



Projects Ltd

- Consultancy
- Project Management
- Site Regeneration

FLOOD RISK ASSESSMENT

Site:
Spurr House Bury

Client:
Watson Homes

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ABBREVIATIONS

Term	Meaning / Definition
AEP	Annual Exceedance Probability
BGL	Below Ground Level
BGS	British Geological Society
CFMP	Catchment Flood Management Plan
CIRIA	Construction Industry Research and Information Association
CoP	Code of Practice
EA	Environment Agency
EFO	Extreme Flood Outline (Boundary of floodplain associated with a flood event with a probability of occurrence of 0.1%, 1 in 1000 years)
FDA	Flood Defence Agency (e.g. Environment Agency)
FERS	Flood Event Recording System
FFL	Finished Floor Level
FRA	Flood Risk Assessment
FW	Foul Water
GPZ	Groundwater Protection Zone
LDD	Local Development Document
LDF	Local Development Framework
LHA	Local Highway Authority
LPA	Local Planning Authority
m AOD	Metres above Ordnance Datum
MAF	Mean Annual Flood
NGR	National Grid Reference
OS	Ordnance Survey
PPG	Planning Policy Guidance
PPS	Planning Policy Statement
SFRA	Strategic Flood Risk Assessment
SSSI	Site of Special Scientific Interest
SuDS	Sustainable Drainage Systems
SW	Surface Water
WFD	Water Framework Directive

1.0 INTRODUCTION

1.1. Watson Homes is proposing a new residential development on land currently known as Spurr House, located in Bury. The development seeks to transform the site into a residential area, and as part of the planning process, a Flood Risk Assessment (FRA) is required by the Local Planning Authority (LPA). Total area of the site is approximately 0.672 ha.

1.2. In accordance with national planning policy, and as part of the planning application process, the Local Planning Authority has requested the completion of a comprehensive Flood Risk Assessment. The purpose of the FRA is to evaluate the flood risk to the site from all sources, including surface water, groundwater, and river or tidal flooding, ensuring the safety and sustainability of the proposed development.

1.3. ELLUC Projects Limited has been commissioned by Watson Homes to prepare the formal Flood Risk Assessment. The assessment will assess the potential flood risk to the site and the impact of the proposed development on the surrounding area, and recommend appropriate flood mitigation measures. This FRA will accompany the planning application and provide necessary documentation to satisfy the LPA's flood risk and drainage requirements..

2.0 PLANNING POLICY

NATIONAL PLANNING POLICY

2.1. The National Planning Policy Framework (NPPF)¹ clearly identifies flood risk as a specific material consideration in the Planning Process and in the allocation and release of sites for development or re-development.

2.2. NPPF builds on its predecessor (PPS 25) and seeks to further strengthen the co-ordination between land-use planning and development planning and the operational delivery of flood and coastal defence strategy. NPPF retains key elements of PPS 25 continuing to encourage Local Planning Authorities to use their existing powers to guide, regulate and control development in relation to flooding and flood risk. NPPF expects Local Authorities to adopt a risk-based approach at all levels of Planning, through the application of the Sequential Test detailed in Table 1 and 2, of the Technical Guidance to NPPF document, a copy of which is attached in Appendix A.

2.3. The aim of the sequential test is to steer new development to areas with the lowest probability of flooding. Development should not be allocated or permitted if there are reasonably available sites appropriate for the proposed development in areas with a lower probability of flooding. The Strategic Flood Risk Assessment will provide the basis for applying this test. A sequential approach should be used in areas known to be at risk from any form of flooding.

2.4. The Water Resources Act 1991 [Section 105] also requires the Environment Agency to exercise a general supervision over all flood defence matters, including flood plains and washlands which accommodate waters during periods of flood. In discharging their functions, the Agency from time to time carries out comprehensive surveys and flood studies, largely of 'main rivers' within its jurisdiction.

2.5. A Section 105 Study involves the Agency topographically surveying the subject watercourse (or parts of it) and obtaining details of the flow mechanics within the watercourse. This data then enables them to generate a comprehensive hydraulic computer model for the watercourse. From this hydraulic model, the EA are able to define the approximate extent of fluvial floodplain associated with the 1 in 100-year (1% annual probability) flooding event or the extent of tidal floodplain associated with the 1 in 200-year (0.5% annual probability) flooding event.

2.6. The extents of the modelled floodplain are then provided to Local Planning Authorities, to enable them to make more informed decisions when considering proposed development in flood-susceptible areas. If development is proposed in a flood-susceptible area, or in an area where there is a history of flooding, the EA, as a statutory consultee in the Planning Process, will generally recommend that the risk of flooding be formally assessed, in accordance with NPPF, and that a Flood Risk Assessment report be produced to support the Planning Application. The broader modelled flood extents are also indicated on the EA's Flood Zone Maps, available through their website.

¹ National Planning Policy Framework

2.7. **Local Planning Policy**

Catchment Flood Management Plan (CFMP)

2.8. Bury Council have produced a report on April 2018 named “Bury Local Flood Risk Management Strategy” available from their web Site.

2.9. CFMP’s are not specifically required by the Water Framework Directive ² and are prepared voluntarily by the EA (under Government sponsorship). A CFMP is a high-level strategic plan for an area which aims to develop policies to manage flood risk over the next 50 to 100 years. These policies take into account the likely impacts of climate change and the effects of land use and land management and identify a range of benefits which contribute towards sustainable development. The CFMP’s policies establish whether action should be taken to increase, decrease or maintain the current level of flood risk.

Strategic Flood Risk Assessment (SFRA)

2.10. The site is located within the SFRA for Greater Manchester Combined Authority Planning March 2019.

2.11. Local Planning Authorities are required to produce Local Development Frameworks, which are a portfolio of Local Development Documents that collectively deliver the spatial planning strategy for the Authority area. The LDD’s undergo a Sustainability Appraisal which assists Planning Authorities in ensuring their policies fulfill the principles of sustainability. Strategic Flood Risk Assessments are one of the documents to be used as the evidence base for planning decisions and are a component of the Sustainability Appraisal process. Therefore, SFRAs should be used in the review or production of LDD’s.

2.12. To assist Local Planning Authorities in their strategic land-use planning, SFRA’s should present sufficient information to enable Local Authorities to apply the Sequential Test to their proposed development sites: *“Decision-makers should use the SFRA to inform their knowledge of flooding, refine the information on the Flood Map and determine the variations in flood risk from all sources of flooding across and from their area. These should form the basis for preparing appropriate policies for flood risk management for these areas.”* ³

2.13. A flood risk assessment was carried out by JBA Consulting, initially a level 1 assessment for all ten Greater Manchester districts followed by a level 2 assessment.

2.14. The SFRA along with the EA flood risk maps indicate that the proposed development sites lie within Flood Zone 1. The EA highlight that a Flood Zone 1 is an area of fluvial risk of flooding above the 1 in 1000 year event.

2.15. The SFRA has been developed with the assistance of the Environment Agency and key landowners to provide a robust assessment of current and future levels of flood risk, ensuring that future development takes full account of flood risk and sustainability at the outset.

