

Surface Water Management

As the site is greater than 1 hectare in size any future planning application must be accompanied by a Flood Risk Assessment (FRA) which focuses on the sustainable management of surface water runoff.

Surface water run-off should be controlled as near to its source as possible with sustainable drainage systems (SuDS). This reduces flood risk through the use of soakaways, infiltration trenches, permeable pavements, grassed swales, ponds etc. SuDS can also increase groundwater recharge, improve water quality and provide amenity opportunities. A SuDS approach is encouraged by Approved Document Part H of the Building Regulations 2000.

The surface water drainage scheme for the proposed development must meet the following criteria:

1. Any outflow from the site must be limited to the maximum allowable rate, so there is no increase in the rate and/or volume of run-off, and preferably it should be reduced.
2. The surface water drainage system must deal with the surface water run-off from the site up to the critical 1% Annual Probability of Flooding (or 1 in a 100-year flood) event, including an allowance for climate change for the lifetime of the development. Drainage calculations must be included to demonstrate this (e.g. Windes or similar sewer modelling package calculations that include the necessary attenuation volume).
3. If there is any surcharge and flooding from the system, overland flood flow routes and "collection" areas on site (e.g. car parks, landscaping) must be shown on a drawing. CIRIA good practice guide for designing for exceedance in urban drainage (C635) should be used.
4. The adoption and maintenance of the drainage system must be addressed and clearly stated.

Pollution Prevention During Construction

Safeguards should be implemented during the construction phase to minimise the risks of pollution and detrimental effects to the water interests in and around the site.

Such safeguards should cover the use of plant and machinery, oils/chemicals and materials; the use and routing of heavy plant and vehicles; the location and form of work and storage areas and compounds and the control and removal of spoil and wastes. We recommend the applicant refer to our Pollution Prevention Guidelines, which can be found at:

<http://www.environment-agency.gov.uk/business/topics/pollution/39083.aspx>.

Water Efficiency

We will expect each dwelling in the development to use no more than 105 litres of water per person per day. This is because the catchment in which the site sits, the Hampshire Avon River, is over abstracted. This is also supported by local planning policy.

Waste Management

Should this proposal be granted planning permission, then in accordance with the waste hierarchy, we wish the applicant to consider reduction, reuse and recovery of waste in preference to offsite incineration and disposal to landfill during site construction.

If any controlled waste is to be removed off site, then site operator must ensure a registered waste carrier is used to convey the waste material off site to a suitably authorised facility.

In England, it is a legal requirement to have a site waste management plan (SWMP) for all new construction projects worth more than £300,000. The level of detail that your SWMP should contain depends on the estimated build cost, excluding VAT. You must still comply with the duty of care for waste. Because you will need to record all waste movements in one document, having a SWMP will help you to ensure you comply with the duty of care. Further information can be found at <http://www.netregs.co.uk>

Charging for further pre-planning advice

We now charge for further technical input into areas of the planning process, beyond the environmental issues identified above. Our charged advice is provided through a formal agreement made up of an offer letter, a programme of advice and [standard terms and conditions](#). We will discuss the advice you need with you, and agree a programme to specify the tasks that will be carried out.

The programme will also give the approximate timetable and cost for the advice. The programme can be varied by written agreement for any changes that need to be made. Charges are based on cost recovery and have been set at £84 per hour.

Please use the form below and detail the documents that you wish us to comment on for the estimation / programme.

Please note that the view expressed in this letter is in response to an 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 should new information, or updates to guidance occur, in relation to any such application.

You should seek your own expert advice in relation to technical matters relevant to any planning application before submission

