

LITTLEBOROUGH FIRE STATION LITTLEBOROUGH

FLOOD RISK ASSESSMENT & OUTLINE DRAINAGE STRATEGY

Job Number: FRA21 1122

Date: June 2022

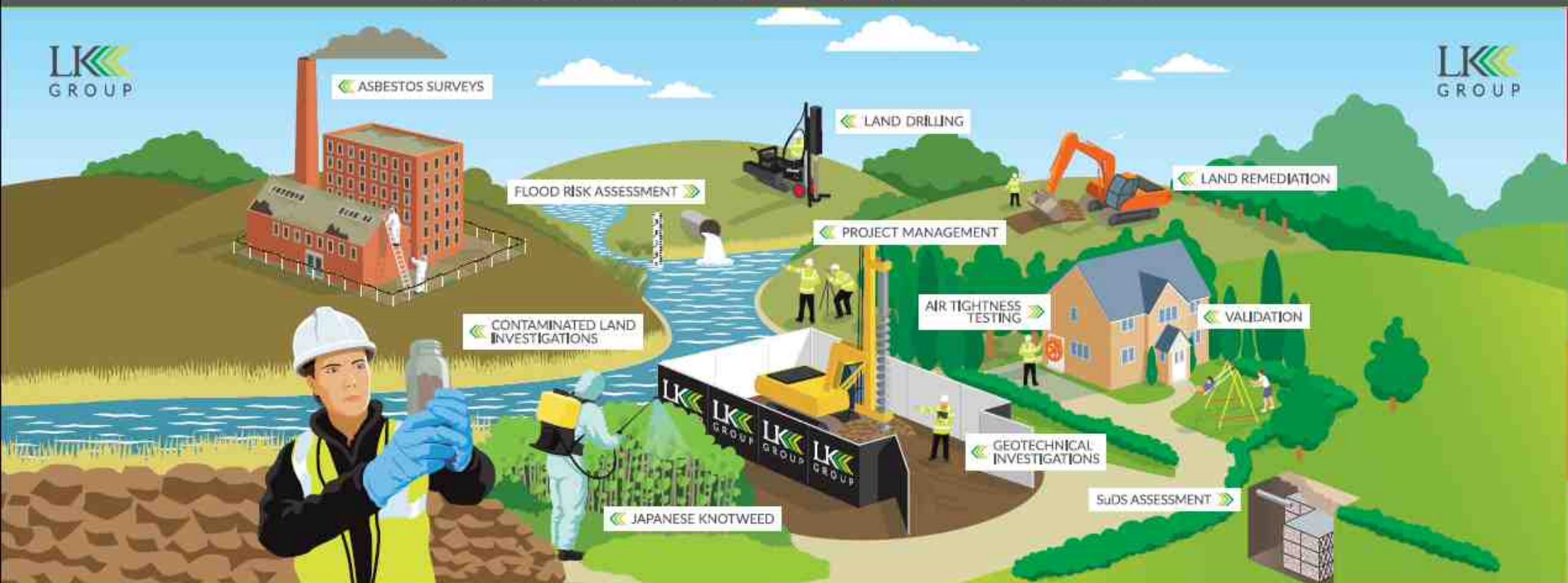
Client: Bradshaw Gass & Hope Ltd



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LK Consult			
Document Verification			
Site Address	Littleborough Fire Station, Whitelees Road, Littleborough, OL15 8DU		
Report Title	Flood Risk Assessment & Outline Drainage Strategy		
Job Number	FRA 21 1122	Document Ref.	FRA 21 1122 – R1
Date Issued	September 2021	Report Version	R1
Prepared By	Lisa Aspinall Senior Engineer	Signature	
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Revision Record			
Revision No.	Date	Nature of Revision	Approved By
R1	June 2022	Layout of the fire station revised	

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EXECUTIVE SUMMARY

Scope and Background

This Flood Risk Assessment and Outline Drainage Strategy (FRA) has been undertaken by LK Consult Ltd (LKC) to support a planning application for the development of an existing fire station at Littleborough Fire Station, Littleborough. The development comprises of a refurbishment and extension of the existing building.

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

In considering the proposals the following key principles have therefore been applied:

- Identification of flood risks.
- Protection of users of the new development.
- No increased flood risk to third parties.

Consultations

The Environment Agency (EA) has been consulted to inform the preparation of this report. They have provided a more detailed flood map, but no modelled data was available.

Rochdale Borough Council and United Utilities were also consulted concerning flood risk.

All relevant consultees have confirmed that there is a Negligible to Low risk of flooding to this site from all sources.

Flood Risk

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

The site is in Flood Zone 1 – Very Low Risk – annual probability of flooding less than 0.1% (1 in 1000).

Groundwater flood risk maps show a Low Risk of encountering groundwater below the surface at the development location.

Mitigation

Design

The development will not result in a reduction in flood plain storage compared to the existing situation.

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 sewer.

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

The outline drainage strategy considers the use of attenuation-based SuDS to be feasible with a discharge to sewer on the eastern boundary of the site. Therefore, the most effective

strategy, in line with the SuDS management train, would be to have a detention tank under the carpark. The required detention tank or similar has been estimated to be **15.5 m³** for the 1 in 30-year greenfield flow restriction.

Similarly, the estimated volume to be retained on site for the 1 in 100-year storm event including the allowance for climate change is between **35.7 m³** and **46.8 m³**.

The site is considered to be at Low risk of flooding. It is recommended that the minimum finished floor levels for the development should be set at a nominal height above the proposed ground levels. This is to allow for overland flow during exceedance flows from an extreme event or a drainage failure.

Access

Access close to the site is elevated above potential flood levels and will always provide safe access to and from the site from Whitelees Road.

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1 Introduction

1.1 Background

LK Consult Ltd (LKC) were commissioned by Bradshaw Gass & Hope Ltd to carry out a Flood Risk Assessment (FRA) and Outline Drainage Strategy for Littleborough Fire Station. The report was undertaken in support of a future planning application to redevelop the site for the refurbishment and extension of an existing Fire Station.

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 the Environment Agency in February 2016 has also been considered.

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.

This report was prepared in line with the Rochdale Core Strategy:

"G8 – Managing Water Resources and Flood Risk

We will ensure that new development (including flood risk mitigation measures) does not lead to any form of increased flooding locally or further downstream, does not impede natural water and flood risk management, is not detrimental to existing or potential flood storage areas, contributes where possible to alleviate existing flood risk, is itself well protected from flood risk and ensures prudent use of water resources. We will require:

- a) Compliance with a 'sequential' approach to new development and flood risk, directing development away from areas of high risk, in accordance with the National Planning Policy Framework.
- b) Full regard to and compliance with the advice of the Environment Agency (or equivalent agency) and the objectives and priorities for flood risk management set out in the Local Flood Risk Management Strategy, including any mitigation measures recommended for particular sites.
- c) Full regard to the published evidence of local flood risk and its significance as included in Strategic Flood Risk Assessments, Surface Water Management Plans and other recognised sources of flood risk data and the production of additional Flood Risk Assessments (FRAs) as appropriate.

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

² DCLG (2016). "Planning Practice Guidance" <http://planningguidance.communities.gov.uk>, November 2016.

- d) Incorporation of appropriate measures for the management of surface and flood water, including flood storage areas, Sustainable Urban Drainage Systems (SUDS) and the protection of overland flow paths.
- e) Compliance with any Surface Water Management Plan or drainage strategies produced, such as for the identified critical drainage areas of Littleborough and Heywood.
- f) The avoidance of culverting and supporting the opening up of existing culverts wherever possible.
- g) The incorporation of measures for the conservation of water to minimise potable water consumption, including rainwater collection measures, which should be integral to the design of buildings and spaces.
- h) Development that does not directly or indirectly lead to pollution of existing water resources such as watercourses and groundwater or the derogation of the quantity of groundwater.
- i) The incorporation of measures to improve water quality; and
- j) The taking of opportunities to improve the habitat value of watercourses and water bodies.

In addition, we will identify additional flood storage areas which will be protected from development.”

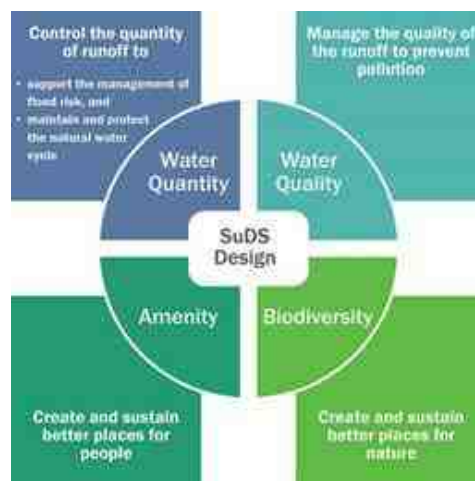


Plate 1: Four 'pillars' of SuDS design as defined by CIRIA in The SuDS Manual.

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	Littleborough Fire Station, Whitelees Road, Littleborough, OL15 8DU. Centred at approximate National Grid Reference 393360E 416665N.
Area	Approximately 3,400m ² .
Topography	152.4 metres Above Ordnance Datum (AOD). Landscaped areas are approximately 0.5m lower.
Current Land Use	<u>Site</u> Fire Station with hardstanding and access road. Grassed areas to the north and east of site <u>Surrounding Area/ Boundary Treatment</u> North: Residential Properties. East: Residential Properties. South: Residential Properties. West: Whitelees Road and Residential Properties.
Proposed Development	Extension and refurbishment of the existing Fire Station. Access will be from Whitelees Road.

Table 1-1: Summary of site details.

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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 – little or no 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.

The proposed development is for a Fire Station, and this is classified within the 'Highly Vulnerable' category in the PPG (paragraph 066, Table 2).

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 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 (Diamicton) in the central and northern part of the site. Head deposits in the south.
	Bedrock		Woodhead Hill Rock (Sandstone). Lower Coal Measures mapped to the south.
	BGS Boreholes		SD91NW9 200m South: Clay and made ground to 4.5mBGL, Brown Sand to 9.0m, Red Sandstone to 27mBGL. SD91NW9 390m Southwest: Mottled Clay to 1.07mBGL, Brown Clay to 6.10mBGL
	Defra Soilscape Mapping		Soilscape 17 – Slowly permeable seasonally wet acid loamy and clayey soils. Impeded Drainage.
Hydrogeology	Aquifer Designation	Superficial	Secondary Aquifer – undifferentiated, associated with Till. Secondary B Aquifer associated with Head deposits.
		Bedrock	Secondary A Aquifer. Site is not within a SPZ.
Hydrology	All adjacent and internal surface water		Nearest watercourse is an ordinary watercourse (Calder Brook) 200m to the northeast. The River Roch (530m southeast) and The Rochdale Canal (650m southeast)
	Flooding		Flood Zone 1
Site History			Previous use likely to have been allotments. Historical maps show a building in the west of the site from around 1960, with an access road from the north-east to a yard/carpark area surrounded by a cutting. A tank was noted on the south-eastern part of the site with another small structure present adjacent to the tank. The tank was no longer present by the mapping from 1989.

Table 2-1: Summary of the Environmental Setting.

2.4 Geo-Environmental Investigation.

The investigation was undertaken on site by LK Consult Ltd in September 2021³.

The investigation involved the drilling of five window sample boreholes (referenced WS101 to WS105) to depths of between 4.38 metres below ground level (mbgl) and 5.45mbgl and Soakaway testing of two pits to a depths of 1.60mbgl and 1.80mbgl.