² www.defra.gov.uk/environment/water/wfd/index.htm

³ NPPF

Further Guidance

CIRIA Guidance

2.16. CIRIA publication 'C624 Development and Flood Risk – Guidance for the Construction Industry'⁴, define three levels of FRA which can be undertaken:

Table 2.1 Levels / Scopes of Flood Risk Assessment

FRA Level	Description / Scope
Level 1	Screening Study to identify whether there are any flooding or surface water management issues related to a development site that may warrant further consideration. This should be based on readily available existing information, including the SFRA, Environment Agency Flood Map and Standing Advice. The Screening Study will ascertain whether a FRA is required.
Level 2	Scoping Study to be undertaken if the Level 1 FRA indicates that the site may lie within an area that is at risk of flooding or that the site may increase flood risk due to increased run-off. This Study should confirm the sources of flooding which may affect the site and should include the following: • an appraisal of the availability and adequacy of existing information; • a qualitative appraisal of the flood risk posed to the site, and potential impact of the development on flood risk elsewhere; • an appraisal of the scope of possible measures to reduce the flood risk to acceptable levels. The Scoping Study may identify that sufficient quantitative information is already available to complete a FRA appropriate to the scale and nature of the development.
Level 3	Detailed Study to be undertaken if the Level 2 FRA concludes that further quantitative analysis is required to assess flood risk issues related to the development site. The Study should include: • quantitative appraisal of the potential flood risk to the development; • Quantitative appraisal of the potential impact of development site on flood risk elsewhere; • quantitative demonstration of the effectiveness of any proposed mitigation measures.

2.17. It is considered that a Level 2 Scoping Study is appropriate at this stage and to minimize pre-commencement conditions this report has therefore been based on the requirements of a Level 2 Study.

⁴ CIRIA publication 'C624 Development and Flood Risk – Guidance for the Construction Industry', 2004

3.0 REQUIREMENTS OF A FLOOD RISK ASSESSMENT

3.1. The EA's Flood Zone Maps, available on the EA's website, indicate that the site is within a Flood Zone 1. Flood Zone 1 is an area of low risk of flooding, with a risk of flooding in storms higher than 1 in 1000 year event. Current EA guidance indicates that all proposed developments in this zone should be accompanied by an FRA for a development site with an area of over 1 hectare, or the Local Authority have requested one, as in this situation. An FRA should contain:

- Information about the surface water disposal measures already in place and their state of maintenance;
- An assessment of the volume of surface water run-off likely to be generated from the proposed development;
- Information on how that surface water run-off will be disposed of (from the new development);
- Estimates of how climate change could affect the probability and intensity of flooding events in the future;
- Information about any other potential sources of flooding to the site - streams, ditches, sewers, groundwater, overland surface water flow or any combination of these.

3.2. As set out in NPPF flood risk assessments 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.

3.3. The detail and complexity of a Flood Risk Assessment should reflect the level of risk to the proposed development and should:

- be proportionate to the risk and appropriate to the scale, nature and location of the development;
- consider the risk of flooding arising from the development in addition to the risk of flooding to the development;
- take the impacts of climate change into account;
- be undertaken by competent people, as early as possible in the particular planning process, to avoid misplaced effort and raising landowner expectations where land is unsuitable for development;
- consider both the potential adverse and beneficial effects of flood risk management infrastructure including raised defences, flow channels, flood storage areas and other artificial features together with the consequences of their failure;
- consider the vulnerability of those that could occupy and use the development, taking account of the Sequential and Exception Tests and the vulnerability classification (including arrangements for safe access;

- consider and quantify the different types of flooding (whether from natural and human sources and including joint and cumulative effects) and identify flood risk reduction measures, so that assessments are fit for the purpose of the decisions being made;
- consider the effects of a range of flooding events including extreme events on people, property, the natural and historic environment and river and coastal processes;
- include the assessment of the remaining (known as ‘residual’) risk after risk reduction measures have been taken into account and demonstrate that this is acceptable for the particular development or land use;
- consider how the ability of water to soak into the ground may change with development, along with how the proposed layout of development may affect drainage systems;
- be supported by appropriate data and information, including historical information on previous events.

4.0 SEQUENTIAL TEST

- 4.1. The sequential test is to ensure that a sequential approach is followed to steer new development to areas with the lowest probability of flooding. The aim is to steer new developments to Flood Zone 1 (areas with a low probability of river or sea flooding).
- 4.2. The proposed development is set within Flood Zone 1.
- 4.3. The proposed residential development will be categorised as ‘less vulnerable’ as classed within NPPF.

Table 4.5 Flood Risk Vulnerability Classification Chart (NPPF)

Flood Zones	Flood Risk Vulnerability Classification				
	Essential infrastructure	Highly vulnerable	More vulnerable	Less vulnerable	Water compatible
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	Exception Test required	✓	✓	✓
Zone 3a †	Exception Test required †	✗	Exception Test required	✓	✓
Zone 3b *	Exception Test required *	✗	✗	✗	✓*

Key:

✓ Development is appropriate

✗ Development should not be permitted.

- 4.4. Based upon the Flood risk Vulnerability classification the development site is classed as appropriate and therefore the sequential test is past.

5.0 SITE CONTEXT

SITE LOCATION

5.1. The site is located off Pole Lane, Bury. The residential site is approximately 0.672ha and has grid National Grid Reference 382101 , 40699 shown in Figures 5.1 and Figure 5.2.