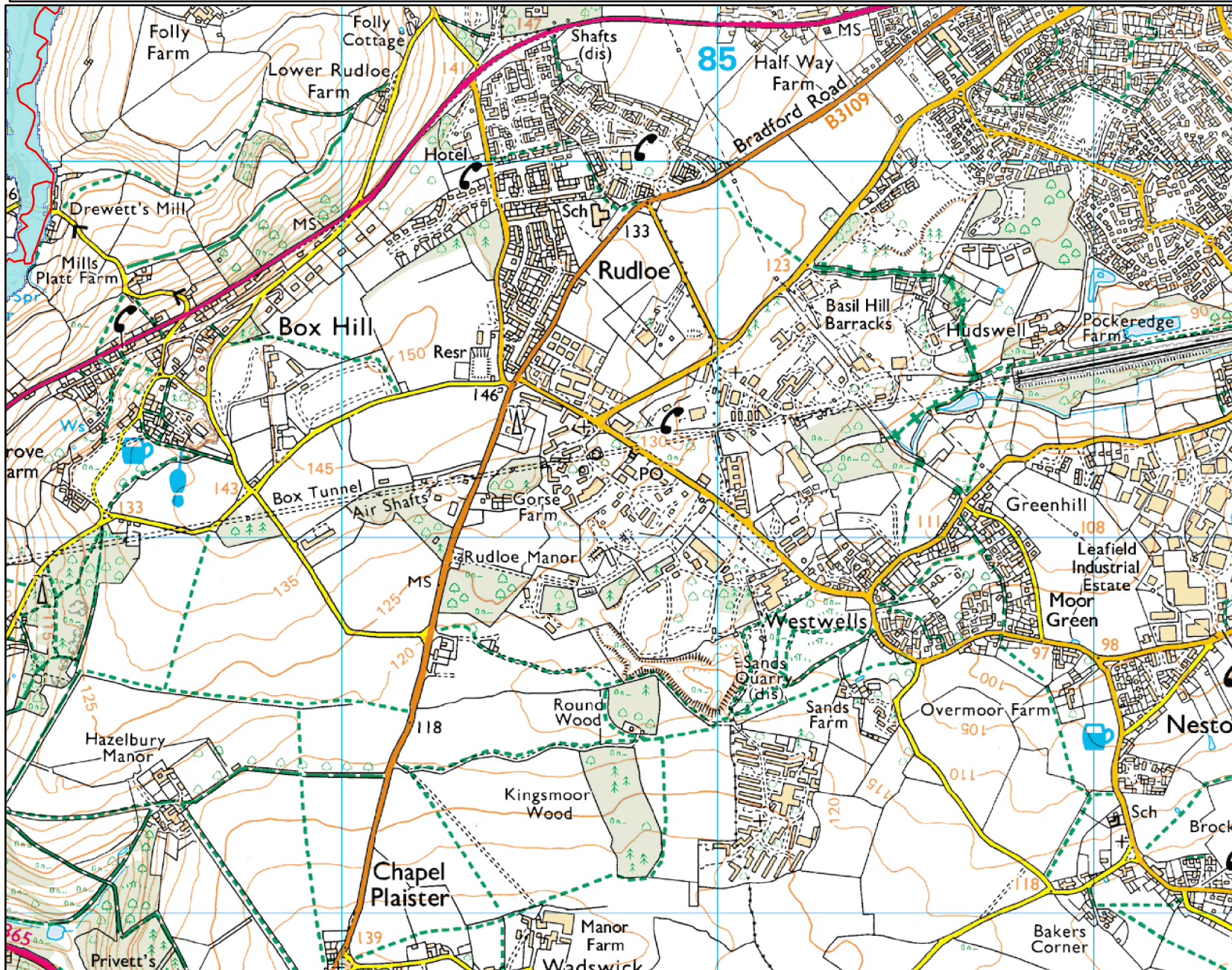
Yours sincerely

Ms Ellie Challans
Sustainable Places - Planning Advisor

Direct dial [REDACTED]

E-mail [REDACTED]

SW/6660 Flood Map for Planning centred on land at Westwells Road Corsham. Created 17 June 2014