All sampling locations are shown in Appendix B.

The ground conditions beneath the site comprised primarily of clay. Profile Logs are shown in Appendix B.

³ Report Name: LK Consult Ltd, LKC21 1310, September 2021.

The soakaway results show both pits failed and as a result, infiltration will not be possible.

2.5 Site Reconnaissance

A site reconnaissance was carried out on 23rd June 2021. Relevant features identified on site are summarised below:

- » Single storey, brick built fire station located on the south and west of the site. The northern building is utilised for garaging and vehicle storage for the fire engines.
- » Approximately half of the site is covered in surfacing and the existing buildings. With the remaining area being soft landscaping to the north and east (consisting of community small garden plots and lawn).
- » The paved areas are approximately 0.5m above the landscaped areas to the rear.
- » Training tower located to the south of site and a boiler room located to the southwest side of the fire station building.
- » No underground storage tanks or usage of firefighting foam from anecdotal information.
- » Manhole covers, gullies and drains were noted on site.
- » The main access is off Whitelees Road with a gate to the northeast from Hare Hill Road.
- » The surrounding area comprises residential buildings and roads. Domestic garages present on the north-eastern boundary. A footpath is present along the northern site boundary.

2.6 Site and Access Levels

With reference to available topographic data, the site has approximately a 2m fall from west to east. The access from Whitelees Road is approximately 152.4m AOD.

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3 Consultation

Information from consultees (Environment Agency (EA), Rochdale Borough Council and United Utilities) is summarised in Table 3-1 below.

Relevant correspondence / information is provided in Appendices C (EA) and D (others).

Source	Details	
Environment Agency	Flood Zone 1: Very Low risk, with annual probability of flooding from rivers and the sea of less than 0.1% (1 in 1000).	
	Modelled Levels for the River Roch	No significant information available for the site.
	Records of Flooding	No records of flooding at the site.
	Records of Flood Warning Service	Not within a flood warning service area.
	Surface Water Flooding	Medium risk of surface water flooding less than 300mm in depth within the landscaped area.
	Flooding from reservoirs	No risk from reservoirs.
	Groundwater Source Protection Zone	Not within Source Protection Zone.
Rochdale Borough Council	Possible or known incidents of highway flooding	Unaware of any current flooding problems associated with Littleborough Fire Station
United Utilities	Likely conditions for connecting into their sewerage system	Infiltration Surface water runoff generated from this development should discharge to the ground via infiltration system where feasible. Based on the underlying geology you have provided indicates that an infiltration-based surface water drainage solution may not be feasible for the site. Waterbody There are no charted watercourses within a reasonable distance from the site and therefore this option can be discounted. Public Sewer United Utilities will consider a connection to the 300mm diameter public surface water sewer located approximately 90m east of the site within Hare Hill Road at a pass forward flow to be agreed by the Lead Local Flood Authority. Whilst we understand the proposed discharge rate you have suggested is a variable rate, United Utilities requires a fixed discharge rate restricted to the equivalent Qbar (1 in 2 year) event. This rate should also be calculated from the positively drained impermeable area, which has been assumed to be the existing roof area as no evidence of yard drainage has been provided for assessment. As a result, the estimated drained area is 0.03Ha which will generate less than 5l/s and therefore 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.

Table 3-1: Summary consultee information.

Source	Details	
United Utilities	Sewer map	There are combined sewers running parallel to the site along the western, northern, and eastern boundaries. A 375mm diameter combined sewer runs north along Whitelees Road, before heading east along the northern boundary of the site. In the north eastern corner this connects with a 675mm diameter combined sewer. This sewer runs to the south along the eastern boundary of the site before heading to the southeast. There is a culverted land drain located to the southeast of the site, however this is privately owned, and no connections are permitted to this.
Strategic Flood Risk Assessment (SFRA)	Level 1 SFRA ⁴	The site has no history of flooding from any source. Littleborough itself however has been identified as a Critical Drainage Area due to historic flooding to the area from the River Roch from surface water flooding being exacerbated by the steep catchment.
	Level 2 SFRA ⁵	The site has no history of flooding from any source. Littleborough has also been defined as a CDA as it is surrounded by steep hillsides that will encourage water to runoff quickly into the settlement.
Preliminary Flood Risk Assessment (PFRA) ⁶	The Preliminary Flood Risk Assessment (PFRA) ³ for the area indicates that there are no records of flooding for the area which conforms with information supplied by the EA.	

Table 3-1 continued: Summary consultee information.

⁴ Strategic Flood Risk Assessment Level 1: Bury, Rochdale & Oldham Council, 2009, JBA Consulting.

⁵ Strategic Flood Risk Assessment Level 2: Bury, Rochdale & Oldham Council, 2009, JBA Consulting.

⁶ Preliminary Flood Risk Assessment: Rochdale Metropolitan Brough Council, 2011, JBA Consulting.

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).

The EA did not have any modelled levels for the stretch of the River Roch closest to the site. Therefore, the comparison data was extracted by comparison with the flood map extents and the available topographical data provided for this site to provide the 100-year and 1000-year plus climate change levels.

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 small areas that have the potential to flood during prolonged heavy rainfall. These areas are associated with natural depressions that are likely to be removed/positively drained following the development process. These areas need consideration within the detailed design or there is the potential to have areas of standing water in gardens and landscaped areas not positively drained if overland flow routes are not considered. Therefore, the risk of flooding from surface water flooding is Very Low but should be considered further during the detailed design.

Surface Water (Overland flow) – This relates to surface water entering the site. The only observed impermeable area at a level generally above that of the study area is Whitelees Road to the east. Any surface water arising from here is likely to be intercepted by the highway drains and therefore pose no threat to the development. Therefore, the risk of flooding from surface water flooding is Very Low.

Groundwater – The BGS has no groundwater records for the study area. The site is shown to be vulnerable to groundwater flooding below the surface with the lower area to the northeast to have a potential for flooding at the surface on the BGS Flood GFS Data map. Site investigation upon the site showed a significant depth of clay below the surface which would resist the emergence of ground water. Therefore, the flood risk associated with this source is considered Low.

Sewers – United Utilities sewer records show combined sewers within the vicinity of the study area within the surrounding housing developments. The Drainage and Water Enquiry states that no property in the vicinity is at risk of internal flooding due to overloaded public sewers. There are no records of sewer flooding at the site location. Therefore, the flood risk associated with this source 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 this source is considered Negligible.

4.3 Summary of Flood Risk

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

Table 4-1: Summary of Existing Risk Level.

The site is located within Flood Zone 1 and a Low risk of flooding from groundwater 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 Surface Water Management

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 any new development is a material planning consideration in determining if the proposals for the development and use of land are acceptable.

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 H3⁷ 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 2010⁸.

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.

5.1 Infiltration

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

Classification	Description	Aquifer Classification	Recorded Water Table Depth	Soakaway Potential
Till / Head Deposits	Diamicton	Secondary Undifferentiated Aquifer / Secondary B Aquifer	4.5m	Poor
Woodhead Rock	Sandstone	Secondary A Aquifer	N/A	Limited

Table 5-1: Geological and Hydrogeological Setting.

⁷ Building Regulations part H3 2010: Approved Document, Drainage and Waste Disposal.

⁸ Flood and Water Management Act 2010: UK Government.

Infiltration methods such as soakaways are unlikely to be feasible, but this may be investigated further at the detailed design stage if required.

5.2 Surface Water Drainage Strategy

There is a slope over the site and surrounding area which indicates that groundwater in the vicinity of the site would drain towards the south.

There are no observable watercourses within or near the boundary of the site.

There is a combined sewer running through the site along the eastern boundary.

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	Comments
a	Soakaway/Infiltration	N/A	Unlikely to be feasible due to ground conditions and potential for groundwater flooding.
b	Connection to Watercourse	2	Would require third party access/a road crossing and EA/LLFA consent and would be expensive due to distance between site and watercourse.
c	Discharge into a sewer	1	The depth of the sewer within the site and levels at the south east corner indicate that a connection is possible – subject to approval from LLFA/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)⁹ 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 not be feasible.
Infiltration basin	X	Depressions that store and dispose of water via infiltration. May not be appropriate given the ground conditions.
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	X	Linear trenches filled with a permeable granular material, often with a perforated pipe in the base of the trench.
Detention basin	*	Dry depressions designed to hold water for a specific retention time.
Swales	✓	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. In the process, a volume of water is kept out of the storm-water management system, thereby helping to reduce flooding risks. Rainwater harvesting systems are currently not included in the development proposals.
Green/blue 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 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.
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 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

X Not suitable

⁹ CIRIA C753 - The SUDS Manual. London 2015.

5.3 Surface Water Attenuation Requirements

The site is considered to be a brownfield site having a positive drainage and connecting into the adjacent public combined sewer.

It is estimated from the supplied plan (see Appendix A) that the site will have the following designated areas (Table 5-4). Table 5-4 shows the assumed split in area included within the calculations.

Designated Areas	Plot Area
Total area (ha)	0.340
Existing Impermeable Area (ha)	0.150
Green Infrastructure (ha)	0.190
Catchment Area	
Catchment Area (ha)	0.234
Developable Area (ha)	0.175
Green Infrastructure (ha)	0.059

Table 5-4: Assumed plot areas.

5.3.1 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 0.175ha and a green space of 0.059ha from the 0.234ha catchment. The majority of the existing greenspace does not contribute towards the catchment as it is lower than the fire station apron and falls away from the buildings. This gives the following existing runoff rates based on the Wallingford method:

➤ Q_{bar} :	17.5 l/s
➤ 1 in 1-year existing runoff rate:	12.6 l/s
➤ 1 in 30-year existing runoff rate:	30.2 l/s
➤ 1 in 100-year existing runoff rate:	38.1 l/s

For the 50% reduction in flows this gives the following allowable runoff.

➤ Q_{bar} :	8.7 l/s
➤ 1 in 1-year existing runoff rate:	6.3 l/s
➤ 1 in 30-year existing runoff rate:	15.1 l/s
➤ 1 in 100-year existing runoff rate:	19.0 l/s

All runoff estimates, and subsequent storage estimates are included in Appendix E.

United Utilities have requested that the flow from the existing impermeable area be restricted to Q_{bar} but had assumed that only the roof area was impermeable. This would limit the flow to less than 5l/s. the photographs included within the site information show a number of gullies and channels servicing the yards, parking and access. The following attenuation has been estimated for the development using a 50% reduced Q_{bar} runoff rates of 8.7l/s and utilises the FSR methodology¹⁰ as:

¹⁰ Flood Studies Report Wallingford NERC 1975.

- Attenuation storage volume: **15.5 m³** (1 in 30-year event)
- Retention on site volume: **35.7 m³** (1 in 100 year + 20% Climate Change)
- Retention on site volume: **46.8 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 runoff for a range of annual flow rate probabilities before discharge to public sewer. As the flow from the development would be reduced there should be little change in the flows that enter the public sewer 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, requires a storage volume of **15.5 m³** and for the 1 in 100-year event, a storage capacity of between **35.7 m³** and **46.8 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 adjacent sewer.

5.4 Site Specific SuDS

The use of attenuation tank or similar deem to be the most feasible and practical option for the development. The attenuation tank will provide 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. It has been assumed that the reduced discharge can be connected to the existing drainage system. Surface water drainage should be kept separate from foul drainage.

