

LAND TO THE WEST OF RUTLAND STREET HEYWOOD

FLOOD RISK ASSESSMENT & SUSTAINABLE DRAINAGE STRATEGY

Job Number: FRA 24 1073

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EXECUTIVE SUMMARY

Scope and Background

This Flood Risk Assessment (FRA) and Sustainable Drainage (SuDS) Strategy has been undertaken by LK Consult Ltd (LKC) to support a planning application for the development of Land to the west of Rutland Street, Heywood. The development comprises to redevelop the site for residential use.

LKC has prepared this SuDS Strategy in line with the NPPF and Technical Guidance where appropriate.

Consultations

Rochdale Borough Council – Lead Local Flood Authority (LLFA) and United Utilities (UU) have been contacted during preparation of this report.

The Environment Agency (EA) website has been utilised to assess if there are any limitations that may affect the form of SuDS that may be appropriate to this site. The records show that the site is within Flood Zone 1.

Flood Risk

The site is shown on the EA's Flood Zone Mapping website as being in Flood Zone **1** (PPG Table 1).

Negligible to very low risks of flooding from fluvial, tidal, pluvial, groundwater, sewers and artificial sources have been identified from information provided

Mitigation

The ground conditions beneath the site are recorded on BGS mapping as Glaciofluvial superficial deposits (sand and gravel) over bedrock comprising Pennine Lower Coal Measures Formation (mudstone, siltstone and sandstone). However, this is not reflective of the available BGS boreholes and site investigation works in the area by LKC where interbedded cohesive and granular material is shown to be present within boreholes, and in some areas cohesive material was proven in boreholes to >5.45mbgl (i.e. no granular material encountered).

There is a slight rise across the site to the south and east, however, there is a 3-4m fall in ground levels beyond the western boundary and beyond the southern boundary.

The finished floor level should be set at a nominal height above the finished ground levels to allow for overland flow routes in extreme events and drainage failures.

Pedestrian and vehicular safe access to and from the site is achievable under all conditions via the access road off Rutland Street.

The outline drainage strategy considers the use of an infiltration-based SuDS not to be feasible based upon prevailing shallow soil conditions, the constrained nature of the site and the potential for destabilising the slopes and causing flooding the site to the south.

The most favourable disposal route for surface water runoff is for discharge into the culverted watercourse (Millers Brook) c. 15m west of the site.

The estimated volume to be retained on site for the 1 in 30-year storm event including an allowance for climate change is **8.8m³**.

The estimated volume to be retained on site for the 1 in 100-year storm event including an allowance for climate change is **13.8m³**.

The flows from the site should be restricted to an acceptable level to the LLFA, EA and UU as required.

The proposed development will increase the proportion of the site covered by impermeable surfaces and will therefore generate more runoff. Attenuation will be required to allow for climate change and restrictions placed upon the proposed development due to planning requirements and/or water company flow restrictions. The estimated volume can be stored within the site boundary.

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1 Introduction

1.1 Background

LK Consult Ltd (LKC) were commissioned to carry out a Flood Risk Assessment and Sustainable Drainage Strategy for Land to the west of Rutland Street, Heywood, OL10 4JJ. The report was undertaken in support of a future planning application to redevelop the site for residential use.

The report will address the vulnerability to flooding from all possible sources and will also consider the impact of the development on surface water runoff accounting for climate change and the potential to increase flood risk elsewhere. The Outline Drainage Strategy in Section 5 will provide an overview of the SuDS techniques which could be considered on the site. The issues of actual flood risk are discussed in Section 4.

Government policy with respect to development in flood risk areas is contained within the Department of Communities and Local Government National Planning Policy Framework¹ and accompanying Technical Guidance of March 2012 (revised to the Planning Practice Guidance (PPG)², which supersedes Planning Policy Statement 25 (PPS25) 'Development and Flood Risk'. The guidance on Climate Change allowance issued by DEFRA of the Environment Agency Data of version 2 of the Hydrology Data Explorer application (February 2021).

LKC has prepared this Flood Risk Assessment (FRA) in line with the NPPF and the PPG where appropriate. The level of detail entered into any flood risk assessment is dependent upon the scale and potential impact of the proposed development, and the vulnerability classification of the proposed land-use.

The report will consider the impact of the development on surface water runoff accounting for climate change. The sustainable drainage assessment in Section 4 will provide an overview of the SuDS techniques which could be considered on the site.

This preliminary SuDS assessment complies with the principles presented in the Draft National Standards for Sustainable Drainage Systems (Defra, 2015)³ and the Planning Practice Guidance (PPG) March 2014⁴. The sustainable drainage assessment is presented with reference to the hydrological and hydrogeological context of the development.

The report findings are based upon professional judgement and are summarised below. The report includes baseline data from the Environment Agency (EA), rainfall data from the Wallingford Studies and Hydrogeological information from the British Geological Survey (BGS). The assessment will summarise and refer to these datasets in the text.

Drainage on the site has been assessed by considering the following key constraints:

¹ DCLG (2021). "National Planning Policy Framework." Department of Communities and Local Government. July 2021.

² DCLG (2014). "Planning Practice Guidance" <http://planningguidance.communities.gov.uk>, April 2014.

³ Non-statutory Technical Standards for Sustainable Drainage Systems – DEFRA March 2015.

⁴ Planning Practice Guidance – Department for Communities and Local Government July 2021.

- Topography of the site.
- Local water features and hydrological context.
- Underlying geology, soil types and permeability.
- Layout and geometry of the proposed development.

1.2 Site Details

A summary of the general site details is presented in Table 1-1. Plans, Drawings and Figures are provided in Appendix A.

Site Details	
Location	West of Rutland Street, Heywood, OL10 4JJ. NGR 385858E, 411032N.
Area	c. 883m ² .
Topography	Approx. 109-110 metres above ordnance datum (AOD). Slight rise to the south and east. There is a 3-4m fall in ground levels beyond the western boundary and beyond the southern boundary.
Current Land Use	<u>Site</u> Mainly rough grassland with a hardstood area along the northern strip and 2no. domestic garages on the eastern boundary. <u>Surrounding Area/ Boundary Treatment</u> North and East: Residential Properties. South: Steep bank with Industrial Units beyond. West: Steep vegetated bank with Public Open Space beyond.
Proposed Development	4no. residential dwellings with private gardens and off street parking for Plot 4.

Table 1-1: Summary of site details.

2 Site Setting

2.1 Vulnerability

As an initial phase in identifying whether a site is potentially at risk of flooding, LKC has consulted the Environment Agency's (EA) website Flood Zone Mapping. This mapping is (often) based on coarse scale modelling and provides only an initial indication of the flood risk to a site. The Environment Agency Flood Zone maps were developed using a very coarse Digital Elevation Map (DEM) and are superseded by a more detailed analysis of modelled flood levels and topographic survey levels.

The Flood Zones divide the floodplain into three categories of flood risk, and do not take flood defences into account. The NPPF defines the Flood Zones as:

- Flood Zone 1 – Very Low Risk, with annual probability of flooding from rivers and the sea of less than 0.1% (1 in 1000).
- Flood Zone 2 – Low Risk, with annual probability of flooding of 0.1 to 1.0% from rivers and 0.1 to 0.5% from the sea.
- Flood Zone 3 – Medium to High Risk of flooding with an annual probability of flooding of 1.0% or greater from rivers, and 0.5% or greater from the sea.

The Flood Zone Mapping indicates the site as being within Flood Zone 1 in the PPG (paragraph 065, Table 1).

2.2 The Sequential and Exception Tests

The NPPF does not require that the Sequential Test be applied to development proposals in Flood Zone 1. Since the site has been shown to be located in Zone 1 for flood risk (see section 4.1), a sequential approach should not be required for planning.

However, the principles should still be applied for developments within the site such that, for example, dwellings are situated on a high part of the site when there is a risk of local surface water flooding. The issues of actual flood risk are discussed below. The issues of safety and reduction in flood risk to others required by an Exception Test are also addressed in this document.

The Local Planning Authority (LPA) will make the final decision with regard to any planning application.

2.3 Environmental Setting

LKC has undertaken a review of public domain information including British Geological Survey data, Environment Agency SEPA data, historical mapping, and aerial photography to provide a summary of the environmental setting of the site. This is summarised in Table 2-1 below.

Summary of the Environmental Setting			
Geology	Superficial	Glaciofluvial Deposits, Devensian - Sand and gravel.	
	Bedrock	Pennine Lower Coal Measures Formation - Mudstone, siltstone and sandstone.	
	BGS Boreholes	BH Ref: SD81SE288, 150m southwest: MADE GROUND to 3.10m, silty CLAY with sand lenses to 4.50m, coarse SAND to 4.80m, silty stony CLAY to 6.40m, SAND to 7.00m. Water struck at 4.50m. BH Ref. SD81SE289, 155m southeast: MADE GROUND to 1.20m, silty sandy CLAY to 2.30m, silty SAND to 3.90m, SAND and GRAVEL to 5.80mbgl, silty SAND to 6.60mbgl and sandy stony CLAY to >7.00mbgl. Water struck at 4.50m. Ground Investigation carried out off Holland Street c. 180m southwest. 4no. boreholes proved clay below the made ground to >5.45m whereas 1no. borehole comprised granular strata below the made ground to >5.45m.	
	Soilscape	Type 10: Freely draining slightly acid sandy soils	
Hydrogeology	Aquifer	Superficial	Secondary A Aquifer.
	Designation	Bedrock	Secondary A Aquifer.
	Source Protection Zone (SPZ)	Site not within an SPZ.	
Flood Zone (EA)	The site is within Fluvial Flood Zone 1. Flood Zone 1: Very Low risk, with annual probability of flooding from rivers and the sea of less than 0.1% (1 in 1000).		
Hydrology	Millers Brook, flowing north, is located in a culvert to the west of the site. The brook emerges from the culvert c. 95m north of the site. on the west of the site boundary and flows towards the north. Millers Brook is a designated “Main River”.		
Site History (review of LKC archive Ordnance Survey Mapping)	1851 - Millers Brook comprises an open watercourse with a meander. 1891 - Cotton Mill is present to the west of the site and a dyeworks adjacent south. Millers Brook has been straightened in the site vicinity to be utilised by these premises and culverted under Starkey Street to the north. . 1910-1937 - Reservoirs are constructed adjacent to the Cotton Mill. 1957 - Cotton Mill has been demolished and Millers Brook is shown in open channel to the west and south of the site. 1973 - Millers Brook has been culverted to the west of the site and the area landscaped. It remains in open channel to the south 1990 – Millers Brook culverted to the south of the site. 5no. domestic garages present on eastern boundary from 1990 mapping (2 no. remain)		
Flooding History in Site Vicinity	Pluvial flooding associated with the Millers Brook culvert occurred in 2004 and 2006 around Millers Brook Close (c. 60m west of the site) ⁵		

Table 2-1: Summary of the Environmental Setting.

⁵ Douglas *et al* (2010): "Urban pluvial flooding: A qualitative case study of cause, effect and non-structural mitigation". Article in Journal of Flood Risk Management, February 2010.

2.4 Site Levels

A topographic survey of the site was not provided, therefore opensource LiDAR levels have been extracted to OS GPS datum, and information is included on the drawings in Appendix B.

The site rises slightly to the east and south across the site.

The final site levels and ground floor levels of dwellings have not yet been determined. It is assumed the existing access off Rutland Street for Plot 4 will be retained at the current level of 109.53mAOD.

Access to Plots 1-3 in the southern part of the site would join Rutland Street at around 110.20mAOD.

3 Consultation

Information from consultees is summarised in Table 3-1 below.

Relevant correspondence and background information is provided in Appendix C.

Source	Details	
Environment Agency	The development site is outside of an area at risk of surface water flooding. The development is in Flood Zone 1.	
Lead Local Flood Authority (LLFA)	Provided EA plan of Millers Brook Culvert – this shows entries MH05 and MH06 in the site vicinity with elevations assumed to be ground / cover levels Provided extract of SFRA mapping for Rochdale. This indicates the urban area of Heywood is within a Critical Drainage Area. SFRA indicates council policy for brownfield sites is 50% less than pre-development and for greenfield sites is current runoff up to 1 in 100 year event plus climate change. There are records on the file of historic flooding at Millers Brook Close adjacent to the site in 2006 and 2018 with the combined sewer flooding from sewers. No private drainage would be permitted to discharge to adopted highways. Policy JP-S4 indicates that development should achieve greenfield run-off rates unless it is demonstrated to be impracticable.	
United Utilities (UU)	Sewer Map	1275mm diameter surface water sewer to the west of the site (Millers Brook) with Chamber 8006 c.15m west of site. There is a 225mm diameter surface water sewer to the east of site flowing north before connecting to a combined sewer to the front of 8 Rutland Street. There is a 150mm diameter combined sewer and chamber located in the narrow strip at the north of the site.
	General Comments	No modelled flood risk in the vicinity of the site.
	Likely conditions for connecting into their sewerage system	United Utilities (UU) would request conditions for a separate system with only foul draining to foul / combined sewers and surface water draining to soakaway/SuDS, watercourse or surface water sewer. All surface water flow from the proposed development should drain in-line with the drainage hierarchy, as outlined in Paragraph 80 of the National Planning Practice Guidance. Surface water runoff generated from this development should discharge to the ground via infiltration system where feasible. If...infiltration is not feasible, we recommend that you contact the Lead Local Flood Authority and/or Environment Agency to discuss a point of discharge to the watercourse located 16m West of the proposed site. Foul flow from this site will be allowed to drain into the public foul water/combined sewer system. UU's preferred point of discharge would be to the 225mm diameter public combined sewer within Rutland Street at an unrestricted rate. United Utilities (UU) confirmed that they did not have any record of internal or external sewer flooding of properties in the vicinity of the site as a result of overloaded sewers.