Figure 5.1 Site Location Plan

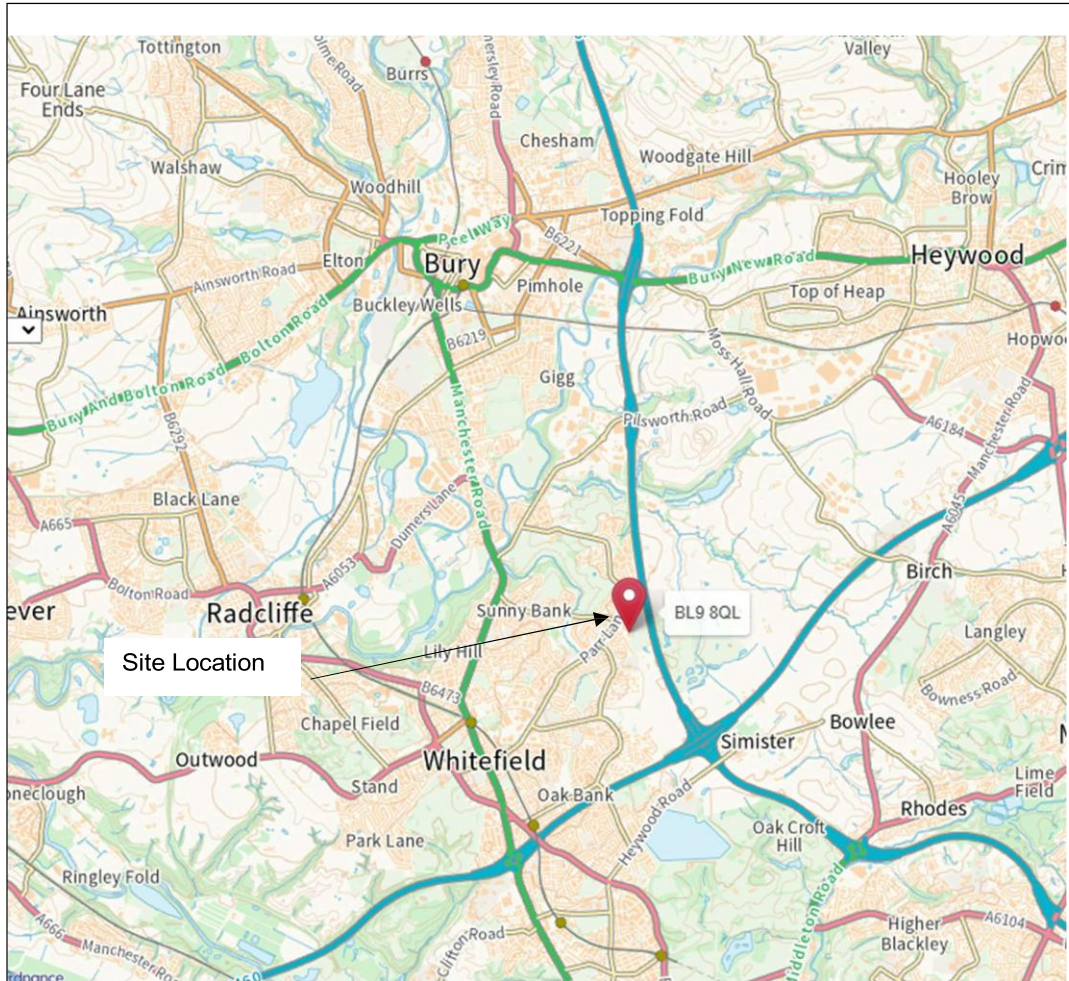




Figure 5.2: Aerial Image

EXISTING SITE CHARACTERISATION / LAND-USE

- 5.2. The site and surrounding boundary conditions are shown on the Aerial Image in Figure 5.2.
- 5.3. The site is brownfield.
- 5.4. The north of the site is bound by residential properties.
- 5.5. To the west the site is bound by residential properties.
- 5.6. The south of the site is bound by Unsworth Cricket Club.
- 5.7. To the east the site is bound by Unsworth Academy.

EXISTING SITE TOPOGRAPHY

- 5.8. The site's generally is flat at circa 93.00 AOD.

EXISTING WATERCOURSES / WATER BODIES / DRAINAGE INFRASTRUCTURE

- 5.9. Castle Brook is located 600m to the East and Parr Brook 580m to the West of the site.

5.10. Existing Ground Conditions

According to the Phase II Geo-Environmental Assessment Report CM/C5102/11367 Rev A November 2022 Generalised ground conditions from the ground investigation comprise (top down):

Made ground encountered from ground level to 1.95m bgl with an average thickness of 0.61m.

Natural strata encountered to 5.45m bgl.

Solid geology was not encountered during the investigation.

Groundwater recorded between 1.10m and 4.50m bgl during site works.

Post site works monitoring levels ranged between 3.20m and 4.09m bgl.

Proposed Development

PROPOSED LAYOUT

- 5.11. The proposed site layout is indicatively shown in Figure 6.1 and the full version is in Appendix C
- 5.12. The proposed development is for residential dwellings.

PROPOSED LEVELS

- 5.13. The proposed ground levels for the plots will be set as close as possible to existing ground levels.



Figure 6.1 Proposed Layout

ELLUC-WH-24104-21112024-FRA

6.0 PROPOSED DRAINAGE

SURFACE WATER DRAINAGE OPTIONS

6.1. Due to the history of the commercial activities and its associated risk of contamination hotspots, the infiltration technique for the management of the surface water is discounted.

6.2. To ensure that post-development run-off volumes and peak flow rates discharging from the site do not exceed current levels, it may be necessary to employ SuDS (Sustainable Drainage Systems) methods and source control techniques, including flow control devices to restrict flows and to store attenuated water on site. The provision of such techniques will ensure that the maximum discharge from the site does not exceed the agreed rates with the statutory bodies. In addition, where practicable, opportunities for reducing flood risk through the management of surface water run-off from the site should be included.

6.3. Storage of attenuated flows within the site could be provided in a number of ways:

- underground – over-sized pipes / tanks or proprietary storage systems such as ‘Stormcell’;
- above ground – storage / balancing pond, designated surface areas (low risk areas such as car parks, open space);
- combination of underground and above ground.

6.4. Proposed SW drainage systems are generally designed in accordance with ‘Sewer Sector Guidance’ which requires that any surface water drainage system, which is proposed to be Adopted after construction, should not surcharge during the 1 in 2-year storm event, and should not produce any surface flooding during a 1 in 30-year storm event (i.e. all run-off contained wholly within the sewerage system during the 1 in 30-year event).

6.5. It is generally accepted that a degree of surface flooding can be permitted during extreme storm events, subject to specific surface areas being designated as flood-susceptible and subject to flooding of these areas posing little or no risk to human life and/or damage to property. Examples of surface areas which might be permitted to flood during extreme events are:

- Agricultural land;
- Recreational land (playing fields etc.);
- Landscaped areas;
- Car parks;
- Other non-inhabited, designated areas.

6.6. In all cases where surface flooding might be permitted or designed in to a scheme, due diligence needs to be given to NPPF and the need to make potential users of such areas aware of their functionality and purpose, and the requirement to maintain safe access and egress at all times.

6.7. The Building Regulations Approved Document H (2002) outlines a hierarchy of potential methods of disposing of surface water from a site:

-
- A soakaway; or where that is not practicable
 - A watercourse or river; or where that is not practicable,

- A sewer.

6.8. The viability of this hierarchy has been assessed below:

SOAKAWAY

6.9. Due to the history of the commercial activities and its associated risk of contamination hotspots, the infiltration technique for the management of the surface water is discounted. The EA surface water flood map shows the site is susceptible to surface water flooding which add to the risk of use of infiltration techniques.

WATERCOURSES / WATER BODIES

6.10. There is no watercourse within the vicinity of the development with practical outfall option.

SEWERS

6.11. The foul and surface water will discharge from each dwelling into a separate gravity pipe networks running from the northern boundary to the southern boundary into an existing combined sewer subject to United Utilities approval.

6.12. Below is a chart based on table 1.1 typical SuDS components within CIRIA Guidance 697 SuDS manual. This discusses the viable SuDS components and whether they are useable for this site.

Component	Description	Is it viable
Filter Strips	These are wide, gently sloping areas of grass or other dense vegetation that treat runoff from adjacent impermeable areas.	Infiltration is not likely to be successful therefore this type of SuDS system should not be viable on the site.
Swales	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)	Infiltration is not likely to be successful therefore this type of SuDS system should not be viable on the site.
Infiltration Basins	Infiltration basins are depressions in the surface that are designed to store runoff and infiltrate the water to the ground. They may also be landscaped to provide aesthetic and amenity value	Infiltration is not likely to be successful therefore this type of SuDS system should not be viable on the site.
Wet Ponds	Wet ponds are basins that have a permanent pool of water for water quality treatment. They provide temporary storage for additional storm runoff above the permanent water level. Wet ponds may provide amenity and wildlife benefits	The development doesn't consists of public open space areas therefore wet ponds are not suitable for SUDS.
Extended detention basins	Extended detention basins are normally dry, though they may have small permanent pools at the inlet and outlet. They are designed to detain a certain volume of runoff as well as providing water quality treatment.	The development doesn't consists of public open space areas therefore wet ponds are not suitable for SUDS.
Constructed Wetland	Constructed wetlands are ponds with shallow areas and wetland vegetation to improve pollutant removal and enhance wildlife habitat	Constructed wetland would not be possible Therefore this type of SuDS is unsuitable.
Filter drains and perforated pipes	Filter drains are trenches that are filled with permeable material. Surface water from the edge of paved areas flows into the trenches, is filtered and conveyed to other parts of the site. A slotted or perforated pipe may be built into the base of the trench to collect and convey the water.	Infiltration is not likely to be successful therefore this type of SuDS system should not be viable on the site.
Infiltration devices	Infiltration devices temporarily store runoff from a development and allow it to percolate into the ground.	Infiltration is not likely to be successful therefore this type of SuDS system should not be viable on the site.