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.

5.5 Foul Drainage

The foul flows will be allowed to discharge at an unrestricted rate into the public combined sewer via the existing connection.

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6 Mitigation Measures

6.1 Proposed Site levels and Developments Level

Current Environment Agency 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 plus an allowance for freeboard.

This and the 0.1% annual probability (1 in 1000-year) are significantly below the existing levels on site. On this basis the entrances to the building should be set at a nominal height above the finalised external 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 Whitelees Road to the west significantly above the 1% annual probability event. Therefore, no further mitigation is proposed.

6.3 Flood Resistance and Resilience

The development proposed may be subject to groundwater entering excavations for foundations and services due to the potentially shallow water table. Dewatering may be required for excavations and means of limiting flows in service trench bedding be incorporated. However, as the adjacent ground is lower 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, ground floor levels should be set above proposed levels across the site where practical 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.

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7 Conclusions

The site is shown on published mapping to be located within the Environment Agency's Flood Zone 1. Comparison of topographical data with the EA modelled flood level data indicates that the whole site is in Flood Zone 1 – Very Low Risk of fluvial flooding.

A Low risk from groundwater flooding has been identified from the BGS mapping indicating that groundwater may be countered within deep excavations at the development location has been identified from information provided by the British Geological Survey.

An assessment of these risks 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 Whitelees Road.
- » Potential for soakaway use for rainwater disposal is low; however, this could be investigated further at the detailed design phase if required.
- » Surface water arising from the site could potentially discharge into a combined sewer via the existing connection.
- » A formal evacuation plan is not considered to be required.

Further details on the proposed mitigation measures are provided in Section 6. All proposed measures should be agreed with the Local Authority prior to commencement of the development.

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Appendix A

Figures, Plans and Drawings



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1:1250

ref	revision	by	date

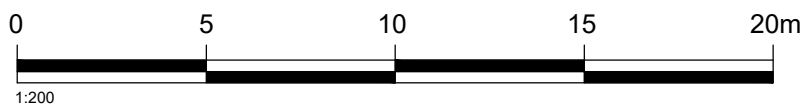
client	GREATER MANCHESTER FIRE		
project	LITTLEBOROUGH FS EXTENSION AND REFURBISHMENT		
drawing	SITE LOCATION PLAN		
drawn by	DJH	date	23.04.2021
scale	1:1250		A4
dwg no	1978.34.201	rev	status
			PRELIMINARY



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Bradshaw Gass & Hope LLP



status		
PRELIMINARY		
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Hazard Identification		
ref	hazard	date

P1	OPTION 4 PLAN DATED 26.5.2022	PAB	30.5.22
ref	revision	by	date



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Quantity Surveyors

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www.bghbolton.co.uk

Bradshaw Gass & Hope LLP

client	GREATER MANCHESTER FIRE AND RESUE SERVICE.		
project	LITTLEBOROUGH FIRE STATION EXTENSION AND REFURBISHMENT.		
drawing	PROPOSED SITE PLAN		
drawn by	PAB	date	MAY 22
checked by		date	
scale	1:200	A1	
dwg no	1978.37.201	rev	P1

Appendix B

Site Information

**LK CONSULT LTD**Eton Business Park, Eton Hill Road, Radcliffe, M26 2ZS
Tel: 0161 763 7200 web: www.thelkgroup.com**Site**

Littleborough Fire Station, Littleborough

Number
WS101**Excavation Method**Drive-in Windowless Sample
driven to 5.41mbgl.**Dimensions****Location**

393362 E 416686 N

Ground Level (mOD)**Dates**

02/09/2021

Client

Greater Manchester Combined Authority

Project Contractor

Taylor Drilling Services

Job
Number

LKC 21 1310

Sheet

1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.00-0.40	ES1 PID=0.3ppm				(0.45)	MADE GROUND: Dark grey slightly gravelly sandy SILT with occasional rootlets and rare clinker. Sand is fine to medium. Gravel is fine to medium and subangular comprising mudstone.			
0.50-1.00	ESB2 PID=0.2ppm				0.45				
1.00	PP 114kPa				(0.75)	Firm becoming stiff consistency high strength orangish brown and grey slightly gravelly sandy silty CLAY with rare rootlets. Sand is fine to medium. Gravel is fine to medium and subangular to angular comprising sandstone and mudstone. Increasing gravel content with depth.			
1.20-1.65	SPT N=16		8,15/4,4,4,4		1.20	Firm consistency medium to high strength dark grey gravelly sandy CLAY with occasional coal fragments. Sand is fine to medium. Gravel is fine to medium and subangular to angular comprising sandstone and mudstone.			
1.20-1.65	D3								
1.70-2.00	B4								
2.00	PP 44.96kPa				(1.70)	Very sandy below 2.00mbgl.			
2.00-2.45	SPT N=10		2,2/2,3,2,3						
2.00-2.45	D5								
2.50-2.70	B6					Bands of gravel between 2.50-2.70mbgl.			
3.00	PP 117.36kPa				2.90	Stiff to very stiff consistency high to very high strength brown slightly gravelly CLAY. Gravel is fine to coarse and subangular to subrounded comprising sandstone and mudstone.			
3.00-3.45	SPT N=15		4,4/4,3,4,4						
3.00-3.45	D7								
4.00	PP 116.49kPa				(2.51)	Very stiff consistency below 4.00mbgl. Wet strata below 4.00mbgl.			
4.00-4.45	SPT N=18		5,4/3,5,4,6						
4.00-4.45	D8								
5.00	PP 167.58kPa				5.41	Complete at 5.41m			
5.00-5.41	SPT 50/260		10,11/15,15,13,7						
5.00-5.41	D9								

RemarksSPT refusal at 5.41mbgl on very hard consistency CLAY.
Wet strata below 4.00mbgl.
Borehole stable.**Scale**
(approx)

1:40

Logged
By

HM

Figure No.

LKC 21 1310.WS101

**LK CONSULT LTD**Eton Business Park, Eton Hill Road, Radcliffe, M26 2ZS
Tel: 0161 763 7200 web: www.thelkgroup.com**Site**

Littleborough Fire Station, Littleborough

Number
WS102**Excavation Method**

Drive-in Windowless Sampler

Dimensions**Location**

393381 E 416694 N

Ground Level (mOD)**Dates**

02/09/2021

Client

Greater Manchester Combined Authority

Job
Number
LKC 21 1310**Project Contractor**

Taylor Drilling Services

Sheet

1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.00-0.50	ES1 PID=0.4ppm				(0.50)	MADE GROUND: Dark grey slightly gravelly sandy SILT with occasional rootlets and rare clinker. Sand is fine to medium. Gravel is fine to medium and subangular comprising mudstone.		
0.50-1.00	ESB2 PID=0.2ppm				0.50			
1.00	PP 61.31kPa							
1.20-1.65	SPT N=7		2,2/2,1,2,2		(1.30)	Firm to stiff consistency medium strength orangish brown and grey mottled slightly gravelly sandy silty CLAY with occasional sand bands and coal fragments. Sand is fine to medium. Gravel is fine to medium and subangular comprising sandstone and mudstone. Becoming darker brown with less grey mottling with depth.		
1.20-1.65	D3					Becoming stiff consistency and darker brown with more orange mottling below 1.20mbgl.		
1.80-2.00	ESB3 PID=0.1ppm				1.80			
2.00	PP 91.97kPa							
2.00-2.45	SPT N=12		2,1/2,3,3,4			Soft to firm consistency dark grey gravelly sandy CLAY. Sand is fine to medium. Gravel is fine to medium and subangular to subrounded comprising sandstone and mudstone. Becoming very gravelly with depth.		
2.00-2.45	D4					Very gravelly CLAY with occasional gravel bands below 2.00mbgl.		
3.00-3.45	D5				(2.20)			
3.00-3.45	SPT N=10		Water strike(1) at 3.00m. 2,2/2,2,3,3			Limited recovery between 3.00-4.00mbgl. Wet strata below 3.00mbgl.		V1
4.00-4.45	SPT N=17				4.00			
4.00-4.45	D6		2,3/4,4,4,5		(1.00)	Stiff consistency high strength brown slightly gravelly CLAY. Gravel is fine to medium and subrounded comprising mudstone.		
5.00	PP 98.1kPa				5.00	SPT at 5.00mbgl not possible due to collapse of borehole at 4.00mbgl.		
						Complete at 5.00m		

RemarksBorehole collapse from 4.00mbgl.(gravel band).
Wet strata below 3.00mbgl.
Pocket Penetrometer not possible at 3.00-4.00mbgl due to granular nature of strata and limited recovery.**Scale**
(approx)

1:40

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By

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Figure No.

LKC 21 1310.WS102

**LK CONSULT LTD**Eton Business Park, Eton Hill Road, Radcliffe, M26 2ZS
Tel: 0161 763 7200 web: www.thelkgroup.com**Site**

Littleborough Fire Station, Littleborough

Number
WS103**Excavation Method**Drive-in Windowless Sample
driven to 5.45mbgl.**Dimensions****Location**

393396 E 416646 N

Ground Level (mOD)**Dates**

02/09/2021

Client

Greater Manchester Combined Authority

Project Contractor

Taylor Drilling Services

Job
Number
LKC 21 1310**Sheet**
1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.10-1.00	ES1				(1.00)	Dark greyish brown slightly gravelly sandy silty CLAY with occasional rootlets. Sand is fine to medium. Gravel is fine to medium and angular to subrounded comprising sandstone, slate and mudstone.			
1.00	PP 40.85kPa				1.00 (0.20)				
1.20-1.60	ESB2				1.20	Firm consistency medium strength brown and yellow mottled gravelly sandy CLAY with low cobble content and occasional coal fragments. Sand is fine to medium. Gravel is fine to coarse and angular to subrounded comprising sandstone, slate and mudstone.			
1.70-2.00	B3				(0.80)				
2.00	PP 32.7kPa		1,1/1,1,1,1		2.00	Soft consistency low strength dark grey slightly gravelly sandy silty organic CLAY with wood debris. Sand is fine to medium. Gravel is fine to medium and subangular comprising sandstone.			
2.00-2.45	SPT N=4								
2.00-2.50	B4				(1.00)	Brown slightly clayey gravelly SAND with occasional coal fragments. Sand is fine to coarse. Gravel is fine to medium and rounded to subangular comprising sandstone.			
3.00-3.45	SPT N=37		Water strike(1) at 3.00m. 6,7/17,7,7,6		3.00	NO RECOVERY due to probable sandstone cobble impeding recovery.		▽1	
					(1.00)				
4.00-4.45	SPT N=5		1,1/1,1,1,2		4.00	Stiff consistency high strength brownish grey slightly gravelly slightly sandy CLAY. Sand is fine to medium. Gravel is fine to medium and subrounded to subangular comprising sandstone and mudstone.			
					(1.45)				
5.00	PP 134.88kPa		2,2/3,4,4,4		5.45	Complete at 5.45m			
5.00-5.45	SPT N=15								
5.00-5.45	D5								

RemarksGroundwater strike at 3.00mbgl.
Borehole stable.
Location accurate to 3.00-5.00m.**Scale**
(approx)

1:40

Logged
By

HM

Figure No.