Table 3-1: Summary of Consultee Information.

4 Assessment of Flood Risk

4.1 Flood Zones

The detailed flood map provided by the EA indicates that the site is in Flood Zone 1. (see Appendix C). No flood zones are mapped to Millers Brook culvert adjacent to the site.

Flood Zones are mapped on and adjacent to the watercourse emerges where it emerges from culvert c. 95m north. A direct comparison was made between the EA flood levels in this area the LiDAR levels. This indicates a level of 103.5mAOD at the outer edge of Flood Zone 2. This is significantly lower than site levels of c. 109mAOD. It can be reasonably concluded on the evidence above that the site is in Flood Zone 1 for the purposes of this assessment.

4.2 Sources of Flooding

The risk of flooding from the following flood sources has been considered:

Fluvial – The EA has confirmed the study area is within Flood Zone 1. Therefore, the flood risk associated with this source is considered Very Low.

Tidal – The study area is remote from the sea and tidally influenced water bodies. Therefore, the flood risk associated with this source is considered Negligible.

Pluvial (Rainfall) – The surface water flood risk maps show the lower areas of lower lying ground to the west and south of the site have the potential to flood during prolonged heavy rainfall. No risk areas are shown on the site nor to the land at a similar level to the north and east. Therefore, the risk of flooding from pluvial sources is Very Low.

Surface Water (Overland flow) – This relates to surface water entering the site. Impermeable areas around the site are generally at a similar level to that of the study area. Surface water arising from the north and east of the study area is likely to be intercepted by the highway drains and therefore pose no threat to the development. If there was a drainage failure causing overland flow it would flow westwards and to the adjacent lower area. Therefore, the flood risk of flooding from surface water sources is considered Very Low.

Groundwater – The BGS has groundwater records for the site vicinity in the form of borehole records. The records show the water table is recorded at 4.50mbgl c. 150m south of the site. Any groundwater present would be emergent in the lower area to the west of the site. Therefore, the flood risk associated with groundwater sources is considered Negligible.

Sewers – UU sewer records show foul and surface water sewers adjacent north of the site and adjacent east in Rutland Street. In addition Millers Brook to the west of the site is indicated as a surface water sewer. There are no records of modelled flood risk from sewers in the site vicinity. Therefore, the flood risk associated with sewers is considered Very Low.

Artificial sources – According to the EA online maps, the study area is not at risk from reservoir flooding. Therefore, the flood risk associated with artificial sources is considered Negligible.

4.3 Summary of Flood Risk

Source of Flooding	Risk Assessment Level
Fluvial	Very Low
Tidal	Negligible
Pluvial (Rainfall)	Very Low
Surface Water	Very Low
Groundwater	Negligible
Sewers	Very Low
Artificial Sources	Negligible

Table 4-1: Summary of Existing Risk Level.

The site is located within Flood Zone 1 and a Negligible to Very Low Risk of flooding from fluvial, tidal, pluvial, groundwater, sewers and artificial sources have been identified for the site. LKC therefore consider that a strategy for surface water management will be required at the site to mitigate the risk to others. The assessments of a range of measures that are feasible for the site are outlined in Section 5.

5 Sustainable Drainage Strategy

5.1 Introduction

The NPPF recognises that flood risk and other environmental damage can be managed by minimising changes in the volume and rate of surface run-off from development sites through the use of Sustainable Drainage Systems (SuDS), this being complementary to the control of development within the floodplain.

SuDS will not alleviate flooding in an area prone to flooding; however, properly designed SuDS have the potential to prevent the surface water runoff from new development worsening the flood risk. The effective disposal of surface water from development is a material planning consideration in determining proposals for the development and use of land.

The accepted principles are that surface water arising from a developed area should, as far as practicable, be managed in a sustainable manner to mimic the surface water flows arising from the site prior to the proposed development, while reducing the flood risk to the site itself and elsewhere, taking climate change into account.

The Building Regulations Requirement H3⁶ stipulates that rainwater from roofs and paved areas is carried away from the surface to discharge to one of the following, listed in order of priority:

- an adequate soakaway or other adequate infiltration system,
- a watercourse or, where that is not practicable,
- a sewer.

The concept of a sustainable drainage system has been incorporated into the outline drainage strategy for the study area in order to comply with the Flood and Water Management Act 2010⁷.

Suitability of different SuDS will be governed by prevailing site conditions, such as the type and scale of development, topography, ground conditions (soil permeability, ground stability, depth to water table), local hydrogeology and risk of groundwater contamination (presence of sensitive aquifers and source protection zones) etc.

5.2 Sustainable Drainage Hierarchy

5.2.1 Infiltration

The Groundwater Source Protection Zone mapping from the EA website shows that the site is not within any identified source protection zones.

A summary of the BGS superficial and bedrock aquifer descriptions and classifications supplemented by local records is shown in Table 5-1 below:

⁶ Building Regulations part H3 2010: Approved Document, Drainage and Waste Disposal.

⁷ Flood and Water Management Act 2010: UK Government.

Classification	Description	Recorded Water Table Depth	Soakaway Potential
Glaciofluvial Deposits (Devensian)	Sand and gravel.	4.5m	Good
Till (Devensian) Clay	Silty, sandy gravelly clay	N/A	Unlikely
Pennine Lower Coal Measures Formation	Mudstone, siltstone and sandstone.	N/A	Limited

Table 5-1: Geological and Hydrogeological Setting.

BGS superficial deposits mapping indicates sand and gravel glacio-fluvial deposits across the site vicinity with clay (Till) mapped c.350m west and c. 575m south of the site.

This is not reflective of the available BGS boreholes and site investigation works in the area by LKC where interbedded cohesive and granular material is present within borehole records, and in some areas cohesive material was proven in boreholes to >5.45mbgl (i.e. no granular material encountered).

Given the intrusive borehole information on shallow ground conditions then infiltration methods such as soakaways may not be feasible.

Given the constrained nature of the site the most likely location for a soakaway would be in the southwest corner of the site. However, with recourse to guidance in the SuDS Manual and interbedded granular and cohesive layers in the shallow soils, the installation of a soakaway in this location may restrict infiltration and destabilise the boundary slopes to the west and south and lead to break-out of water at the base of or on the face of the slope. This could also cause flooding to the site adjacent southwest as it is c. 4m lower than the study site.

5.2.2 Watercourses

There is a culverted watercourse running adjacent to the site. Access to the watercourse would be across third party land.

5.2.3 Public Sewer

There is a surface water sewer running adjacent to the site in Rutland Street, which connects to a combined sewer.

There is a combined sewer chamber located in the narrow section at the north of the site. The sewer map does not show a connection from this section to the public sewer.

5.2.4 Other Sewers

There are no known private connections to the public sewer from the study site.

5.3 Surface Water Drainage Strategy

Following the assessment of the site settings and existing constraints to the development. The drainage options relating to the final discharge of surface water for this section of the site are listed in Table 5-2 in order of priority within the NPPF:

Option No:	Drainage Solution	Most feasible solution	Reasoning
a	Soakaway/Infiltration	3	Considered least favourable at this stage given the constrained nature of the site. The only possible location for a soakaway is in the southwest part of the site and has the potential for causing ground instability of the boundary slopes and possible “break out” to the site to the south which is c. 4m lower than the study site.
b	Connection to Watercourse	1	Would require third party access and EA/LLFA consent. 1275mm Culvert between chambers 8006 & 8005 adjacent west of the site will be feasible.
c	Discharge into a sewer	2	A connection into the 225mm diameter surface water sewer in Rutland Street would be possible east of the site – subject to approval from LLFA and connection consent from UU.

Table 5-2: Drainage options.

Table 5-3 provides a summary of the SuDS options appraisal with consideration of CIRIA C753 (The SUDS Manual)⁸ for the development:

SuDS Option	Appropriate to Development	Comments	Benefits	Description
Infiltration				
Soakaways	X	Due to the likely geology, the constrained nature of the site and the steep slope on the southern and western boundaries, the use of infiltration systems may not be feasible.	Water quantity Water quality	Soakaways provide stormwater attenuation, stormwater treatment and groundwater recharge. Runoff is treated by physical filtration to remove solids, by absorption into the soil and removal and by biochemical reactions involving micro-organisms growing on the soil.
Infiltration basin	X	Depressions that store and dispose of water via infiltration. May not be appropriate given the site conditions.	Water quantity Water quality Biodiversity Amenity	Infiltration basin reduces the volume of runoff from a drainage area, can be very effective at pollutant removal via filtering through the soils, contributes to groundwater recharge and baseflow augmentation. Runoff is treated by physical filtration to remove solids, by absorption into the soil and removal and by biochemical reactions involving micro-organisms growing on the soil.
Infiltration trench	X	Infiltration trenches are shallow excavations with rubble or stone. May not be appropriate given the site conditions.	Water quantity Water quality Amenity	An Infiltration trench can create temporary subsurface storage of stormwater runoff, thereby enhancing the natural capacity of the ground to store and drain water. Infiltration trenches allow water to dissipate into the surrounding soils from the bottom and sides of the trench where runoff is treated by physical filtration, adsorption and biochemical reactions involving micro-organisms growing in the soil. Infiltration trenches are easy to integrate into a site. They are ideal for use around playing fields, recreational areas, or public open space.
Rain gardens	*	Rain gardens are relatively small depressions in the ground that are planted up with native vegetation. Most likely to be implemented on private property close to buildings on relatively flat areas.	Amenity Biodiversity Water quality Water quantity	Attractive features that can help to improve open space. Can be planned as landscaping features. Flexible layout to fit into landscape. Runoff can be treated by physical filtration to remove solids, by absorption and removal by biochemical reactions involving micro-organisms growing on the soil. They can reduce rate of run off and provide some volume reduction.
Filtration				
Filter drain / trench	✓	Linear trenches filled with a permeable granular material, often with a perforated pipe in the base of the trench.	Water quantity Water quality	Filter trenches create temporary subsurface storage of stormwater runoff and provide stormwater treatment. These trenches can be used to filter and convey stormwater to downstream SuDS components.
Filter strip	✓	Engineered filters that use vegetation to remove and treat runoff. The filter strip is sloped to allow sheet flow across the vegetated strip. May be appropriate given the site topography.	Water quality Amenity Biodiversity	A filter strip offers no storage and is used solely to remove pollutants from surface water. The vegetation traps organic and mineral particles that are then incorporated into the soil, while the vegetation takes up any nutrients. A filter strip features medium amenity potential. Local wild grass and flower species can be introduced for visual interest and to provide a wildlife habitat.

⁸ CIRIA C753 - The SUDS Manual. London 2015.

SuDS Option	Appropriate to Development	Comments	Benefits	Description
Retention & Detention				
Detention basin	X	Dry depressions designed to hold water for a specific retention time. Basins tend to be found towards the end of the SuDS management train, so are used if extended treatment of the runoff is required or if they are required for wildlife or landscape reasons. The site is too constrained for this option.	Water quantity Water quality Biodiversity Amenity	Detention basins provide flow control through attenuation of stormwater runoff for a wide range of rainfall events. Basins treat runoff in a variety of ways: settlement of solids in still or slow moving water, adsorption by the soil, biological activity. Basins offer many opportunities for the landscape designer. Basins should not be built on but can be used for sports and recreation. Basins can be part of public open space.
Attenuation Ponds	X	Attenuation ponds can be used to offset the increase in surface water flows attributable to increased area of hard standing, in order to minimise the risk of flooding to and from the proposed development. The site is too constrained for this option.	Water quantity Water quality Biodiversity Amenity	Ponds will attenuate the surface water flow prior to discharging to the public surface water sewers. The storage volume afforded by these features should not include any permanent water in the pond. Ponds treat runoff in a variety of ways: settlement of solids in still water (having plants in the water enhances calm conditions and promotes settlement), adsorption by aquatic vegetation, biological activity. Permanently wet ponds can be used to store water for reuse and offer excellent opportunities for the provision of wildlife habitats. Ponds can be part of public open space.
Geo-cellular storage systems	✓	Modular block systems can be used to provide an underground storage facility. Any geo-cellular storage systems should be lined with a geo-membrane to provide attenuation storage.	Water quantity	Geo-cellular systems can be used to control and manage rainwater surface water runoff either as a soakaway or as a storage tank. Geo-cellular storage systems provide high storage volume capacity High void ratios (up to 96%). Capable of managing high flow events.
Oversized Pipes	✓	Oversizing the pipes that make up the on-site drainage network is a cost-effective method for providing attenuation storage within the network. Such systems could be considered on the parts of the development where gradients are relatively flat.	Water quantity	Oversized pipes can reduce rate of run off and provide some volume reduction.
Tanks	✓	Prefabricated underground tanks could be considered at the detailed design stage in order to provide storage to attenuate surface water runoff.	Water quantity	Storage tanks can be used to control and manage rainwater surface water runoff providing high storage volume capacity. Tanks are capable of managing high flow events.