Scale 1:10,000



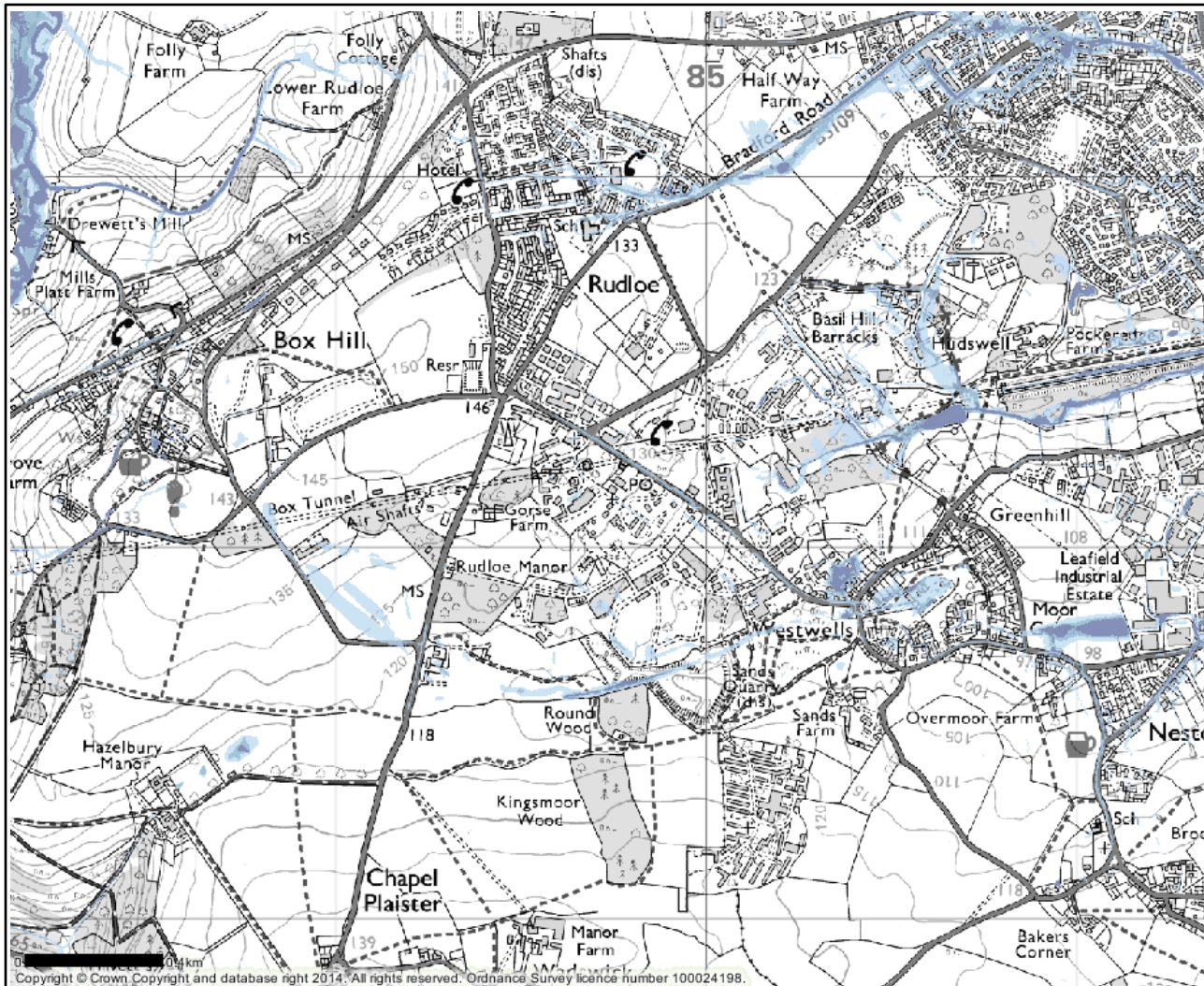
Legend

-  Areas Benefiting from Flood Defences
-  Flood Map - Flood Zone 3
-  Flood Map - Flood Zone 2

Flood Map Areas
(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.

Risk of flooding from Surface Water centred on land at Westwells, Corsham

Created 17 June 2014 (SW6660)



Likelihood of Flooding from Surface Water

- High
- Medium
- Low
- Very Low

Likelihood of Flooding from Surface Water

- High: Greater than or equal to 1 in 30 (3.3%) chance in any given year
- Medium: Less than 1 in 30 (3.3%) but greater than or equal to 1 in 100 (1%) chance in any given year
- Low: Less than 1 in 100 (1%) but greater than or equal to 1 in 1,000 (0.1%) chance in any given year
- Very Low: Less than 1 in 1,000 (0.1%) chance in any given year

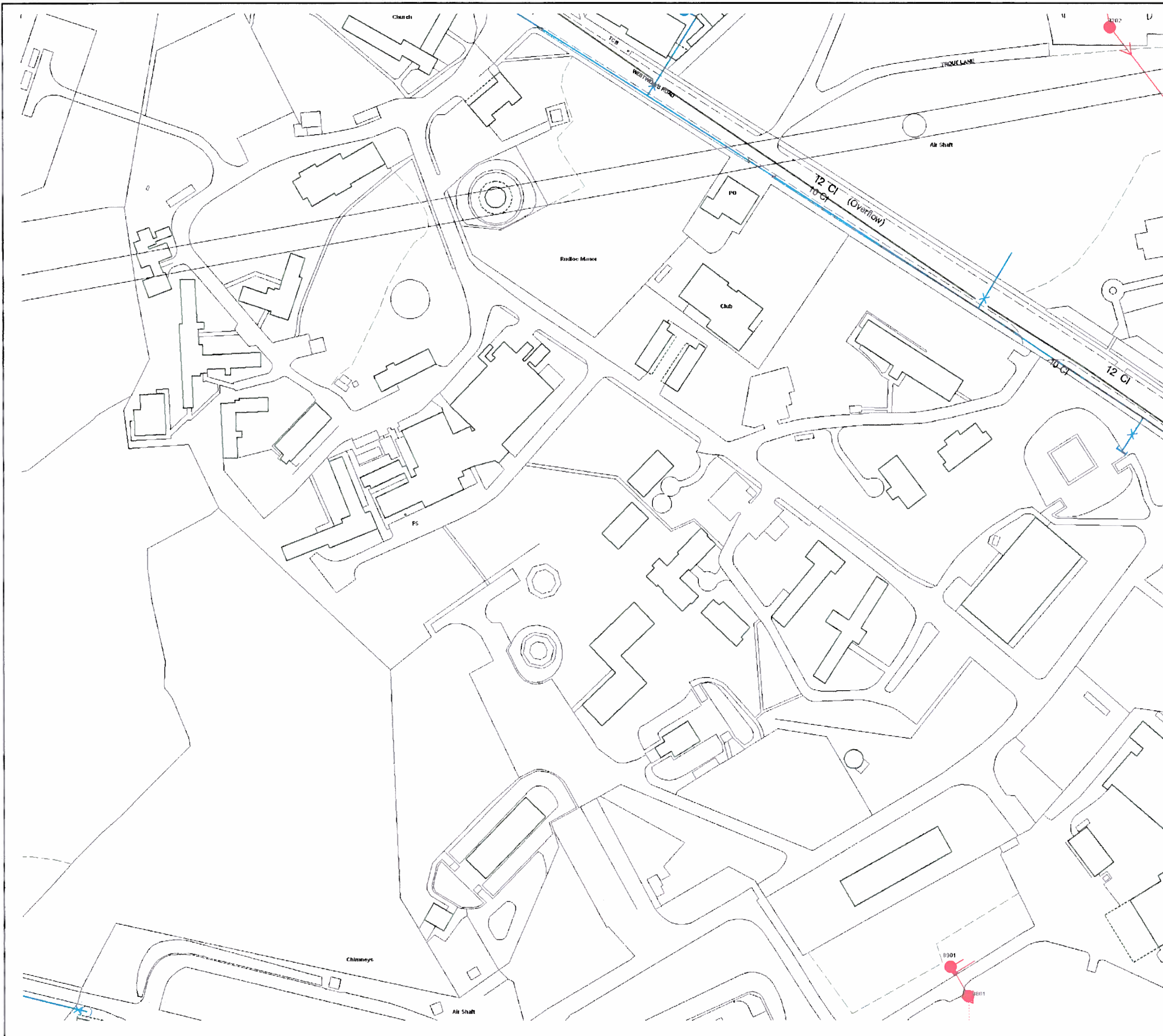
This information is shown on the Risk of Flooding from Surface Water map on our website.