LKC 21 1310.WS103

**LK CONSULT LTD**Eton Business Park, Eton Hill Road, Radcliffe, M26 2ZS
Tel: 0161 763 7200 web: www.thelkgroup.com**Site**

Littleborough Fire Station, Littleborough

Number
WS104**Excavation Method**Drive-in Windowless Sample
driven to 4.38mbgl.**Dimensions****Location**

393384 E 416655 N

Ground Level (mOD)**Dates**

02/09/2021

Client

Greater Manchester Combined Authority

Job
Number
LKC 21 1310**Project Contractor**

Taylor Drilling Services

Sheet
1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.15-0.50	ES1 PID=6.2ppm				0.12	MADE GROUND: Tarmacadam.			
0.50-1.00	ES2 PID=6.0ppm				(0.98)	MADE GROUND: Dark brown sandy silty GRAVEL with frequent brick fragments, ash, clinker, rare clay inclusions. Sand is fine to coarse. Gravel is fine to coarse and subangular to subrounded comprising sandstone and mudstone. Slight possible surfactant type odour.			
1.00	PP 30.65kPa				1.10	Soft consistency low strength greyish brown and yellow mottled slightly gravelly sandy CLAY. Sand is fine to medium. Gravel is fine to medium and subrounded comprising sandstone.			
1.20-1.65	SPT N=3		1,0/1,0,1,1		(0.90)				
1.20-1.60	ES3 PID=2.5ppm				2.00	Firm to stiff consistency high strength brownish grey and orange mottled gravelly CLAY with occasional coal fragments. Gravel is fine to coarse and rounded to subangular comprising sandstone and mudstone. Increasing gravel content with depth.			
1.70-2.00	B4								
2.00	PP 88.9kPa		2,2/4,4,4,4						
2.00-2.45	SPT N=16								
2.00-2.45	D5								
2.50-3.00	B6								
3.00	PP 126.12kPa		4,4/5,4,4,4		(2.00)				
3.00-3.45	SPT N=17								
4.00	PP 98.1kPa		5,4/13,13,20,4		4.00	Sandstone cobble at 3.80-3.85mbgl.			
4.00-4.38	SPT 50/230				(0.38)	Very dense dark grey very clayey GRAVEL with occasional clay inclusions. Gravel is fine to coarse and angular to subangular comprising mudstone (probable extremely weathered MUDSTONE bedrock).			
4.00-4.30	B7				4.38	SPT refusal at 4.38mbgl on very dense GRAVEL (probable extremely weathered MUDSTONE bedrock).			
						Complete at 4.38m			

RemarksSPT refusal at 4.38mbgl on very dense GRAVEL (probable extremely weathered MUDSTONE bedrock).
Borehole dry and stable.
Location accurate to 3.00-5.00m.**Scale**
(approx)

1:40

Logged
By

HM

Figure No.

LKC 21 1310.WS104

**LK CONSULT LTD**Eton Business Park, Eton Hill Road, Radcliffe, M26 2ZS
Tel: 0161 763 7200 web: www.thelkgroup.com**Site**

Littleborough Fire Station, Littleborough

Number
WS105**Excavation Method**Drive-in Windowless Sample
driven to 4.45mbgl.**Dimensions****Location**

393376 E 416659 N

Ground Level (mOD)**Dates**

02/09/2021

Client

Greater Manchester Combined Authority

Job
Number
LKC 21 1310**Project Contractor**

Taylor Drilling Services

Sheet

1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.30-0.70	ES1 PID=0.6ppm				(0.15) (0.45) (0.29)	MADE GROUND: Tarmacadam.		
0.70-1.20	ES2 PID=0.5ppm				(0.45) 0.70 (0.55)	MADE GROUND: Grey sandy GRAVEL. Sand is fine to coarse. Gravel is fine to medium and subangular comprising limestone (MOT).		
1.20-1.65	SPT N=5		1,1/2,1,1,1		1.25	MADE GROUND: Brown gravelly clayey SAND with occasional clay inclusions and rare brick fragments. Sand is fine to coarse. Gravel is fine to coarse and subangular to subrounded comprising sandstone.		
1.30-1.60	ES3 PID=0.3ppm					MADE GROUND: Brown and grey mottled gravelly sandy CLAY with rare clinker and brick fragments. Sand is fine to medium. Gravel is fine to coarse and subangular to subrounded comprising sandstone.		
1.70-2.00	B4				(0.75)	Soft to firm consistency medium strength yellowish brown and grey mottled slightly gravelly sandy CLAY. Sand is fine to medium. Gravel is fine to medium and subangular to rounded comprising sandstone and mudstone. Slight organic odour.		
2.00	PP 49.05kPa		2,1/2,3,3,4		2.00	Stiff consistency high strength brown gravelly CLAY. Gravel is fine to medium and subrounded to subangular comprising sandstone.		
2.00-2.45	SPT N=12							
2.00-2.45	D5							
2.50-3.00	B6				(1.00)			
3.00	PP 122.63kPa		3,3/3,4,4,4		3.00	Firm consistency high strength dark grey very sandy CLAY. Sand is fine to medium.		
3.00-3.45	SPT N=15				(0.50)			
3.00-3.45	D7							
3.40-4.00	B8				3.50	Medium dense dark grey very clayey GRAVEL. Gravel is fine to medium and angular to subangular comprising mudstone (probable extremely weathered MUDSTONE bedrock).		
4.00-4.45	SPT N=15		3,4/5,4,2,4		(0.95)			
					4.45	Complete at 4.45m		

RemarksBorehole not continued beyond 4.45mbgl due to damage to drilling equipment.
Borehole dry and stable.
Location accurate to 3.00-5.00m.**Scale**
(approx)

1:40

Logged
By

HM

Figure No.

LKC 21 1310.WS105

Excavation Method

Machine excavated to 1.6mbgl.

Dimensions

2.0m x 0.6m x 1.6m

Ground Level (mOD)

156.00

Client

Greater Manchester Combined Authority

**Job
Number**

LKC 21 1310

Location (Handheld GPS)

3933385 E 416675 N

Dates

02/09/2021-
03/09/2021

Project Contractor

Taylor Drilling Services

Sheet

1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.00-0.50	ES1 PID=<0.01ppm				(0.50)	MADE GROUND: Dark brown gravelly sandy SILT with occasional rootlets within 0.1mbgl, rare concrete and brick fragments. Sand is fine to medium. Gravel is fine to medium, subangular to subrounded comprising mixed lithologies.		
0.50-1.60	B2			155.50	0.50	Land drain encountered at 0.4mbgl.		
1.10	SV 12kPa				(1.10)	Soft consistency grey mottled brown gravelly slightly sandy silty CLAY. Sand is fine to medium. Gravel is fine to medium, subangular to subrounded comprising mudstone and sandstone.		
1.60	SV 22kPa			154.40	1.60	Complete at 1.60m		


Remarks

Elevation estimated using www.freemaptools.com/elevation-finder.htm
Grid reference accurate for 3-5 meters.
Pit was stable and dry.
Soakaway test carried out within pit, see separate sheet.
Clay strata noted to contain a high gravel content and to be friable.

Scale (approx)

1:20

Logged By

RW

Figure No.

LKC 21 1310.SA101

Excavation Method

Machine excavated to 1.8mbgl.

Dimensions

2.0m x 0.6m x 1.8m

Ground Level (mOD)

156.00

Client

Greater Manchester Combined Authority

**Job
Number**

LKC 21 1310

Location (Handheld GPS)

393397 E 416663 N

Dates

02/09/2021-
03/09/2021

Project Contractor

Taylor Drilling Services

Sheet

1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.30-0.70	ES1 PID=<0.01ppm			155.70	(0.30)	MADE GROUND: Grey silty GRAVEL (MOT) with occasional rootlets. Gravel is fine to medium, subangular to angular comprising limestone.		
0.70-1.80	B2			155.30	(0.40)	MADE GROUND: Dark brown gravelly sandy SILT with occasional rootlets, rare ash and brick fragments. Sand is fine to medium. Gravel is fine to medium, subangular to subrounded comprising mixed lithologies. Land drain encountered at 0.4mbgl.		
1.10	SV 21kPa				(0.90)	Soft consistency grey mottled brown gravelly slightly sandy silty CLAY. Sand is fine to medium. Gravel is fine to medium, subangular to subrounded comprising mudstone and sandstone.		
1.70	SV 34kPa			154.40	1.60	Complete at 1.80m		


Remarks

Elevation estimated using www.freemaptools.com/elevation-finder.htm
Grid reference accurate for 3-5 meters.
Pit was stable and dry.
Soakaway test carried out within pit, see separate sheet.
Clay strata noted to contain a high gravel content and to be friable.

Scale (approx)

1:20

Logged By

RW

Figure No.

LKC 21 1310.SA102

Site : Littleborough Fire Station, Littleborough

Client : Greater Manchester Combined Authority

Project Contractor
: LKC

Job Number

LKC 21 1310

Sheet

1 / 2

Location	Date	Level	Location
SA101	02/09/2021	156.00 mOD	E: 3933385 N: 416675

Pit Width (m)	0.60
Pit Depth (m)	1.60
Pit Length (m)	2.00

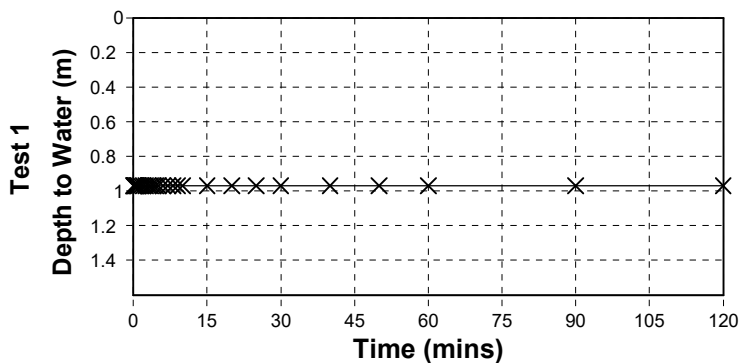
Soil type at test level	Clay
Groundwater	None
Drain discharge depth	None
Sidewall stability	Stable
Stone filled or open pit	Stone filled

	1
Effective depth (m)	0.63
Volume outflowing between 75% & 25% (m3)*	
Mean surface area through which outflow occurs (m2)	
Time for outflow between 75% & 25% (min)	
SOIL INFILTRATION RATE (ms-1), f	Test Failed

Remarks

* Volume outflowing reduced to account for granular backfill used during testing (30 % of free volume assumed).