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 release to surface water	Infiltration is not likely to be successful therefore this type of SuDS system should not be viable on the site.
Green Roofs	Green roofs are system which cover a building's roof with vegetation. They are laid over a drainage layer, with other layers providing protection, waterproofing and insulation.	Infiltration is not likely to be successful and green roofs would be difficult to maintain therefore this type of SuDS system should be not viable.
Oversized Pipes	Oversized pipes are pipes below ground that hold surface water	These are viable and will be used within the site.

SURFACE WATER DRAINAGE STRATEGY

- 7.16 The surface water will discharge to the existing combined system in Pole Lane.
- 7.17 The site will discharge at 50 % betterment to the existing 1 in 1 year at the rate equating to 12.90 l/s subject to approval from the UU and LLFA.
- 7.18 The proposed surface water network has been designed using Microdrainage flow simulation software to ensure the following:
- No surcharging of drainage network for Design Storm of 1 in 2 years.
 - No flooding for design flood frequency of 1 in 30 years.
 - 1:100 year + 45% model should be duly reviewed, and flood routing plans prepared as part of the detailed site designs.
 - Maintenance of the drainage will be undertaken by Watson Homes until adopted and/or transferred to a management company.

8.0 FLOOD HAZARDS & SOURCES OF FLOODING

POTENTIAL FLOOD HAZARDS

- 8.1 Prior to undertaking an FRA, the different types of flooding mechanisms which may affect the site need to be identified and then assessed to determine whether the development site is located within an area which is at risk of flooding from one or more of the applicable mechanisms.
- 8.2 CIRIA Report C624⁵, Table A2.1, lists a number of key factors that should be considered during a Level 1 FRA. This table can be used to summarise the findings of a Level 1 FRA study and to identify those flood hazards which may be applicable to the site in question. The boxes shaded grey indicate those sources of flooding which are unlikely to be identified for each question. If sufficient information is not available to identify the specific source of flooding, then all possible sources should be ticked. If a tick is placed below any flood hazard then a Level 2 FRA will be required to assess flood risk issues relating to that hazard in more detail.
- 8.3 Table 8.1 below identifies the flood hazards applicable to this site.

⁵CIRIA publication 'C624 Development and Flood Risk – Guidance for the Construction Industry'

Table 8.1 Flood Hazard Identification

Question	Flood Hazard						
	Fluvial	Sea	Estuaries	Groundwater	Overland flow	Artificial drainage systems	Infrastructure failure
Is the development site next to the sea or any watercourse shown on Ordnance Survey maps?	x	x	x				
Is the development site, or part of the development site, identified as being at risk of flooding within available documentation?	x	x	x	x	x	x	x
If a strategic flood risk assessment is available, is the development site, or part of the development site, identified as being at risk of flooding?	x	x	x	x	x	x	x
If a flood zone map is available, is the development site, or part of the development site, within a High Risk zone?	x	x	x				
If a flood zone map is available, is the development site, or part of the development site, within a Low to Medium Risk zone?	✓	x	x				
If a flood zone map is not available, is the development site, or part of the development site, situated on alluvium based on consideration of geological maps of the area?	x	x	x				
If there is an existing property on, or next to the site at the same level, is the property within a flood warning area?	x	x	x	x			
Are the LPA / FDA aware of any existing, historical or potential flooding problems that may affect the site?	x	x	x	x	x	x	x
Do the physical characteristics of the site suggest that it may be prone to flooding?	x	x	x	x	x	x	x
If a flood zone map is not available, is the development site below 10m AOD AND does the FDA consider the development to be at risk of tidal flooding?		x	x				
Is the development located within a natural or artificial hollow, or at the base of a valley or at the bottom of a hill slope?				x	x		
Does examination of historical maps indicate any likelihood of flood risk at the site?	x	x	x	x	x		
Do the names of surrounding roads, areas or houses suggest the possibility of seasonal or historical flooding?	x	x	x	x	x		
Is the site likely to involve excavation / construction below existing ground levels (excluding foundations)?	x	x	x	x	x		
Is the land use upslope of the site such that the generation of overland flow may be encouraged, and can water from this area flow onto the site?					x		
Are there any artificial drainage systems on or next to the site, at the same level, or upslope of, the site?						x	x
Is the development site protected by an existing flood defence?	x	x	x			x	x
Is the development site protected by a flood control structure (e.g. flap valve, sluice gate, tidal barrier etc)	x	x	x			x	x
Is the development site located upstream of a culvert which may be prone to blockage?	x		x	x	x	x	x
Are water levels in a watercourse located in or next to a development site controlled by a pumping station?	x	x	x	x	x	x	x
Is the development site next to or downstream / down slope of a canal?						x	x
Is the development site downstream/ down slope of a reservoir or other significant water body?						x	x
FURTHER COMMENT ON FLOOD RISK WITHIN THIS FRA?	✓	x	x	x	x	x	x

SOURCES OF FLOODING

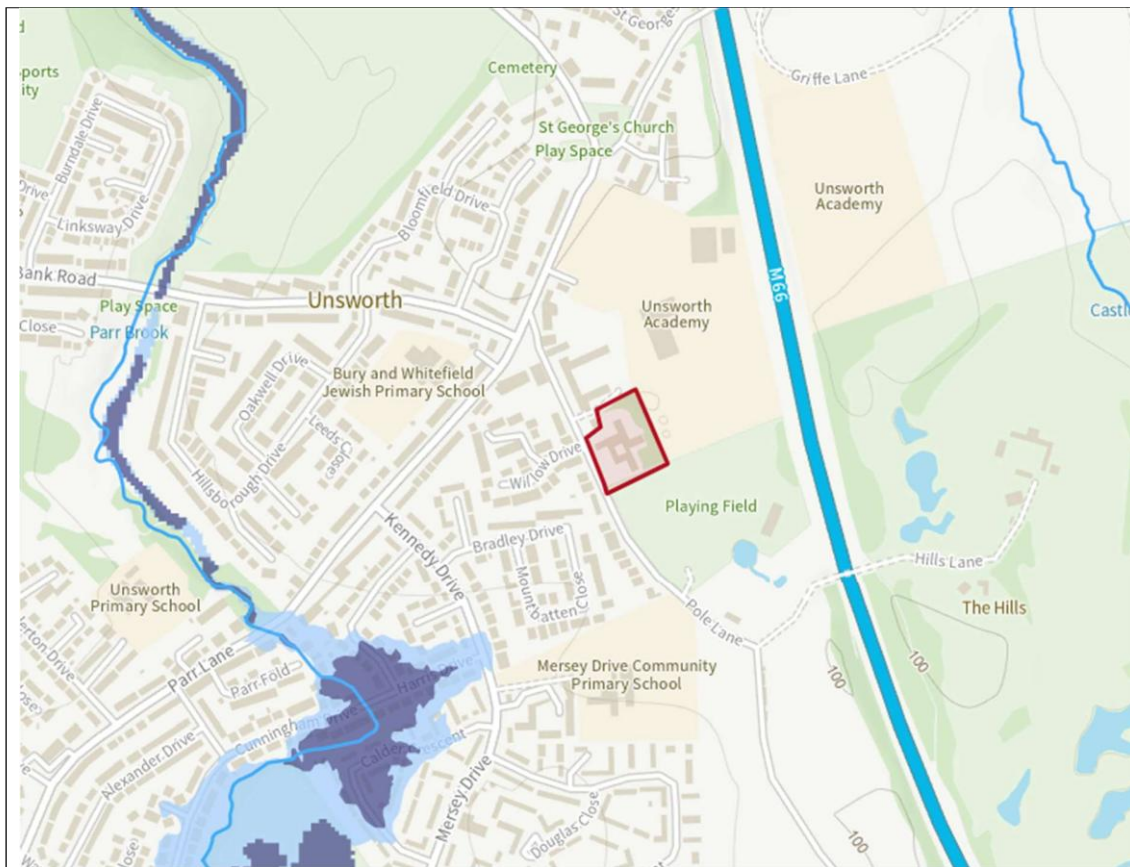
- 8.4 It is considered that there could be one potential source of flooding to the site:
- Surface water flooding to the site which will be remediated by non infiltration positive drainage system.
- 8.5 The risk of flooding from these various sources is assessed in the following sections of this report.