SuDS Option	Appropriate to Development	Comments	Benefits	Description
Swales & conveyance channels				
Swales	X	Swales are shallow grass-lined channels that provide capacity for conveying flows at a controlled rate into ponds and watercourses. The site is too constrained for this option.	Water quality Biodiversity Amenity Water quantity	Swales are effective at removing polluting suspended solids through filtration and sedimentation. The vegetation traps organic and mineral particles that are then incorporated into the soil, while the vegetation takes up any nutrients. Swales are often integrated into the surrounding land use. Local wild grass and flower species can be introduced for visual interest and to provide a wildlife habitat. Swales are usually designed as conveyance systems but can also be designed with check dams to increase attenuation and, where applicable, infiltration.
Channels & rills	X	Channels and rills are open surface water channels with hard edges. The site is too constrained for this option.	Water quality Amenity Water quantity Biodiversity	Effective in water & pollution treatment. Can act as pre-treatment to remove silt before water is conveyed into further SuDS features. Can be visually appealing in urban landscapes. Amenity value for the local community and biodiversity value (design dependant).
Control structures				
Flow control devices	✓	Flow control devices e.g. hydro-brake style flow control systems, and restricted orifices enable the discharge to be restricted to a constant rate from the development.	Water quantity	Control the peak flow. Complex controls can reduce upstream storage requirements.
Inlets, outlets and controls	✓	There are many different designs and variations, including landscaped pipes, perforated pipes, weirs.	Water quality Amenity	Inlets, outlets and other control structures are key elements of well-designed SuDS. Inlet and outlet features allow water to flow into and out of features and also limit the rate at which water flows along and out of the system. There are many different approaches and products available and they can be easily designed to add interest to the urban landscape. Can provide accurate flow control from one SuDS feature to another.
Source control				
Green roofs	*	Green roofs comprise a multi-layered system that covers the roof of a building or podium structure with vegetation cover/landscaping.	Water quality Water quantity Amenity Biodiversity	Green roof installations can help to reduce surface water runoff from roof areas depending on the system specified. Good removal capability of atmospherically deposited urban pollutants. Ecological, aesthetic and amenity benefits.
Blue roofs	*	A blue roof is a roof design that is explicitly intended to store water, typically rainfall.	Water quantity Amenity Biodiversity	Blue roofs are designed to attenuate and manage stormwater on a flat roof in urban areas where options for ground-based attenuation systems are limited, and in particular, where construction is being carried out within flood sensitive areas. Amenity value for the local community

SuDS Option	Appropriate to Development	Comments	Benefits	Description
Rainwater harvesting	*	Rainwater harvesting collects the rain which falls onto roofs, then stores it in a tank until required for a non-potable use.	Water quantity	In the process, a volume of water is kept out of the storm-water management system, thereby helping to reduce flooding risks. When required, the water is pumped to the point of use, thus displacing what would otherwise be a demand for mains-water. Reduces demand on mains water.
Permeable Pavements – with granular and geo-cellular storage systems	✓	Permeable pavements allow inflow of rainwater into underlying construction. Any geo-cellular storage systems would have to be lined with an impermeable membrane to provide storage rather than infiltration for runoff from highways.	Water quality Water quantity	Reduced peak flows to watercourses, reducing the risk of flooding downstream. Reduced effects of pollution in runoff on the environment.
Other SuDS				
Wetlands	✗	These comprise of shallow ponds and marshy areas, covered almost entirely in aquatic vegetation.	Water quality Water quantity Amenity Biodiversity	Wetlands provide both stormwater attenuation and treatment. Wetlands detain flows for an extended period to allow sediments to settle, and to remove contaminants by facilitating adhesion to vegetation and aerobic decomposition. They also provide significant ecological benefits.

Table 5-3: Summary of the SuDS options appraisal.

Notes

✓ Suitable for use given the nature and scale of the development

* Possibly suitable for use – not included in the client and architect design proposal at present

✗ Not suitable

5.4 Surface Water Attenuation Requirements

In line with the LLFA requirements, the flow from this development should be reduced by the minimum of 50% from the existing runoff rates for estimating the attenuation volumes required.

It is estimated from the supplied plan (see Appendix A) that the site will have the following designated areas (Table 5-4).

Designated Areas	Plot Area (m ²)
Total area	883
Existing Impermeable Area	243
Green Infrastructure	640
Contributing Catchment	
Catchment Area	883
Developable Area	883
Impermeable Area	534
Permeable Area	349
Other Green Infrastructure	0

Table 5-4: Designated areas.

It can be seen that there is an increase in impermeable area from the existing usage to the proposed. This is likely to require attenuation to reduce the proposed flow off site to a level which is acceptable to the LLFA and to UU, including an allowance for climate change.

5.4.1 Attenuation Estimate

Surface water storage and greenfield runoff estimations based on the HR Wallingford procedure have been undertaken for the development and the output report is presented in Appendix E.

For the contributing catchment an estimate has been produced assuming a developable area of 883m² and a resulting impermeable area of 534m². This gives the following runoff rates and attenuation requirements for this section based on the Wallingford IH 124 method:

Q _{bar} :	0.62 l/s
1 in 1-year greenfield runoff rate:	0.53 l/s
1 in 30-year greenfield runoff rate:	1.04 l/s
1 in 100-year greenfield runoff rate:	1.30 l/s
Q _{bar} :	3.3 l/s
1 in 1-year peak runoff rate:	2.5 l/s
1 in 30-year peak runoff rate:	6.3 l/s
1 in 100-year peak runoff rate:	7.9 l/s

This reduced by 50% would give the following rates:

Q _{bar} :	1.65 l/s
1 in 1-year peak runoff rate:	1.25 l/s
1 in 30-year peak runoff rate:	3.15 l/s
1 in 100-year peak runoff rate:	3.95 l/s

5.4.2 Discharge Rate

Where the drainage system discharges to a surface water body capable of accommodating uncontrolled surface water discharges without impacting flood risk—such as the sea or a large estuary—the peak flow control standards (S2 and S3) and volume control technical standards (S4 and S6) may not apply. In such cases, the natural capacity of the water body to absorb and dissipate excess water without contributing to flood risk negates the need for strict adherence to these controls.

However, it remains essential to ensure that any discharge does not exacerbate conditions downstream or in adjacent areas. Even when discharging to a large surface water body, careful consideration should be given to potential environmental impacts, including erosion, sediment transport, and water quality.

Peak flow control

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

Volume control

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

A discharge rate to the watercourse or sewers has not been specified to LKC at this time. UU would generally specify a discharge rate of 5l/s therefore a restricted discharge rate of 2.5l/s has been proposed. This would provide betterment on the existing Q_{bar} brownfield discharge rate.

The following attenuation has been estimated for the development using 2.5l/s runoff rates and utilises the FSR methodology⁹ as:

- Attenuation storage volume: **8.8m³** (1 in 30 year event + 30% Climate Change)
- Retention on site volume: **13.8 m³** (1 in 100 year + 40% Climate Change)

Attenuation storage aims to limit the peak rate of runoff from the development to the corresponding reduced 2.5l/s runoff for a range of annual flow rate probabilities before discharging into a watercourse. As the flow from the development would be restricted to the existing 1 in 1 year equivalent there should be little change in the flows that enter the culverted watercourse and thus the risk of flooding as a result from the development should not increase the risk of flooding off-site.

The attenuation required for a 1 in 30-year storm event plus 30% climate change, requires a storage volume of **8.8m³**. For the 1 in 100-year event plus 40% climate change, a storage capacity of **13.8m³** will be required from on-site storage as well as

⁹ Flood Studies Report Wallingford NERC 1975.

SuDS systems. All volumes can be stored within the site boundary and discharges will be limited by flow control devices to the adjacent watercourse.

5.5 Site Specific SuDS

The use of attenuation SuDS are deemed to be the most feasible and practical option for the development. The attenuation tank or similar will provide the required storage volume to limit peak runoff arising from the development.

Utilisation of a flow control device at the end of the system will control the peak flow rates.

As the flow restriction would be infrequently operated it may cause maintenance issues and increase flooding potential to the property. We would not recommend the installation of such a flow restriction unless it is still required following discussions with the LLFA.

The use of permeable paving may be viable dependant on the detailed design of the proposed development. If this drainage technique is considered to be feasible then it will reduce the requirement for attenuation as it will reduce the contributing impermeable area. The permeable paving will also provide some level of water treatment reducing effects of pollution in runoff on the environment.

Assuming that the outline drainage strategy is acceptable to the Local Authority, a more detailed design can be presented and agreed with the appropriate regulatory bodies during the detailed design phase.

5.6 Foul Drainage

UU indicated the foul flow from this site will be allowed to drain into the 225mm diameter public combined sewer within Rutland Street at an unrestricted rate.

6 Mitigation Measures

6.1 Proposed Site levels and Developments Level

Current EA guidance recommends that the minimum ground floor levels of residential developments are set at a minimum of 600mm above the 1% annual probability (1 in 100 year) flood level including an additional fluvial allowance for climate change. It is generally accepted that vehicle parking can be accommodated within the flood zone with suitable safeguards. The 'design' flood level for the site should therefore be the 1% annual probability event with allowance for climate change.

This and the 0.1% annual probability (1 in 1000-year) are below the lowest existing ground level measured on site by approximately 5m. On this basis the finished floor levels (FFL) should be set at a nominal height above the finalised ground levels to allow for any overland flow from a drainage failure. No further mitigation measures are therefore recommended.

6.2 Safe Access

Safe and dry access is available via Rutland Street (109m AOD) to the east at c. 5m above the 1% annual probability event (103.5m AOD). Therefore, no mitigation is proposed.

6.3 Flood Resistance and Resilience

The development proposed may be subject to flooding at more extreme events than those considered. However, the risk appears to be sufficiently low that flood resilience measures need not be included into ground floor construction to aid recovery after any event. If utilised, typical measures would include solid floors, use of suitable materials and services fed from upper floors with outlets at high level. The need can be discussed and agreed with building control officers during detailed design.

6.4 Residual Risk

It is impossible to completely guard against flooding since extreme events greater than the design standard event are always possible. However, it is likely that with the 1% annual probability flood event with an allowance for climate change significantly below the lowest site levels, the relatively elevated position of the development will safeguard it from localised fluvial flooding during extreme rainfall events and fluvial flooding events outside the scope of this assessment. However, ground floor levels should be set above proposed levels across the site and provide a nominal freeboard to allow overland flow under exceptional conditions. Overland flow routes should be considered in case of drainage failure and the extreme events.

7 Conclusion

The site comprises a mix of rough grassland, hardstanding / access and former garage bases with residential properties adjacent to the site. The western and southern boundaries are above existing steep slopes.

The proposal is to redevelop the site for residential use.

The site is shown on published mapping to be located within the EA's Flood Zone 1 and negligible to very low risks of flooding from fluvial, tidal, pluvial, groundwater, sewers and artificial sources have been identified from information provided.

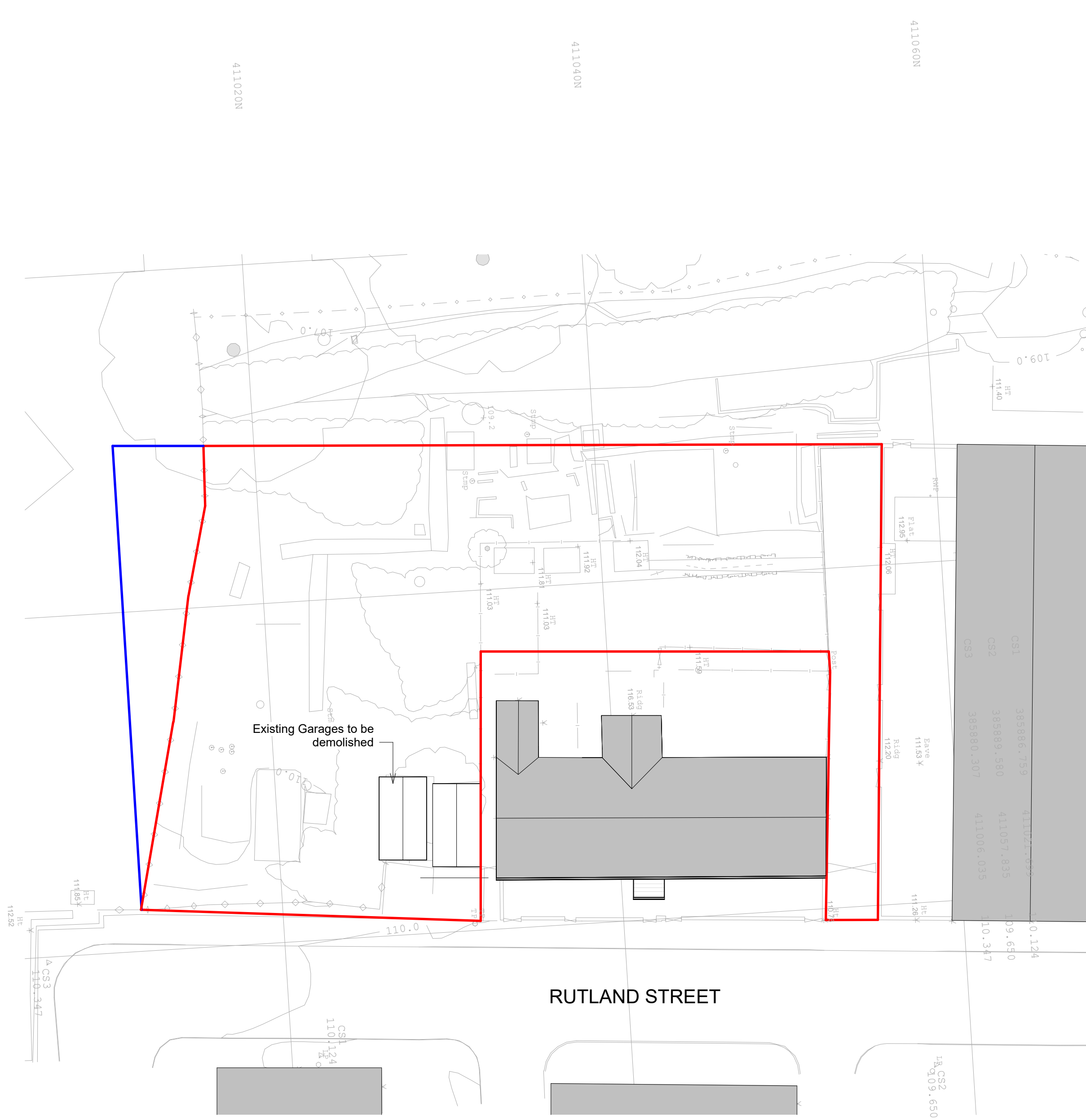
An assessment of these risks in conjunction with the development proposals have resulted in the following recommendations for the safe development of the site:

An assessment of the site settings and existing constraints in conjunction with the development proposals have resulted in the following recommendations for the safe development of the site:

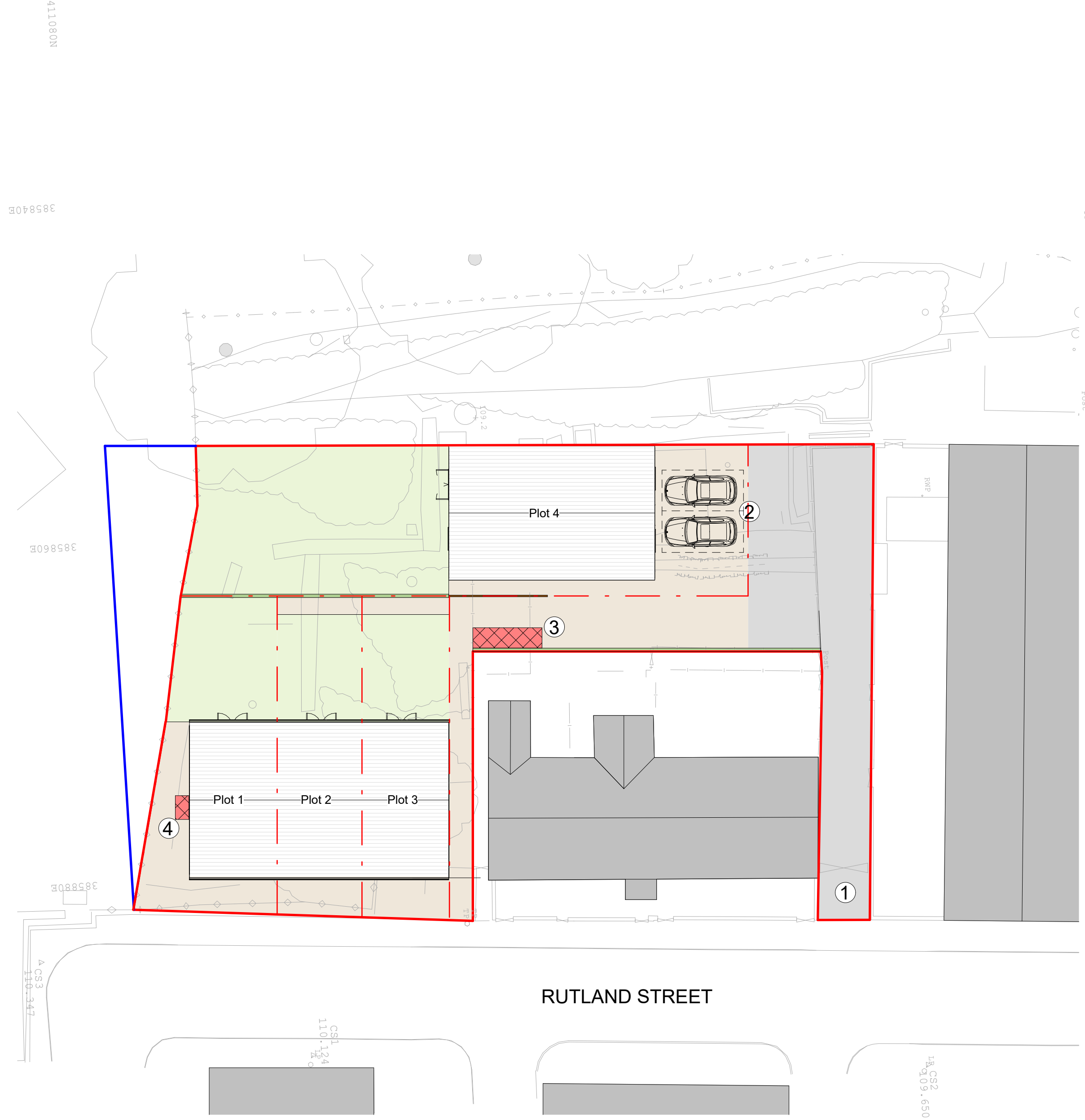
- » The finished floor level should be set at a nominal height above the finished ground levels to allow for overland flow routes in extreme events and drainage failures.
- » Pedestrian and vehicular safe access to and from the site is achievable under all conditions via the access road off Rutland Street.
- » Given the constrained nature of the site the most likely location for a soakaway would be in the southwest corner of the site. However, interbedded granular and cohesive layers may restrict infiltration, destabilise the boundary slopes to the west and south, cause break-out of water at the base of or on the face of the slope. Therefore soakaways are not considered feasible.
- » A surface watercourse (Millers Brook) is present in a 1,275mm diameter culvert c. 15m west of the site. This is considered the most feasible option for disposal of surface water; however, this would be subject to LLFA and EA approval and permission to access third party land.
- » At a restricted discharge rate of 2.5l/s the attenuation required for a 1 in 30 year event plus 30% climate change allowance, is **8.8m³** and for the 1 in 100-year event plus a 40% climate change allowance, a storage capacity of **13.8m³** will be required from on-site storage as well as SuDS systems.
- » The suitability and depth of a potential connection into the adjacent culverted watercourse should be confirmed on site.
- » Foul flow from this site will be allowed to drain into the 225mm diameter public combined sewer within Rutland Street at an unrestricted rate.
- » All proposed outflow connections from the development should be agreed with the LLFA, EA and UU as required.

APPENDIX A

FIGURES, PLANS AND DRAWINGS

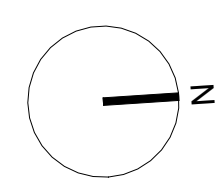


1 Existing Site Plan
1 : 200



2 Proposed Site Plan
1 : 200

- Existing Vehicle Access Road to be retained.
- Plot 4 Bungalow 2No. Parking Spaces and turning
- Plot 2 & 3, and Plot 4 Bungalow Refuse Store (5m²)
- Plot 1 Refuse Store (1.8x0.8m)



Do not scale from this drawing. Use figured dimensions only, which are displayed in millimeters unless stated otherwise. The contractor is requested to check all dimensions before work is put in hand. Any discrepancies within the drawing should be reported prior to commencement of works.

Copyright of this drawing belongs solely to BP Architects. This drawing must only be used for the purpose for which it is supplied and its contents must not be reproduced for any purpose without written permission.

Notes

- Proposed Site Boundary
- Site Ownership
- Plot Extent

Previous Revisions

No.	Description	Date	By
1	Planning	12/04/24	BP

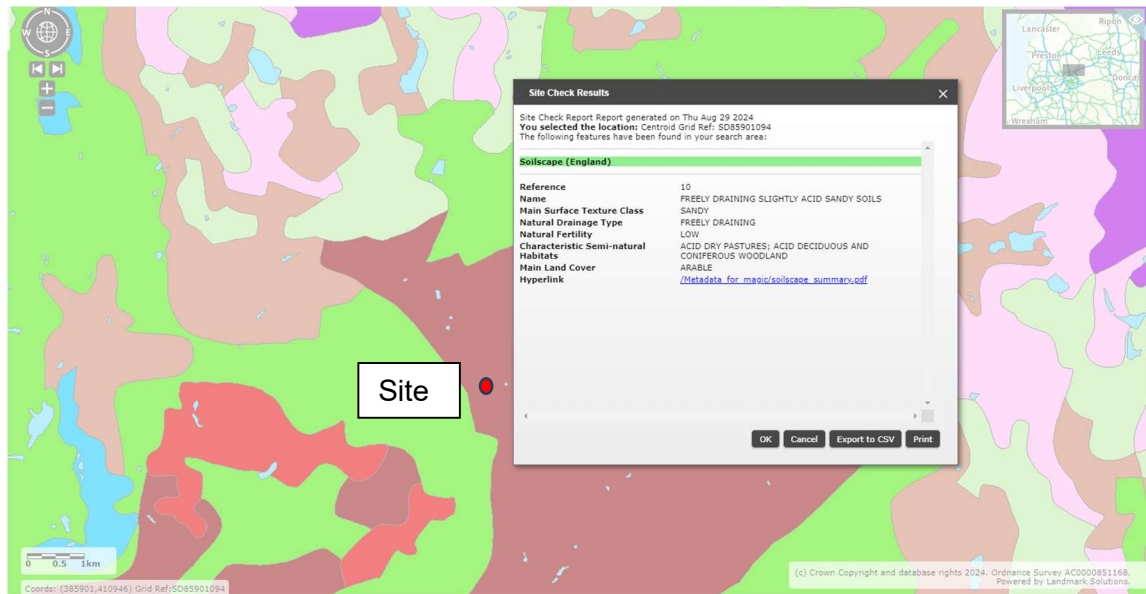
BP Architects

Project	Rutland Street
Client	Mr L. Owen
Title	Existing & Proposed Site Plan
Number	015 101
Scale	As indicated at A1
Revision	1
Description	Planning
Status	Planning
Drawn	Author
Date	12/04/24

APPENDIX B

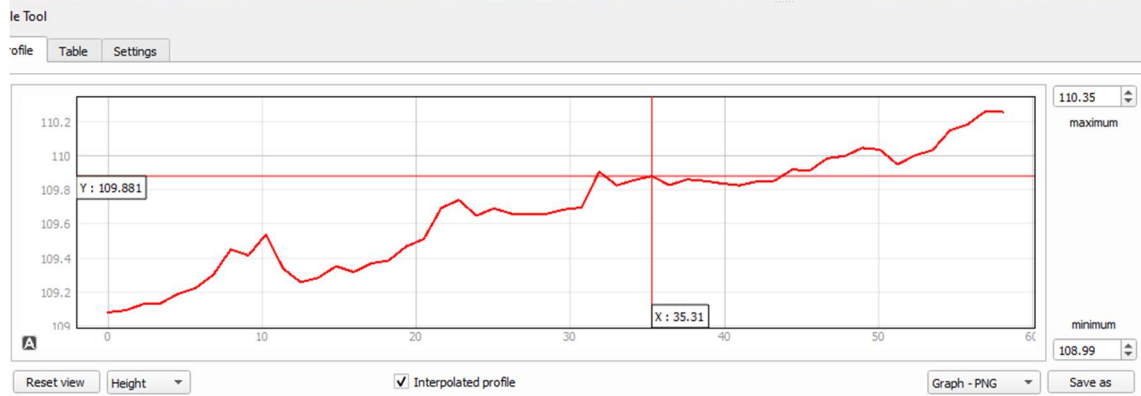
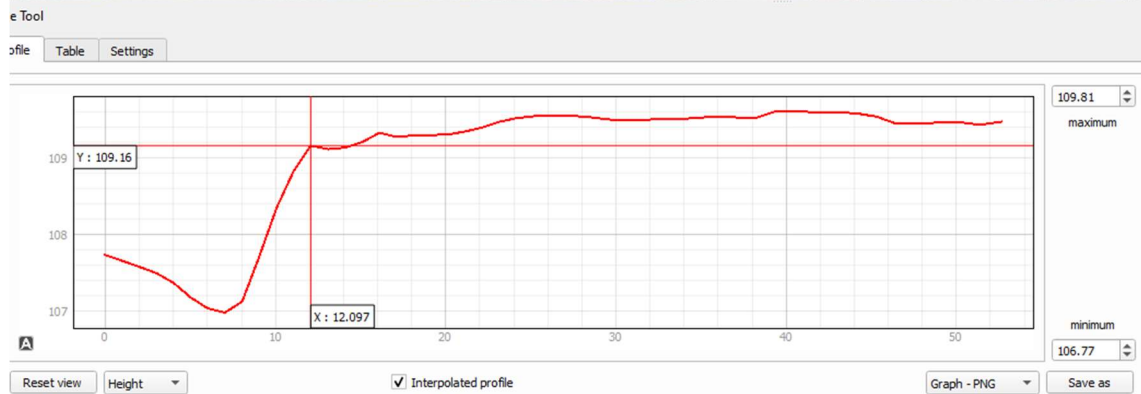
SITE INFORMATION