Elapsed time (hh:mm:ss)	Depth to Water Test 1
00:00:00	0.97
00:00:05	0.97
00:00:10	0.97
00:00:20	0.97
00:00:30	0.97
00:00:40	0.97
00:00:50	0.97
00:01:00	0.97
00:01:30	0.97
00:02:00	0.97
00:02:30	0.97
00:03:00	0.97
00:03:30	0.97
00:04:00	0.97
00:04:30	0.97
00:05:00	0.97
00:06:00	0.97
00:07:00	0.97
00:08:00	0.97
00:09:00	0.97
00:10:00	0.97
00:15:00	0.97
00:20:00	0.97
00:25:00	0.97
00:30:00	0.97
00:40:00	0.97
00:50:00	0.97
01:00:00	0.97
01:30:00	0.97
02:00:00	0.97



Site : Littleborough Fire Station, Littleborough

Client : Greater Manchester Combined Authority

Project Contractor
: LKC

Job Number

LKC 21 1310

Sheet

2 / 2

Location	Date	Level	Location
SA102	02/09/2021	156.00 mOD	E: 393397 N: 416663

Pit Width (m)	0.60
Pit Depth (m)	1.80
Pit Length (m)	2.00

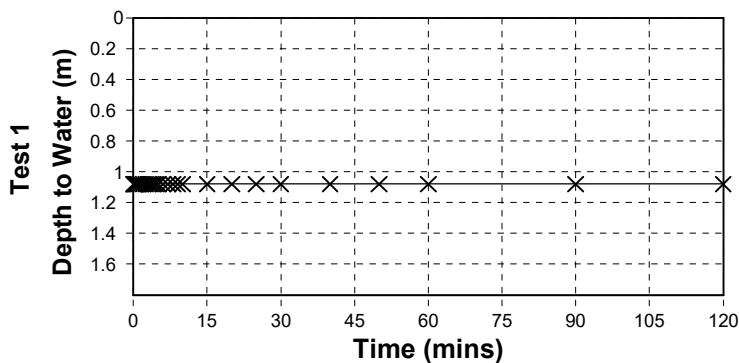
Soil type at test level	Clay
Groundwater	None
Drain discharge depth	None
Sidewall stability	Stable
Stone filled or open pit	Stone filled

	1
Effective depth (m)	0.72
Volume outflowing between 75% & 25% (m3)*	
Mean surface area through which outflow occurs (m2)	
Time for outflow between 75% & 25% (min)	
SOIL INFILTRATION RATE (ms-1), f	Test Failed

Remarks

* Volume outflowing reduced to account for granular backfill used during testing (30 % of free volume assumed).

Elapsed time (hh:mm:ss)	Depth to Water Test 1
00:00:00	1.08
00:00:05	1.08
00:00:10	1.08
00:00:20	1.08
00:00:30	1.08
00:00:40	1.08
00:00:50	1.08
00:01:00	1.08
00:01:30	1.08
00:02:00	1.08
00:02:30	1.08
00:03:00	1.08
00:03:30	1.08
00:04:00	1.08
00:04:30	1.08
00:05:00	1.08
00:06:00	1.08
00:07:00	1.08
00:08:00	1.08
00:09:00	1.08
00:10:00	1.08
00:15:00	1.08
00:20:00	1.08
00:25:00	1.08
00:30:00	1.08
00:40:00	1.08
00:50:00	1.08
01:00:00	1.08
01:30:00	1.08
02:00:00	1.08



Appendix C

Environment Agency Data

Lisa Aspinall

From: GMMC Info Requests <InfoRequests.GMMC@environment-agency.gov.uk>
Sent: 02 August 2021 12:36
To: Lisa Aspinall
Subject: GMMC227361AB Response attached from the Environment Agency
Attachments: 1978.34.201 Site Location Plan..pdf; 1978.34.201 Site Location Plan..pdf; GMMC227361AB- DFM.PDF; GMMC227361AB- Table.pdf; GMMC227361AB - FDM.PDF

Dear Lisa,

Re: Littleborough Fire Station, OL15 8DU

Thank you for your enquiry which was received on 26/7/21.

We respond to requests under the Freedom of Information Act 2000 and Environmental Information Regulations 2004.

I enclose the data requested.

We have no records of flooding affecting the site. However, this does not mean flooding has not occurred in the past or that it will not flood in future. We recommend that you also contact United Utilities and Rochdale Council who may hold additional information (the former especially in relation to sewer flooding).

There is no 2D modelling data for this site

Here are some additional links that may be of use:

<https://www.gov.uk/guidance/flood-risk-assessment-local-planning-authorities>

<https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances>

The Groundwater team do not hold records on groundwater flooding; groundwater flooding is the responsibility of the Lead Local Flood Authority

For further information please see below

Local authorities search

<https://www.gov.uk/find-your-local-council>

Local authorities – new roles and responsibilities

<http://www.defra.gov.uk/environment/flooding/legislation/la-roles/>

Please refer to the [Open Government Licence](#) which explains the permitted use of this information.

Please get in touch if you have any further queries or contact us within two months if you'd like us to review the information we have sent.

Kind regards,

Anne Ball
Customer and Engagement Officer
Greater Manchester, Merseyside and Cheshire

Email: Inforequests.gmmc@environment-agency.gov.uk

From: Lisa Aspinall [<mailto:L.Aspinall@thelkgroup.com>]

Sent: 26 July 2021 11:22

To: Enquiries, Unit <enquiries@environment-agency.gov.uk>

Subject: Ref: 210729/GA14-FRA Query - Littleborough Fire Station, OL15 8DU

Dear Sir/Madam

LK Consult Ltd. has been commissioned to undertake a Flood Risk Assessment (FRA), of Littleborough Fire Station, Whitelees Road, Littleborough, OL15 8DU

Centred at approximate National Grid Reference 393369E, 416669N. The area of interest appears to be within Flood Zone 1

The proposed site plan is attached to this email.

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

- The modelled 1% and 0.1% annual probability fluvial flood level, the 1% annual probability plus climate change flood level and any lower order flood levels, in particular the modelled 5% fluvial flood level if relevant for functional floodplain, (with confirmation of the reference datum used for the levels – i.e. Local OSBM or OSGPS) if available.
- Details of any flood defences in the immediate area, including their extent, crest levels (and datum), assumed level of standard, construction and maintenance regime, as well as any other structures which may influence the local hydraulics.
- Proposed defence levels and timescale for implementation.
- Results of any breach analyses for defences in the area which may be relevant.
- Records of any historic flood events and potential sources of flooding from rivers, land drainage, groundwater, foul and surface water sewers on site and in the area.
- Any restrictions to infiltration and discharge to the watercourse.
- A copy of your detailed flood zone map and the modelled flood extent plans for the area.

If you have any queries please get in touch with me.

We are, of course, happy to pay your reasonable charge for this service. Please let me know by return what information is available and what the charge will be and we will pay the relevant fees by debit card as soon as possible.

We will also contact Rochdale Borough Council and United Utilities for their information and requirements.

Any advice or recommendations you may have regarding the potential discharges from the development of this site?

Regards

Lisa Aspinall



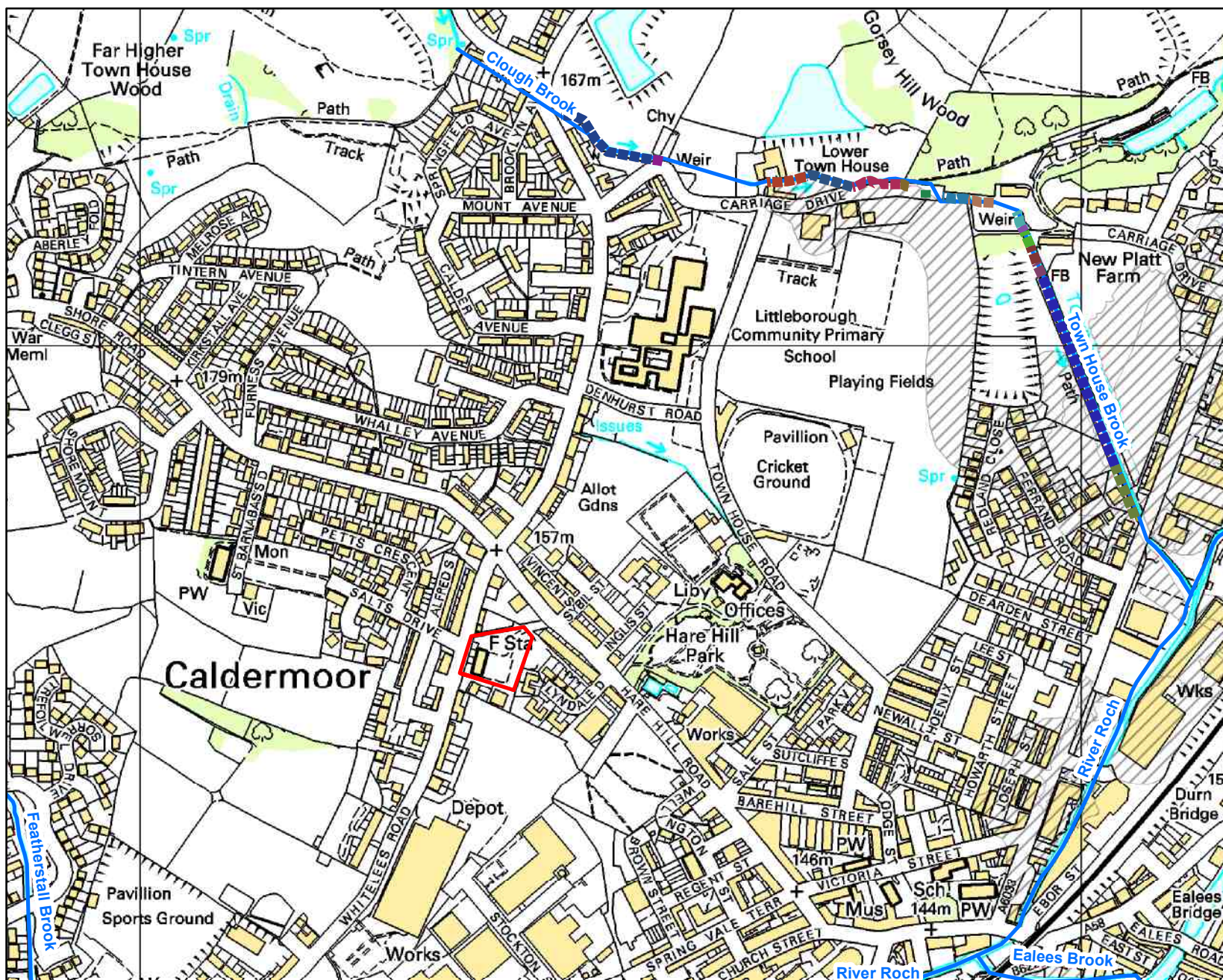
Lisa Aspinall BSc. (Hons) EngTech MICE
Senior Flood Risk & Drainage Engineer
LK Group | 0161 763 7200
Manchester | London | Liverpool | Glasgow
www.thelkgroup.com

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



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Flood Defence Map centred on Whitelees Road, Littleborough, OL15 8DU. Created on 30/07/2021 [GMMC227361AB]



