

LAND ADJACENT TO 2 FERNGROVE HOUSE, BURY

SUSTAINABLE DRAINAGE STRATEGY

Job Number: FRA 20 1272

Date: February 2021

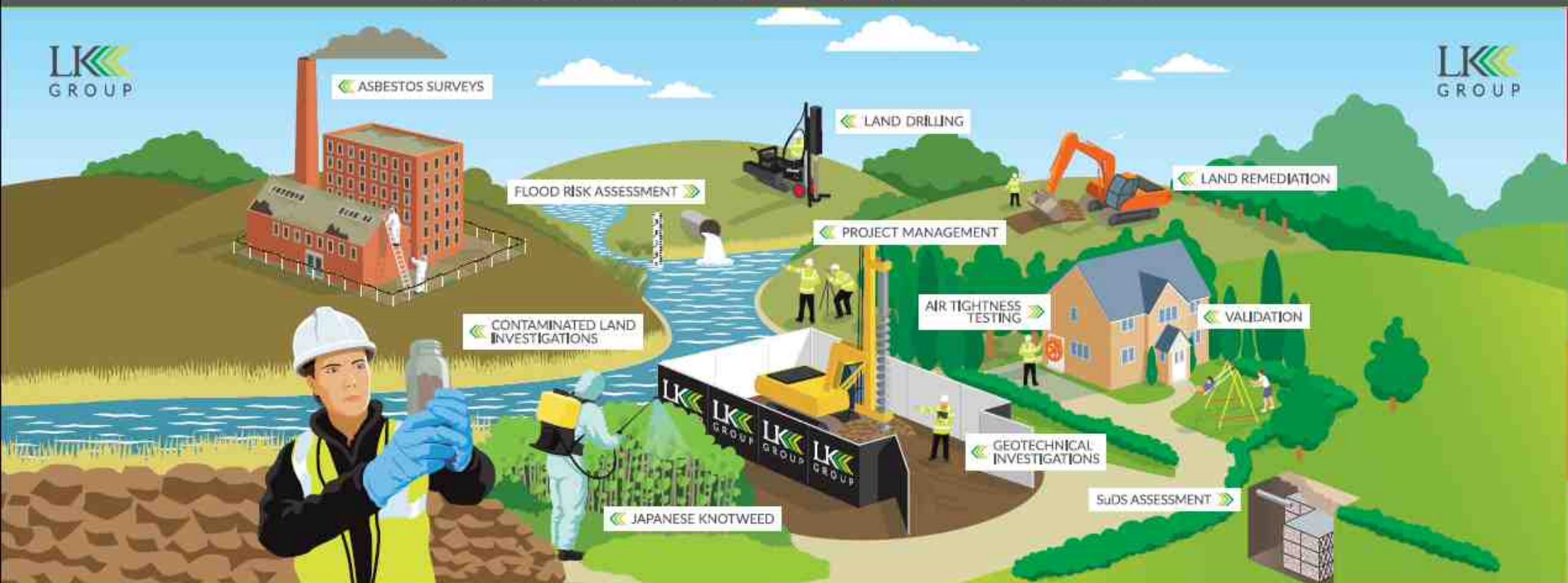
Client: Lords Roofing (NW) Ltd

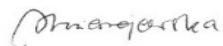


INCREASING LAND VALUE

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LK Consult Document Verification			
Site Address	Land adjacent to 2 Ferngrove House, Rochdale Old Road, Bury, BL9 7LS		
Report Title	Sustainable Drainage Strategy		
Job Number	FRA 20 1272	Document Ref.	FRA 20 1272 - R0
Date Issued	February 2021	Report Version	R0
Prepared By	Anna Mierzejewska – Environmental Scientist	Signature	
Reviewed By	Mark Jones - Associate	Signature	

Revision Record			
Revision No.	Date	Nature of Revision	Approved By

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EXECUTIVE SUMMARY

Scope and Background

This Sustainable Drainage (SuDS) Strategy has been undertaken by LK Consult Ltd (LKC) to support a planning application for the development of Land adjacent to 2 Ferngrove House, Bury. The development comprises new residential dwellings with private gardens and associated car parking.

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

Consultations

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 Fluvial Flood Zone 1.

Bury Metropolitan Borough Council (Lead Local Flood Authority) and United Utilities have also been contacted during preparation of this report.

Mitigation

Design

The ground conditions beneath the site are recorded as Till, Devensian superficial deposits that mainly consist of silty sandy Clay with occasional gravel and water level at around 4mbgl. Made ground was recorded across the site during the site visit.

There is a slight slope towards the watercourse in the west and towards the south.

In considering the potential drainage options for the site at present it is assumed that surface water runoff arising from the development will discharge into the existing watercourse.

The flows from the site should be restricted to an acceptable level to the Lead Local Flood Authority.

The proposed development will increase the proportion of the site covered by impermeable surfaces and will therefore generate more runoff. Attenuation will be required.

The outline drainage strategy considers the use of attenuation-based SuDS to be feasible with a discharge to the watercourse. Therefore, the most effective strategy, in line with the SuDS management train, would be to have a shallow attenuation tank at the western boundary towards the watercourse or permeable paving and flow control device prior connecting into the watercourse. For the 5l/s discharge rate the required storage has been estimated to be **5.2m³** for the 1 in 30-year event.

Similarly, the estimated volume to be retained on site for the 1 in 100-year storm event including the allowance for climate change is **13.5m³**.

The suitability and a depth of connection into the watercourse need to be confirmed on site.

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 by Lords Roofing (NW) Ltd to carry out a Sustainable Drainage Strategy for land adjacent to 2 Ferngrove House, Bury. The report was undertaken in support of a future planning application to redevelop the site for residential 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)¹ and the Planning Practice Guidance (PPG) March 2014². 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:

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

¹ Non-statutory Technical Standards for Sustainable Drainage Systems – DEFRA March 2015

² Planning Practice Guidance – Department for Communities and Local Government April 2014

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. Figure 1 indicates the site location and boundary. Figure 2 indicates the proposed development.

Site Details	
Location	The corner of Rochdale Old Road and Fergrove, to the east of Bury centre, Bury, BL9 7LS. Centred at approximate National Grid Reference 382180E, 411435N.
Area	Approximately 0.14ha.
Topography	108.3m metres above ordnance datum (AOD) in the north east and 105.0m AOD within the southern extent of the site. Site is sloping down relatively steeply from the northeast towards the watercourse and slightly south adjacent to Woodgate Hill Road.
Current Land Use	<u>Site</u> Grassed land with trees adjacent to the boundaries. The site is bounded by a mix of a stone walls and wooden fencing. <u>Surrounding Area</u> North: Green open space and public footpath. East: Woodgate Hill Road and terrace housing. South: Rochdale Old Road and terrace housing. West: Ferngrove House.
Proposed Development	Residential dwellings with private gardens and associated car parking. Access will be from Woodgate Hill Road.

Table 1-1: Summary of site details.

2 Site Setting

2.1 Environmental Setting

LKC has undertaken a review of public domain information including British Geological Survey data, Environment Agency 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		Till, Devensian (Diamicton).
	Bedrock		Pennine Lower Coal Measures – Sandstone (majority of site). Pennine Lower Coal Measures - Mudstone, Siltstone, Sandstone (north of site).
	BGS Boreholes		TP Ref: SD81SW249, 45m northeast: Topsoil to 0.5m, firm silty very sandy Clay with occasional gravel to 1.0m, soft and firm silty sandy and very silty sandy Clay with occasional gravel to 1.8m, fine to coarse Gravel with much soft sandy clay to 2.0m. Dry. BH Ref: SD81SW/6, 50m north: well to 2.4m, gravel to 3.6m, recorded as grey rock and grey sandstone to 26.5m over blue shale to 39.0m. BH Ref: SD81SW340, 60m east: Topsoil to 0.3m, made ground of slightly sandy clay with brick fragments and rootlets to 1.3m, soft to stiff slightly sandy Clay to 2.5m, loose slightly silty fine to medium Sand with occasional gravel to 4.4m, stiff slightly sandy Clay with occasional gravel to 5.2m. Water met at 2.8mbgl, water level at 4.3m.
Hydrogeology	Aquifer Designation	Superficial	Secondary Undifferentiated Aquifer.
		Bedrock	Secondary A Aquifer.
	Source Protection Zone (SPZ)		Site not within an SPZ.
Hydrology	All adjacent and internal surface water		Ordinary watercourse running parallel to the western boundary recorded as an Inland River.
Site History			Watercourse annotated in the west from the earliest mapping (1893-1894). Fern Grove Mill and associated reservoirs annotated to the north of the site.

Table 2-1: Summary of the Environmental Setting.

2.2 Site Reconnaissance

A site reconnaissance was undertaken in February 2020 and photographs are provided in Appendix B.

Relevant features identified on site are summarised below:

- » The site is currently unmaintained grassland.
- » The site is falling steeply to the southwest.
- » The site is bordered by dry stone walls and occasional mature trees.
- » There is a watercourse at the west of the site, which flows in a southerly direction. The watercourse is open in the area adjacent to the central part of the site but is culverted at the north and south.
- » There are manholes and gullies within Rochdale Old Road to the south, and in Woodgate Hill Road to the east and Ferngrove to the west.
- » Hand-dug samples taken within the northern, central and southern parts of the site indicate Made Ground to 0.5-0.7m – consisting of silty Clay with frequent brick and occasional ash.

2.3 Site and Access Levels

A topographic survey of the site has been undertaken to OS GPS datum, and information is included on the drawings in Appendix B. The site falls with a decline of 4.3m AOD from 108.3m AOD within the north eastern corner, towards the watercourse and to 105.0m AOD within the southern extent of the site. The watercourse appears to be approximately 0.5m deep.

3 Consultation

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

Relevant correspondence / information is provided in Appendix C.

Source	Details	
Environment Agency (EA)	Flood Zone 1: Very Low risk, with annual probability of flooding from rivers and the sea of less than 0.1% (1 in 1000).	
Bury Metropolitan Borough Council (LLFA)	No specific information provided at the time of writing. Bury Council published their SuDS Guidance in March 2020.	
United Utilities (UU)	Likely conditions for connecting into their sewerage system	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 or into watercourse where feasible. If not feasible and once evidence provided, UU will consider a connection to the 275mm diameter public surface water sewer located in Ferngrove at a pass forward flow to be agreed by the Lead Local Flood Authority. UU request that any agreed rate does not exceed 5l/s. Foul flow from this site will be allowed to drain into the public combined sewer system. UU's preferred point of discharge would be to the 225mm diameter public combined sewer within Ferngrove at an unrestricted rate. Alternative connection point may be agreed further if required.
	Sewer Map	A 275mm diameter surface water sewer is shown running in Ferngrove to the west of the site. This discharges into a 450x600mm culverted watercourse emerging from within the southeast of the site. There are combined sewers recorded within adjacent highways, a 225mm diameter in Ferngrove and a 600x675mm in Woodgate Hill Road, discharging into a 450mm diameter sewer in Rochdale Old Road.

Table 3-1: Summary Consultee Information.

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4 Sustainable Drainage Strategy

4.1 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 H3³ 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 2010⁴.

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.

4.1 Infiltration

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

A summary of the British Geological Survey superficial and bedrock aquifer descriptions and classifications supplemented by local records is shown in Table 4-1 below:

³ Building Regulations part H3 2010: Approved Document, Drainage and Waste Disposal.

⁴ Flood and Water Management Act 2010: UK Government.

Classification	Description	Aquifer Classification	Recorded Water Table Depth	Soakaway Potential
Till, Devensian Deposits	Silty, sandy Clay with occasional gravel and sand lenses	Secondary Undifferentiated	c. 4.3m	Poor
Pennine Lower Coal Measures Bedrock	Sandstone	Secondary A	N/A	Limited
Pennine Lower Coal Measures	Mudstone, Siltstone and Sandstone			Poor

Table 4-1: Geological and Hydrogeological Setting.

Infiltration methods such as soakaways are unlikely to be feasible on account of made ground recorded across the site and further silty sandy Clay anticipated below that, but this may be investigated further at the detailed design stage, if required.

There is a slope over the site which indicates that groundwater in the vicinity of the site would likely drain towards the watercourse in the west.

4.2 Watercourses

There is a watercourse running through the site that currently collects surface water off site. It runs parallel to the western boundary and is open in the area adjacent to the central part of the site but is culverted at the north and south.

The watercourse is recorded as a 450x600mm culverted watercourse further downstream on the UU records. It runs across Rochdale Old Road and further south across the area under the M65.

This watercourse is not recoded as an EA's Main River therefore it would remain within remit of LLFA.

4.3 Public Sewer

There is a surface water sewer running adjacent to the site in Ferngrove. It connects to the culverted watercourse.

There are combined sewers in adjacent highways.