9.0 FLOOD RISK ASSESSMENT

FLUVIAL FLOODING

- 9.1 The site is within an area of Flood Zone 1. Flood Zone 1 is an area at low risk of flooding.
- 9.2 The Flood Zone Maps, which are available on the Environment Agency's website (ref. Section 2 of this Assessment), shows the site to be within Flood Zone 1. (see figure 9.2).

Figure 9.2 EA Flood Zone Map (not to scale)



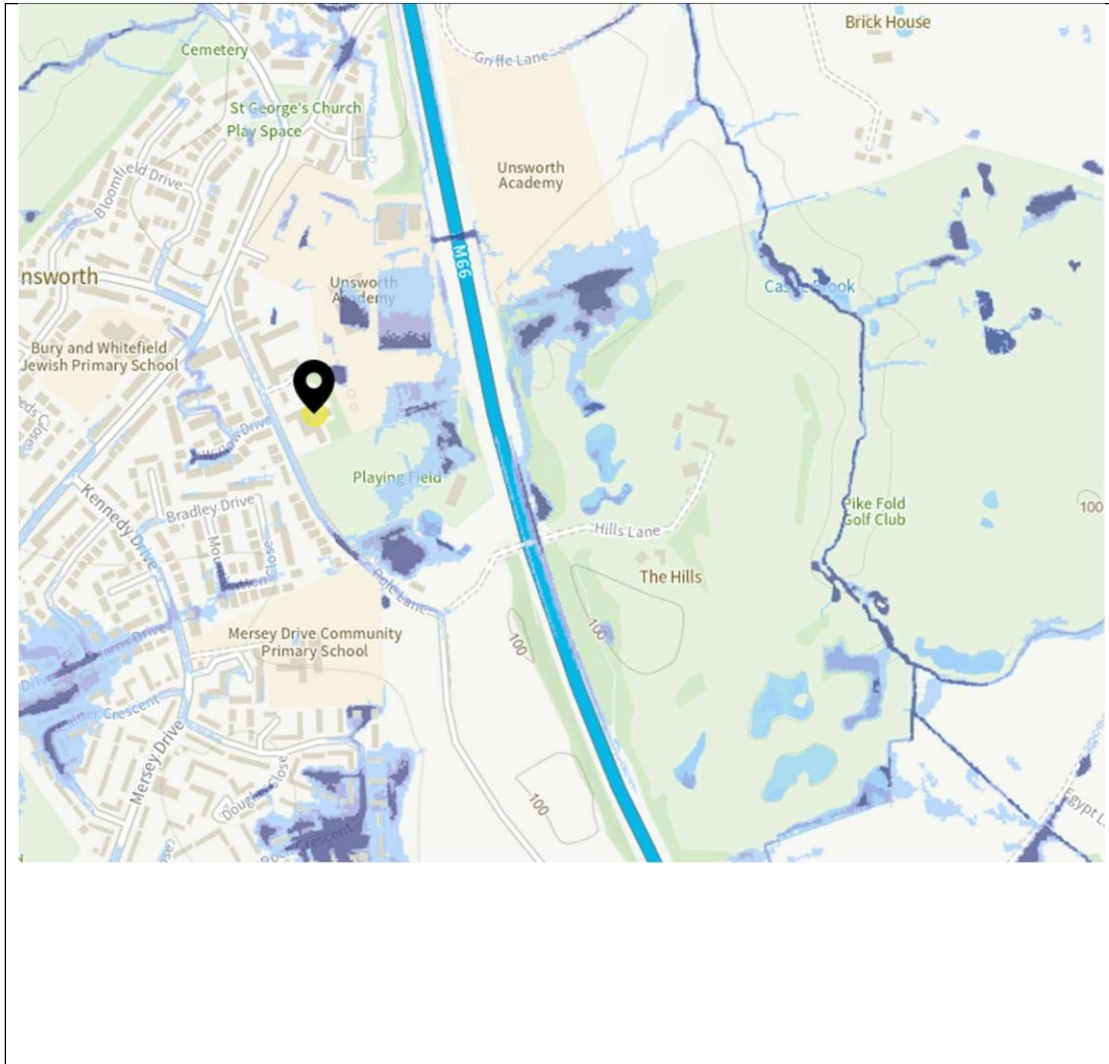
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- 9.3 Based on currently available information, the risk of fluvial flooding at the site from adjacent watercourses, drains and other waterbodies is currently considered to be low.

SURFACE WATER FLOODING

- 9.4 The EA surface water map indicates that the site is at a very low risk of surface water flooding.
- 9.5 Figure 9.13 shows areas of the site which are at different levels of risk of surface water flooding.

Figure 9.13 EA Surface Water Map (not to scale)



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- 9.6 It is assumed that there are no springs underneath the site.
- 9.7 The site is at a very low risk of surface water flooding. The levels are to be raised which will mitigate the risk of surface water flooding.
- 9.8 A new drainage system will be included which will attenuate drainage up to and including the 1 in 100 year event plus 45% climate change.
- 9.9 Based on currently available information, the risk of surface water flooding to the proposed development is Low.

SURCHARGING OF ARTIFICIAL DRAINAGE

- 9.10 There is a combined sewer in Pole Lane, at the time of the writing of this report there were no evidence that the said combined sewer suffers from floodings.