1:6,000



Legend

Site Location

Main River

Defences

Asset ID

5981

34481

64750

99169

100053

100055

100423

100426

100427

101113

101115

101497

101500

101902

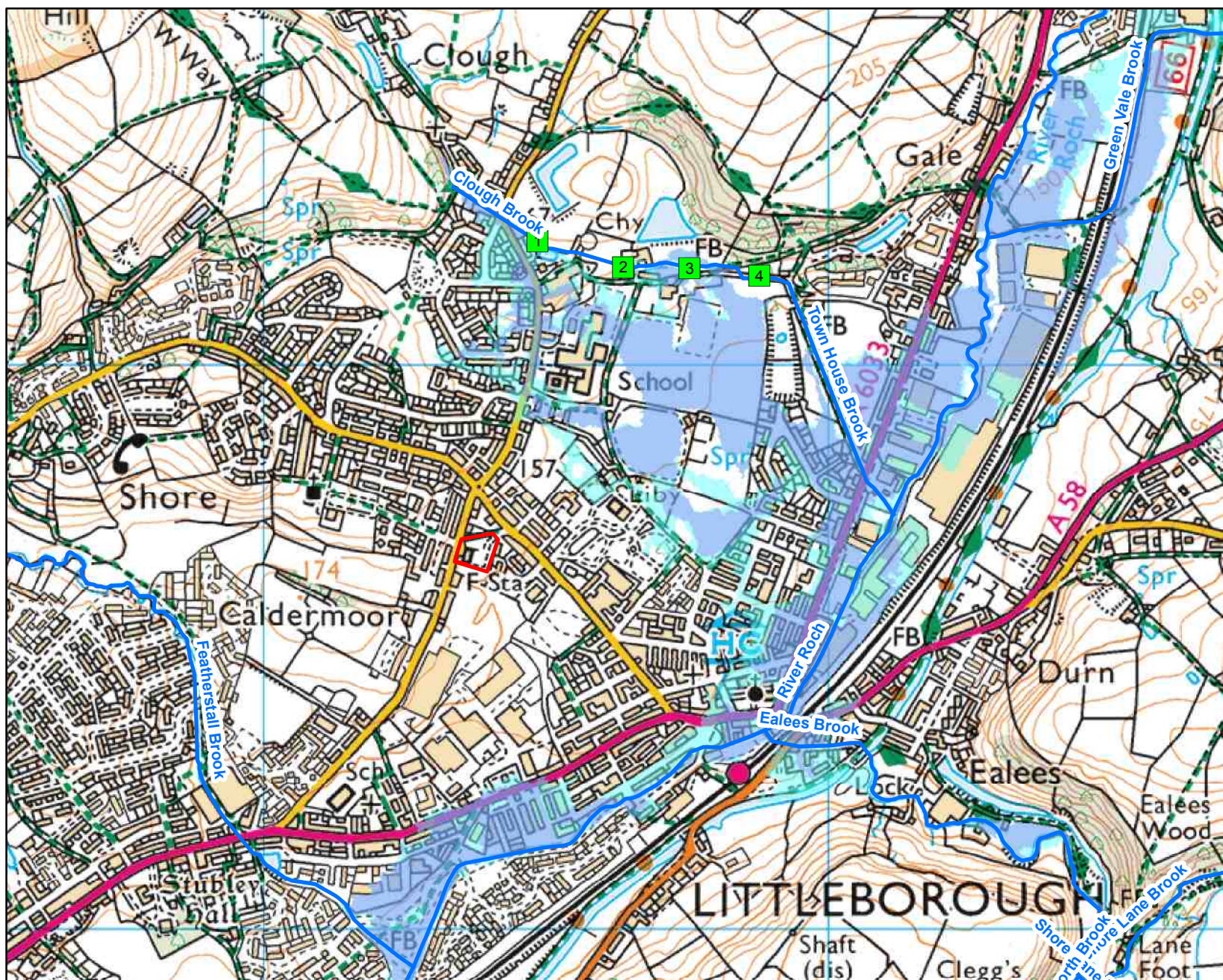
173749

173750

181164

Areas benefiting

Detailed Flood Map centred on Whitelees Road, Littleborough, OL15 8DU. Created on 30/07/2021 [GMMC227361AB]



1:10,001



Legend

-  Site Location
-  Model Measurements
-  Main River
-  Flood Zone 3
-  Flood Zone 2

Map Reference	Model Node Reference	Easting	Northing	Data	Undefended							Defended						
					5 % AEP (1 in 20 year)	1.33 % AEP (1 in 75 year)	1 % AEP (1 in 100 year)	1 % AEP (1 in 100 year) + 35% increase in flow	1 % AEP (1 in 100 year) + 70% increase in flow	0.5 % AEP (1 in 200 year)	0.1 % AEP (1 in 1000 year)	5 % AEP (1 in 20 year)	1.33 % AEP (1 in 75 year)	1 % AEP (1 in 100 year)	1 % AEP (1 in 100 year) + 35% increase in flow	1 % AEP (1 in 100 year) + 70% increase in flow	0.5 % AEP (1 in 200 year)	0.1 % AEP (1 in 1000 year)
1	ea013_model_TOWH_0047	393490	417219	Modelled Water Level (m aodN)	163.07	163.17	163.19	163.26	163.35	163.21	163.30	163.07	163.17	163.19	163.26	163.35	163.21	163.30
				Modelled Flow (cumecs)	2.36	2.89	2.92	3.01	3.07	2.97	3.05	2.28	2.89	2.92	3.01	3.07	2.97	3.05
2	ea013_model_TOWH_754	393633	417174	Modelled Water Level (m aodN)	158.02	158.24	158.26	158.36	158.47	158.30	158.42	158.02	158.24	158.26	158.36	158.47	158.30	158.42
				Modelled Flow (cumecs)	2.35	3.06	3.14	3.52	3.96	3.27	3.73	2.35	3.06	3.14	3.52	3.96	3.27	3.73
3	ea013_model_TOWH01_693	393758	417169	Modelled Water Level (m aodN)	155.32	155.40	155.41	155.42	155.46	155.42	155.46	155.34	155.44	155.45	155.47	155.50	155.46	155.50
				Modelled Flow (cumecs)	2.33	2.34	2.34	2.34	2.34	2.34	2.35	2.33	2.34	2.35	2.36	2.37	2.36	2.37
4	ea013_model_TOWH01_534	393879	417157	Modelled Water Level (m aodN)	153.31	153.34	153.34	153.34	153.36	153.35	153.39	153.32	153.35	153.35	153.35	153.38	153.36	153.40
				Modelled Flow (cumecs)	1.88	1.94	1.95	2.02	2.08	1.97	2.06	1.89	1.96	1.97	2.05	2.19	1.99	2.08

Model data taken from Rochdale and Littleborough 2013 Study

AEP - Annual Exceedence Probability

m aodN - metres above ordnance datum Newlyn

cumecs - cubic metres per second

Notes:

*Climate Change Scenario - 35% and 70% increases in flow calculated for the 2080's (2070 - 2115). Please see <https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances> for more information regarding the new climate change guidance. The location of the site and the type (vulnerability) of development determine the climate change allowances to consider in any flood risk assessment.

Flood Defences					
Start Date	Asset Type	Asset ID	Standard of Protection	Upstream Actual Crest Level (m aod)	Downstream Actual Crest Level (m aod)
01/01/2005	Embankment	5981	100	146.14	145.17
01/01/2005	Embankment	34481	100	154.51	154.51
01/01/2005	High Ground	64750	100	152.29	152.36
01/01/2005	Embankment	99169	100	154.29	153.99
01/01/2005	High Ground	100053	100	150.44	151.29
01/01/2005	High Ground	100055	100	152.36	153.83
01/01/2005	Wall	100423	100	146.37	145.96
01/01/2005	High Ground	100426	100	148.49	148.48
01/01/2005	High Ground	100427	100	148.48	150.44
01/01/2005	High Ground	101113	100	162.25	162.92
01/01/2005	High Ground	101115	100	162.92	163.69
01/01/2005	High Ground	101497	100	154.55	154.18
01/01/2005	Wall	101500	100	157.54	157.44
01/01/2005	High Ground	101902	100	153.84	153.58
01/01/2005	Embankment	173749	100	147.26	146.68
01/01/2005	High Ground	173750	100	155.07	156.59
01/01/2005	High Ground	181164	100	154.18	155.07

Appendix D

Consultee Correspondence

Highways and Engineering Service - Economy and Environment

Author: **Stephen McCann**, Drainage & Flooding Engineer, Highways, Property & Strategic Housing

☎ 01706 924606 ✉ stephen.mccann@rochdale.gov.uk

Rochdale Borough Council, Floor 2, No. One Riverside, Smith Street, Rochdale, OL16 1XU

COUNCIL DRAINAGE OFFICER – INFO RE. LITTLEBOROUGH FIRE STATION:

As far as the Drainage Officer knows (in post since Nov 2019), the fire station doesn't have any flooding issues.

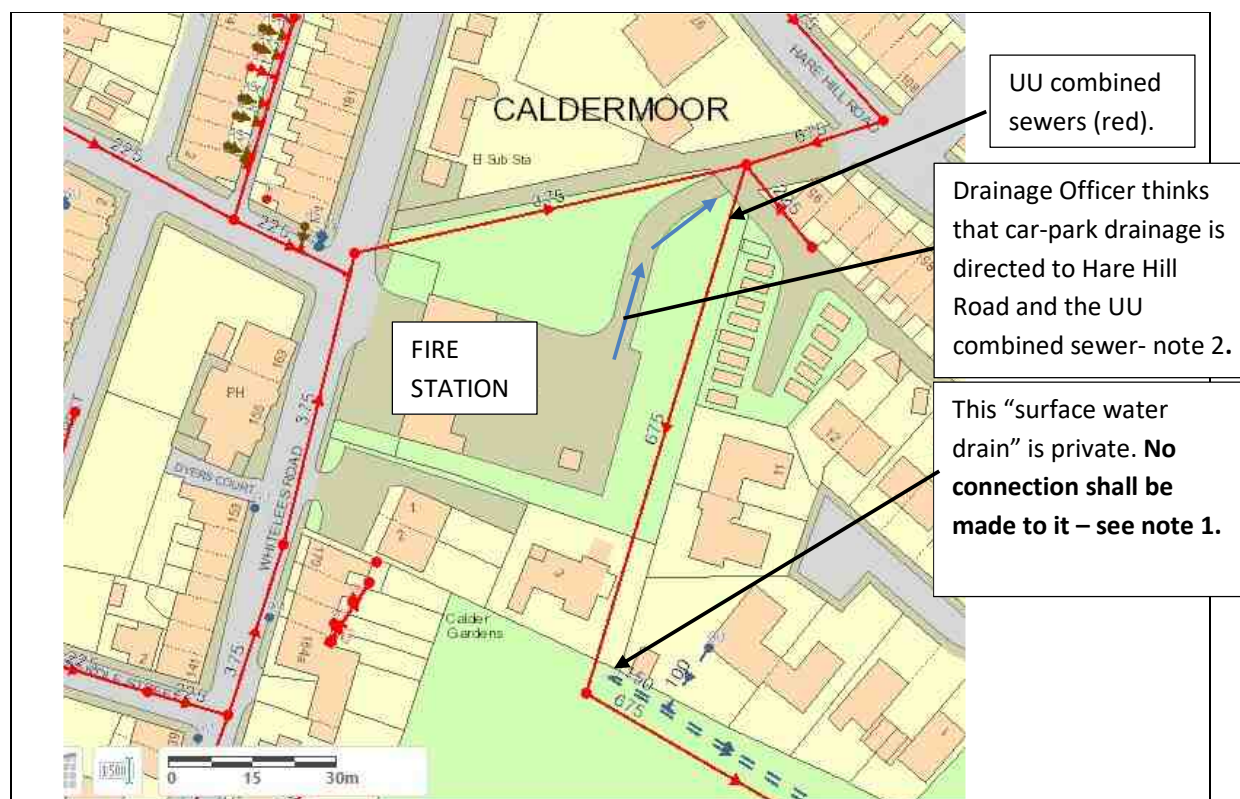


Fig 1. UU safedig plans screenshot.

Note 1:- the 'culvert-land-drain shown as dashed lines is on private land owned by McCormick. It has connections from No. 3 Calder Gardens and no. 7 Lynam Drive. There have been problems with flooding of ground floor at no. 7 which have now been resolved, after works carried out in 2019 by McCormick on the private land-drain. No additional surface water connections shall be made to it because it is a private drain. For more info, feel free to contact stephen.mccann@rochdale.gov.uk

Note 2:- The fire station car park drainage can be checked via dye testing.