Extract from www.magic.defra.gov.uk



Extract from LiDAR 2022 1m DTM





Extract from Risk of Flooding from Surface Water WMS Dataset





Norwest Holst Soil Engineering Ltd.						Borehole No. 4	
Contract No. F5732		BOREHOLE LOG		Sheet 1 of 1			
Location Heywood East Sewer				Chainage			
Client Rochdale Metropolitan Borough Council				Ground Level 109.15 m.A.O.D.			
Method of Boring Percussion		SD81SE 288		Date 10/11/83 - 11/11/83			
Diameter of Borehole 150mm							
Description of Strata	Legend	Depth Below G.L. (m)	O.D. Level (m)	Casing Depth at Sampling	Sampling and Coring	"N"/R.O.D.%	Daily Progress
MADE GROUND--:- Loose black ash with sand							
		3.10	106.1		1.50	3	
					2.50	7	
Soft brown silty CLAY with sand lenses		4.50	104.7		3.50 (20)		
Medium loose grey coarse SAND		4.80	104.4		4.50	12	
Stiff grey silty stony CLAY		6.40	102.8		6.00 (45)		
Loose brown SAND		7.00	102.2				
(20) U100 blows Remarks (Observations of Ground Water etc.) Water struck at 4.50m (seepage) Level rose after 20 mins to 4.20m Sealed by casing at 5.00m Water struck at 6.40m Level rose after 20 mins to 6.00m Service pit dug to 1.50m							
Type of Sample							
Is S.P.T. Undisturbed							
Ic. C.P.T. Vane							
O Jar Water							
● Bulk Piezometer							



Norwest Holst Soil Engineering Ltd.						Borehole No. 6	
Contract No. F5732		BOREHOLE LOG		Sheet 1 of 1			
Location Haywood East Sewer				Chainage			
Client Rochdale Metropolitan Borough Council				Ground Level 112.20 m.A.O.D.			
Method of Boring Percussion		SD81SE 289		Date 9/11/83			
Diameter of Borehole 150mm							
Description of Strata	Legend	Depth Below G.L.(m)	O.D. Level (m)	Casing Depth at Sampling	Sampling and Coring	"N"/R.O.D.%	Daily Progress
MADE GROUND:- Demolition rubble, topsoil, timber etc.		1.20	111.0				
Stiff brown silty sandy CLAY with occasional gravel		2.30	109.9		1.30 (39)		
Medium dense brown silty medium SAND with some gravel		3.90	108.3		2.40	10	
Medium dense brown SAND and GRAVEL		4.80	107.4		3.40	12	
Loose to medium dense brown silty SAND and GRAVEL		5.80	106.4		4.40	15	
Loose brown silty, fine SAND		6.60	105.6		5.50	5	
Firm grey/brown sandy stony CLAY		7.00	105.2		6.50	19	

Type of Sample	Remarks (Observations of Ground Water etc.) (39) - U100 blows
Is S.P.T. Undisturbed	Water struck at 4.80m
Ic. C.P.T. Vane	Standing level after 15 mins 3.90m
O Jar Water	water added to assist boring from 3.90m
● Bulk Piezometer	Service pit dug to 1.30m

APPENDIX C

CONSULTEE CORRESPONDENCE

Colin Crompton

From: Calum Mountifield <Calum.Mountifield@Rochdale.Gov.UK>
Sent: 09 August 2024 11:59
To: Sam Shaw
Subject: Request for Information - Land to the West of Rutland Street, Heywood, OL10 4JJ
Attachments: 2017s6287_Manchester_SFRA_Detailed_Rochdale_Map_40.pdf; Millers Brook 119596 1-1250 - EA plan of culvert sheet 2 (002).pdf

Hi Sam,

I have just picked up your email below and while I can't answer all the points I can respond to the majority from the planning side.

Greater Manchester Strategic Flood Risk Assessment

The starting point is the GM Strategic Flood Risk assessment, I have attached the interactive map for the site which has a lot of information including sources of flooding, Critical Drainage Areas, some historic flood records.

All the documents for the level 1 & level 2 SFRA are available to view via the Places for Everyone examination web page [here](#) (see 04.02.01 – 04.02.19).

Historic Flooding

In addition to the SFRA data, while there may have been other incidents of flooding on the site, there are records on the file of historic flooding at Millers Brook Close adjacent to the site in 2006 and 2018 with the combined sewer flooding from sewers.

Culvert

I have also attached an EA plan of the culvert on site.

Highways

No private drainage would be permitted to discharge to adopted highways.

Policy

In terms of SuDs policies there is Policy JP-S4 of the Places for Everyone Plan [Places for Everyone Joint Development Plan Document \(greatermanchester-ca.gov.uk\)](#) (p.98) and Policy G8 of the [Rochdale Core Strategy](#) (p.102).

Kind regards

Calum

Calum Mountifield

Principal Planning Officer (Climate Resilience)
Economy



 01706 924317

 calum.mountifield@rochdale.gov.uk

Rochdale Borough Council
Floor 3, Number One Riverside
Smith Street, Rochdale, OL16 1XU

To access our services go to www.rochdale.gov.uk

LKGroup**Unit 29
Eton Hill Road,
Radcliffe,
m26 2zs****FAO:****How to contact us:****United Utilities Water Limited
Property Searches
Haweswater House
Lingley Mere Business Park
Great Sankey
Warrington
WA5 3LP****Telephone: 0370 7510101****E-mail: propertysearches@uuplc.co.uk****Your Ref: FRA 24 1073
Our Ref: UUPS-ORD-587402
Date: 17/07/2024****Dear Sirs****Location: Land to the West of Rutland Street**

I acknowledge with thanks your request dated 17/07/2024 for information on the location of our services.

Please find enclosed plans showing the approximate position of United Utilities' apparatus known to be in the vicinity of this site.

The enclosed plans are being provided to you subject to the United Utilities terms and conditions for both the wastewater and water distribution plans which are shown attached.

If you are planning works anywhere in the North West, please read United Utilities' access statement before you start work to check how it will affect our network. <http://www.unitedutilities.com/work-near-asset.aspx>.

I trust the above meets with your requirements and look forward to hearing from you should you need anything further.

If you have any queries regarding this matter please [contact us](#).

Yours Faithfully,



Karen McCormack
Property Searches Manager

TERMS AND CONDITIONS - WASTEWATER AND WATER DISTRIBUTION PLANS

These provisions apply to the public sewerage, water distribution and telemetry systems (including sewers which are the subject of an agreement under Section 104 of the Water Industry Act 1991 and mains installed in accordance with the agreement for the self construction of water mains) (UUWL apparatus) of United Utilities Water Limited "(UUWL)".

TERMS AND CONDITIONS:

- This Map and any information supplied with it is issued subject to the provisions contained below, to the exclusion of all others and no party relies upon any representation, warranty, collateral contract or other assurance of any person (whether party to this agreement or not) that is not set out in this agreement or the documents referred to in it.
- This Map and any information supplied with it is provided for general guidance only and no representation, undertaking or warranty as to its accuracy, completeness or being up to date is given or implied.
- In particular, the position and depth of any UUWL apparatus shown on the Map are approximate only. UUWL strongly recommends that a comprehensive survey is undertaken in addition to reviewing this Map to determine and ensure the precise location of any UUWL apparatus. The exact location, positions and depths should be obtained by excavation trial holes.
- The location and position of private drains, private sewers and service pipes to properties are not normally shown on this Map but their presence must be anticipated and accounted for and you are strongly advised to carry out your own further enquiries and investigations in order to locate the same.
- The position and depth of UUWL apparatus is subject to change and therefore this Map is issued subject to any removal or change in location of the same. The onus is entirely upon you to confirm whether any changes to the Map have been made subsequent to issue and prior to any works being carried out.
- This Map and any information shown on it or provided with it must not be relied upon in the event of any development, construction or other works (including but not limited to any excavations) in the vicinity of UUWL apparatus or for the purpose of determining the suitability of a point of connection to the sewerage or other distribution systems.
- No person or legal entity, including any company shall be relieved from any liability howsoever and whensoever arising for any damage caused to UUWL apparatus by reason of the actual position and/or depths of UUWL apparatus being different from those shown on the Map and any information supplied with it.
- If any provision contained herein is or becomes legally invalid or unenforceable, it will be taken to be severed from the remaining provisions which shall be unaffected and continue in full force and affect.
- This agreement shall be governed by English law and all parties submit to the exclusive jurisdiction of the English courts, save that nothing will prevent UUWL from bringing proceedings in any other competent jurisdiction, whether concurrently or otherwise.

Colin Crompton

From: wastewaterdeveloperservices@uuplc.co.uk
Sent: 19 July 2024 12:11
To: Sam Shaw
Subject: RE: Request for Information - Land to the West of Rutland Street, OL10 4JJ

Good Afternoon Sam,

I can confirm that we do not have modelled flood risk within the vicinity of the proposed development.

Please note that United Utilities Water Limited (U UW) can only record and check flooding events which are reported to us and we have to comply with our Regulators instructions on the qualification of flooding events.

Our response does not include:

- any sewer flooding events caused by blockages or collapses which are the result of third party actions, natural events or other actions over which U UW has no control and not a facet of sewer capacity; or*
- any historical sewer flooding events that have been resolved as a result of investment in our infrastructure.*

As with all development sites, we recommend you liaise with our water and wastewater engineers by contacting our Developer Services team so the details of your development proposal can be considered further. Details can be found at the following link.

<https://www.unitedutilities.com/services/builders-developers/>

Should you require any further information please do not hesitate to contact me.

Also if you need further information please apply for a pre development assessment via the link below.

<https://www.unitedutilities.com/builders-developers/larger-developments/pre-development/wastewater-pre-dev/>

Regards,



James Darlington
Developer Engineer
Developer Services & Metering
M: 07917096253
unitedutilities.com

If you have received a great service today why not tell us?
Visit: [unitedutilities.com/wow](https://www.unitedutilities.com/wow)

APPENDIX D

CALCULATIONS



MasterDrain
HY 11.0

The LK Group

www.thelkgroup.com

Eton Business Park,
Eton Hill Road,
Radcliffe M26 2ZS
Tel: 0161 763 7200
email: m.jones@thelkgroup.com

Job No.		
Sheet no. 1		
Date 03/09/24		
By	Checked	Reviewed

Project **Rutland St, Heywood**

Title **Greenfield Runoff**

Hydrological Data:-

FSR Hydrology:-

Location = Rutland Street, Heywood Grid reference = SD8511
M5-60 (mm) = 20 r = 0.29
Soil runoff = 0.45 SAAR (mm/yr) = 1098
WRAP = 4 Area = England & Wales
Hydrological area = 10 Hydrological zone = 8

Soil classification for WRAP type 4

Clayey, or loamy over clayey soils with an impermeable layer at shallow depth.

Design data:-

Area = 0.000833 Km² - 0.083 Ha - 833 m²

Calculation method:-

Runoff is calculated from:-

$$Q_{\text{BAR(rural)}} = 0.00108 \text{ AREA}^{0.89} \cdot \text{SAAR}^{1.17} \cdot \text{SOIL}^{2.17}$$

where

AREA = Site area in Km²

SAAR = Standard Average Annual Rainfall (mm/yr)

SOIL = Soil value derived from Winter Rainfall Acceptance Potential

$Q_{\text{BAR(rural)}}$ = Runoff (cumecs)

$Q_{\text{BAR(rural)}}$ is then multiplied by a growth factor - GC(T) - for different storm return periods derived from EA publication W5-074/A.

Calculated data:-

For areas less than 50Ha, a modified calculation which multiplies the 50Ha runoff value by the ratio of the site area to 50Ha is used
Reducing factor used for these calculations is 0.002

Mean Annual Peak Flow $Q_{\text{BAR(rural)}}$ = 0.62 l/s



MasterDrain
HY 11.0

The LK Group

www.thelkgroup.com

Eton Business Park,
Eton Hill Road,
Radcliffe M26 2ZS
Tel: 0161 763 7200
email: m.jones@thelkgroup.com

Job No.		
Sheet no. 2		
Date 03/09/24		
By	Checked	Reviewed

Project	Rutland St, Heywood
Title	Greenfield Runoff

Values for $Q_{BAR(rural)}$

Ret. per.	m ³ /hr	l/s	l/s/ha	Ret. per.	m ³ /hr	l/s	l/s/ha
1yr	1.896	0.527	6.323	100yr+20%	5.622	1.562	18.746
2yr	2.075	0.576	6.918	100yr+30%	6.090	1.692	20.308
5yr	2.699	0.750	9.001	100yr+40%	6.559	1.822	21.871
10yr	3.079	0.855	10.266	200yr	5.354	1.487	17.854
30yr	3.748	1.041	12.497	200yr + 30%	6.960	1.933	23.210
50yr	4.127	1.146	13.762	500yr	6.090	1.692	20.308
100yr	4.685	1.301	15.622	1000yr	6.782	1.884	22.614

Growth factors -

1yr	2yr	5yr	10yr	30yr	50yr	100yr	200yr	500yr	1000yr
0.85	0.93	1.21	1.38	1.68	1.85	2.10	2.40	2.73	3.04

The above is based on the Institute of Hydrology Report 124
to which you are referred for further details (see Sect 7).
Note that the 200 and above year growth curves were taken from W5-074.