4.4 Surface Water Drainage Strategy

The drainage options relating to the final discharge of surface water for this section of the site are listed in Table 4-2 in order of priority within the NPPF:

Option No:	Drainage Solution	Most feasible solution	Comments
a	Soakaway/Infiltration	3	Reasoning: likely low permeability of underlying clay deposits, unknown ground water table.
b	Connection to Watercourse	1	Would be practical given location within the site. Subject to approval and conditions from LLFA.
c	Discharge into a sewer	2	A connection into the 225mm diameter surface water sewer in Ferngrove would be possible – subject to approval from LLFA and a formal connection agreement with UU

Table 4-2: Drainage options.

Table 4-3 provides a summary of the SuDS options appraisal with consideration of CIRIA C697 (The SUDS Manual)⁵ for the development:

SuDS Option	Appropriate to Development	Comments
Soakaways	X	Due to the nature of the ground conditions, the use of infiltration systems may be feasible.
Infiltration basin	X	Depressions that store and dispose of water via infiltration. May be appropriate given the ground conditions.
Sand filter	X	Treatment devices using sand beds as filter media.
Filter strip	X	Engineered filters that use vegetation to remove and treat runoff. The filter strip is sloped to allow sheet flow across the vegetated strip. A filter strip offers no storage and is used solely to remove pollutants from surface water.
Filter drains	✓	Linear trenches filled with a permeable granular material, often with a perforated pipe in the base of the trench.
Detention basin	X	Dry depressions designed to hold water for a specific retention time.
Swales	X	Swales are shallow grass-lined channels that provide capacity for conveying flows at a controlled rate into ponds and watercourses.
Rainwater harvesting	*	Rainwater harvesting collects the rain which falls onto roofs, then stores it in a tank until required for a non-potable use.. Rainwater harvesting systems are currently not included in the development proposals.
Green roofs	*	Green roof installations can help to reduce surface water runoff from roof areas depending on the system specified. Green roofs are not currently included in the development proposals.
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.
Permeable Pavements – with 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 into ground.
Ponds	*	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. 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.
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.
Tanks	✓	Prefabricated underground tanks could be considered at the detailed design stage in order to provide storage to attenuate surface water runoff.
Flow control devices	✓	The peak flow rates will be controlled by flow control devices e.g. hydrobrake style flow control systems, and restricted orifices. Flow control devices enable the discharge to be restricted to a constant rate from the development.

Table 4-3: 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.
- X Not suitable

⁵ CIRIA C697 - The SUDS Manual. London 2015

4.5 Surface Water Attenuation Requirements

In line with the local SuDS Guidance, the flow from this development should be limited to a 'greenfield scenario' 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 4-4).

Designated Areas	Plot Area
Total area (ha)	0.14
Existing Impermeable Area (ha)	0.00
Green Infrastructure (ha)	0.14
Contributing Catchment	
Catchment Area (ha)	0.10
Impermeable split (ha)	0.07
Permeable split (ha)	0.03

Table 4-4: Assumed plot areas.

Table 4-4 shows the assumed split in area included within the calculations.

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 existing flow off site to a level which is acceptable to the LLFA or UU, if applicable.

4.5.1 Attenuation Estimate

Surface water storage and greenfield runoff estimations based on the HR Wallingford procedure IH 124⁶ have been undertaken for the development and the output report is presented in Appendix D.

For the contributing catchment an estimate has been produced assuming a roofs and hardstanding area of 0.07ha and contributing garden areas/ green open space of 0.03ha from the 0.14ha plot. Therefore, the resulting impermeable area would be 0.07ha. This gives the following runoff rates and attenuation requirements for this section based on the Wallingford IH 124 method:

» Q_{bar} :	1.04 l/s
» 1 in 1-year greenfield runoff rate:	0.89 l/s
» 1 in 30-year greenfield runoff rate:	1.75 l/s
» 1 in 100-year greenfield runoff rate:	2.19 l/s

As this is less than the accepted minimum flow, that flow control devices work efficiently with minimal maintenance, the flow is offered to be limited to 5l/s.

The following attenuation has been estimated for the development using 5l/s runoff rates and utilises the FSR methodology⁷ as:

- » Attenuation storage volume: **5.2 m³** (1 in 30-year event)
- » Retention on site volume: **13.5 m³** (1 in 100 year + 30% Climate Change)

Attenuation storage aims to limit the peak rate of runoff from the development to 5l/s before discharge to watercourse. As the flow from the development would be reduced there should be little change in the flows that enter the watercourse and thus the risk

⁶ IH124 Flood Estimation of Small Catchments.

⁷ Flood Studies Report Wallingford NERC 1975.

of flooding and the level of erosion created 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, requires a storage volume of **5.2 m³** and for the 1 in 100-year event, a storage capacity of **13.5 m³** will be required from on-site storage as well as SuDS systems. All volumes can be stored within the site boundary and discharges will be limited by flow control devices to the on-site watercourse.

4.6 Site Specific SuDS

The use of attenuation SuDS was 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.

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

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.

4.7 Foul Drainage

The foul water could be discharged by gravity into the 225mm diameter foul sewer in Ferngrove as relative levels indicate that this will be feasible in terms of fall. Alternatively, a connection point into a 450mm diameter combined sewer located in Woodgate Hill Road to the east of the site could also be considered, upon further consultations with UU.

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5 Conclusion

The site is currently unmaintained grassland. The proposal is to develop new residential dwellings with associated car parking and access off Woodgate Hill Road.

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:

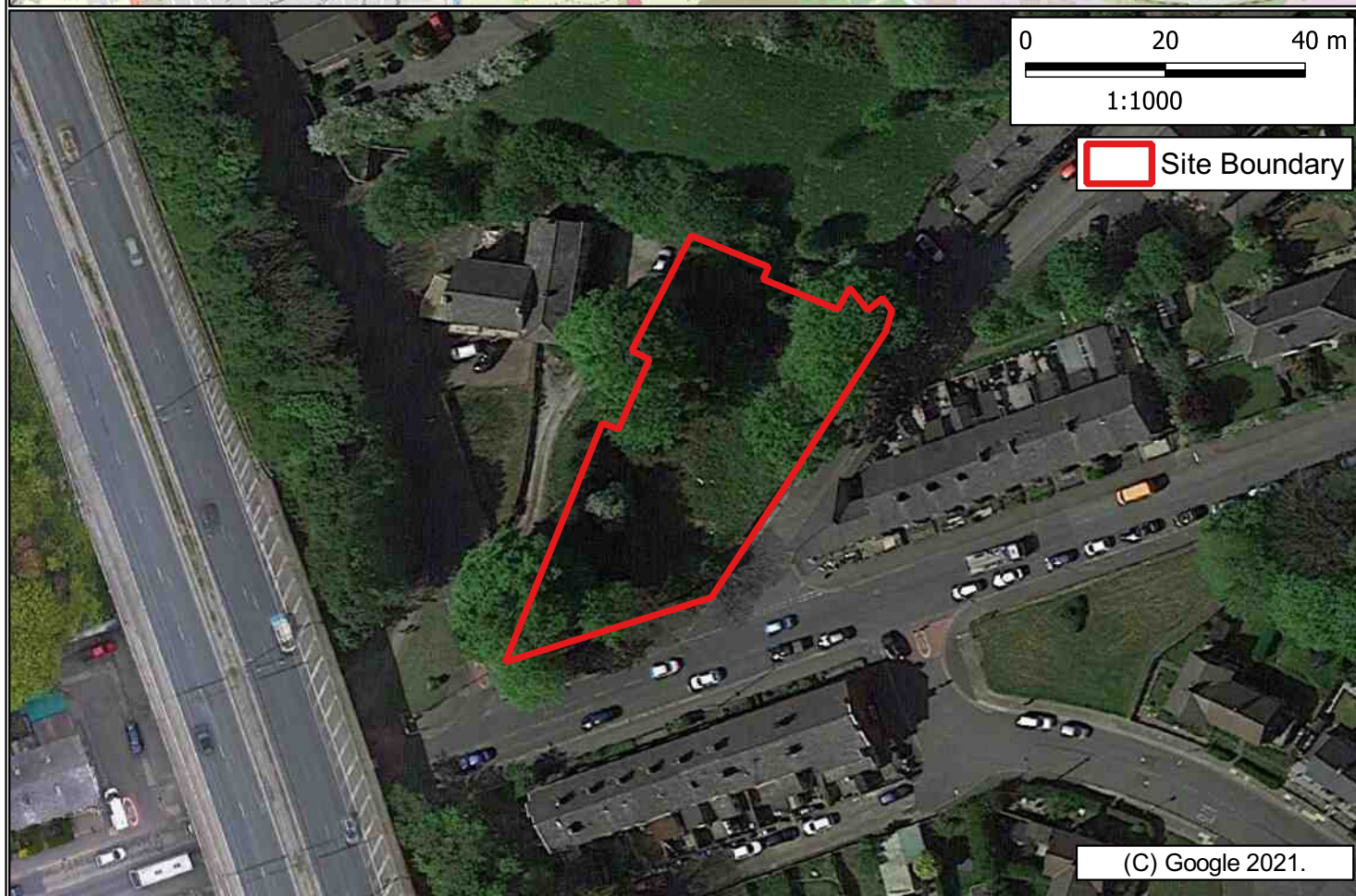
- » The site is considered to be too constrained due to the existing topography and proximity of the adjacent properties for the use of soakaway.
- » The recorded geology on site would indicate that infiltration may not be practical. This could be investigated at the detailed design stage if required.
- » A suitability and a depth of the potential connection into the onsite watercourse should be confirmed on site. The watercourse remains in remit of LLFA.
- » There are no existing connections of the site to the adjacent public sewers. A pre-development advice received from United Utilities considered a flow rate of 5l/s would be acceptable if infiltration or connection into the watercourse proved to be impractical.
- » All proposed outflow connections from the development should be agreed with the Lead Local Planning Authority.

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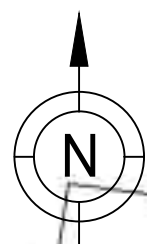
APPENDIX A

FIGURES, PLANS AND DRAWINGS

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Client: Lords Roofing (NW) Ltd				Title: Site Location & Boundary Plan		LK CONSULT
Site: Land adj. to 2 Ferngrove House, Bury				Scale (see scale bar): 1:25,000 & 1:1,000 @ A4		
Job No.: FRA 20 1272	Drawn By: AM	Checked By: MJ	Drawn: Feb 2021	Figure: 1	Revision:	



Extract from: Harry Jackson Surveyors Limited
Drawing Ref: Proposed Site Plan, No.01 (November 2020)

Do not scale from this drawing and work from marked dimensions only. All dimensions and features should be confirmed on site by the Contractor. Where this drawing includes information provided to LK Consult Ltd by others, LK Consult Ltd gives no warranty, representation or assurance as to the accuracy of such information.



Client:			
Lords Roofing (NW) Ltd			
Site:			
Land adj. to 2 Ferngrove House, Bury			
Title:			
Proposed Development Plan			
Job No.:	Scale (See Scale Bar):	Figure:	Revision:
FRA 20 1272		2	
Drawn By:	Checked By:	Drawn:	
AM	MJ	Feb 2021	

APPENDIX B

SITE INFORMATION

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Rust Environmental		Project: Fern Grove, Bury	Trial Pit Sheet 1 of 1
Bearing: EDBISW	Trial Pit Plan 	Client: Morris Homes Ltd	Project No.: EGMCH001
Ground Level: 249		Shoring:	Date: 30/4/97
Co-ordinates: 8223 1149		Stability: Some spalling during excavation	Plant: JCB 3CX
		Water: Dry	Logged by: OGB Checked by:

Depth	Face A:	Face B:	Face C:	Depth
0.00		1		0.00
0.50		2		0.50
1.00		3		1.00
1.50		4		1.50
2.00				2.00

Sampling			Strata		
Sample Depth	Type	Strength (kN/m ²)	Ref. No.	Strata Depth	Description
			1	0.00	Dark brown TOPSOIL,
			2	0.50	Firm orange brown silty very sandy CLAY with occasional gravel.
			3	1.00	Soft and firm orange brown mottled grey silty sandy and very silty sandy CLAY with occasional gravel
			4	1.80	Dark grey fine to coarse sub-rounded to rounded GRAVEL with much soft very sandy clay.
				2.00	Base of pit

Remarks Ground level : 110 m AOD (to nearest 0.5m)

SD 81 SW 16.

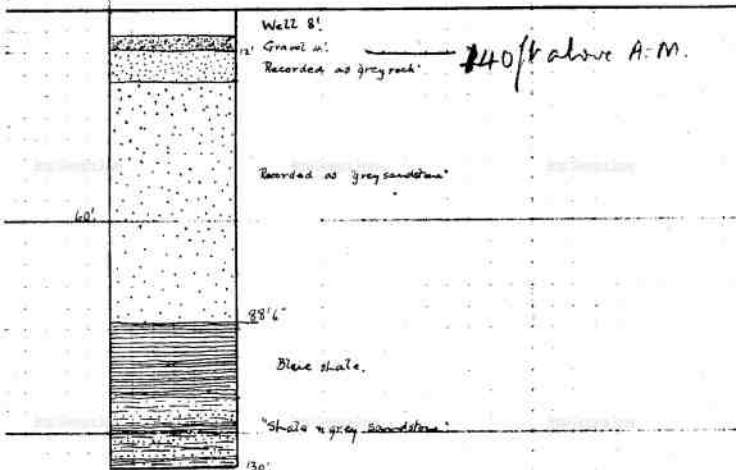
SECTION OF BOREHOLE

AT

188 N.W.^E

1" 85

BURY QUILTING CO. FERN GROVE MILLS, BURY.