LKGroup**Unit 29 Eton Business Park
Eton Hill Road, Radcliffe
Radcliffe, Greater
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: FRA21 1122
Our Ref: UUPS-ORD-317586
Date: 19/08/2021****Dear Sirs****Location: GREATER MANCHESTER FIRE & RESCUE SERVICE FIRE STATION WHITELEES ROAD,
LITTLEBOROUGH, OL15 8DU**

I acknowledge with thanks your request dated 16/08/2021 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

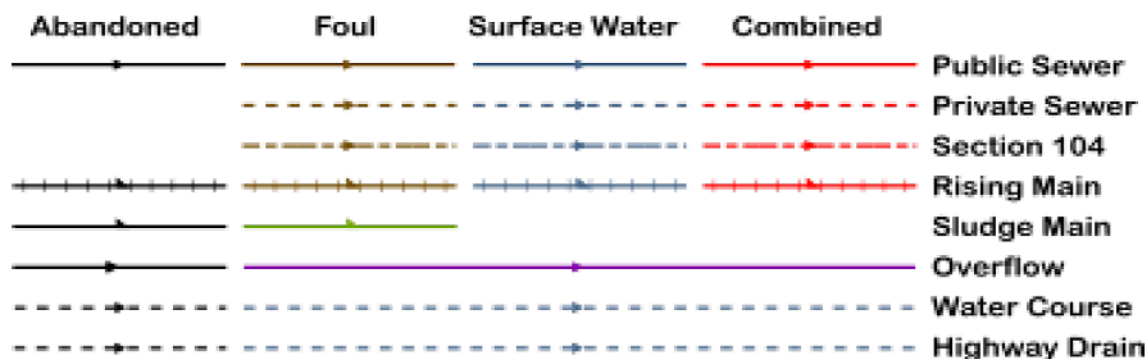
TERMS AND CONDITIONS - WASTEWATER AND WATER DISTRIBUTION PLANS

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:

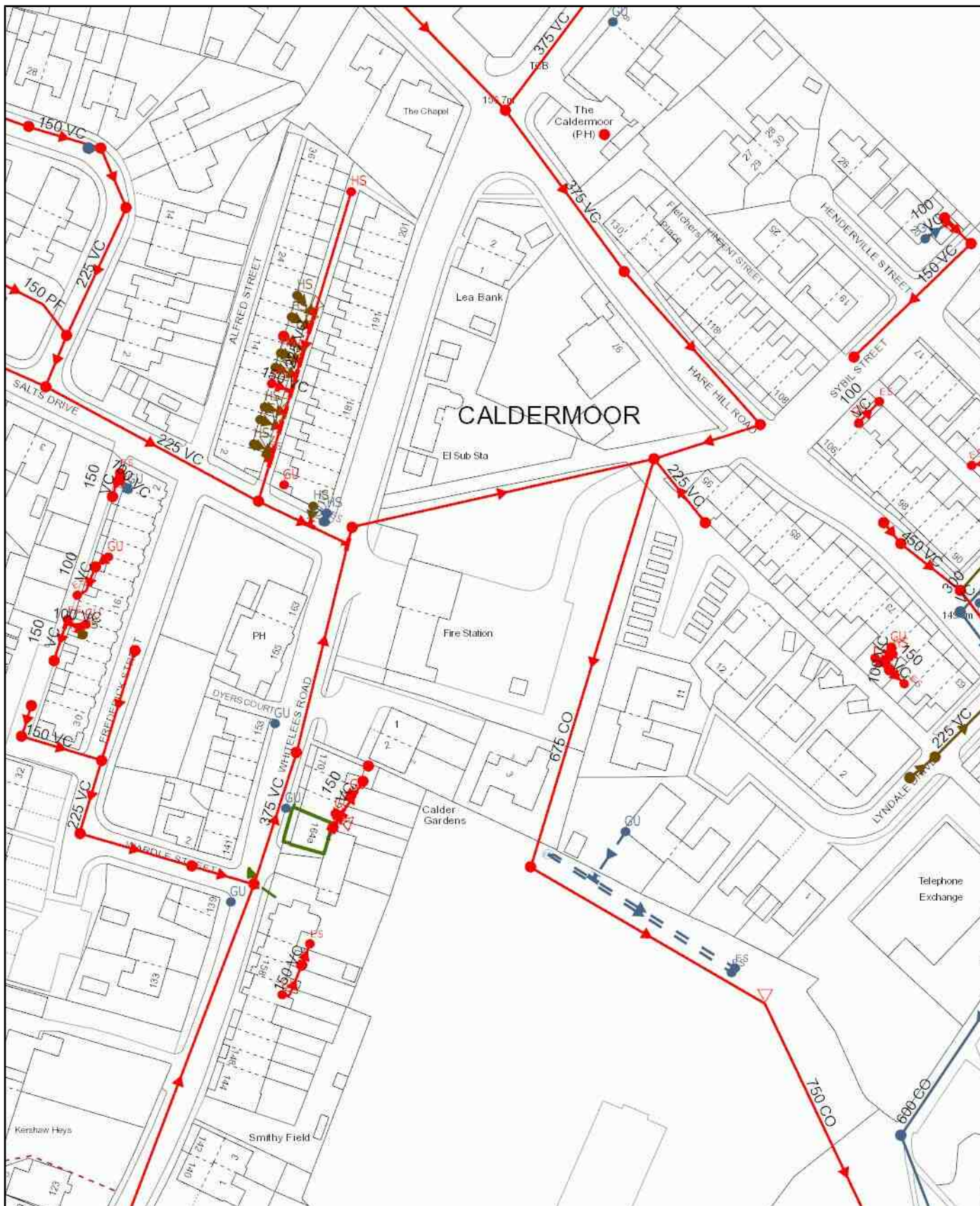
- This Map and any information supplied with it is issued subject to the provisions contained below, to the exclusion of all others and no party relies upon any representation, warranty, collateral contract or other assurance of any person (whether party to this agreement or not) that is not set out 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.

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	



Scale: 1:1250
Date: 19/08/2021

SEWER RECORDS



Water for the North West

Address or Site Reference: GREATER MANCHESTER FIRE & RESCUE
SERVICE FIRE STATION WHITELEES ROAD,
LITTLEBOROUGH, OL15 8DU

Printed by: Property Searches

The position of the underground apparatus shown on this plan is approximate only and is given in accordance with the best information currently available. United Utilities Water will not accept liability for any loss or damage caused by the actual position being different from those shown.

Crown copyright and database rights 2017 Ordnance Survey 100022432. Unauthorised reproduction will infringe these copyrights.

Lisa Aspinall

From: Wastewater Developer Services <WastewaterDeveloperServices@uuplc.co.uk>
Sent: 13 September 2021 15:08
To: Mark Jones; Wastewater Developer Services
Cc: Lisa Aspinall
Subject: PDE 4200042106 Littleborough Fire Station, OL15 8DU

Good afternoon Mark,

No problem at all. I hope you are all well.

Pre Development Enquiry for: Littleborough Fire Station, OL15 8DU UU Reference Number : 4200042106

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 675mm diameter public combined sewer located within the site boundary at an unrestricted rate.

If you are able to identify an alternative, more suitable point of discharge, we request that you contact us at your earliest convenience so that we can assess suitability.

In accordance with our infrastructure plans we may ask you to change your point of connection. Therefore please contact us when you are ready to formalise your drainage proposals, we would suggest before you submit for Full Planning.

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

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

Based on the underlying geology you have provided indicates that an infiltration based surface water drainage solution may not be feasible for the site. However, should intrusive ground investigations yield more favourable ground conditions, it is imperative that the drainage of the site is done so in the most sustainable method possible.

Waterbody

There are no charted watercourses within a reasonable distance from the site and therefore this option can be discounted.

Highway Drainage

If infiltration is completely discounted following ground investigations, we recommend that you investigate the possibility of draining surface water to the highway drain where this ultimately discharges to a watercourse, by contacting the relevant Highway Authority.

Public Sewer

In accordance with the hierarchy of drainage options within the National Planning Practice Guidance, all options 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 300mm diameter public surface water sewer located approximately 90m east of the site within Hare Hill Road at a pass forward flow to be agreed by the Lead Local Flood Authority. Whilst we understand the proposed discharge rate you have suggested is a variable rate, United Utilities requires a fixed discharge rate restricted to the equivalent QBar (1 in 2 year) event. This rate should also be calculated from the positively drained impermeable area, which has been assumed to be the existing roof area as no evidence of yard drainage has been provided for assessment. As a result, the estimated drained area is 0.03Ha which will generate less than 5l/s and therefore 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.

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, and furthermore we do not accept land drainage, overland flows or track drainage into the public sewerage network under any circumstances.

Sustainable Drainage Systems (SuDS)

If you need advice on any site proposals which incorporate open SuDS features either that interact with a traditional adoptable piped network you can complete the form below and we will be in touch within 2 weeks to discuss the proposals further.

Pre Design Enquiry

Existing Wastewater Assets Crossing the Site

According to our public sewer records there are public sewers located within your site boundary. We will require unrestricted access to the sewer for maintenance purposes, we would ask that you maintain a minimum clearance of 6m which is measured 3m from the centre line of the pipe unless there happens to be a formal easement agreement in place, in which case the specified easement width would apply. If you cannot achieve this then you may wish to consider diverting and or abandoning the public sewer.

Whilst we can only request 3m either side of the centreline of the sewer in line with Building Regulations, on some larger assets these easements may not be sufficient for future access and maintenance purposes under Section 158/159 of the Water Industry Act. As a result we would suggest that the following easements are adhered to in line with newly adoptable systems, which is information taken directly from our website:

Table 1:

Easement minimum distances from buildings/structures for sewers proposed for adoption that are not located within the adoptable highway.

Sewer Diameter / size (mm)	Less than 150	150 - 299	300 - 449	450 - 600	601 - 749	750 - 924	925 - 1000	1001 - 1124	1125 - 1399	1400 or greater	Box culverts
Depth to Invert of sewer (m)											
Less than 3.0	3.0	3.0	3.0	3.5	3.5	4.0	5.0	5.0	5.0	5.0	4.0m from centreline or 2.0m from outside edge
3.0 to 4.0	3.0	3.0	3.0	4.0	4.0	5.0	5.0	5.0	5.0	5.0	5.0m from centreline or 2.5 from outside edge
4.0 to 5.0	4.0	4.0	4.0	5.0	5.0	5.0	6.0	6.0	6.5	6.5	6.0m from centreline or 2.5m from outside edge
5.0 to 6.0	5.0	5.0	5.0	6.0	6.0	6.5	6.5	6.5	6.5	6.5	6.0m from centreline or 2.5m from outside edge
6.0 to 7.5	6.0	6.0	6.0	6.0	6.0	6.0	6.5	6.5	6.5	6.5	6.0m from centreline or 2.5m from outside edge
7.5 or greater	4.0	4.0	4.0	4.0	4.0	5.0	5.0	5.0	5.0	6.0	6.0m from centreline or 2.5m from outside edge

Please refer to the link below to obtain full details of the processes involved with sewer diversions:

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

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,

	Robert Brenton Developer Engineer Developer Services & Metering Customer Services M: 07880299827 unitedutilities.com
---	---

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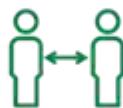
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From: Mark Jones [mailto:M.Jones@thelkgroup.com]
Sent: 02 September 2021 10:45
To: Wastewater Developer Services <WastewaterDeveloperServices@uuplc.co.uk>
Cc: Lisa Aspinall <L.Aspinall@thelkgroup.com>
Subject: RE: GENQ 4200042106 Littleborough Fire Station, OL15 8DU

EXTERNAL EMAIL This email originated outside of the organisation. Do not click links or open attachments unless you recognise the sender and know the content is safe.