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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

APPENDIX D

Wessex Water Records and Correspondence



Former MoD site

Corsham, Wilts

Printed on : 20/05/2014 16:13

WATER MAINS		Public	Private
Public		—	---
Raw Water		---	---
Abandoned		---	---
Valve	X	Hydrant	PRV
			Meter
SEWERS		Public	Section 104 - Private
Foul		---	---
Combined		---	---
Surface		---	---
Abandoned sewers		X	X
OTHER WESSEX PIPES			
Rising Mains		---	---
Effluent Disposal Main		---	---
Overflow		---	---
NON-WESSEX PIPES			
Private Rising Mains		---	---
Culverted Water Course		---	---
Highway Drain		---	---

Information in this plan is provided for identification purposes only. No warranty as to accuracy is given or implied. The precise route of pipe work may not exactly match that shown. Wessex Water does not accept liability for inaccuracies.

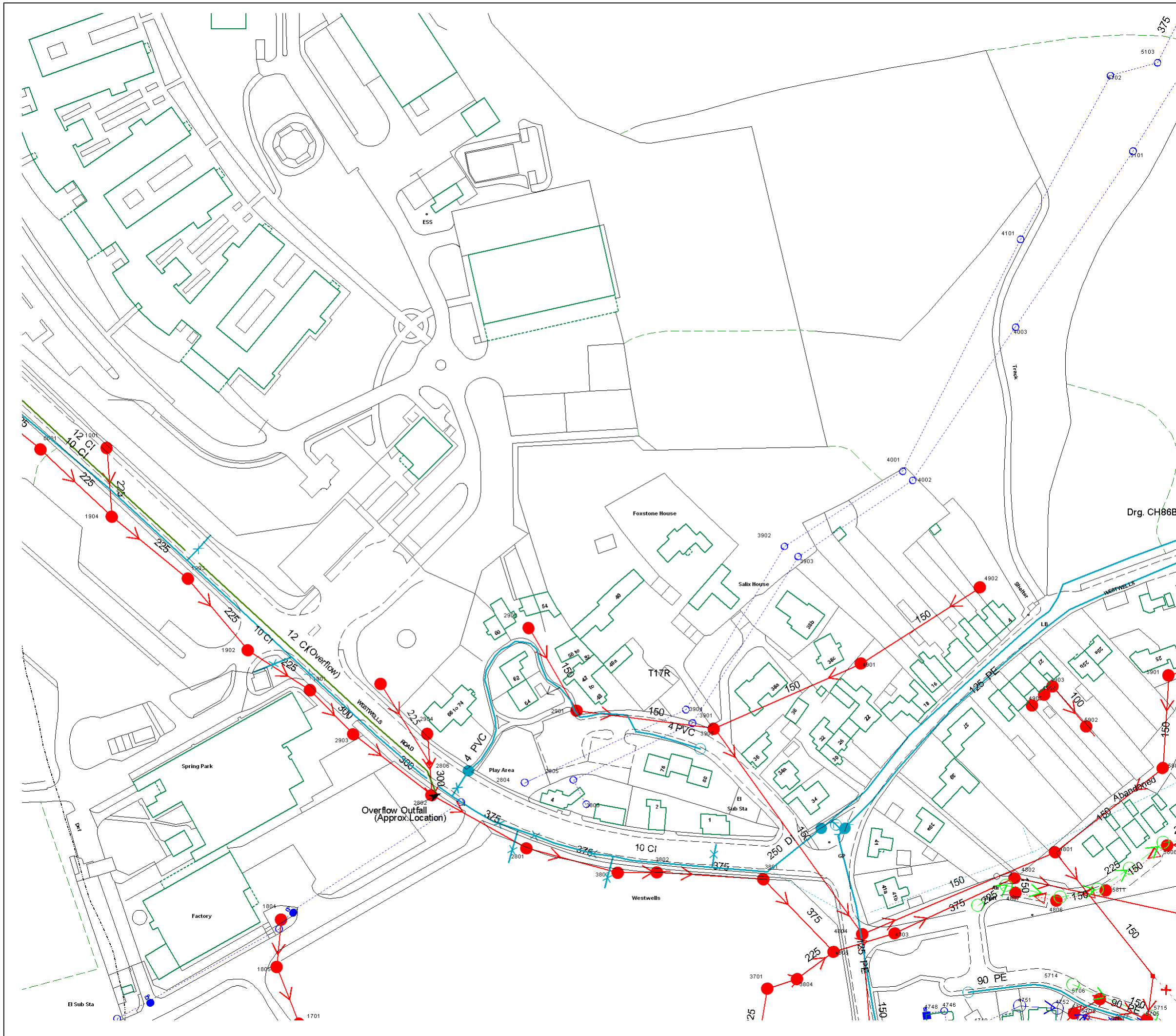
Sewers and lateral drains adopted by Wessex Water under the Water Industry (Schemes for Adoption of Private Sewers) Regulations 2011 are to be plotted over time and may not yet be shown.