SDRIS62 8224 1141 340



Location Gin Hall Service Reservoir	Borehole No. BH1
Client: BeWT	Project Ref: 1-31-09-909
Equipment and methods Light cable percussion	
Start Date: 21/11/97	End Date: 21/11/97
Final Depth: 5.20m	Casing Diameter: 150mm
	Depth: 4.50m

Job No.: **9069-45**

FIELD RECORDS	Samples / Tests				Description	Depth (m) (Station m)	Strata Revised Level (m)	Legend
	Core (Type) Depth (m)	Depth (m) From to	SAMPLE Type & No	SPT (N) (IC)				
		0.50		D 1	Grass over TOPSOIL	(0.70) 0.30	103.85	[Cross-hatch pattern]
		1.00		D 2	MADE GROUND (soft orange/brown and grey mottled slightly sandy clay with brick fragments and nodules)	(1.00)		
[u30]		1.20	1.65	U 1	(27)		104.85	[Dotted pattern]
		1.80		D 3	Soft to firm light brown mottled slightly sandy CLAY	(1.20)		
[u60]		2.20	2.65	U 2	(86)			[Horizontal lines pattern]
					becoming stiff at 2.20m	2.50	103.65	
T1 M1 2.80 2.80	2.80	3.25	B 1	(10)	Loose brown slightly silty fine to medium SAND with occasional fine gravel and mudstone fragments	(1.90)		[Vertical lines pattern]
		3.80		S 1				
1.2 2.3 1.2	3.80 (0.30)	3.80	B 2	(9)				[Vertical lines pattern]
			S 2					
[u60]		4.50	4.95	U 3	(97)			[Vertical lines pattern]
					Stiff reddish brown and grey slightly sandy CLAY with occasional fine to coarse gravel and sandstone - containing mudstone with depth	4.40	101.75	
(11/11/97)		5.20		D 4	Borehole Completed	(0.80) 5.20	100.95	

Remarks 1) Service pit dug 0.60m x 0.70m x 1.20m 2) Water rose at 2.80m with no rise after 30 mins 3) Borehole dry pm 21/11/97 4) Piezometer installed with stopcock cover 5) Borehole dry before installation, water level 4.30m after installation	Logged by LW Drilled by GB Ground level 106.15mAD Co-ordinates:
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100-000000-000000-000000

Geology 1:50,000 Maps Legends

Artificial Ground and Landslip

Map Colour	Lex Code	Rock Name	Rock Type	Min and Max Age
	WMGR	Infilled Ground	Artificial Deposit	Not Supplied - Holocene
	WGR	Worked Ground (Undivided)	Void	Not Supplied - Holocene
	MGR	Made Ground (Undivided)	Artificial Deposit	Not Supplied - Holocene
	SLIP	Landslide Deposit	Unknown/Unclassified Entry	Not Supplied - Quaternary

Superficial Geology

Map Colour	Lex Code	Rock Name	Rock Type	Min and Max Age
	ALV	Alluvium	Clay, Silt, Sand and Gravel	Not Supplied - Holocene
	TILLD	Till, Devensian	Diamicton	Not Supplied - Devensian
	GFDUD	Glaciofluvial Deposits, Devensian	Sand and Gravel	Not Supplied - Devensian
	HMGDD	Hummocky (Moundy) Glacial Deposits, Devensian	Diamicton	Not Supplied - Devensian
	RTD1	River Terrace Deposits, 1	Sand and Gravel	Not Supplied - Quaternary
	RTD2	River Terrace Deposits, 2	Sand and Gravel	Not Supplied - Quaternary
	HEAD	Head	Clay, Silt, Sand and Gravel	Not Supplied - Quaternary

Bedrock and Faults

Map Colour	Lex Code	Rock Name	Rock Type	Min and Max Age
	PLCM	Pennine Lower Coal Measures Formation	Mudstone, Siltstone and Sandstone	Not Supplied - Westphalian
	PLCM	Pennine Lower Coal Measures Formation	Sandstone	Not Supplied - Westphalian
	WH	Woodhead Hill Rock	Sandstone	Not Supplied - Westphalian
	HER	Helpet Edge Rock	Sandstone	Not Supplied - Westphalian
	MLRS	Milnrow Sandstone	Sandstone	Not Supplied - Westphalian
	DF	Darwen Flags	Sandstone	Not Supplied - Westphalian

Map Colour	Lex Code	Rock Name	Rock Type	Min and Max Age
	GAS	Great Arc Sandstone	Sandstone	Not Supplied - Westphalian
	OL	Old Lawrence Rock	Sandstone	Not Supplied - Westphalian
	CAR	Cannel Rock (South Lancashire)	Sandstone	Not Supplied - Westphalian
	TRBR	Trencherbone Rock	Sandstone	Not Supplied - Westphalian
	RR	Rough Rock	Sandstone	Not Supplied - Namurian
	ROSSE	Rossendale Formation	Mudstone and Siltstone	Not Supplied - Namurian
	UH	Upper Haslingden Flags	Sandstone	Not Supplied - Namurian
		Faults		
		Rock Segments		



Geology 1:50,000 Maps

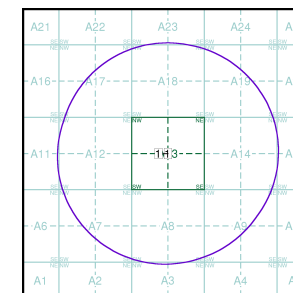
This report contains geological map extracts taken from the BGS Digital Geological map of Great Britain at 1:50,000 scale and is designed for users carrying out preliminary site assessments who require geological maps for the area around the site. This mapping may be more up to date than previously published paper maps.

The various geological layers - artificial and landslip deposits, superficial geology and solid (bedrock) geology are displayed in separate maps, but superimposed on the final 'Combined Surface Geology' map. All map legends feature on this page. Not all layers have complete nationwide coverage, so availability of data for relevant map sheets is indicated below.

Geology 1:50,000 Maps Coverage

Map ID: 1
Map Sheet No: 085
Map Name: Manchester
Map Date: 2010
Bedrock Geology: Available
Superficial Geology: Not Available
Artificial Geology: Not Available
Faults: Not Supplied
Landslip: Not Available
Rock Segments: Not Supplied

Geology 1:50,000 Maps - Slice A



Order Details:

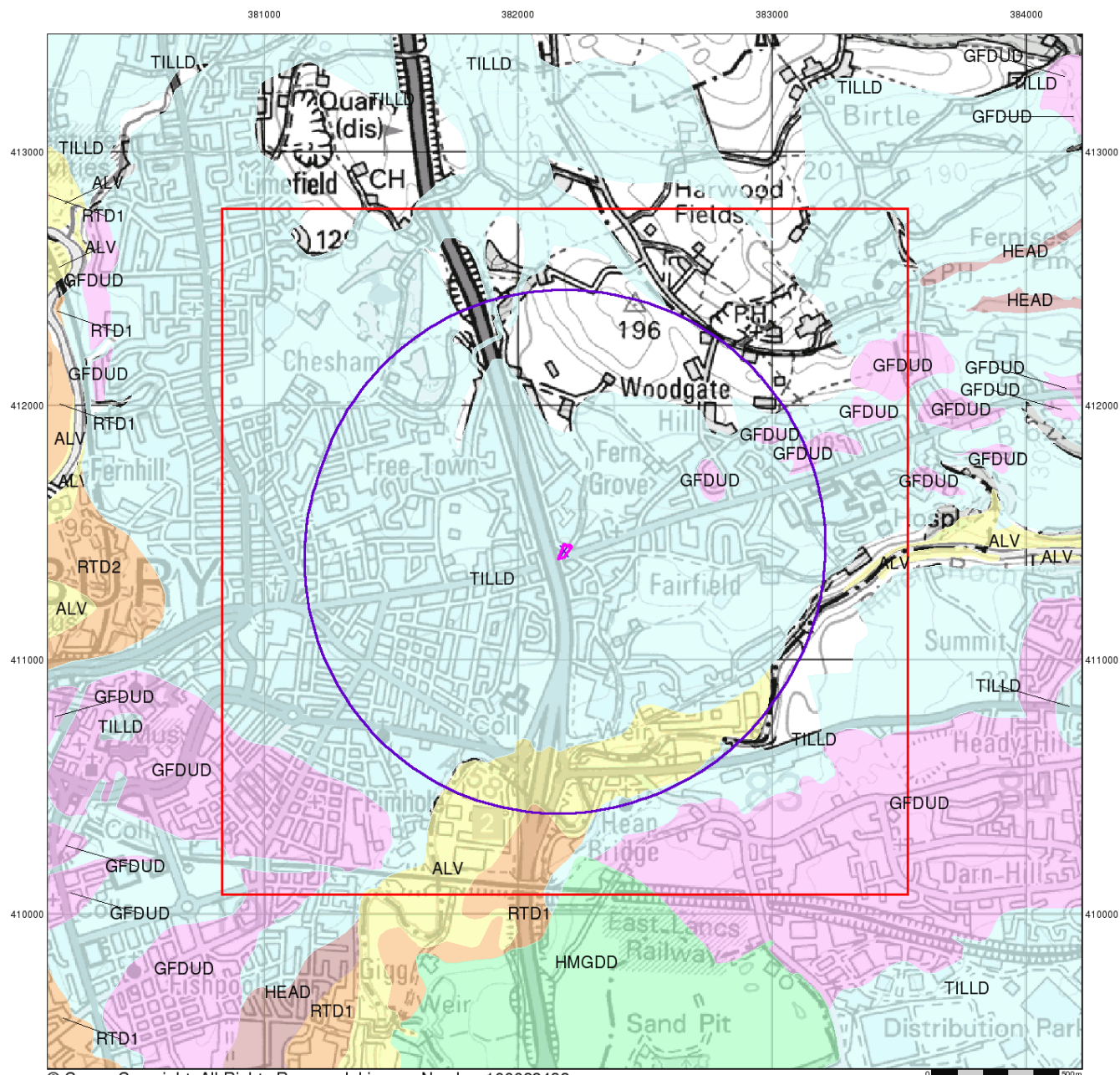
Order Number: 273312241_1_1
Customer Reference: LKC 20 2015
National Grid Reference: 382180, 411430
Slice: A
Site Area (Ha): 0.15
Search Buffer (m): 1000

Site Details:

Land between Ferngrove and Woodgate Hill Road, Rochdale Old Road, Bury, BL9 7LS

Landmark
INFORMATION GROUP

Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk



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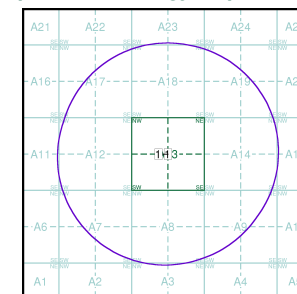
Superficial Geology

Superficial Deposits are the youngest geological deposits formed during the most recent period of geological time, the Quaternary, which extends back about 1.8 million years from the present.

They rest on older deposits or rocks referred to as Bedrock. This dataset contains Superficial deposits that are of natural origin and 'in place'. Other superficial strata may be held in the Mass Movement dataset where they have been moved, or in the Artificial Ground dataset where they are of man-made origin.

Most of these Superficial deposits are unconsolidated sediments such as gravel, sand, silt and clay, and onshore they form relatively thin, often discontinuous patches or larger spreads.