MasterDrain
SW

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Job No.		
Sheet no. 1		
Date 03/09/24		
By	Checked	Reviewed

Project **Rutland Street, Heywood**
Title **P2.33yr peak runoff calculations**

Area data:-

FSR data

M5-60 = 20

Soil index = 0.45

WRAP value = 4

r = 0.29

SAAR = 1098

Nat grid = SD8511

Site data:-

Ret. period (yrs) = 2.33

Time of entry = 6.00

Impervious area drained = 243 m²

Site slope = Medium 2% - 3.5%

Length of overland flow = 0.00

ToC = 6.0 mins

Overland flow time = 0.0 mins

Pervious area drained = 640 m²

Soil type = Clay

Climate change factor = 0.0 %

Calculated data:-

Calculated runoff factor = 40.0%

Rainfall rate= 61.8 mm/Hr

UCWI = 111.0

Runoff rate (gross)= 3.3 l/s

Methods

Runoff factor (RF) = 40.0, calculated from:-

Runoff factor = $(0.829 \times \text{PIMP}) + (25 \times \text{SOIL}) + (0.078 \times \text{UCWI}) - 20.7$

where

PIMP = $\text{Impervious Area} \times 100 / (\text{Impervious Area} + \text{Pervious Area})$

UCWI = Calculated value for Wetness Index

Calculations produced by MasterDrain Surface Water design program



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Job No.		
Sheet no. 1		
Date 03/09/24		
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Project **Rutland Street, Heywood**
Title **30yr Peak runoff calculations**

Area data:-

FSR data

M5-60 = 20

Soil index = 0.45

WRAP value = 4

r = 0.29

SAAR = 1098

Nat grid = SD8511

Site data:-

Ret. period (yrs) = 30

Time of entry = 4.00

Impervious area drained = 243 m²

Site slope = Medium 2% - 3.5%

Length of overland flow = 0.00

ToC = 4.0 mins

Overland flow time = 0.0 mins

Pervious area drained = 640 m²

Soil type = Clay

Climate change factor = 0.0 %

Calculated data:-

Calculated runoff factor = 40.0%

Rainfall rate= 116.8 mm/Hr

UCWI = 111.0

Runoff rate (gross)= 6.3 l/s

Methods

Runoff factor (RF) = 40.0, calculated from:-

Runoff factor = $(0.829 \times \text{PIMP}) + (25 \times \text{SOIL}) + (0.078 \times \text{UCWI}) - 20.7$

where

PIMP = $\text{Impervious Area} \times 100 / (\text{Impervious Area} + \text{Pervious Area})$

UCWI = Calculated value for Wetness Index

Calculations produced by MasterDrain Surface Water design program



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Project	Rutland Street, Heywood
Title	100yr Peak runoff calculations

Area data:-

FSR data

M5-60 = 20

Soil index = 0.45

WRAP value = 4

r = 0.29

SAAR = 1098

Nat grid = SD8511

Site data:-

Ret. period (yrs) = 100

Time of entry = 4.00

Impervious area drained = 243 m²

Site slope = Medium 2% - 3.5%

Length of overland flow = 0.00

ToC = 4.0 mins

Overland flow time = 0.0 mins

Pervious area drained = 640 m²

Soil type = Clay

Climate change factor = 0.0 %

Calculated data:-

Calculated runoff factor = 40.0%

Rainfall rate= 146.5 mm/Hr

UCWI = 111.0

Runoff rate (gross)= 7.9 l/s

Methods

Runoff factor (RF) = 40.0, calculated from:-

Runoff factor = $(0.829 \times \text{PIMP}) + (25 \times \text{SOIL}) + (0.078 \times \text{UCWI}) - 20.7$

where

PIMP = $\text{Impervious Area} \times 100 / (\text{Impervious Area} + \text{Pervious Area})$

UCWI = Calculated value for Wetness Index

Calculations produced by MasterDrain Surface Water design program



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Job No.		
Sheet no. 1		
Date 03/09/24		
By	Checked	Reviewed

Project	Rutland Street, Heywood
Title	1yr Peak runoff calculations

Area data:-

FSR data

M5-60 = 20

Soil index = 0.45

WRAP value = 4

r = 0.29

SAAR = 1098

Nat grid = SD8511

Site data:-

Ret. period (yrs) = 1

Time of entry = 8.00

Impervious area drained = 243 m²

Site slope = Medium 2% - 3.5%

Length of overland flow = 0.00

ToC = 8.0 mins

Overland flow time = 0.0 mins

Pervious area drained = 640 m²

Soil type = Clay

Climate change factor = 0.0 %

Calculated data:-

Calculated runoff factor = 40.0%

Rainfall rate= 45.9 mm/Hr

UCWI = 111.0

Runoff rate (gross)= 2.5 l/s

Methods

Runoff factor (RF) = 40.0, calculated from:-

Runoff factor = $(0.829 \times \text{PIMP}) + (25 \times \text{SOIL}) + (0.078 \times \text{UCWI}) - 20.7$

where

PIMP = $\text{Impervious Area} \times 100 / (\text{Impervious Area} + \text{Pervious Area})$

UCWI = Calculated value for Wetness Index

Calculations produced by MasterDrain Surface Water design program



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Job No.		
Sheet no. 1		
Date 03/09/24		
By	Checked	Reviewed

Project	Rutland Street, Heywood
Title	Storage calcs 30yr + 30% CC

Data:-

FSR Hydrology:-

Location = Rutland Street, Heywood

M5-60 (mm) = 20

Soil index = 0.45

Return period = 30

UCWI = 113.6

Grid reference = SD8511

r = 0.29

SAAR (mm/yr) = 1098

WRAP = 4

Climate change = 30

Clayey, or loamy over clayey soils with an impermeable layer at shallow depth.

Runoff factor (RF) = 50.0, calculated from:-

Runoff factor = $(0.829 \times \text{PIMP}) + (25 \times \text{SOIL}) + (0.078 \times \text{UCWI}) - 20.7$

where

PIMP = Impervious Area * 100 / (Impervious Area + Pervious Area)

UCWI = Calculated value for Wetness Index

Design data:-

Imperv. area = 534 m²

Total area (TA) = 883 m²

Mean pump disch. rate = 2.500 l/s

Additional flow = 0.00 l/s

Pervious area = 349 m²

Equiv area = 442 m² (TA x RF).

Areal reduction factor = 1.000

Climate change factor = 30

Calculated data:-

Time to max = 39.0 mins

Rainfall at max = 52.16 mm/hr

Pipeline storage = 0.0 m³

Offline storage = 0.0 m³

Calculated storage volume = 8.8 m³

Allowed discharge rate = 2.500 l/s

Available MH storage = 0.0 m³

Fixed 6 hour data:-

Rainfall event = 6 hours

Rainfall rate = 12.00 mm/hr

Calculated storage volume = 0.0 m³

Allowed discharge rate = 2.500 l/s

Rainfall intensities calculated using the Wallingford Procedure

Storage lengths for initial calculation (x 1.1, 1.2, 1.3 or 1.5 as above if required) :-

Diam	Len	Diam	Len	Ovoid	Len	Box culvert	Len
100	1123.0	1125	8.9	400 x 600	49.0	500 x 500	35.3
150	499.1	1200	7.8	600 x 900	21.3	500 x 750	23.5
225	221.8	1275	6.9	800 x 1200	12.0	500 x 1000	17.6
300	124.8	1350	6.2			750 x 1000	11.8
375	79.9	1425	5.5			750 x 1200	9.8
450	55.5	1500	5.0			750 x 1500	7.8
525	40.7	1575	4.5			1000 x 1000	8.8
600	31.2	1650	4.1			1000 x 1200	7.3
675	24.6	1725	3.8			1000 x 1500	5.9
750	20.0	1800	3.5			1000 x 1800	4.9
825	16.5	1875	3.2			1000 x 2000	4.4
900	13.9	1950	3.0			1500 x 1500	3.9
975	11.8	2025	2.7			1500 x 1800	3.3
1050	10.2	2100	2.5			1500 x 2000	2.9



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Data:-

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Project	Rutland Street, Heywood	
Title	Storage calcs 30yr + 30% CC	

Time (mins)	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)
10	107.0	7.750	1.500	6.250
20	76.0	11.003	3.000	8.003
30	61.0	13.163	4.500	8.663
40	51.0	14.818	6.000	8.818
50	45.0	16.175	7.500	8.675
60	40.0	17.330	9.000	8.330
70	36.0	18.340	10.500	7.840
80	33.0	19.239	12.000	7.239
90	31.0	20.050	13.500	6.550
100	29.0	20.788	15.000	5.788
110	27.0	21.466	16.500	4.966
120	26.0	22.094	18.000	4.094
130	24.0	22.677	19.500	3.177
140	23.0	23.221	21.000	2.221
150	22.0	23.732	22.500	1.232
160	21.0	24.213	24.000	0.213
170	20.0	24.666	25.500	0.000
180	19.0	25.095	27.000	0.000
190	19.0	25.502	28.500	0.000
200	18.0	25.915	30.000	0.000
210	17.0	26.308	31.500	0.000
220	17.0	26.687	33.000	0.000
230	16.0	27.054	34.500	0.000
240	16.0	27.408	36.000	0.000
250	15.0	27.752	37.500	0.000
260	15.0	28.086	39.000	0.000
270	15.0	28.410	40.500	0.000
280	14.0	28.725	42.000	0.000
290	14.0	29.031	43.500	0.000
300	14.0	29.330	45.000	0.000
310	13.0	29.622	46.500	0.000
320	13.0	29.906	48.000	0.000
330	13.0	30.184	49.500	0.000
340	12.0	30.455	51.000	0.000
350	12.0	30.721	52.500	0.000
360	12.0	30.981	54.000	0.000
370	12.0	31.235	55.500	0.000
380	11.0	31.485	57.000	0.000
390	11.0	31.729	58.500	0.000
400	11.0	31.969	60.000	0.000
410	11.0	32.204	61.500	0.000
420	11.0	32.436	63.000	0.000
430	11.0	32.663	64.500	0.000
440	10.0	32.886	66.000	0.000
450	10.0	33.105	67.500	0.000
460	10.0	33.320	69.000	0.000
470	10.0	33.532	70.500	0.000
480	10.0	33.741	72.000	0.000
490	10.0	33.947	73.500	0.000
500	9.0	34.149	75.000	0.000
510	9.0	34.348	76.500	0.000
520	9.0	34.545	78.000	0.000
530	9.0	34.738	79.500	0.000
540	9.0	34.929	81.000	0.000
550	9.0	35.117	82.500	0.000
560	9.0	35.303	84.000	0.000
570	9.0	35.486	85.500	0.000
580	9.0	35.667	87.000	0.000
590	8.0	35.845	88.500	0.000
600	8.0	36.021	90.000	0.000