In carrying out any works, you accept liability for the cost of any repairs to Wessex Water apparatus damaged as a result of your works. You are advised to commence excavations using hand tools only. Mechanical digging equipment should not be used until pipe work has been precisely located.

If you are considering any form of building works and pipe work is shown within the boundary of your property or a property to be purchased (or very close by) a surveyor should plot its exact position prior to commencing works or purchase. Building over or near Wessex Water's apparatus is not normally permitted.

Centre: 384718.82, 169093.07

Scale = 1:1500
Metres 20 40 60 80





Rudloe Site No.2

Corsham, Wilts

Printed on : 10/09/2014 14:25

WATER MAINS Public Private

Public ———— ————

Raw Water ————

Abandoned - - - - -

Valve X Hydrant ● PRV Meter M

SEWERS Public - Section 104 - Private

Foul ———— ————

Combined ———— ————

Surface ———— ————

Abandoned sewers * * * * *

OTHER WESSEX PIPES

Rising Mains ————

Effluent Disposal Main ————

Overflow ————

NON-WESSEX PIPES

Private Rising Mains - - - - -

Culverted Water Course ————

Highway Drain ————

Information in this plan is provided for identification purposes only. No warranty as to accuracy is given or implied. The precise route of pipe work may not exactly match that shown. Wessex Water does not accept liability for inaccuracies.

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If you are considering any form of building works and pipe work is shown within the boundary of your property or a property to be purchased (or very close by) a surveyor should plot its exact position prior to commencing works or purchase. Building over or near Wessex Water's apparatus is not normally permitted.

Centre:385307.07 , 168989.31

Scale = 1:1500

Metres 20 40 60 80

Sam Reed

From: Gillian Sanders [REDACTED]
Sent: 03 July 2014 11:55
To: Sam Reed
Subject: WW Resp: ST86NW/ 127 Rudloe No.2 Site, Westwells Road, Corsham 160/ 170 dwellings

Dear Sam,

Thank you for providing a copy of the presentation slides.

Fiveways consists of two, two compartment reservoirs with capabilities to accept supply from a number of different service reservoirs and Water Treatment Works depending upon operational needs. Water is distributed from Fiveways to systems including Corsham, Rudloe, Lacock, Bradford on Avon and Atworth. The top water level of the compartments are recorded at 151m AOD, meaning that there could be issues with serving developments in close proximity by a gravity system. We have previously network modelled known development within this area to recommend a point of connection and any boosting requirements. I will arrange for the development site to be added to the Corsham model – results will be available in between 6 – 8 weeks.

I look forward to receiving more information on surface / foul water in due course. In the meantime I can advise that the addition of proposed development foul flows within this area is predicted to increase the risk of sewer flooding in the downstream catchment. We are currently arranging an Impermeable Area Survey in the downstream catchment to help inform the requirement for capacity improvements.

I hope this assists – and we will keep in touch. Have you had the exhibition yet?

Regards

Gillian Sanders

Planning Liaison

Phone: [REDACTED]

Fax: 01225 528000

e-mail: [REDACTED]

Web: www.wessexwater.co.uk

From: SReed@rsk.co.uk [REDACTED]
Sent: 03 July 2014 10:55
To: Gillian Sanders
Subject: RE: ST86NW/ 127 Rudloe No.2 Site, Westwells Road, Corsham

Thanks Gillian

Could you possibly provide additional details for the Fiveways Reservoir please? I assume it is located to the west of the Rudloe Site on the opposite side of Bradford Road?

The proposed development is for between 160 & 170 residential units. I have attached some presentation slides which may better show the current site layout, but please note the master plan is being reviewed and updated to incorporate SuDS devices.

Based on the site geology, infiltration is unlikely and thus we have assumed that the site currently drains to a private drainage network. We are undertaking a site walkover next week to gain a better understanding of the current drainage arrangement and will let you know our findings. Our current thinking is that the proposed site drainage may need to be pumped from the low point at the southeast corner of the site to Westwells Road.