Superficial Geology Map - Slice A



Order Details:

Order Number: 273312241_1_1
 Customer Reference: LKC 20 2015
 National Grid Reference: 382180, 411430
 Slice: A
 Site Area (Ha): 0.15
 Search Buffer (m): 1000

Site Details:

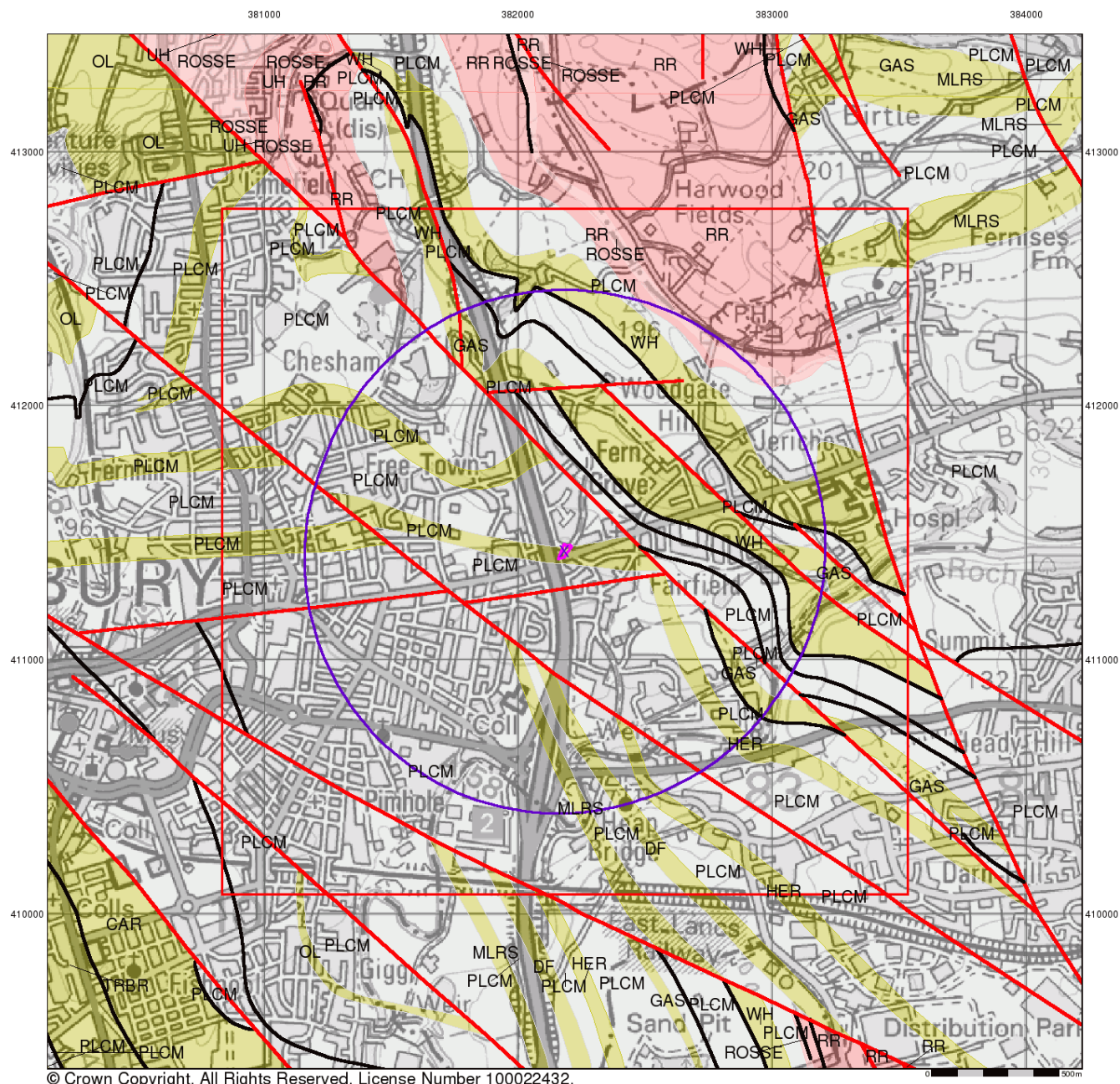
Land between Ferngrove and Woodgate Hill Road, Rochdale Old Road, Bury, BL9 7LS



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v15.0 12-Feb-2021

Page 3 of 5



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Bedrock and Faults

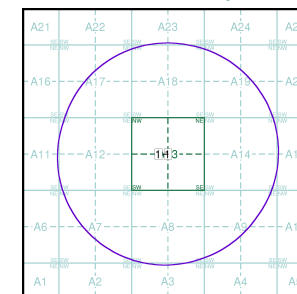
Bedrock geology is a term used for the main mass of rocks forming the Earth and are present everywhere, whether exposed at the surface in outcrops or concealed beneath superficial deposits or water.

The bedrock has formed over vast lengths of geological time ranging from ancient and highly altered rocks of the Proterozoic, some 2500 million years ago, or older, up to the relatively young Pliocene, 1.8 million years ago.

The bedrock geology includes many lithologies, often classified into three types based on origin: igneous, metamorphic and sedimentary.

The BGS Faults and Rock Segments dataset includes geological faults (e.g. normal, thrust), and thin beds mapped as lines (e.g. coal seam, gypsum bed). Some of these are linked to other particular 1:50,000 Geology datasets, for example, coal seams are part of the bedrock sequence, most faults and mineral veins primarily affect the bedrock but cut across the strata and post date its deposition.

Bedrock and Faults Map - Slice A



Order Details:

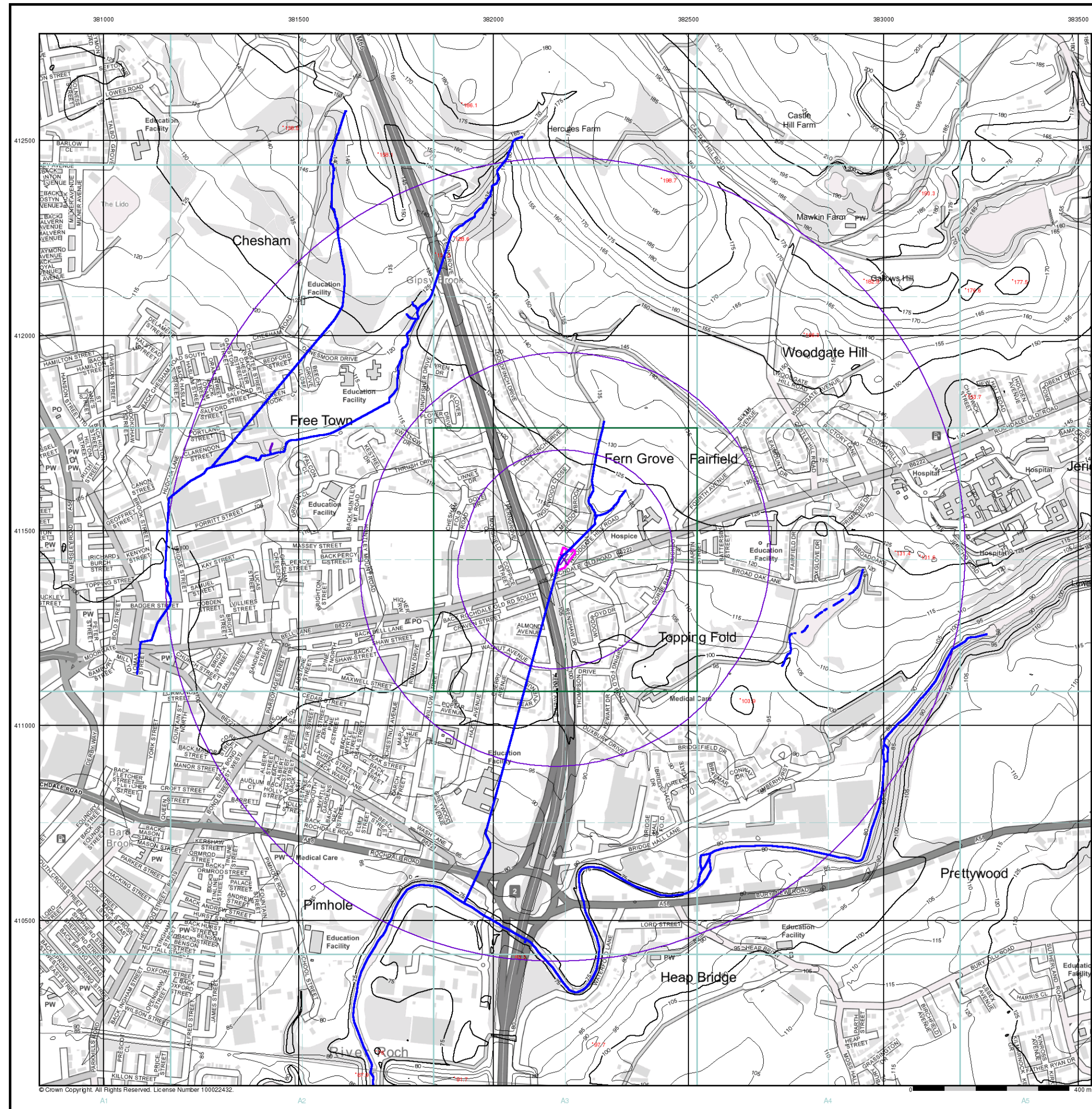
Order Number: 273312241_1_1
 Customer Reference: LKC 20 2015
 National Grid Reference: 382180, 411430
 Slice: A
 Site Area (Ha): 0.15
 Search Buffer (m): 1000

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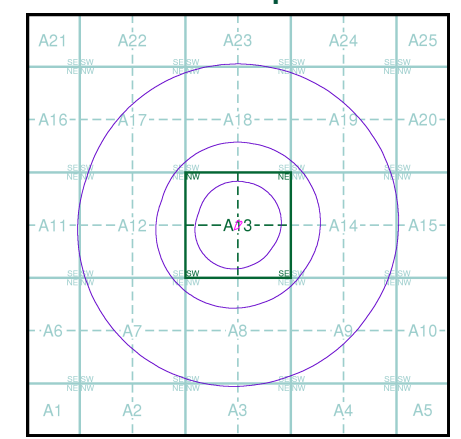


- General**
- Specified Site
 - Specified Buffer(s)
 - Bearing Reference Point

- OS Water Network Data**
- | | |
|--------------|-------------------------|
| Canal | Drain |
| Reservoir | Other |
| Foreshore | Lake |
| Marsh | Transfer |
| Tidal River | Lock Or Flight Of Locks |
| Inland River | Sea |

- Contours (height in meters)**
- Standard Contour 105
- Master Contour 100
- Spot Height 167.3
- MLW Mean Low Water
- MHW Mean High Water

OS Water Network Map - Slice A



Order Details

Order Number: 273312241_1_1
Customer Ref: LKC 20 2015
National Grid Reference: 382180, 411430
Slice: A
Site Area (Ha): 0.15
Search Buffer (m): 1000

Site Details

Land between Ferngrove and Woodgate Hill Road, Rochdale
Old Road, Bury, BL9 7LS



Tel: 0844 844 9952
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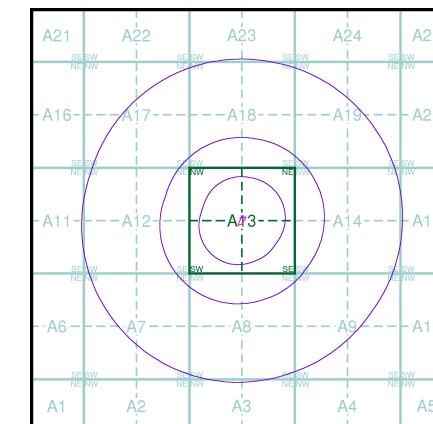
General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point

Agency and Hydrological (Flood)

- Extreme Flooding from Rivers or Sea without Defences (Zone 2)
- Flooding from Rivers or Sea without Defences (Zone 3)
- Area Benefiting from Flood Defence
- Flood Water Storage Areas
- Flood Defence