Storage volume (m³) = 8.8 m³



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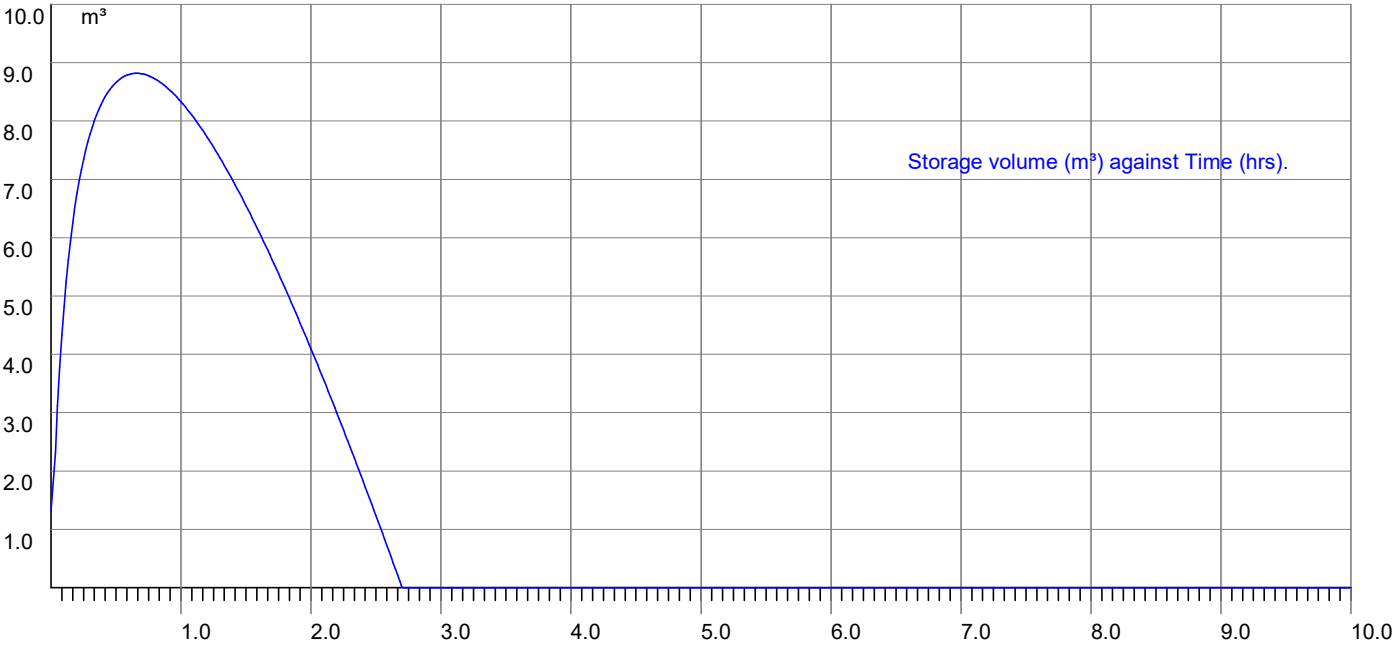
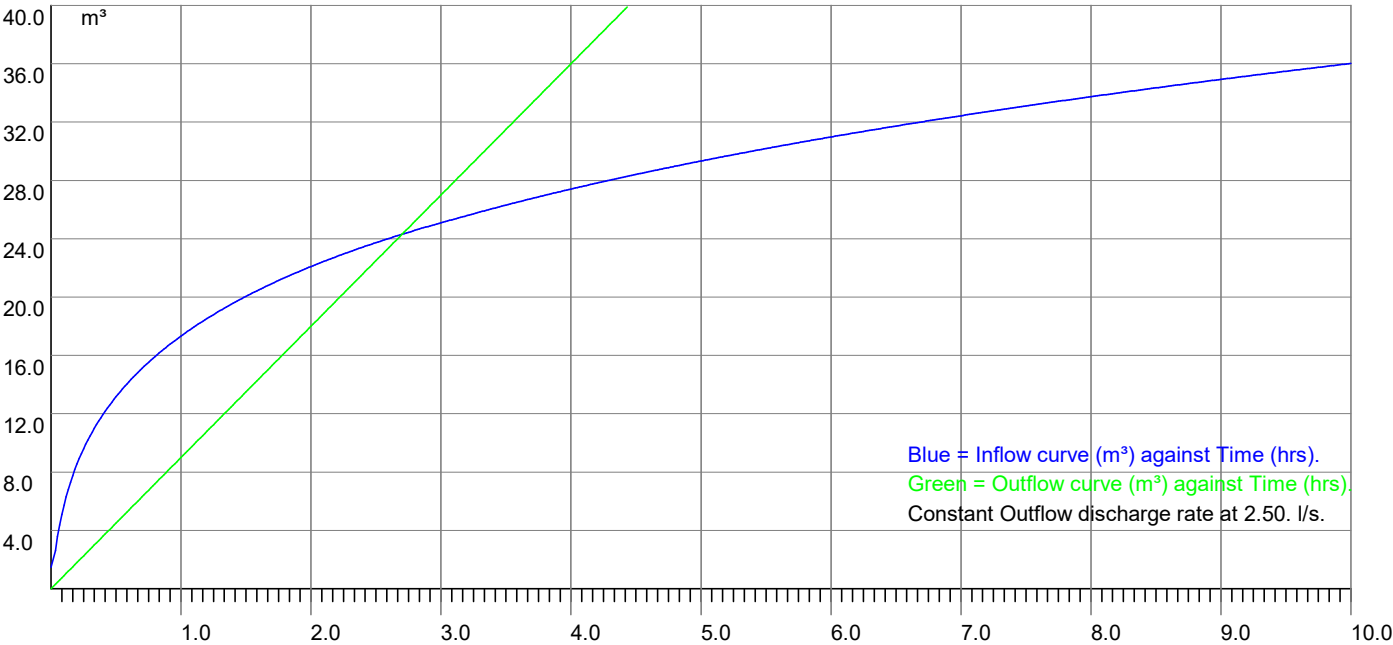
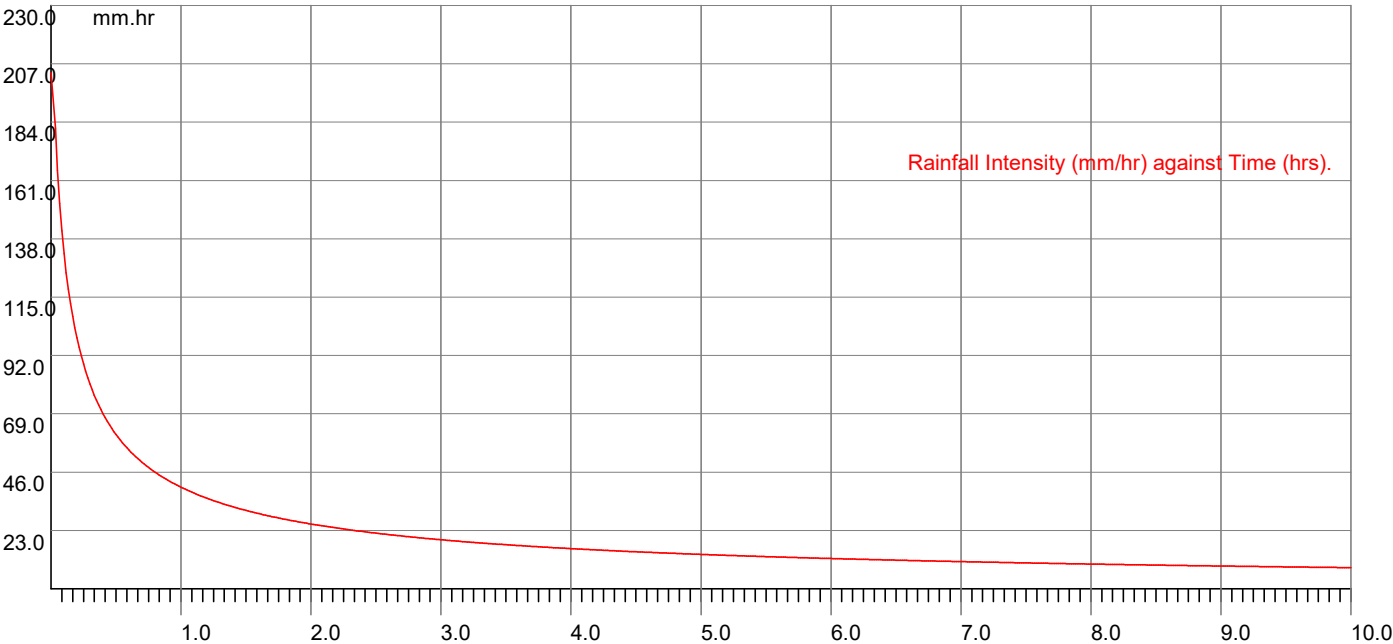
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Job No.		
Sheet no. 3		
Date 03/09/24		
By	Checked	Reviewed

Project	Rutland Street, Heywood	
Title	Storage calcs 30yr + 30% CC	





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Project	Rutland Street, Heywood		By	Checked
Title	Storage calcs 30yr + 30% CC			Reviewed

Explanatory notes for Peak Flow Storage

- 1) This system uses the rainfall intensity/ duration curve calculated using either the Wallingford or FEH method as selected.
- 2) The balance is calculated from the inflow minus the outflow.
- 3) The storage volume is the maximum value of the balance curve.
- 4) This method was described by Davis (1963) - see Butler & Davies, 2nd edition, p294
- 5) References to 'storm duration' relate only to the hydrograph method (qv).
- 6) There are always 600 steps in the calculation process, thus a 'run' time of 10 hours will be sampled every minute,

Explanatory notes for Hydrograph Storage

- 1) The user has the choice of Summer or Winter curves
- 2) The mean intensity varies with the duration of the storm curve
- 3) There are always 120 steps in the calculation process, irrespective of storm duration.
- 4) The balance is calculated from the inflow minus the outflow.
- 5) The storage volume is the sum of the balance values for each step.
- 6) Varying durations should be tried to find the maximum storage value - this can be narrowed down very closely.

*Modelling using the flow characteristics of the restrictor is available using Vortex Control modelling function. Please be aware that this function needs the full design data file to function.

Why do the two methods give different results?

The rainfall characteristics for each method are very different.

The Peak flow (using the Intensity/Duration/Frequency curve) does not model the actual rainfall. This curve is joined points which represent the mean intensity of a storm at a given duration i.e. a value of 19.5 mm/hr for a 60 minute storm indicates that over the sixty minute period, the mean intensity was 19.5 mm/hr. The calculation method samples the IDF curve for a given location and frequency (Return Period) and calculates the storage for that rate and duration less the outflow volume. The maximum value is displayed as the 'worst case' storage. The outflow volume is constant throughout the process at the specified discharge rate.

The hydrograph method uses a standard curve for either Winter or Summer storms. Traditionally these are symmetrical about the central peak. UK rainfall does not fit into this convenient curve, so the calculations are dealing with a stylised set of data. The mean intensity for the storm is calculated from the IDF curve and applied to the curve data, calculating the storage for that step less the outflow volume. The final storage volume is the sum of the storage for all the steps. The outflow volume varies with the hydraulic head on the control device using flow equations provided by the control manufacturer. This is a far more accurate method than the peak flow method and often results in bigger storage volumes.

It can be seen that these two methods are very different, and the user may have the choice of which result to use. This is not an exact science, though is often treated as such by those that do not understand the principles of the calculations.



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Job No.		
Sheet no. 1		
Date 03/09/24		
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Project	Rutland Street, Heywood
Title	Storage calcs 100yr + 40% CC

Data:-

FSR Hydrology:-

Location = Rutland Street, Heywood

M5-60 (mm) = 20

Soil index = 0.45

Return period = 100

UCWI = 113.6

Grid reference = SD8511

r = 0.29

SAAR (mm/yr) = 1098

WRAP = 4

Climate change = 30

Clayey, or loamy over clayey soils with an impermeable layer at shallow depth.

Runoff factor (RF) = 50.0, calculated from:-

Runoff factor = $(0.829 \times \text{PIMP}) + (25 \times \text{SOIL}) + (0.078 \times \text{UCWI}) - 20.7$

where

PIMP = Impervious Area * 100 / (Impervious Area + Pervious Area)

UCWI = Calculated value for Wetness Index

Design data:-

Imperv. area = 534 m²

Total area (TA) = 883 m²

Mean pump disch. rate = 2.500 l/s

Additional flow = 0.00 l/s

Pervious area = 349 m²

Equiv area = 442 m² (TA x RF).

Areal reduction factor = 1.000

Climate change factor = 30

Calculated data:-

Time to max = 56.0 mins

Rainfall at max = 54.97 mm/hr

Pipeline storage = 0.0 m³

Offline storage = 0.0 m³

Calculated storage volume = 13.8 m³

Allowed discharge rate = 2.500 l/s

Available MH storage = 0.0 m³

Fixed 6 hour data:-

Rainfall event = 6 hours

Rainfall rate = 14.00 mm/hr

Calculated storage volume = 0.0 m³

Allowed discharge rate = 2.500 l/s

Rainfall intensities calculated using the Wallingford Procedure

Storage lengths for initial calculation (x 1.1, 1.2, 1.3 or 1.5 as above if required) :-

Diam	Len	Diam	Len	Ovoid	Len	Box culvert	Len
100	1757.0	1125	13.9	400 x 600	76.6	500 x 500	55.2
150	780.9	1200	12.2	600 x 900	33.4	500 x 750	36.8
225	347.1	1275	10.8	800 x 1200	18.8	500 x 1000	27.6
300	195.2	1350	9.6			750 x 1000	18.4
375	124.9	1425	8.7			750 x 1200	15.3
450	86.8	1500	7.8			750 x 1500	12.3
525	63.7	1575	7.1			1000 x 1000	13.8
600	48.8	1650	6.5			1000 x 1200	11.5
675	38.6	1725	5.9			1000 x 1500	9.2
750	31.2	1800	5.4			1000 x 1800	7.7
825	25.8	1875	5.0			1000 x 2000	6.9
900	21.7	1950	4.6			1500 x 1500	6.1
975	18.5	2025	4.3			1500 x 1800	5.1
1050	15.9	2100	4.0			1500 x 2000	4.6



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Project **Rutland Street, Heywood**
Title **Storage calcs 100yr + 40% CC**

Data:-

Time (mins)	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)
40	67.0	19.427	6.000	13.427
80	44.0	25.306	12.000	13.306
120	34.0	28.992	18.000	10.992
160	27.0	31.631	24.000	7.631
200	23.0	33.691	30.000	3.691
240	21.0	35.516	36.000	0.000
280	18.0	37.114	42.000	0.000
320	17.0	38.539	48.000	0.000
360	15.0	39.830	54.000	0.000
400	14.0	41.010	60.000	0.000
440	13.0	42.100	66.000	0.000
480	12.0	43.114	72.000	0.000
520	12.0	44.062	78.000	0.000
560	11.0	44.953	84.000	0.000
600	11.0	45.795	90.000	0.000
640	10.0	46.592	96.000	0.000
680	10.0	47.351	102.000	0.000
720	9.0	48.074	108.000	0.000
760	9.0	48.766	114.000	0.000
800	9.0	49.428	120.000	0.000
840	8.0	50.065	126.000	0.000
880	8.0	50.677	132.000	0.000
920	8.0	51.267	138.000	0.000
960	7.0	51.837	144.000	0.000
1000	7.0	52.388	150.000	0.000
1040	7.0	52.921	156.000	0.000
1080	7.0	53.437	162.000	0.000
1120	7.0	53.939	168.000	0.000
1160	7.0	54.425	174.000	0.000
1200	6.0	54.899	180.000	0.000
1240	6.0	55.359	186.000	0.000
1280	6.0	55.808	192.000	0.000
1320	6.0	56.245	198.000	0.000
1360	6.0	56.671	204.000	0.000
1400	6.0	57.088	210.000	0.000
1440	6.0	57.494	216.000	0.000
1480	5.0	57.892	222.000	0.000
1520	5.0	58.281	228.000	0.000
1560	5.0	58.661	234.000	0.000
1600	5.0	59.033	240.000	0.000
1640	5.0	59.398	246.000	0.000
1680	5.0	59.756	252.000	0.000
1720	5.0	60.107	258.000	0.000
1760	5.0	60.450	264.000	0.000
1800	5.0	60.788	270.000	0.000
1840	5.0	61.120	276.000	0.000
1880	5.0	61.445	282.000	0.000
1920	4.0	61.765	288.000	0.000
1960	4.0	62.079	294.000	0.000
2000	4.0	62.388	300.000	0.000
2040	4.0	62.692	306.000	0.000
2080	4.0	62.992	312.000	0.000
2120	4.0	63.286	318.000	0.000
2160	4.0	63.576	324.000	0.000
2200	4.0	63.861	330.000	0.000
2240	4.0	64.142	336.000	0.000
2280	4.0	64.419	342.000	0.000
2320	4.0	64.693	348.000	0.000
2360	4.0	64.962	354.000	0.000
2400	4.0	65.227	360.000	0.000