We are currently only looking at the Rudloe No.2 Site.

If you require any further information before looking at pre-development enquiries for mains, surface and foul water please let me know.

Thanks and regards.

Sam Reed

Infrastructure Engineer/Hydrologist

RSK

18 Frogmore Road, Hemel Hempstead, Hertfordshire, HP3 9RT, UK

Direct Dial: [REDACTED]
 Switchboard: +44 (0)1442 437500
 Fax: +44 (0)1442 437550
 Mobile: [REDACTED]
 Email: [REDACTED]

<http://www.rsk.co.uk>

RSK Land & Development Engineering Ltd is registered in England at Spring Lodge, 172 Chester Road, Helsby, Cheshire, WA6 0AR, UK
 Registered number: 4723837

From: Gillian Sanders [REDACTED]
Sent: 24 June 2014 12:32
To: Sam Reed
Subject: ST86NW/ 127 Rudloe No.2 Site, Westwells Road, Corsham

Dear Sam,

Thank you for your email below and accompanying plans. This site has **not** been included in recent capacity appraisals for Corsham nor does it appear in Core Strategy allocations for the area. I believe it is "inside of the wire" and also just adjacent to the large MOD communications mast. Historically on site infrastructure on MOD sites has been under MOD ownership and control so we do not possess records. In many instances MOD sites are served by MOD operated boreholes and sewage treatment works. This area does not look to have been occupied for a while – incorporating parade grounds and training huts / barracks? So minimal impact on any services – public or otherwise.

The site is adjacent Wessex Water's Fiveways reservoir so you will note the large number of water supply mains bordering the site – no building within 3 metres or new tree planting within 6 metres.

Please can you advise upon proposed numbers of dwellings so we may comment on capacity? Do you have any indication of how the surface water is disposed of currently?

Finally can you advise on Rudloe No 1 and are there further sites?

Regards

Gillian Sanders

Planning Liaison

Phone: [REDACTED]
 Fax: 01225 528000
 e-mail: [REDACTED]
 Web: www.wessexwater.co.uk

12/11/2014

From: [REDACTED]
Sent: 23 June 2014 14:59
To: Gillian Sanders
Subject: Rudloe No.2 Site, Westwells Road, Corsham

Hi Gillian,

My name is Sam Reed from RSK and I am looking at the Drainage for a potential residential development at Rudloe No.2 Former Ministry of Defence Site on Westwells Road, Corsham.

We are looking to make pre-development enquiries for the surface, foul and mains water for the proposed development but are having trouble establishing where the infrastructure on site currently drains, and where to drain surface and foul water in the post-development case.

We have received records from Wessex Water, however they seem somewhat sparse in detail. I have attached the site location plan and I have drawn the site boundary on the Wessex Water records.

If you could please let me know your thoughts on the current site drainage and any drainage proposals it would be greatly appreciated.

Thanks very much for your help.

Sam Reed
Infrastructure Engineer/Hydrologist

RSK

18 Frogmore Road, Hemel Hempstead, Hertfordshire, HP3 9RT, UK

Direct Dial: [REDACTED]
Switchboard: +44 (0)1442 437500
Fax: +44 (0)1442 437550
Mobile: [REDACTED]
Email: [REDACTED]

<http://www.rsk.co.uk>

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Registered number: 4723837

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Sam Reed

From: Dave Ogborne [REDACTED]
Sent: 30 October 2014 10:58
To: Sam Reed
Cc: Gillian Sanders; Ian Griffin
Subject: RE: Rudloe Site No.2 - SW, FW & Mains Water

Sam

Gillian is away on leave this week and I am responding to your enquiry.

Surface Water

The existing discharge arrangements are unorthodox as most discharges will be made to public sewer systems.

Mains records do not provide sufficient detail to confirm where flows outfall. The capacity of the receiving overflow main is unlikely to accept and convey the flows quoted from the existing site.

Therefore I raise some concerns over these proposals and enquire if there are any existing site records and any easements associated with the land to confirm the current arrangements. We will be grateful if you can provide any further information upon the existing surface water drainage.

The restricted flows associated with the redevelopment provides a positive approach as these can be managed with more confidence once we have resolved rights of connection.

Foul Water

Points of connection and the downstream capacity improvements will need to be assessed and confirmed and we request details of the proposed development and where possible some estimate of foul water flows. We can review in more detail once this has been provided.

From a preliminary review we understand that there are two schemes that are being considered to overcome capacity constraints to serve new development at this location

- Upsizing 90metres d/s 150mm dia with 225mm dia
- Attenuation of flows with proportionate contributions under a requisition arrangement

Water Supply

I will request an update on the supply modelling work and get back to you as soon as we have the information.

Please call me to discuss if necessary.

Dave Ogborne
Planning Liaison Manager
Wessex Water
Claverton Down

Bath
BA2 7WW
DD [REDACTED]
[REDACTED]

From: [REDACTED]
Sent: 21 October 2014 13:40
To: Gillian Sanders
Subject: Rudloe Site No.2 - SW, FW & Mains Water

Hi Gillian

Thanks for your help with the Surface, Foul and Mains Water constraints for the Rudloe No.2 site. Please find attached a letter regarding our proposals for these aspects of the design, of which our client is eager to gain more certainty around.