Flood Map - Slice A

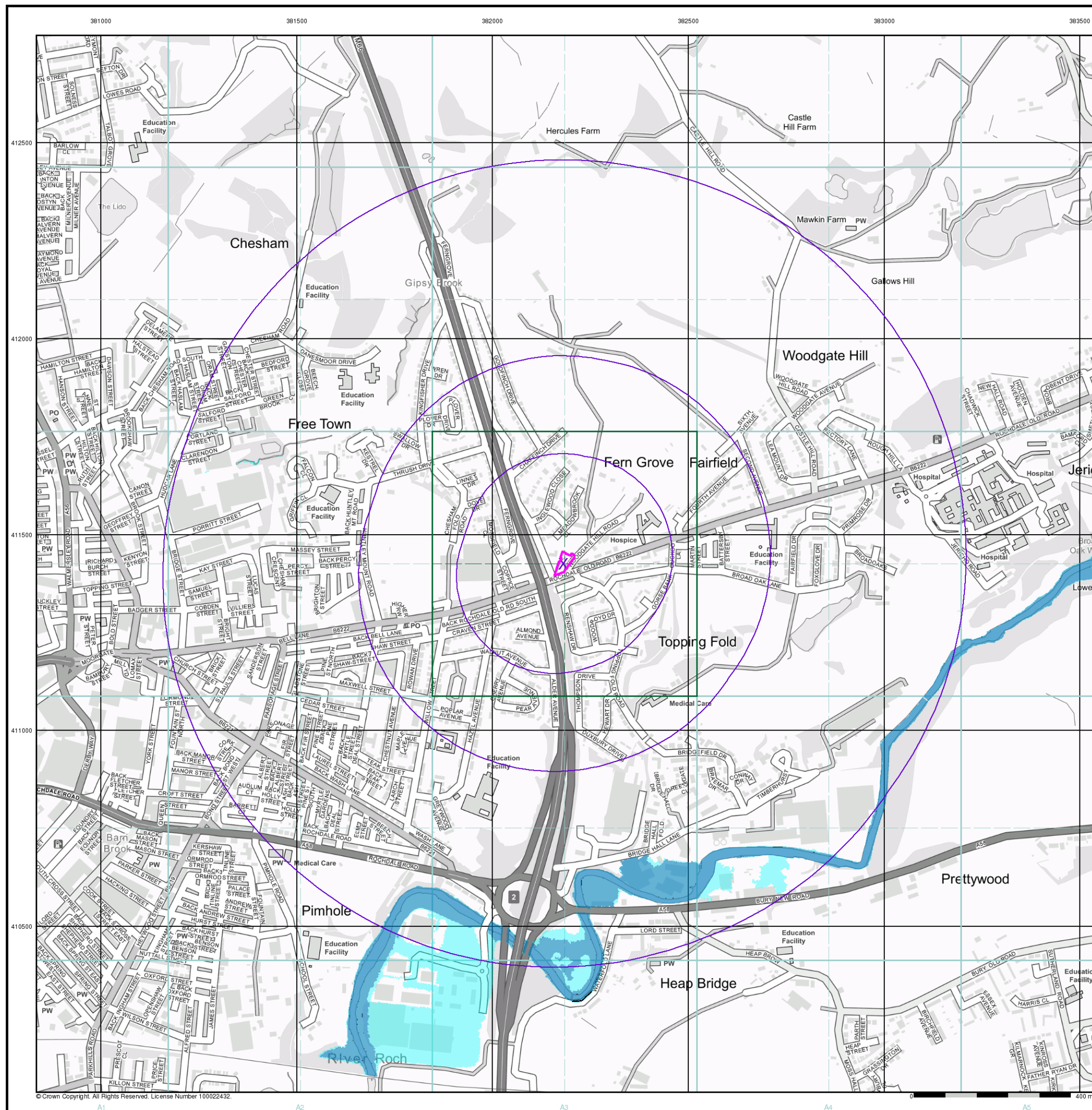


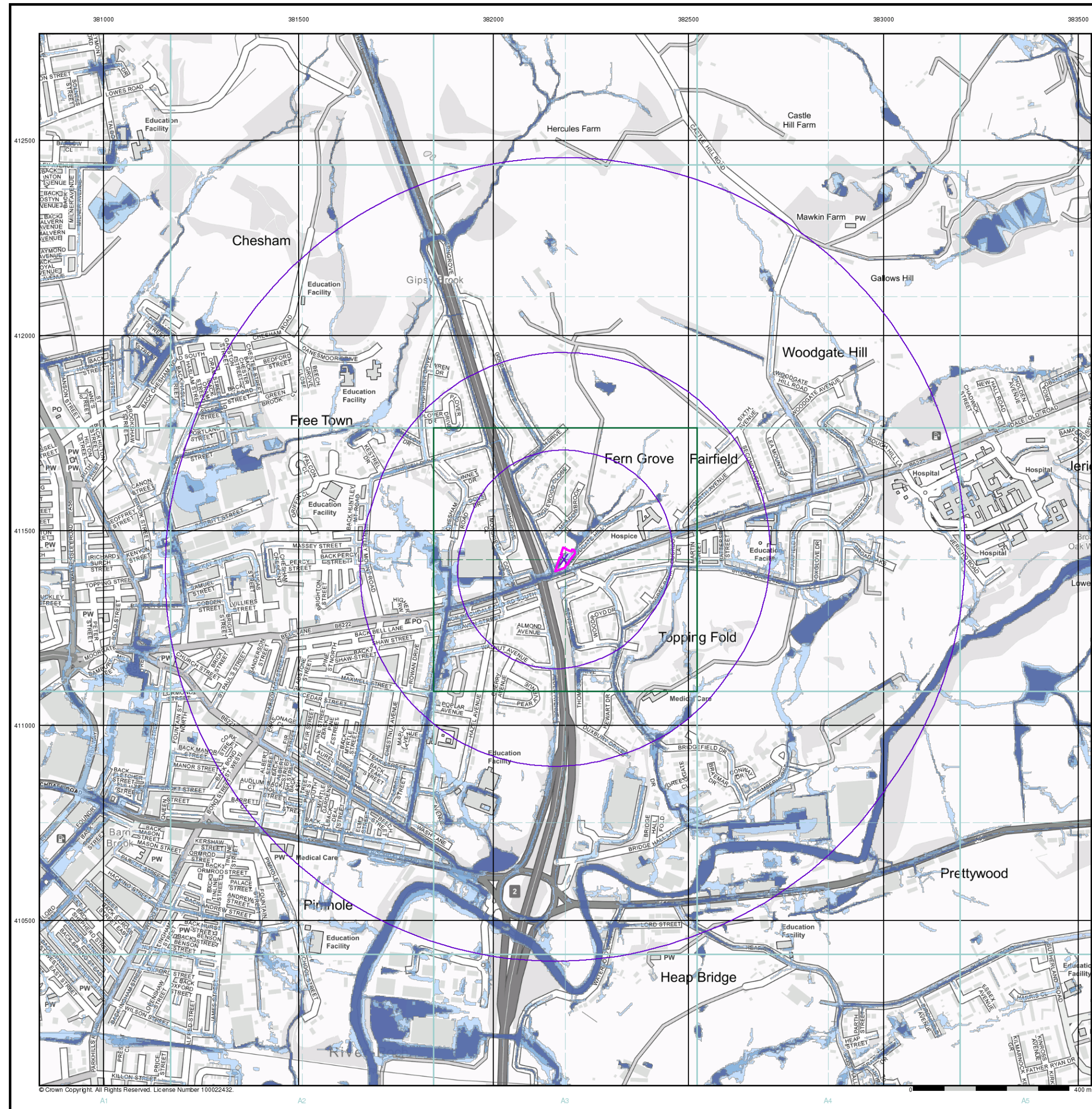
Order Details

Order Number: 273312241_1_1
 Customer Ref: LKC 20 2015
 National Grid Reference: 382180, 411430
 Slice: A
 Site Area (Ha): 0.15
 Search Buffer (m): 1000

Site Details

Land between Ferngrove and Woodgate Hill Road, Rochdale
 Old Road, Bury, BL9 7LS





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General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point

Risk of Flooding from Surface Water

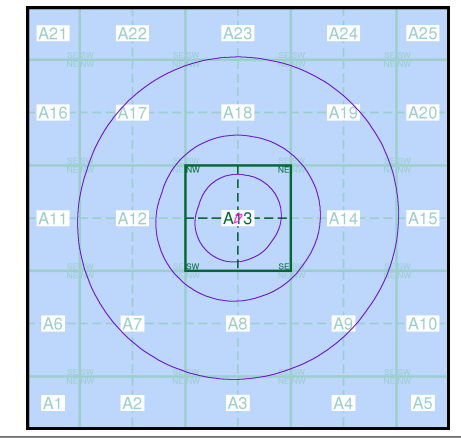
- High - 30 Year Return
- Medium - 100 Year Return
- Low - 1000 Year Return

Suitability

See the suitability map below

- National to county
- County to town
- Town to street
- Street to parcels of land
- Property

E/NRW Suitability Map - Slice A



Order Details

Order Number: 273312241_1_1
Customer Ref: LKC 20 2015
National Grid Reference: 382180, 411430
Slice: A
Site Area (Ha): 0.15
Search Buffer (m): 1000

Site Details

Land between Ferngrove and Woodgate Hill Road, Rochdale
Old Road, Bury, BL9 7LS



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Fax: 0844 844 9951
Web: www.envirocheck.co.uk



Photograph 1
(facing NE):
Northern part of site.



Photograph 2
(facing SW):
Facing south, along western boundary. Culvert beneath photograph location.



Photograph 3
(facing W):
Northern end of site, at highest point.



Photograph 4
(facing E):
Highest point of site, northeastern corner.



Photograph 5
(facing N):
View across site from southwestern corner.



Photograph 6
(facing W):
Taken from northeastern corner of site.



Photograph 7
(facing SW):
View across site,
taken from eastern
boundary.



Photograph 8
(facing NW):
Southeastern site
boundary.



Photograph 9
(facing N):
Watercourse at
western boundary.



Photograph 10
(facing N):
Watercourse at
western boundary.



Photograph 11
(facing N):
Upstream culvert
at northwest of
site.



Photograph 12
(facing SW):
Downstream
culvert at
southwest of site.



Photograph 13
(facing E):
 Site entrance at southwestern boundary.



Photograph 14
(facing N):
 Manhole in Ferngrove to the west.



Photograph 15
(facing SW):
 Manhole in Woodgate Hill Road to the east.



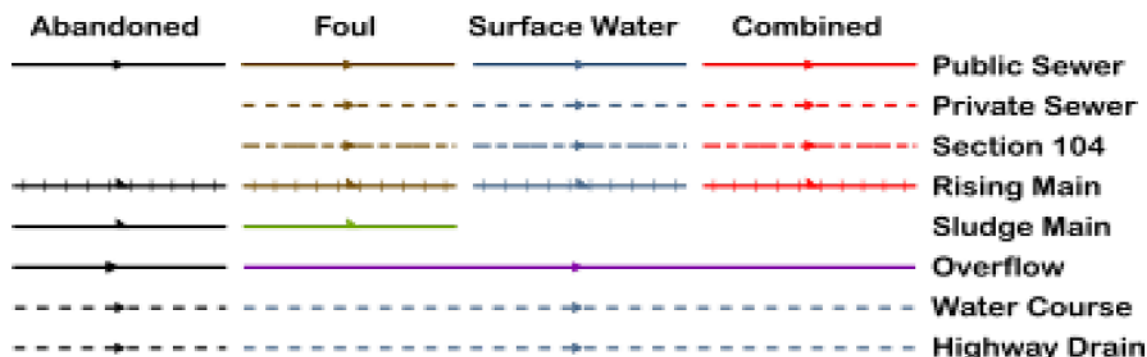
Photograph 16
(facing SW):
Manhole in
Rochdale Old
Road to the south.

APPENDIX C

CONSULTEE CORRESPONDENCE

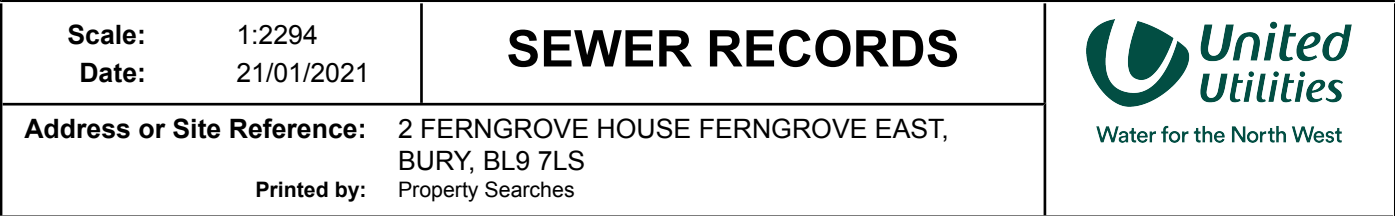
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Wastewater Symbolology



All point assets follow the standard colour convention: **red** – combined **brown** - foul
blue – surface water **purple** - overflow

Manhole	Side Entry Manhole
Head of System	Outfall
Extent of Survey	Screen Chamber
Rodding Eye	Inspection Chamber
Inlet	Bifurcation Chamber
Discharge Point	Lamp Hole
Vortex	T Junction / Saddle
Penstock	Catchpit
Washout Chamber	Valve Chamber
Valve	Vent Column
Air Valve	Vortex Chamber
Non Return Valve	Penstock Chamber
Soakaway	Network Storage Tank
Gully	Sewer Overflow
Cascade	Ww Treatment Works
Flow Meter	Ww Pumping Station
Hatch Box	Septic Tank
Oil Interceptor	Control Kiosk
Summit	
Drop Shaft	Change of Characteristic
Orifice Plate	



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Anna Mierzejewska

From: Wastewater Developer Services <WastewaterDeveloperServices@uuplc.co.uk>
Sent: 15 January 2021 16:57
To: Anna Mierzejewska
Cc: Wastewater Developer Services
Subject: FW: PDE 4200036152 Adj. to 2 Ferngrove House, Rochdale Old Road, Bury, BL9 7LS

Good afternoon Anna,

Pre Development Enquiry for: the construction of 5 dwellings on land adj. to 2 Ferngrove House, Rochdale Old Road, Bury, BL9 7LS. UU Reference Number : PDE 4200036152.

We have carried out an assessment of your application which is based on the information provided. This pre-development advice on your drainage strategy will be valid for 12 months. Your drainage strategy will need to be reviewed by other competent authorities as part of the planning process, and we advise that you carry out the necessary site investigations to confirm the viability of your proposals.

If your investigations require access to our public sewer network, we ask that you contact our network engineers with a request for an access certificate via our main contact telephone number 0345 3723223 or refer to the link below:

<https://www.unitedutilities.com/builders-developers/working-near-our-assets/>

Foul Water

Foul flow from this site will be allowed to drain into the public foul water/ combined sewer system.

Our preferred point of discharge would be to the 225mm diameter public combined sewer located within Ferngrove located to the West of your proposed development at an unrestricted rate.

Surface Water

All surface water flow from the proposed development should drain in-line with the drainage hierarchy, as outlined in Paragraph 80, (Reference ID: 7-080-20150323), of the National Planning Practice Guidance. We also recommend you prioritise the use of multi-functional sustainable drainage systems for the management of surface water in accordance with national planning policy.