INFRASTRUCTURE FAILURE

- 9.11 The central CIRIA Report C624 defines ‘infrastructure failure’ as the structural, hydraulic, geotechnical, mechanical or operational failure of infrastructure which normally retains, transmits or controls the flow of water. This risk of flooding is usually associated with three main categories of infrastructure:
- failure of infrastructure designed to store or carry water (e.g. dam break, canal leak, water mains burst);
 - failure of infrastructure designed to protect an area from flooding (e.g. flood defence breach, flap valve failure, penstock failure, pumping station failure);
 - blockage of a pipe, bridge or culvert.
- 9.12 The Environment Agency maintains a Public Register of Large Raised Reservoirs. Table 1 identifies the reservoirs within Bury. The chance of reservoir failure is very unlikely as reservoirs are regularly inspected and there is an extremely good safety record in the UK with no loss of life due to reservoir flooding since 1925.
- 9.13 Failure of any water mains could result in leakage and consequently over-land flows within the site. There is therefore a risk of over-land flows being generated because of an infrastructure failure in any water mains, however, such failures occur very infrequently and there is little that can be done to anticipate them.
- 9.14 Water main failures are usually notified to the asset owner within a short period of time of the failure occurring and remedial Work is usually implemented soon thereafter to prevent subsequent property damage and inconvenience. Any failure of a water main is therefore likely to continue for a relatively short period of time.
- 9.15 Based on the above information, the risk of flooding as a result of infrastructure failure is considered to be low and on this basis any further assessment of flooding from infrastructure failure is not considered necessary.

GROUNDWATER FLOODING

- 9.16 There is only a minimal risk of groundwater flooding in the full planning area.
- 9.17 The ground levels will be raised by a minimum of 150mm to take into account groundwater flooding and minimise the risk of groundwater flooding.

10.0 RESIDUAL RISKS & IMPACTS

RESIDUAL RISKS

- 10.1 Table 10.1 outlines the initial qualitative assessment of risk posed by each potential source of flooding, the mechanisms for flooding and the likely consequences. The table also includes a review of possible mitigation measures and what effect, if any, the mitigation measures are likely to have on the residual risk posed by each potential flood source.
- 10.2 Categories of risk have been qualitatively defined as:
- ‘High’ Risk: Flooding is likely to result in significant damage to property and pose a significant risk to life;
 - ‘Medium’ Risk: Flooding is likely to result in possible minor damage to property but flood progress would allow adequate time for residents to be warned and safely evacuated to higher ground or appropriate places of safety;
 - ‘Low’ Risk: Flooding is unlikely to result in any damage to property damage and pose little or no risk to life.

Table 10.1 Qualitative Assessment of Residual Flood Risks

Source	Flood Mechanism & Consequences	Initial Assessment of Risk	Recommended Mitigation Measures	Residual Risk
Fluvial flooding	The site is within Flood Zone 1. An area at low risk of flooding	Low	No fluvial mitigation required.	Low
Surface Water Flooding	The EA surface water flood map indicates that the site is mostly at low risk of surface water flooding.	Low	The installation of an effective drainage strategy will help mitigate to risk of surface water flooding on the site.	Low
Surcharging of artificial drainage systems	Drainage systems operating above design capacity, resulting in: - surcharging of manholes / drainage systems; - over-land flow through development; - ponding in low-lying areas of site; - no over-land flow route for flood waters accumulating in low-lying areas.	Medium	- Appropriate design of SW drainage system to provide sufficient attenuation. - There are no records of sewer flooding on the site.	Low
Infrastructure failure	Water main burst or pumping station failure, resulting in: - Possible over-land flows through / adjacent to the site and possible inundation of property; - Possible pooling in low-lying areas.	Low	None required	Low
		Low		Low

Groundwater	There is no known record of groundwater		The levels in on the site will be raised to minimise the risk of flooding.	
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- 10.3 The mitigation measures proposed in this report will generally reduce the risk of flooding from each potential source.

IMPACT OF DISPLACED WATER

- 10.4 The proposed site is not within an area of fluvial flooding. This suggests there will be minimal risk of displacing water.

IMPACT ON COASTAL OR FLUVIAL MORPHOLOGY

- 10.5 The proposed development will not directly impact on coastal morphology.

11.0 CLIMATE CHANGE

- 11.1 Below are the recommended rainfall intensity increases from the Flood Risk Assessment climate change allowances

Table 11.1 Peak rainfall intensity allowance in small and urban catchments (use 2050 to 2050 baseline)

Applies across all of England	Total potential change anticipated for 2050	Total potential change anticipated for 2070
Upper End	20%	40%
Central	25%	40%

- 11.2 For practical reasons, it is difficult to define the lifetime of a development as each development has different characteristics. However, residential development is considered to have a minimum lifetime horizon of 100 years, unless there is specific justification for considering a shorter period (e.g. development controlled by a time-limited Planning Condition). This development lifetime is approximately 100-year design life.
- 11.3 Therefore, over the next 100 years, the recommendations contained in table 2 Flood Risk assessments: climate change allowance document in terms of increased rainfall, would equate to an increase of between 25% and 40% in peak rainfall intensity.
- 11.4 Based on previous contact with UU a rainfall intensity of 45% has been used for designing this development. The preliminary design of the proposed SW drainage system has taken account of this increase in peak rainfall intensity over the lifetime of the proposed development and has demonstrated that surface water run-off can be managed in a sustainable manner on the site, including the effects of climate change. It is therefore considered that the proposed development has taken account of climate change effects.

12.0 CONCLUSIONS & RECOMMENDATIONS

- 12.1 Watson Homes are proposing a new residential development at the land of Spurr House, Bury. Total area of the site is approximately 0.672Ha.
- 12.2 The Local Planning Authority has requested that the risk of flooding be formally assessed through a Flood Risk Assessment.
- 12.3 The development site is Brownfield and currently is vacant..
- 12.4 The site lies within Flood Zone 1.
- 12.5 The site is overall at a low risk from surface water flooding.
- 12.6 The installation of an effective drainage strategy will mitigate the risk of groundwater flooding and artificial drainage flooding on site.
- 12.7 The discharge will be set at 12.9 l/s (50% betterment rate) to be agreed with local water authority and the LLFA.
- 12.8 Discharge to the watercourse is discounted since the nearest water course/ river is 600 meters away.
- 12.9 The foul water for the development will run through a gravity pipe system to the south of the development in which then discharges into an existing combined manhole located within Spurr House– Subject to United Utilities approval.
- 12.10 Based on the information provided to ELLUC Projects Ltd to accompany this Flood Risk Assessment, redevelopment of the site would be considered sustainable in terms of Flood Risk

APPENDIX A:

Introduction

1. This document provides additional guidance to local planning authorities to ensure the effective implementation of the planning policy set out in the National Planning Policy Framework on development in areas at risk of flooding and in relation to mineral extraction. This guidance retains key elements of Planning Policy Statement 25 and of the existing minerals policy statements and minerals planning guidance notes which are considered necessary and helpful in relation to these policy areas. The retention of this guidance is an interim measure pending a wider review of guidance to support planning policy.

Flood risk

2. As set out in the National Planning Policy Framework, 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. For these purposes:
 - “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 Environment Agency;
 - “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.

The Sequential and Exception Tests

3. As set out in the National Planning Policy Framework, the aim of the Sequential Test is to steer new development to areas with the lowest probability of flooding. The flood zones (see table 1) are the starting point for this sequential approach. Zones 2 and 3 are shown on the flood map¹ with Flood Zone 1 being all the land falling outside Zones 2 and 3. These flood zones refer to the probability of sea and river flooding only, ignoring the presence of existing defences.
4. Strategic Flood Risk Assessments (see paragraphs 7-8) refine information on the probability of flooding, taking other sources of flooding and the impacts of climate change (see paragraphs 11-15) into account. They provide the basis for applying the Sequential Test, on the basis of the flood zones in table 1. Where table 1

¹ To access the flood map, see the Environment Agency's website at:
<http://www.environment-agency.gov.uk/homeandleisure/floods/default.aspx>

indicates the need to apply the Exception Test (as set out in the National Planning Policy Framework), the scope of a Strategic Flood Risk Assessment will be widened to consider the impact of the flood risk management infrastructure on the frequency, impact, speed of onset, depth and velocity of flooding within the flood zones considering a range of flood risk management maintenance scenarios. Where a Strategic Flood Risk Assessment is not available, the Sequential Test will be based on the Environment Agency flood zones.