Storage volume (m³) = 13.8 m³



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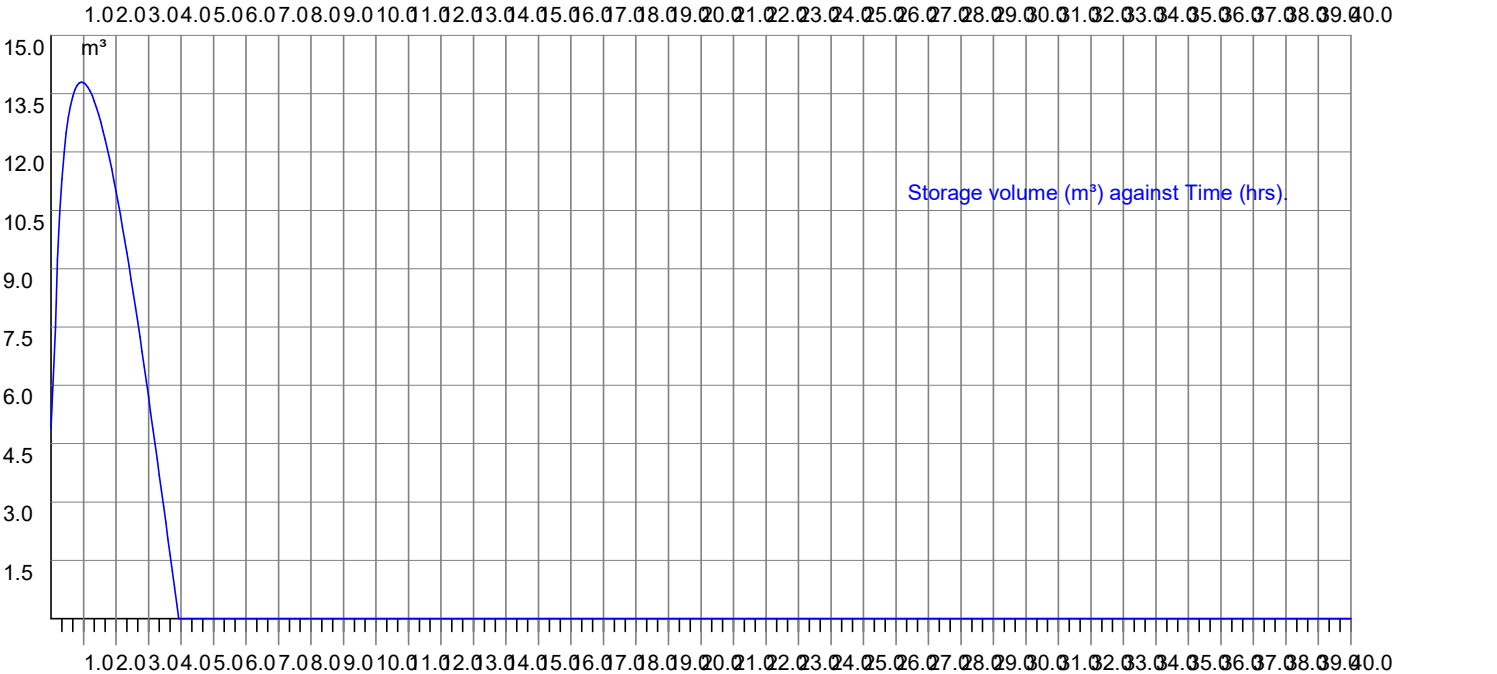
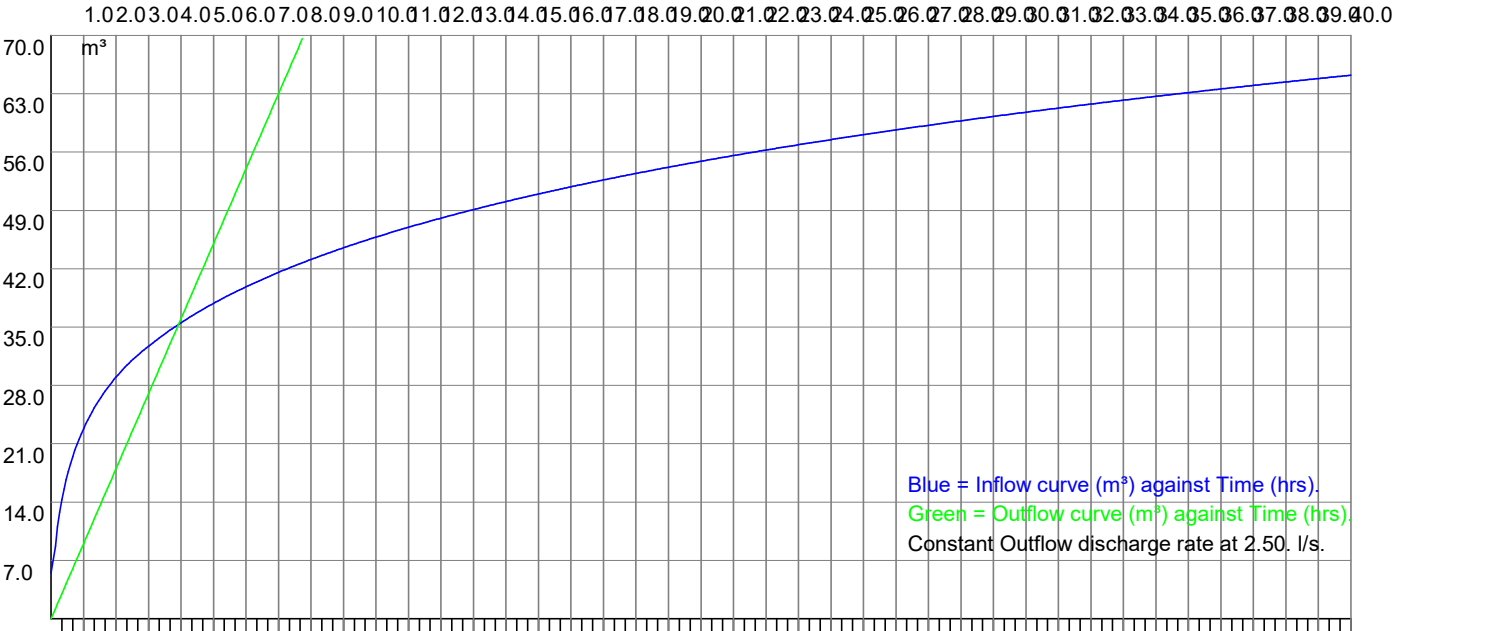
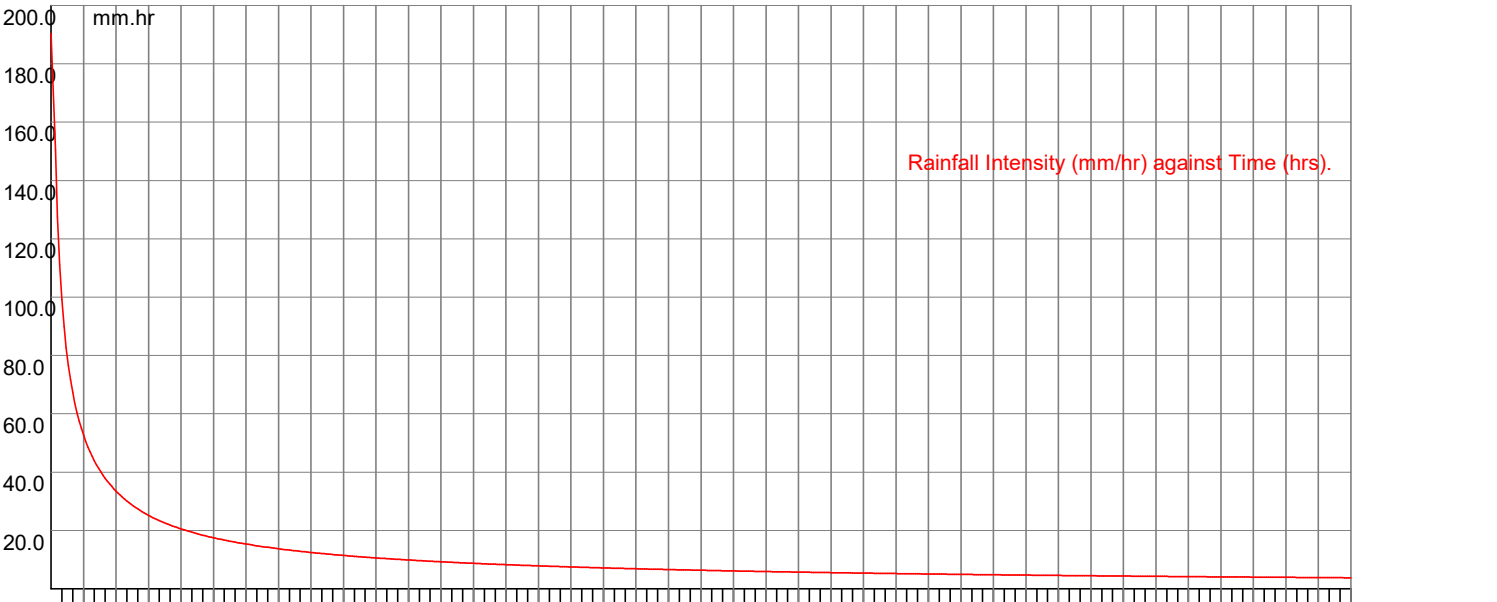
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Job No.		
Sheet no. 3		
Date 03/09/24		
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Project	Rutland Street, Heywood
Title	Storage calcs 100yr + 40% CC





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Project Rutland Street, Heywood				By	Checked	Reviewed
Title Storage calcs 100yr + 40% CC						

Explanatory notes for Peak Flow Storage

- 1) This system uses the rainfall intensity/ duration curve calculated using either the Wallingford or FEH method as selected.
- 2) The balance is calculated from the inflow minus the outflow.
- 3) The storage volume is the maximum value of the balance curve.
- 4) This method was described by Davis (1963) - see Butler & Davies, 2nd edition, p294
- 5) References to 'storm duration' relate only to the hydrograph method (qv).
- 6) There are always 600 steps in the calculation process, thus a 'run' time of 10 hours will be sampled every minute,

Explanatory notes for Hydrograph Storage

- 1) The user has the choice of Summer or Winter curves
- 2) The mean intensity varies with the duration of the storm curve
- 3) There are always 120 steps in the calculation process, irrespective of storm duration.
- 4) The balance is calculated from the inflow minus the outflow.
- 5) The storage volume is the sum of the balance values for each step.
- 6) Varying durations should be tried to find the maximum storage value - this can be narrowed down very closely.

*Modelling using the flow characteristics of the restrictor is available using Vortex Control modelling function. Please be aware that this function needs the full design data file to function.

Why do the two methods give different results?

The rainfall characteristics for each method are very different.

The Peak flow (using the Intensity/Duration/Frequency curve) does not model the actual rainfall. This curve is joined points which represent the mean intensity of a storm at a given duration i.e. a value of 19.5 mm/hr for a 60 minute storm indicates that over the sixty minute period, the mean intensity was 19.5 mm/hr. The calculation method samples the IDF curve for a given location and frequency (Return Period) and calculates the storage for that rate and duration less the outflow volume. The maximum value is displayed as the 'worst case' storage. The outflow volume is constant throughout the process at the specified discharge rate.

The hydrograph method uses a standard curve for either Winter or Summer storms. Traditionally these are symmetrical about the central peak. UK rainfall does not fit into this convenient curve, so the calculations are dealing with a stylised set of data. The mean intensity for the storm is calculated from the IDF curve and applied to the curve data, calculating the storage for that step less the outflow volume. The final storage volume is the sum of the storage for all the steps. The outflow volume varies with the hydraulic head on the control device using flow equations provided by the control manufacturer. This is a far more accurate method than the peak flow method and often results in bigger storage volumes.

It can be seen that these two methods are very different, and the user may have the choice of which result to use. This is not an exact science, though is often treated as such by those that do not understand the principles of the calculations.

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