Generally, the aim should be to discharge surface run off as high up the following hierarchy of drainage options as reasonably practicable.

This is outlined as follows, in order of priority:

- 1. into the ground (infiltration);**
- 2. to a surface waterbody;**
- 3. to a surface water sewer or highway drain;**
- 4. to a combined sewer.**

For guidance, The North West SuDS Pro-Forma provides information on the appropriate evidence required at each stage of the hierarchy, to demonstrate how each level has been discounted.

The Lead Local Flood Authority has responsibility for all surface water drainage concerns and their input to your proposal is critical. You should also consider whether it is necessary to discuss your proposal with the Environment Agency, or Internal Drainage Board (if operating in your area).

The Local Planning Authority are the determining authority for any application for planning permission and the appropriate authority for determining cost viability of a proposed drainage scheme, such assessments are outside of the jurisdiction of United Utilities.

Infiltration

Whilst it appears infiltration may not be viable to manage surface water flows from the proposed development, that said, on site ground investigation should be undertaken before fully discounting infiltration.

Surface water runoff generated from this development should discharge to the ground via infiltration system where feasible.

A detailed evidence based feasibility assessment must be carried out in line with Chapter 25 of the CIRIA SuDS Manual 2015 to determine whether infiltration is a suitable method of surface water disposal.

Particular attention must be paid to Ground Water Source Protection Zones to ensure that the risk of pollution to these valuable resources is not compromised. Details can be obtained from the government website:

<https://www.gov.uk/guidance/groundwater-source-protection-zones-spzs#find-groundwater-spzs>

If your site is in a Groundwater Source Protection Zone, you should have regard to the Environment Agency's approach to Groundwater Protection. Information on this is available via the link below:

<https://www.gov.uk/government/publications/groundwater-protection-position-statements>

Please note that such a location could have implications for the principle of your development and the need for additional mitigating measures to protect the groundwater environment and public water supply in the detailed design of your site.

Waterbody

If an evidence based assessment has been carried out and confirms that 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 within the site boundary.

Public Sewer

In accordance with the hierarchy of drainage options within the National Planning Practice Guidance, both discharge to ground via infiltration and discharge to a waterbody should be discounted prior to consideration of discharging surface water to the public sewer system. Evidence should be provided to demonstrate how these have been discounted, as outlined in the North West SuDS pro-forma.

Once evidence is provided as outlined above, United Utilities will consider a connection to the 275mm diameter public surface water sewer within Ferngrove located to the West of the proposed site at a pass forward flow to be agreed by the Lead Local Flood Authority. United Utilities request that any agreed rate does not exceed 5l/s.

As a Water Company, we have no obligation to accept highway drainage into our public sewer network. However, should your proposals include runoff from highways, we would request that consideration is given to SuDS components that deliver source control are incorporated within the design of the scheme to reduce the volume and frequency of discharges of these flows to the public sewer.

Please note, as the proposed development site is crossed by an open/ culverted watercourse and situated in close proximity to a public surface water sewer, under no circumstances would we permit a surface water connection into the combined public sewerage system from this proposed development

Levels

For low-lying sites, (where the ground level of the site or the level of a basement is below the ground level at the point where the drainage connects to the public sewer), care should be taken to ensure that the property is not at increased risk of flooding. If these circumstances exist, we recommend that you contact us to discuss further. It could affect the detailed design of your site and result in the need to incorporate appropriate mitigating measures in your drainage scheme.

Land drainage / Overland flows / track drainage

United Utilities have no obligation to accept land drainage, overland flows or track drainage into the public sewerage network under any circumstances.

Sewer Adoptions

It is unclear whether you intend to put the sewers forward for adoption (including any SuDS components that can come within the meaning of a sewer) – if adoption is intended, please provide the following information:

Should you wish to put new sewers forward for adoption, please note, United Utilities assess adoption applications based on the current Design & Construction Guidance and local practices which have now replaced 'Sewers For Adoption 6th Edition'.

We recommend that you submit a pre design assessment to the sewer adoption mailbox (SewerAdoptions@uuplc.co.uk) stating pre design assessment in the title.

Please refer to links below to obtain further guidance:

<https://www.unitedutilities.com/builders-developers/larger-developments/wastewater/sewer-adoptions/>

Site drainage must be designed in accordance with Building Regulations, National Planning Policy, and local flood authority guidelines, we would recommend that you speak and make suitable agreements with the relevant statutory bodies.

If you intend to put forward your wastewater assets for adoption by United Utilities, the proposed detail design will be subject to a technical appraisal by an Adoption Engineer as we need to be sure that the proposals meet the requirements set out in the Design & Construction Guidance. The proposed design should give consideration to long term operability and give United Utilities a safe and cost effective proposal for the lifetime of the assets. In these cases, we strongly recommend that no construction commences until the detailed drainage design, submitted as part of the Section 104 application, has been assessed and accepted in writing by United Utilities. Any work carried out prior to the technical assessment being approved is done entirely at the developer's own risk and could be subject to change.

Codes For Adoption

The new Codes for Adoption are outlined on the Water UK Website. The link below takes you to their webpage:

<https://www.water.org.uk/technical-guidance/developers-services/codes-for-adoption/>

A free copy of the new Design & Construction Guidance can be downloaded via the link below:

<https://www.water.org.uk/wp-content/uploads/2020/03/SSG-App-C-Des-Con-Guide-v-2-100320-C.pdf>

Existing Water Assets Crossing the Site

It is the developer responsibility to identify utilities on-site. Where clean water assets are shown on our records, we recommend that you contact our Water Pre-Development Team, via the following email address: DeveloperServicesWater@uuplc.co.uk. Further information for this service can be found on our website via the link below:

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

Connection Application

Although we may discuss and agree discharge points and rates in principle, please be aware that you will have to apply for a formal sewer connection. This is so that we can assess the method of construction, Health & Safety requirements and to ultimately inspect the connection when it is made. Details of the application process and the form itself can be obtained from our website by following the link below:

<https://www.unitedutilities.com/builders-developers/larger-developments/wastewater/sewer-connections/>

We recommend that the detailed design should confirm the locations of all utilities in the area and ensure that any proposed drainage solution considers routing and clash checks where required.

If we can be of any further assistance please don't hesitate to contact us further.

Kind regards,

Tom



Thomas Bethell
Assistant Engineer
Developer Services & Metering
Customer Services
M: 07880 339 195
[unitedutilities.com](https://www.unitedutilities.com)

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From: Anna Mierzejewska [<mailto:a.mierzejewska@thelkgroup.com>]

Sent: 07 January 2021 17:14

To: Wastewater Developer Services <WastewaterDeveloperServices@uuplc.co.uk>

Subject: SuDS Enquiry - Land adj. to 2 Ferngrove House, Rochdale Old Rd, Bury

Dear All,

LK Consult Ltd. has been commissioned to undertake a Sustainable Drainage (SuDS) Strategy for a site located adjacent to , 2 Ferngrove House, Rochdale Old Rd, Bury, BL9 7LS, centred at approximate National Grid Reference 382180E, 411435N. The site is approximately 0.18Ha in total.

The area of interest appears to be within Flood Zone 1. A low to high risk of surface water flooding is recorded within depressions associated with the presence of existing watercourse.

BGS data indicates that there are the site is underlain by Glacial Till superficial deposits and Pennine Lower Coal Measures - Sandstone – across majority of the site and Mudstone, Siltstone, Sandstone in the north. The nearest BGS records shown silty/sandy Clay with some sand and gravel to 3mbgl and relatively shallow ground water levels at around 2.0mbgl. The soakaway potential may be limited.

There is a culverted watercourse running across the site towards northeast. There are indications of public sewers within the adjacent highways.

To complete the SuDS Strategy, we would be grateful if you could supply us with the following, if available, for the vicinity of the site:

- Records of any historic flood events and potential sources of flooding from foul and surface water sewers on site and in the area.
- Any restrictions to discharge into the sewers
- Any recorded depths of the onsite culvert

The nearest borehole records, runoff calculations, and a Pre-development Enquiry Form are also attached to this email.

Please note a topographical survey was not available for the site. No ground investigation has been carried out as yet. Surface water runoff would likely be discharged into the onsite watercourse, however indications on any alternatives would be appreciated.

We will be in contact with all other relevant authorities to get a more complete understanding of the issues in the area.

Regards,
Anna



Anna Mierzejewska MSc
Environmental Scientist – Flood Risk
LK Group | 0161 763 7200 | 07515 051 602
Manchester | London | Liverpool | Glasgow
www.thelkgroup.com

I N C R E A S I N G L A N D V A L U E



EMGateway3.uuplc.co.uk made the following annotations

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APPENDIX 1

Sustainable Drainage Pre-application Standing Advice Bury Council

Sustainable Drainage and the Planning Process

From April 2015 planning applications relating to major development will ensure that Sustainable Urban Drainage systems (SuDs) for the management of run-off are put in place, unless demonstrated to be inappropriate for reasons of ground suitability, safety or viability.

Alongside the legislative changes to implement SuDs through the planning process, the Lead Local Flood Authorities (LLFAs) are now statutory consultees to Planning Authorities in the role of providing technical advice with regard to local flood risk.

The legislation is aimed at major developments to promote good practice for a SuDS approach to be considered on all development sites, whilst it is acknowledged that each site may present constraints and may limit the potential for a solution to achieve maximum benefits for all functions, it is important that it can be demonstrated that consideration has been given to the hierarchy of drainage techniques and run-off destinations in all instances and opportunities to incorporate SuDS measures into drainage schemes maximised.

To support the design and delivery of sustainable drainage the Government have published Non-Statutory Technical Standards¹ which should be used in conjunction with the National Planning Policy Framework (NPPF)², and the associated National Planning Practice Guidance (NPPG).

Major Developments

- A Residential Development consisting of 10 dwellings or more or residential development with a site area of 0.5 hectares or more where the number of dwellings is not yet known.
- A Non Residential Development with provision of a building or buildings where the total floor space to be created is 1000m² or more where the floor area is not yet known, a site area of 1 hectare or more.

Planning applications for major development should be accompanied by a site-specific drainage strategy or statement that demonstrates that the drainage

¹ The Non-Statutory Technical Standards provided by Government relate to the design, construction, operation and maintenance of sustainable drainage systems (SUDS) and have been published as guidance for those designing schemes.

² The NPPF (and associated PPG) related to Government policy on the provision and long term maintenance of sustainable drainage systems.

scheme proposed is in compliance with the both the NPPF / NPPG and the Non-Statutory Technical Standards.

Minor Developments

- A residential development where the number of properties to be constructed is between 1 and 9 inclusive or where the number of properties to be constructed is not given in the application, a site area of less than 0.5 hectares.
- For all other uses, the floor space to be built is less than 1,000 square metres or where the site area is less than 1 hectare.

The density, topography and site history of a proposed development can impact on the types of SuDS features that would be applicable due to previous use and pressures on the area available, often set aside for other uses such as public open space and recreational activities. For this reason it is really important that early consideration and integrated design with respect to SuDS is given which can promote innovative, sustainable and cost effective schemes delivering multiple benefits.

The benefits of sustainable drainage systems (SuDS)

Development can harm water resources if a traditional approach to drainage is adopted. Removing water from site too quickly through piped systems can increase flood risk downstream and reduce infiltration impacting on ground water levels. Surface water run off can also contain contaminants such as oil, toxic metals etc. and can affect water quality in rivers and streams.

SuDS mimic natural drainage processes to reduce the effect on the quality and quantity of run-off from developments. This approach uses a range of techniques including swales, permeable paving and green roofs to mimic the natural drainage of a site. They increase infiltration of water where it lands and reduce the speed of run-off and in addition can provide amenity and biodiversity benefits. When specifying SuDS, early consideration of the potential multiple benefits and opportunities will help deliver the best results.

Hierarchy of drainage techniques

A prioritised order of methods for management of surface water, which is to be considered at all stages of design. Wherever possible the natural drainage of surface water from new developments into the ground will be preferred. Surface water runoff should be managed as close to its source as possible in line with the following drainage hierarchy

The hierarchy of techniques to be used is:

- Prevention of runoff by good site design and reduction of impermeable areas.
- Source control, dealing with water where and when it falls (e.g. infiltration techniques).
- Site control, management of water in the local area (e.g. swales, detention basins).
- Regional control, management of runoff from sites (e.g. balancing ponds, wetlands).

Developers should demonstrate how they have considered and used these techniques.

Runoff Destinations

Surface water runoff not collected for use must be discharged to one or more of the following in the order of priority shown:

- Ground (infiltration),
- Surface water body,
- Surface water sewer, highway drain or other drain,
- Combined sewer.

All SuDS feature design should be completed in accordance with the SuDS Manual (CIRIA C697) with consideration of CIRIA C609B, Sustainable drainage systems: hydraulic, structural and water quality advice.