5. The overall aim should be to steer new development to Flood Zone 1. Where there are no reasonably available sites in Flood Zone 1, local planning authorities allocating land in local plans or determining planning applications for development at any particular location should take into account the flood risk vulnerability of land uses (see table 2) and consider reasonably available sites in Flood Zone 2, applying the Exception Test if required (see table 3). Only where there are no reasonably available sites in Flood Zones 1 or 2 should the suitability of sites in Flood Zone 3 be considered, taking into account the flood risk vulnerability of land uses and applying the Exception Test if required.

Table 1: Flood zones

(Note: These flood zones refer to the probability of river and sea flooding, ignoring the presence of defences)

Zone 1 - low probability

Definition

This zone comprises land assessed as having a less than 1 in 1,000 annual probability of river or sea flooding (<0.1%).

Appropriate uses

All uses of land are appropriate in this zone.

Flood risk assessment requirements

For development proposals on sites comprising one hectare or above the vulnerability to flooding from other sources as well as from river and sea flooding, and the potential to increase flood risk elsewhere through the addition of hard surfaces and the effect of the new development on surface water run-off, should be incorporated in a flood risk assessment. This need only be brief unless the factors above or other local considerations require particular attention.

Policy aims

In this zone, developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area and beyond through the layout and form of the development, and the appropriate application of sustainable drainage systems².

² Sustainable drainage systems cover the whole range of sustainable approaches to surface drainage management. They are designed to control surface water run off close to where it falls and mimic natural drainage as closely as possible.

Zone 2 - medium probability

Definition

This zone comprises land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (1% – 0.1%), or between a 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.5% – 0.1%) in any year.

Appropriate uses

Essential infrastructure and the water-compatible, less vulnerable and more vulnerable uses, as set out in table 2, are appropriate in this zone. The highly vulnerable uses are *only* appropriate in this zone if the Exception Test is passed.

Flood risk assessment requirements

All development proposals in this zone should be accompanied by a flood risk assessment.

Policy aims

In this zone, developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area through the layout and form of the development, and the appropriate application of sustainable drainage systems.

Zone 3a - high probability

Definition

This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%), or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.

Appropriate uses

The water-compatible and less vulnerable uses of land (table 2) are appropriate in this zone. The highly vulnerable uses should not be permitted in this zone.

The more vulnerable uses and essential infrastructure should only be permitted in this zone if the Exception Test is passed. Essential infrastructure permitted in this zone should be designed and constructed to remain operational and safe for users in times of flood.

Flood risk assessment requirements

All development proposals in this zone should be accompanied by a flood risk assessment.

Policy aims

In this zone, developers and local authorities should seek opportunities to:

- reduce the overall level of flood risk in the area through the layout and form of the development and the appropriate application of sustainable drainage systems;

- relocate existing development to land in zones with a lower probability of flooding; and
- create space for flooding to occur by restoring functional floodplain and flood flow pathways and by identifying, allocating and safeguarding open space for flood storage.

Zone 3b - the functional floodplain

Definition

This zone comprises land where water *has* to flow or be stored in times of flood.

Local planning authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency. The identification of functional floodplain should take account of local circumstances and not be defined solely on rigid probability parameters. But land which would flood with an annual probability of 1 in 20 (5%) or greater in any year, or is designed to flood in an extreme (0.1%) flood, should provide a starting point for consideration and discussions to identify the functional floodplain.

Appropriate uses

Only the water-compatible uses and the essential infrastructure listed in table 2 that has to be there should be permitted in this zone. It should be designed and constructed to:

- remain operational and safe for users in times of flood;
- result in no net loss of floodplain storage;
- not impede water flows; and
- not increase flood risk elsewhere.

Essential infrastructure in this zone should pass the Exception Test.

Flood risk assessment requirements

All development proposals in this zone should be accompanied by a flood risk assessment.

Policy aims

In this zone, developers and local authorities should seek opportunities to:

- reduce the overall level of flood risk in the area through the layout and form of the development and the appropriate application of sustainable drainage systems;
- relocate existing development to land with a lower probability of flooding.

APPENDIX B:

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Appendix C:

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APPENDIX D

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7 Regents Court Far Moor Lane Redditch B98 0SD		
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STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	5	Add Flow / Climate Change (%)	0
M5-60 (mm)	19.000	Minimum Backdrop Height (m)	0.200
Ratio R	0.400	Maximum Backdrop Height (m)	1.500
Maximum Rainfall (mm/hr)	50	Min Design Depth for Optimisation (m)	1.200
Maximum Time of Concentration (mins)	30	Min Vel for Auto Design only (m/s)	1.00
Foul Sewage (l/s/ha)	0.000	Min Slope for Optimisation (1:X)	500
Volumetric Runoff Coeff.	0.750		

Designed with Level Soffits

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.246	4-8	0.125

Total Area Contributing (ha) = 0.371

Total Pipe Volume (m³) = 6.220

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Auto Design
1.000	53.000	0.500	106.0	0.271	5.00	0.0	0.600	o	300	
1.01	30.000	0.150	200.0	0.100	0.00	0.0	0.600	o	300	
1.02	5.000	0.050	100.0	0.000	0.00	0.0	0.600	o	300	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	5.58	91.900	0.271	0.0	0.0	0.0	1.53	107.9	36.7
1.001	50.00	6.03	91.400	0.371	0.0	0.0	0.0	1.11	78.3	50.2
1.002	50.00	6.08	91.250	0.371	0.0	0.0	0.0	1.57	111.1	50.2

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Micro Drainage

XP Solutions

Network 2014.1.1

Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam., L*W (mm)	PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)
1	93.000	1.100	Open Manhole	1200	1.000	91.900	300			
2	93.000	1.600	Open Manhole	1200	1.001	91.400	300	1.000	91.400	300
3	92.700	1.450	Open Manhole	1200	1.002	91.250	300	1.001	91.250	300
Ex MH	92.300	1.100	Open Manhole	0		OUTFALL		1.002	91.200	300

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PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.000	o	300	1	93.000	91.900	0.800	Open Manhole	1200
1.01	o	300	2	93.000	91.400	1.300	Open Manhole	1200
1.02	o	300	3	92.700	91.250	1.150	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.000	53.000	106.0	2	93.000	91.400	1.300	Open Manhole	1200
1.01	30.000	200.0	3	92.700	91.250	1.150	Open Manhole	1200
1.02	5.000	100.0	Ex MH	92.300	91.200	0.800	Open Manhole	0

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.002	Ex MH	92.300	91.200	0.000	0	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

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

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	5	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Storm Duration (mins)	30
Ratio R	0.400		