Please feel free to forward this letter on as necessary and please call me if there is anything you would like to discuss.

Thanks and kind regards

Sam Reed
Infrastructure Engineer/Hydrologist

RSK
18 Frogmore Road, Hemel Hempstead, Hertfordshire, HP3 9RT, UK

Direct Dial: [REDACTED]
Switchboard: +44 (0)1442 437500
Fax: +44 (0)1442 437550
Mobile: [REDACTED]
Email: [REDACTED]

<http://www.rsk.co.uk>

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APPENDIX E

Calculations

Rudloe Site No. 2
FRA - Surface Water Strategy
Existing Runoff

Job No. 132283
Name: Sam Reed
Date: 24/11/2014

Reference: The SUDS Manual 2007

	input
	output

1.0 Existing Area Summary

Total Area	8.02 ha
Impermeable Area	2.77 ha
	34.6%

1.1 Existing Runoff - Modified Rational Method

$$Q = 2.78 C_v C_r i A$$

C_v = Volumetric Runoff Coefficient - a co-efficient that describes the proportion of rainfall appearing in the surface water drainage system, assumed to be 0.95 for impermeable areas

C_r = Routing Coefficient - a routing co-efficient added to the Rational Method to represent runoff characteristics of a particular site or area in a more accurate manner, assumed to be 1.3 for urban areas

i = Rainfall Intensity (mm/h) based on a 1 hour rainfall event

A = Area (ha)

2.78 = Coefficient which accounts for the differences in units used for the inputs and the outputs of the equation (1000/360)

C_v	0.95
C_r	1.3
i (mm/hr)	13.2 Qbar
	6.9 1 in 1 year storm
	29.5 1 in 30 year storm
	41.8 1 in 100 year storm

Rainfall data has been taken from the DDF calculator contained within the FEH CD ROM (CD3)

	Peak flow	
Return Period	Impervious	
	35%	
Qbar	125.6	l/s
1 in 1 year storm	65.7	l/s
1 in 30 year storm	280.7	l/s
1 in 100 year storm	397.8	l/s

1.2 Proposed Runoff - IOH124 Greenfield Runoff

Carried out using WinDES source control

Grid Reference	385 169
SAAR	827 mm
Soil	0.4
Region Number	8
	(from WinDES)

	Peak flow	
Return Period	Total Site	per ha
Qbar	34.1	4.3 l/s
1 in 1 year storm	26.6	3.3 l/s
1 in 30 year storm	65.0	8.1 l/s
1 in 100 year storm	82.5	10.3 l/s

Rudloe Site No. 2

FRA - Surface Water Strategy

Proposed Development and Required Storage

Reference: The SUDS Manual 2007

Job No. 132283

Name: Sam Reed

Date: 24/11/2014

	input
	output

2.0 Proposed Development

2.1 Area Summary

NORTHERN AREA

	Total Site	
Roof area (100% impermeable)	2,072	m ²
Roads, car parks, paths (100% impermeable)	4,654	m ²

Impermeable area	6,726	m ²	32%
Permeable areas	14,229	m ²	68%
Total Area	20,955	m ²	100%

2.2 WinDes Quickstore

Carried out using WinDES source control

Region	England and Wales	
Grid Reference	385	169
M5-60	20.7	mm
Ratio	0.362	
Cv (summer)	0.75	
Cv (winter)	0.84	
	Total	
Impermeable area	0.673	ha
Maximum Allowable Discharge	2.9	l/s
Default to a minimum of	5.0	l/s
	(from WinDES)	
	Total Site	
Return Period	Storage required, m³	
	min	max
1 in 30 year storm	194	187
1 in 100 year storm	273	388
1 in 100 year storm + 30% for climate change	385	541

Quick Storage Estimate

Micro Drainage

Variables

Results

Design

Overview 2D

Overview 3D

Vt

FSR Rainfall

Return Period (years)

Region

Map

M5-60 (mm)

Ratio R

Cv (Summer)

Cv (Winter)

Impervious Area (ha)

Maximum Allowable Discharge (l/s)

Infiltration Coefficient (m/hr)

Safety Factor

Climate Change (%)

0.750

0.840

0.673

5.0

0.00000

2.0

30

Analyse

OK

Cancel

Help

Enter Climate Change between -100 and 600

Quick Storage Estimate

Micro Drainage

Variables

Results

Design

Overview 2D

Overview 3D

Vt

Results

Global Variables require approximate storage of between 385 m³ and 541 m³.

These values are estimates only and should not be used for design purposes.