Pre-application engagement

National Planning Practice Guidance stresses the importance of pre-application engagement with stakeholders to improve efficiency and effectiveness of the planning application system, the planning applications and likelihood of success. Drainage systems considered at the earliest stages of site selection and design are easier to integrate into developments influencing other aspects of the site (i.e. design, layout and function) and reducing impermeable areas wherever possible.

Evidence from case studies suggests that SuDS are cheaper to install and maintain for many new developments. Where SuDS are predominantly green landscaped SuDS measures such as swales and basins much of the maintenance forms part of the site landscaping and is at little or no extra cost.

Effective early engagement can also help deliver SuDS as part of a developments core green infrastructure e.g. in multi-functional spaces such as car parks, landscaped areas, communal spaces etc. and improve cost effectiveness and integration within the development.

Bury Council encourages prospective developers to first contact the local planning authority as in doing so it can help to determine whether your development proposal is acceptable in principle and reduce the likelihood of submitting invalid applications.

The following points should be noted:

- Pre-application advice may be charged for;
- The Environment Agency will continue to provide pre-application advice for developments within Flood Zone 2 or 3; however this is chargeable and needs to be addressed separately.

- The likely drainage method should be identified as early as possible to ensure appropriate drainage can be delivered through sustainable development.
- Bury Council have UDP planning policies which should be taken into account and identified at pre-application stage.

Contact Details

Development Management Section

Department for Business, Growth and Infrastructure | Bury Council

3 Knowsley Place, Duke Street, Bury BL9 0EJ

Tel: +44 (0) 161 253 5432

Email to: development.control@bury.gov.uk

Web site: www.bury.gov.uk/e-planning

Outline Planning Application

An application for outline planning permission allows for a decision on the general principles of how a site can be developed. Outline planning permission will be granted subject to conditions requiring subsequent approval of one or more reserved matters.

The applicant should include the following information as a minimum to enable the LLFA to provide an informed substantive response when advising applicants and when consulted by Local Planning Authorities on planning applications in their role as a statutory consultee.

Outline Planning Application
<i>Compulsory information required to validate the applications.</i>
Drainage statement which includes:
Outline Drainage Assessment to incorporate the following: • Topography of the development site, showing existing surface water flow routes, drains, sewers and watercourses • Geological and soil types. • Initial scoping of flood risk issues to inform where applicable the flood risk assessment which may include any of the following: • Flood risk from main river • Surface water • Groundwater flood risk
Indicative Site Drainage Strategy, including: • Preliminary sustainable drainage proposals • Outfall locations • Discharge rates • On-site storage requirements
Further information that may be required to validate the application.
An appropriate/proportionate site-specific flood risk assessment where one is required. Guidance can be found: • https://www.gov.uk/guidance/flood-risk-assessment-for-planning-applications • https://www.gov.uk/guidance/flood-risk-assessment-standing-advice • http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/site-specific-flood-risk-assessment-checklist/ A flood risk assessment (FRA) will be needed for developments in: • flood zone 2 or 3 including minor developments and change of use • more than 1 hectare in flood zone 1 • less than 1 hectare in flood zone 1, including change of use in development type to a more vulnerable class (e.g. commercial to

- residential), where they could be affected by sources of flooding other than rivers (e.g. surface water, drains, reservoirs)
- in areas within flood zone 1 which has critical drainage problems as notified by the Environment Agency.

The information provided in the flood risk assessment should be credible and fit for purpose. Site-specific flood risk assessments should always be proportionate to the degree of flood risk and make optimum use of information already available, including information in a Strategic Flood Risk Assessment for the area, and the interactive flood risk maps available on the Environment Agency's web site.

Full Planning Application, Reserved Matters, Discharge of Conditions

Full Planning Application, Reserved Matters

(in addition to the information required at Outline stage)

Site and Drainage Layout

Proposed site plan showing exceedance flow routes and identification of catchment area(s)

Drainage layout plan, to include:

- Sustainable drainage system
- Sewers
- Drains
- Watercourses

Site investigation report, including the results for each sustainable drainage system feature of:

- Boreholes or Trial Pits
- Infiltration (Permeability) Testing
- Factual Ground Investigation Report (GIR)
- Geotechnical Design Report (GDR)

Sustainable drainage system flow calculations (*PDF files showing the input and output data for flow calculations*) and storm simulation plan for:

- 1 in 1 year;
- 1 in 2 year;
- 1 in 30 year, and;
- 1 in 100 year + 30% climate change

Discharge of Conditions (in addition to the information required at Full/Reserved Matters)
Drawings and Calculations
Detailed design drawings, including: • Details of inlets, outlets and flow controls • Long and cross section drawings of proposed drainage system(s), including design levels • Details of appropriate water quality treatments
Construction
• Specification of materials • Phasing of development including Construction Management Plan • Construction phase Surface Water Management Plan • Construction details • Operational Maintenance Plan • Location plan and as built drawings to be provided (Flood Risk Asset Register – Flood and Water Management Act 2010).
Operation and maintenance plan for a full planning application.
• Whole life cycle costing for the SuDS including replacement cost. • Details of funding arrangements for SuDS maintenance. • Details of the party / organisation responsible for, and maintenance of, each feature. • Specification for inspection and maintenance, including frequency of maintenance tasks required for each proposed SuDS, setting out a minimum standard to which the SuDS system must be maintained and an estimate of the expected useful life of the suds provision before replacement required. • Details of additional cleansing, repair and maintenance following flooding events where SuDS features are located in a designated flood zone. • Where SuDS features are attached to private property, confirmation of any associated maintenance / adoption / ownership requirements should be provided. For example, if SuDS features are to be included in property deeds, or if householders are required to pay into a communal fund to fund ongoing maintenance. • Details of proposed contingency plans for failure of any part of the drainage system that could present a hazard to people.
Adoption
• Proposed arrangements for adoption / ownership to secure the operation of the scheme throughout its lifetime, including physical access arrangements for maintenance and establishment of legal rights of access in perpetuity.

Safety and Access

Consideration should always be given to safety in design and appropriate consideration of access during the design of SuDS. CDM Regulations 2015 must also be considered and applied to the planning, design and construction and long term maintenance of SuDS systems.

APPENDIX D

CALCULATIONS

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				Sheet no. 1	
				Date 25/02/21	
Project Greenfield runoff				By	Checked
Title IoH 124 Runoff calcs for Ferngrove House, Bury					Reviewed

Hydrological Data:-

FSR Hydrology:-

Location	= Ferngrove House, Bury	Grid reference	= SD8211
M5-60 (mm)	= 19	r	= 0.29
Soil runoff	= 0.45	SAAR (mm/yr)	= 1100
WRAP	= 4	Area	= England & Wales
Hydrological area	= 10	Hydrological zone	= 7

Soil classification for WRAP type 4

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

Design data:-

Area = 0.0014 Km² - 0.14 Ha - 1400 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_{BAR(rural)} = Runoff (cumecs)

Q_{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 0.003

Mean Annual Peak Flow $Q_{\text{BAR(rural)}} = 1.04 \text{ l/s}$



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Job No.		
Sheet no. 2		
Date 25/02/21		
By	Checked	Reviewed

Project	Greenfield runoff
Title	IoH 124 Runoff calcs for Ferngrove House, Bury

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	3.194	0.887	6.337	100yr+20%	9.468	2.630	18.786
2yr	3.494	0.971	6.933	100yr+30%	10.257	2.849	20.352
5yr	4.546	1.263	9.020	100yr+40%	11.046	3.068	21.917
10yr	5.185	1.440	10.288	200yr	9.017	2.505	17.892
30yr	6.312	1.753	12.524	200yr + 30%	11.723	3.256	23.259
50yr	6.951	1.931	13.791	500yr	10.257	2.849	20.352
100yr	7.890	2.192	15.655	1000yr	11.422	3.173	22.663

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.



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Job No.		
Sheet no. 1		
Date 25/02/21		
By	Checked	Reviewed

Project 30year			
Title Peak flow storage calcs for Ferngrove House, Bury			

Data:-

FSR Hydrology:-

Location = Ferngrove House, Bury
M5-60 (mm) = 19
Soil index = 0.45
Return period = 30
UCWI = 113.8

Grid reference = SD8211
r = 0.29
SAAR (mm/yr) = 1100
WRAP = 4
Climate change = 0

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

Runoff factor (RF) = 58.0, calculated from:-

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

where

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

UCWI = Calculated value for Wetness Index

Design data:-

Imperv. area = 730 m²
Total area (TA) = 1030 m²
Allowed discharge rate = 5.000 l/s
Additional flow = 0.00 l/s

Pervious area = 300 m²
Equiv area = 597 m² (TA x RF).
Areal reduction factor = 1.000
Climate change factor = 0

Calculated data:-

Time to max = 16.0 mins
Rainfall at max = 62.51 mm/hr
Pipeline storage = 0.0 m³
Offline storage = 0.0 m³

Calculated storage volume = 5.2 m³
Allowed discharge rate = 5.000 l/s
Available MH storage = 0.0 m³

Fixed 6 hour data:-

Rainfall event = 6 hours
Rainfall rate = 9.00 mm/hr

Calculated storage volume = 0.0 m³
Allowed discharge rate = 5.000 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	656.8	1125	5.2	400 x 600	28.7	500 x 500	20.6
150	291.9	1200	4.6	600 x 900	12.5	500 x 750	13.8
225	129.7	1275	4.0	800 x 1200	7.0	500 x 1000	10.3
300	73.0	1350	3.6			750 x 1000	6.9
375	46.7	1425	3.2			750 x 1200	5.7
450	32.4	1500	2.9			750 x 1500	4.6
525	23.8	1575	2.6			1000 x 1000	5.2
600	18.2	1650	2.4			1000 x 1200	4.3
675	14.4	1725	2.2			1000 x 1500	3.4
750	11.7	1800	2.0			1000 x 1800	2.9
825	9.7	1875	1.9			1000 x 2000	2.6
900	8.1	1950	1.7			1500 x 1500	2.3
975	6.9	2025	1.6			1500 x 1800	1.9
1050	6.0	2100	1.5			1500 x 2000	1.7



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Data:-

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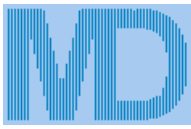
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Job No.		
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Project 30year			
Title Peak flow storage calcs for Ferngrove House, Bury			

Time (mins)	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)
10	78.0	7.786	3.000	4.786
20	56.0	11.069	6.000	5.069
30	44.0	13.246	9.000	4.246
40	37.0	14.919	12.000	2.919
50	33.0	16.293	15.000	1.293
60	29.0	17.466	18.000	0.000
70	27.0	18.494	21.000	0.000
80	24.0	19.411	24.000	0.000
90	23.0	20.240	27.000	0.000
100	21.0	20.997	30.000	0.000
110	20.0	21.694	33.000	0.000
120	19.0	22.339	36.000	0.000
130	18.0	22.941	39.000	0.000
140	17.0	23.504	42.000	0.000
150	16.0	24.034	45.000	0.000
160	15.0	24.533	48.000	0.000
170	15.0	25.005	51.000	0.000
180	14.0	25.453	54.000	0.000
190	14.0	25.879	57.000	0.000
200	13.0	26.284	60.000	0.000
210	13.0	26.671	63.000	0.000
220	12.0	27.040	66.000	0.000
230	12.0	27.415	69.000	0.000
240	12.0	27.776	72.000	0.000
250	11.0	28.126	75.000	0.000
260	11.0	28.465	78.000	0.000
270	11.0	28.795	81.000	0.000
280	10.0	29.116	84.000	0.000
290	10.0	29.428	87.000	0.000
300	10.0	29.732	90.000	0.000
310	10.0	30.029	93.000	0.000
320	10.0	30.319	96.000	0.000
330	9.0	30.602	99.000	0.000
340	9.0	30.878	102.000	0.000
350	9.0	31.149	105.000	0.000
360	9.0	31.413	108.000	0.000
370	9.0	31.673	111.000	0.000
380	8.0	31.927	114.000	0.000
390	8.0	32.176	117.000	0.000
400	8.0	32.420	120.000	0.000
410	8.0	32.660	123.000	0.000
420	8.0	32.895	126.000	0.000
430	8.0	33.127	129.000	0.000
440	8.0	33.354	132.000	0.000
450	7.0	33.577	135.000	0.000
460	7.0	33.797	138.000	0.000
470	7.0	34.013	141.000	0.000
480	7.0	34.226	144.000	0.000
490	7.0	34.435	147.000	0.000
500	7.0	34.642	150.000	0.000
510	7.0	34.845	153.000	0.000
520	7.0	35.045	156.000	0.000
530	7.0	35.242	159.000	0.000
540	7.0	35.437	162.000	0.000
550	7.0	35.629	165.000	0.000
560	6.0	35.818	168.000	0.000
570	6.0	36.005	171.000	0.000
580	6.0	36.189	174.000	0.000
590	6.0	36.371	177.000	0.000
600	6.0	36.550	180.000	0.000