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<u>Online Controls for Storm</u> <u>Hydro-Brake Optimum® Manhole: 3, DS/PN: 1.002, Volume (m³): 3.7</u> <table><tr><td>Unit Reference</td><td>MD-SHE-0160-1290-1200-1290</td></tr><tr><td>Design Head (m)</td><td>1.200</td></tr><tr><td>Design Flow (l/s)</td><td>12.9</td></tr><tr><td>Flush-Flo™</td><td>Calculated</td></tr><tr><td>Objective</td><td>Minimise upstream storage</td></tr><tr><td>Diameter (mm)</td><td>160</td></tr><tr><td>Invert Level (m)</td><td>91.250</td></tr><tr><td>Minimum Outlet Pipe Diameter (mm)</td><td>225</td></tr><tr><td>Suggested Manhole Diameter (mm)</td><td>1200</td></tr></table> <table><tr><th>Control Points</th><th>Head (m)</th><th>Flow (l/s)</th><th>Control Points</th><th>Head (m)</th><th>Flow (l/s)</th></tr><tr><td>Design Point (Calculated)</td><td>1.200</td><td>12.9</td><td>Kick-Flo®</td><td>0.791</td><td>10.6</td></tr><tr><td>Flush-Flo™</td><td>0.358</td><td>12.9</td><td>Mean Flow over Head Range</td><td>-</td><td>11.1</td></tr></table> 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 <table><tr><th>Depth (m)</th><th>Flow (l/s)</th><th>Depth (m)</th><th>Flow (l/s)</th><th>Depth (m)</th><th>Flow (l/s)</th><th>Depth (m)</th><th>Flow (l/s)</th></tr><tr><td>0.100</td><td>5.7</td><td>1.200</td><td>12.9</td><td>3.000</td><td>19.9</td><td>7.000</td><td>29.9</td></tr><tr><td>0.200</td><td>12.1</td><td>1.400</td><td>13.8</td><td>3.500</td><td>21.4</td><td>7.500</td><td>30.9</td></tr><tr><td>0.300</td><td>12.8</td><td>1.600</td><td>14.7</td><td>4.000</td><td>22.8</td><td>8.000</td><td>31.9</td></tr><tr><td>0.400</td><td>12.8</td><td>1.800</td><td>15.6</td><td>4.500</td><td>24.2</td><td>8.500</td><td>32.8</td></tr><tr><td>0.500</td><td>12.6</td><td>2.000</td><td>16.4</td><td>5.000</td><td>25.4</td><td>9.000</td><td>33.7</td></tr><tr><td>0.600</td><td>12.3</td><td>2.200</td><td>17.2</td><td>5.500</td><td>26.6</td><td>9.500</td><td>34.6</td></tr><tr><td>0.800</td><td>10.6</td><td>2.400</td><td>17.9</td><td>6.000</td><td>27.7</td><td></td><td></td></tr><tr><td>1.000</td><td>11.8</td><td>2.600</td><td>18.6</td><td>6.500</td><td>28.8</td><td></td><td></td></tr></table>			Unit Reference	MD-SHE-0160-1290-1200-1290	Design Head (m)	1.200	Design Flow (l/s)	12.9	Flush-Flo™	Calculated	Objective	Minimise upstream storage	Diameter (mm)	160	Invert Level (m)	91.250	Minimum Outlet Pipe Diameter (mm)	225	Suggested Manhole Diameter (mm)	1200	Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)	Design Point (Calculated)	1.200	12.9	Kick-Flo®	0.791	10.6	Flush-Flo™	0.358	12.9	Mean Flow over Head Range	-	11.1	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	0.100	5.7	1.200	12.9	3.000	19.9	7.000	29.9	0.200	12.1	1.400	13.8	3.500	21.4	7.500	30.9	0.300	12.8	1.600	14.7	4.000	22.8	8.000	31.9	0.400	12.8	1.800	15.6	4.500	24.2	8.500	32.8	0.500	12.6	2.000	16.4	5.000	25.4	9.000	33.7	0.600	12.3	2.200	17.2	5.500	26.6	9.500	34.6	0.800	10.6	2.400	17.9	6.000	27.7			1.000	11.8	2.600	18.6	6.500	28.8		
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Storage Structures for Storm

Cellular Storage Manhole: 2, DS/PN: 1.001

Invert Level (m) 91.405 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	210.0	0.0	0.801	0.0	0.0
0.800	210.0	0.0			

Manhole Headloss for Storm

PN	US/MH	US/MH
Name	Headloss	
1.000	1	0.500
1.001	2	0.500
1.002	3	0.500

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

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coefficient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

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

Synthetic Rainfall Details

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

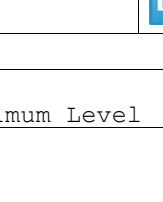
Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	ON
DVD Status	ON
Inertia Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 45

PN	Storm	Return Climate Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	First Z Act.	O/F Lvl	Exc.
1.00	15 Winter	30	0%	100/15 Summer					
1.01	60 Winter	30	0%	100/15 Summer					
1.02	60 Winter	30	0%	30/15 Summer					

PN	US/MH Name	Water		Flooded		Pipe		Status
		Level (m)	Surch'd Depth (m)	Volume (m³)	Flow / Cap. (l/s)	O'flow (l/s)	Flow (l/s)	
1.000	1	92.117	-0.083	0.000	0.84	0.0	85.9	OK
1.01	2	91.688	-0.012	0.000	0.23	0.0	16.6	OK
1.02	3	91.655	0.105	0.000	0.21	0.0	12.8	SURCHARGED

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

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coefficient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

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

Synthetic Rainfall Details

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

Margin for Flood Risk Warning (mm) 300.0
 Analysis Timestep 2.5 Second Increment (Extended)
 DTS Status ON
 DVD Status ON
 Inertia Status ON

Profile(s) Summer and Winter

Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 45

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
1.000	15 Winter	100	+45%	100/15	Summer			
	120 Winter	100	+45%	100/15	Summer			
	120 Winter	100	+45%	30/15	Summer			

PN	US/MH Name	Water		Flooded		Pipe		Status
		Level (m)	Surch'd Depth (m)	Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	
1.000	1	92.811	0.611	0.000	1.46	0.0	149.4	FLOOD RISK
1.01	2	92.069	0.369	0.000	0.43	0.0	30.8	SURCHARGED
1.02	3	92.404	0.854	0.000	0.21	0.0	12.8	FLOOD RISK

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<u>User Report C:\Users\AlirezaAhmadi\Downloads\volume calcs.SPDX for Storm</u>																						
<table><thead><tr><th>USMH</th><th>USMH Dia (mm)</th><th>US MH Depth (m)</th><th>Dia (mm)</th><th>Length (m)</th></tr></thead><tbody><tr><td>1</td><td>1200</td><td>1.100</td><td>300</td><td>53.000</td></tr><tr><td>2</td><td>1200</td><td>1.600</td><td>300</td><td>30.000</td></tr><tr><td>3</td><td>1200</td><td>1.450</td><td>300</td><td>5.000</td></tr></tbody></table>			USMH	USMH Dia (mm)	US MH Depth (m)	Dia (mm)	Length (m)	1	1200	1.100	300	53.000	2	1200	1.600	300	30.000	3	1200	1.450	300	5.000
USMH	USMH Dia (mm)	US MH Depth (m)	Dia (mm)	Length (m)																		
1	1200	1.100	300	53.000																		
2	1200	1.600	300	30.000																		
3	1200	1.450	300	5.000																		
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APPENDIX E