Analyse

OK

Cancel

Help

Enter Climate Change between -100 and 600

Rudloe Site No. 2
FRA - Surface Water Strategy
Proposed Development and Required Storage

Reference: The SUDS Manual 2007

	input
	output

Job No. 132283
Name: Sam Reed
Date: 24/11/2014

2.0 Proposed Development

2.1 Area Summary

SOUTHERN AREA

	Total Site	
Roof area (100% impermeable)	5,824	m ²
Roads, car parks, paths (100% impermeable)	11,346	m ²

Impermeable area	17,170	m²	29%
Permeable areas	42,075	m²	71%
Total Area	59,245	m²	100%

2.2 WinDes Quickstore

Carried out using WinDES source control

Region	England and Wales	
Grid Reference	385	169
M5-60	20.7	mm
Ratio	0.362	
Cv (summer)	0.75	
Cv (winter)	0.84	
	Total	
Impermeable area	1.717	ha
Maximum Allowable Discharge	7.3	l/s

Assumes no infiltration		(from WinDES)
	Total Site	
Return Period	Storage required, m³	
	min	max
1 in 30 year storm	597	868
1 in 100 year storm	826	1150
1 in 100 year storm + 30% for climate change	1157	1599

Quick Storage Estimate

Micro Drainage

Variables

FSR Rainfall Cv (Summer)
Return Period (years) Cv (Winter)
Region Impermeable Area (ha)
 M5-60 (mm) Maximum Allowable Discharge (l/s)
Ratio R Infiltration Coefficient (m/hr)
Safety Factor
Climate Change (%)

Enter Climate Change between -100 and 600

Quick Storage Estimate

Micro Drainage

Results

Global Variables require approximate storage of between 1157 m³ and 1599 m³.

These values are estimates only and should not be used for design purposes.

Enter Climate Change between -100 and 600

Rudloe Site No. 2
FRA - Surface Water Strategy
Proposed Development and Required Storage

Reference: The SUDS Manual 2007

	input
	output

Job No. 132283
 Name: Sam Reed
 Date: 24/11/2014

2.0 Proposed Development

2.1 Area Summary

Full Site

	Total Site		
Roof area (100% impermeable)	7,896	m ²	7,896
Roads, car parks, paths (100% impermeable)	16,000	m ²	16,000

Impermeable area	23,896	m ²	29.8%
Permeable areas	56,304	m ²	70.2%
Total Area	80,200	m ²	100%

2.2 WinDes Quickstore

Carried out using WinDES source control

Region	England and Wales
Grid Reference	385 169
M5-60	20.7 mm
Ratio	0.362
Cv (summer)	0.75
Cv (winter)	0.84
	Total
Impermeable area	2.39 ha
Maximum Allowable Discharge	12.3 l/s

Assumes no infiltration

(from WinDES)

	Total Site
Return Period	Storage required, m³
	min max
1 in 30 year storm	791 1055
1 in 100 year storm	1099 1538
1 in 100 year storm + 30% for climate change	1542 2140

Rudloe Site No. 2
FRA - Surface Water Strategy
SuDS Strategy

Reference: The SUDS Manual 2007

input
output

Job No. 132283
Name: Sam Reed
Date: 24/11/2014

3.0 SUDS Storage
3.1 Storages from SUDS elements

SuDS Feature	Area, m ²	Depth, m	Porosity	Volume, m ³	Required Storage
Northern Area					
Detention Basin	540	2.0	1	580.0	
	40				
				580.0	541.0
Southern Area					
Permeable Paving	1326	0.4	0.3	159.1	
Dentetion Basin	1241	2.0	1	1501.0	
	230				
				1660.1	1599.0
Total				2240.1	2140.0

3.2 Total Storage

	Northern	Southern	Total	
Required Storage 1 in 100 + climate change	541	1599	2140	m ³
Storage from SUDS	580	1660	2240	m ³
Is storage from SUDS adequate?	yes	yes	yes	
excess/deficit	39	61	100	m ³

RSK Ltd		Page 1																								
18 Frogmore Road Hemel Hempstead Herts, HP3 9RT																										
Date 01/07/2014 15:38 File	Designed By SReed Checked By																									
Micro Drainage	Source Control W.12.5																									
<u>ICP SUDS Mean Annual Flood</u> Input <table> <tr> <td>Return Period (years)</td> <td>100</td> <td>Soil</td> <td>0.400</td> </tr> <tr> <td>Area (ha)</td> <td>8.241</td> <td>Urban</td> <td>0.000</td> </tr> <tr> <td>SAAR (mm)</td> <td>827</td> <td>Region Number</td> <td>Region 8</td> </tr> </table> Results 1/s <table> <tr> <td>QBAR Rural</td> <td>34.1</td> </tr> <tr> <td>QBAR Urban</td> <td>34.1</td> </tr> <tr> <td>Q100 years</td> <td>82.5</td> </tr> <tr> <td>Q1 year</td> <td>26.6</td> </tr> <tr> <td>Q30 years</td> <td>65.0</td> </tr> <tr> <td>Q100 years</td> <td>82.5</td> </tr> </table>			Return Period (years)	100	Soil	0.400	Area (ha)	8.241	Urban	0.000	SAAR (mm)	827	Region Number	Region 8	QBAR Rural	34.1	QBAR Urban	34.1	Q100 years	82.5	Q1 year	26.6	Q30 years	65.0	Q100 years	82.5
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