Storage volume (m³) = 5.2 m³



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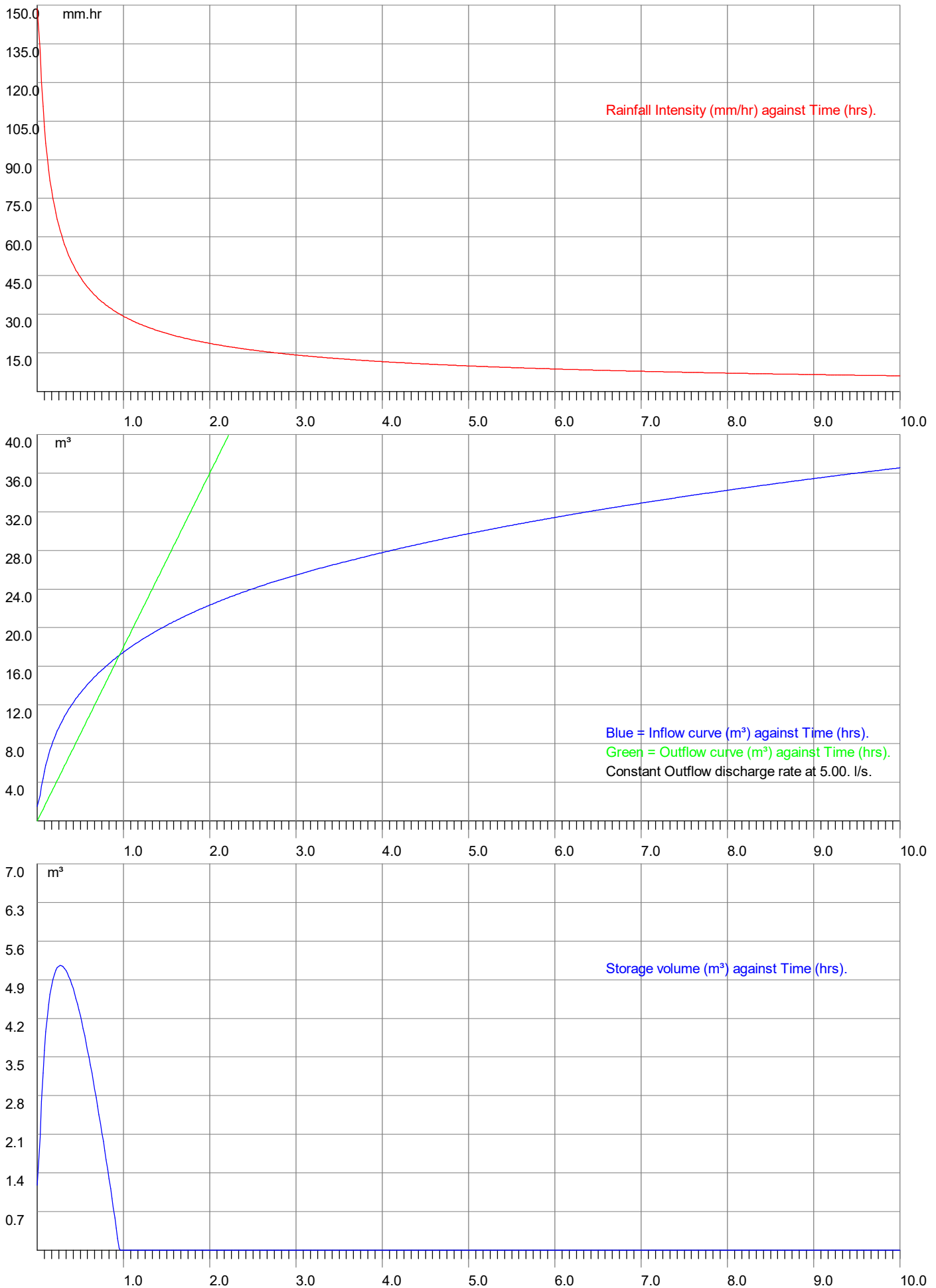
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Project **30year**

Title **Peak flow storage calcs for Ferngrove House, Bury**





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Project **30year**

Title **Peak flow storage calcs for Ferngrove House, Bury**

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 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.

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 25/02/21		
By	Checked	Reviewed

Project	100year plus 30% climate change
Title	Peak flow storage calcs for Ferngrove House, Bury

Data:-

FSR Hydrology:-

Location = Ferngrove House, Bury
M5-60 (mm) = 19
Soil index = 0.45
Return period = 100
UCWI = 113.8

Grid reference = SD8211
r = 0.29
SAAR (mm/yr) = 1100
WRAP = 4
Climate change = 30

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

Runoff factor (RF) = 58.0, calculated from:-

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

where

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

UCWI = Calculated value for Wetness Index

Design data:-

Imperv. area = 730 m²
Total area (TA) = 1030 m²
Allowed discharge rate = 5.000 l/s
Additional flow = 0.00 l/s

Pervious area = 300 m²
Equiv area = 597 m² (TA x RF).
Areal reduction factor = 1.000
Climate change factor = 30

Calculated data:-

Time to max = 34.0 mins
Rainfall at max = 70.06 mm/hr
Pipeline storage = 0.0 m³
Offline storage = 0.0 m³

Calculated storage volume = 13.5 m³
Allowed discharge rate = 5.000 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 = 5.000 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	1721.2	1125	13.6	400 x 600	75.1	500 x 500	54.1
150	765.0	1200	12.0	600 x 900	32.7	500 x 750	36.0
225	340.0	1275	10.6	800 x 1200	18.4	500 x 1000	27.0
300	191.2	1350	9.4			750 x 1000	18.0
375	122.4	1425	8.5			750 x 1200	15.0
450	85.0	1500	7.6			750 x 1500	12.0
525	62.4	1575	6.9			1000 x 1000	13.5
600	47.8	1650	6.3			1000 x 1200	11.3
675	37.8	1725	5.8			1000 x 1500	9.0
750	30.6	1800	5.3			1000 x 1800	7.5
825	25.3	1875	4.9			1000 x 2000	6.8
900	21.2	1950	4.5			1500 x 1500	6.0
975	18.1	2025	4.2			1500 x 1800	5.0
1050	15.6	2100	3.9			1500 x 2000	4.5



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Data:-

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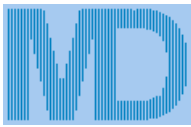
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Job No.		
Sheet no. 2		
Date 25/02/21		
By	Checked	Reviewed

Project	100year plus 30% climate change	
Title	Peak flow storage calcs for Ferngrove House, Bury	

Time (mins)	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)
10	130.0	12.934	3.000	9.934
20	94.0	18.659	6.000	12.659
30	75.0	22.466	9.000	13.466
40	64.0	25.392	12.000	13.392
50	56.0	27.791	15.000	12.791
60	50.0	29.832	18.000	11.832
70	45.0	31.612	21.000	10.612
80	42.0	33.191	24.000	9.191
90	39.0	34.610	27.000	7.610
100	36.0	35.898	30.000	5.898
110	34.0	37.075	33.000	4.075
120	32.0	38.159	36.000	2.159
130	30.0	39.162	39.000	0.162
140	29.0	40.093	42.000	0.000
150	27.0	40.962	45.000	0.000
160	26.0	41.775	48.000	0.000
170	25.0	42.538	51.000	0.000
180	24.0	43.255	54.000	0.000
190	23.0	43.931	57.000	0.000
200	22.0	44.570	60.000	0.000
210	22.0	45.173	63.000	0.000
220	21.0	45.745	66.000	0.000
230	20.0	46.346	69.000	0.000
240	20.0	46.921	72.000	0.000
250	19.0	47.477	75.000	0.000
260	19.0	48.016	78.000	0.000
270	18.0	48.539	81.000	0.000
280	18.0	49.047	84.000	0.000
290	17.0	49.541	87.000	0.000
300	17.0	50.021	90.000	0.000
310	16.0	50.489	93.000	0.000
320	16.0	50.945	96.000	0.000
330	16.0	51.390	99.000	0.000
340	15.0	51.825	102.000	0.000
350	15.0	52.250	105.000	0.000
360	15.0	52.665	108.000	0.000
370	14.0	53.071	111.000	0.000
380	14.0	53.468	114.000	0.000
390	14.0	53.857	117.000	0.000
400	14.0	54.239	120.000	0.000
410	13.0	54.612	123.000	0.000
420	13.0	54.979	126.000	0.000
430	13.0	55.339	129.000	0.000
440	13.0	55.692	132.000	0.000
450	13.0	56.039	135.000	0.000
460	12.0	56.380	138.000	0.000
470	12.0	56.715	141.000	0.000
480	12.0	57.045	144.000	0.000
490	12.0	57.368	147.000	0.000
500	12.0	57.687	150.000	0.000
510	11.0	58.001	153.000	0.000
520	11.0	58.310	156.000	0.000
530	11.0	58.614	159.000	0.000
540	11.0	58.914	162.000	0.000
550	11.0	59.209	165.000	0.000
560	11.0	59.500	168.000	0.000
570	11.0	59.787	171.000	0.000
580	10.0	60.070	174.000	0.000
590	10.0	60.349	177.000	0.000
600	10.0	60.624	180.000	0.000

Storage volume (m³) = 13.5 m³



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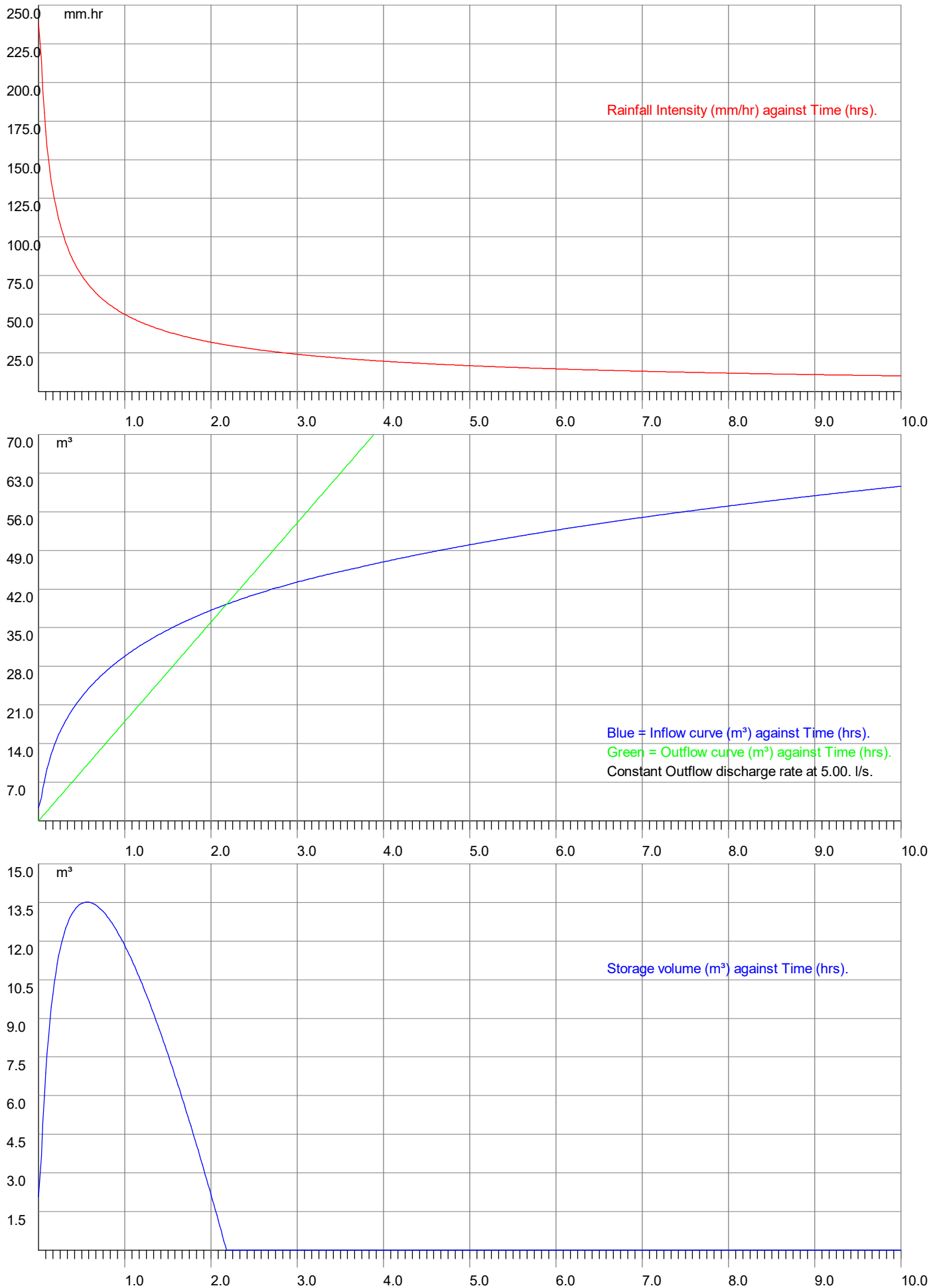
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Title **Peak flow storage calcs for Ferngrove House, Bury**





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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 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.

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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