Rob

Sorry for not sending this with the initial enquiry.

Regards

Mark

From: Wastewater Developer Services <WastewaterDeveloperServices@uuplc.co.uk>
Sent: 03 August 2021 14:25
To: Lisa Aspinall <L.Aspinall@thelkgroup.com>; Wastewater Developer Services <WastewaterDeveloperServices@uuplc.co.uk>
Subject: GENQ 4200042106 Littleborough Fire Station, OL15 8DU

Good afternoon Lisa,

We can confirm that we have no current record of sewer flooding 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 to place on the register.

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 removed from the register as a result of investment in our infrastructure.

In principle 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.

For further discussions related to discharge rates and points of connection, we recommend you complete a wastewater pre-development enquiry which is a free service via the following link:

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

Kind regards,



Robert Brenton
Developer Engineer
Developer Services & Metering
Customer Services
M: 07880299827
[unitedutilities.com](https://www.unitedutilities.com)

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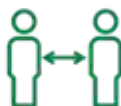
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From: Lisa Aspinall [<mailto:L.Aspinall@thelkgroup.com>]

Sent: 26 July 2021 11:20

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

Subject: FRA Query - Littleborough Fire Station, OL15 8DU

Dear Sir/Madam

LK Consult Ltd. has been commissioned to undertake a Flood Risk Assessment (FRA), of Littleborough Fire Station, Whitelees Road, Littleborough, OL15 8DU

Centred at approximate National Grid Reference 393369E, 416669N. The area of interest appears to be within Flood Zone 1

To complete the FRA 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

If you have any queries please get in touch with me.

We are, of course, happy to pay your reasonable charge for this service. Please let me know by return what information is available and what the charge will be and we will pay the relevant fees by debit card as soon as possible.

Any advice or recommendations you may have regarding the potential discharges from the development of this site?

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

Regards

Lisa Aspinall



Lisa Aspinall BSc. (Hons) EngTech MICE
Senior Flood Risk & Drainage Engineer
LK Group | 0161 763 7200
Manchester | London | Liverpool | Glasgow
www.thelkgroup.com

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Appendix E

Calculations



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Job No.		
Sheet no. 1		
Date 02/09/21		
By	Checked	Reviewed

Project **Qbar**

Title **Peak runoff calculations for Littleborough,Rochdale**

Area data:-

FSR data

M5-60 = 19

Soil index = 0.45

WRAP value = 4

r = 0.24

SAAR = 1180

Nat grid = SD9316

Site data:-

Ret. period (yrs) = 2.333

Time of entry = 7.00

Impervious area drained = 1500 m²

Site slope = Mild <2% (1:50)

Length of overland flow = 0.00

ToC = 7.0 mins

Overland flow time = 0.0 mins

Pervious area drained = 0 m²

Soil type = Clay

Climate change factor = 0.0 %

Calculated data:-

Calculated runoff factor = 83.0%

Rainfall rate= 50.5 mm/Hr

UCWI = 117.3

Runoff rate (gross)= 17.5 l/s

Methods

Runoff factor (RF) = 83.0, 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 02/09/21		
By	Checked	Reviewed

Project **1 yr existing**

Title **Peak runoff calculations for Littleborough,Rochdale**

Area data:-

FSR data

M5-60 = 19

Soil index = 0.45

WRAP value = 4

r = 0.24

SAAR = 1180

Nat grid = SD9316

Site data:-

Ret. period (yrs) = 1

Time of entry = 10.00

Impervious area drained = 1500 m²

Site slope = Mild <2% (1:50)

Length of overland flow = 0.00

ToC = 10.0 mins

Overland flow time = 0.0 mins

Pervious area drained = 0 m²

Soil type = Clay

Climate change factor = 0.0 %

Calculated data:-

Calculated runoff factor = 83.0%

Rainfall rate= 36.4 mm/Hr

UCWI = 117.3

Runoff rate (gross)= 12.6 l/s

Methods

Runoff factor (RF) = 83.0, 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 02/09/21		
By	Checked	Reviewed

Project **30 yr event**

Title **Peak runoff calculations for Littleborough,Rochdale**

Area data:-

FSR data

M5-60 = 19

Soil index = 0.45

WRAP value = 4

r = 0.24

SAAR = 1180

Nat grid = SD9316

Site data:-

Ret. period (yrs) = 30

Time of entry = 6.00

Impervious area drained = 1500 m²

Site slope = Mild <2% (1:50)

Length of overland flow = 0.00

ToC = 6.0 mins

Overland flow time = 0.0 mins

Pervious area drained = 0 m²

Soil type = Clay

Climate change factor = 0.0 %

Calculated data:-

Calculated runoff factor = 83.0%

Rainfall rate= 87.4 mm/Hr

UCWI = 117.3

Runoff rate (gross)= 30.2 l/s

Methods

Runoff factor (RF) = 83.0, 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 02/09/21		
By	Checked	Reviewed

Project **100yr**

Title **Peak runoff calculations for Littleborough,Rochdale**

Area data:-

FSR data

M5-60 = 19

Soil index = 0.45

WRAP value = 4

$r = 0.24$

SAAR = 1180

Nat grid = SD9316

Site data:-

Ret. period (yrs) = 100

Time of entry = 6.00

Impervious area drained = 1500 m²

Site slope = Mild <2% (1:50)

Length of overland flow = 0.00

ToC = 6.0 mins

Overland flow time = 0.0 mins

Pervious area drained = 0 m²

Soil type = Clay

Climate change factor = 0.0 %

Calculated data:-

Calculated runoff factor = 83.0%

Rainfall rate= 110.1 mm/Hr

UCWI = 117.3

Runoff rate (gross)= 38.1 l/s

Methods

Runoff factor (RF) = 83.0, calculated from:-

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

where

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

UCWI = Calculated value for Wetness Index

Calculations produced by MasterDrain Surface Water design program



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Job No.		
Sheet no. 1		
Date 10/06/22		
By	Checked	Reviewed

Project 30 yr event		
Title Storage calcs for Littleborough,Rochdale		

Data:-

FSR Hydrology:-

Location = Littleborough,Rochdale
M5-60 (mm) = 19
Soil index = 0.45
Return period = 30
UCWI = 120.1

Grid reference = SD9316
r = 0.24
SAAR (mm/yr) = 1180
WRAP = 4
Climate change = 0

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

Runoff factor (RF) = 62.0, 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 = 1750 m²
Total area (TA) = 2340 m²
Mean pump disch. rate = 8.700 l/s
Additional flow = 0.00 l/s

Pervious area = 590 m²
Equiv area = 1451 m² (TA x RF).
Areal reduction factor = 1.000
Climate change factor = 0

Calculated data:-

Time to max = 27.0 mins
Rainfall at max = 45.34 mm/hr
Pipeline storage = 0.0 m³
Offline storage = 0.0 m³

Calculated storage volume = 15.5 m³
Allowed discharge rate = 8.700 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 = 8.700 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	1974.5	1125	15.6	400 x 600	86.1	500 x 500	62.0
150	877.6	1200	13.7	600 x 900	37.5	500 x 750	41.3
225	390.0	1275	12.1	800 x 1200	21.1	500 x 1000	31.0
300	219.4	1350	10.8			750 x 1000	20.7
375	140.4	1425	9.7			750 x 1200	17.2
450	97.5	1500	8.8			750 x 1500	13.8
525	71.6	1575	8.0			1000 x 1000	15.5
600	54.8	1650	7.3			1000 x 1200	12.9
675	43.3	1725	6.6			1000 x 1500	10.3
750	35.1	1800	6.1			1000 x 1800	8.6
825	29.0	1875	5.6			1000 x 2000	7.8
900	24.4	1950	5.2			1500 x 1500	6.9
975	20.8	2025	4.8			1500 x 1800	5.7
1050	17.9	2100	4.5			1500 x 2000	5.2



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Data:-

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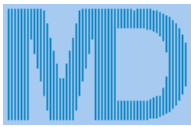
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Date 10/06/22		
By	Checked	Reviewed

Project 30 yr event			
Title Storage calcs for Littleborough,Rochdale			

Time (mins)	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)
10	72.0	17.432	5.220	12.212
20	53.0	25.529	10.440	15.089
30	43.0	31.121	15.660	15.461
40	37.0	35.533	20.880	14.653
50	32.0	39.224	26.100	13.124
60	29.0	42.418	31.320	11.098
70	27.0	45.245	36.540	8.705
80	25.0	47.785	41.760	6.025
90	23.0	50.096	46.980	3.116
100	22.0	52.216	52.200	0.016
110	20.0	54.175	57.420	0.000
120	19.0	55.995	62.640	0.000
130	18.0	57.694	67.860	0.000
140	18.0	59.287	73.080	0.000
150	17.0	60.784	78.300	0.000
160	16.0	62.197	83.520	0.000
170	15.0	63.532	88.740	0.000
180	15.0	64.797	93.960	0.000
190	14.0	66.020	99.180	0.000
200	14.0	67.231	104.400	0.000
210	13.0	68.399	109.620	0.000
220	13.0	69.529	114.840	0.000
230	13.0	70.623	120.060	0.000
240	12.0	71.683	125.280	0.000
250	12.0	72.713	130.500	0.000
260	12.0	73.714	135.720	0.000
270	11.0	74.689	140.940	0.000
280	11.0	75.638	146.160	0.000
290	11.0	76.563	151.380	0.000
300	11.0	77.466	156.600	0.000
310	10.0	78.347	161.820	0.000
320	10.0	79.209	167.040	0.000
330	10.0	80.052	172.260	0.000
340	10.0	80.877	177.480	0.000
350	10.0	81.685	182.700	0.000
360	9.0	82.476	187.920	0.000
370	9.0	83.252	193.140	0.000
380	9.0	84.014	198.360	0.000
390	9.0	84.761	203.580	0.000
400	9.0	85.495	208.800	0.000
410	9.0	86.216	214.020	0.000
420	9.0	86.924	219.240	0.000
430	8.0	87.620	224.460	0.000
440	8.0	88.305	229.680	0.000
450	8.0	88.979	234.900	0.000
460	8.0	89.643	240.120	0.000
470	8.0	90.296	245.340	0.000
480	8.0	90.939	250.560	0.000
490	8.0	91.573	255.780	0.000
500	8.0	92.198	261.000	0.000
510	8.0	92.813	266.220	0.000
520	7.0	93.421	271.440	0.000
530	7.0	94.020	276.660	0.000
540	7.0	94.611	281.880	0.000
550	7.0	95.194	287.100	0.000
560	7.0	95.769	292.320	0.000
570	7.0	96.338	297.540	0.000
580	7.0	96.899	302.760	0.000
590	7.0	97.453	307.980	0.000
600	7.0	98.001	313.200	0.000

Storage volume (m³) = 15.5 m³



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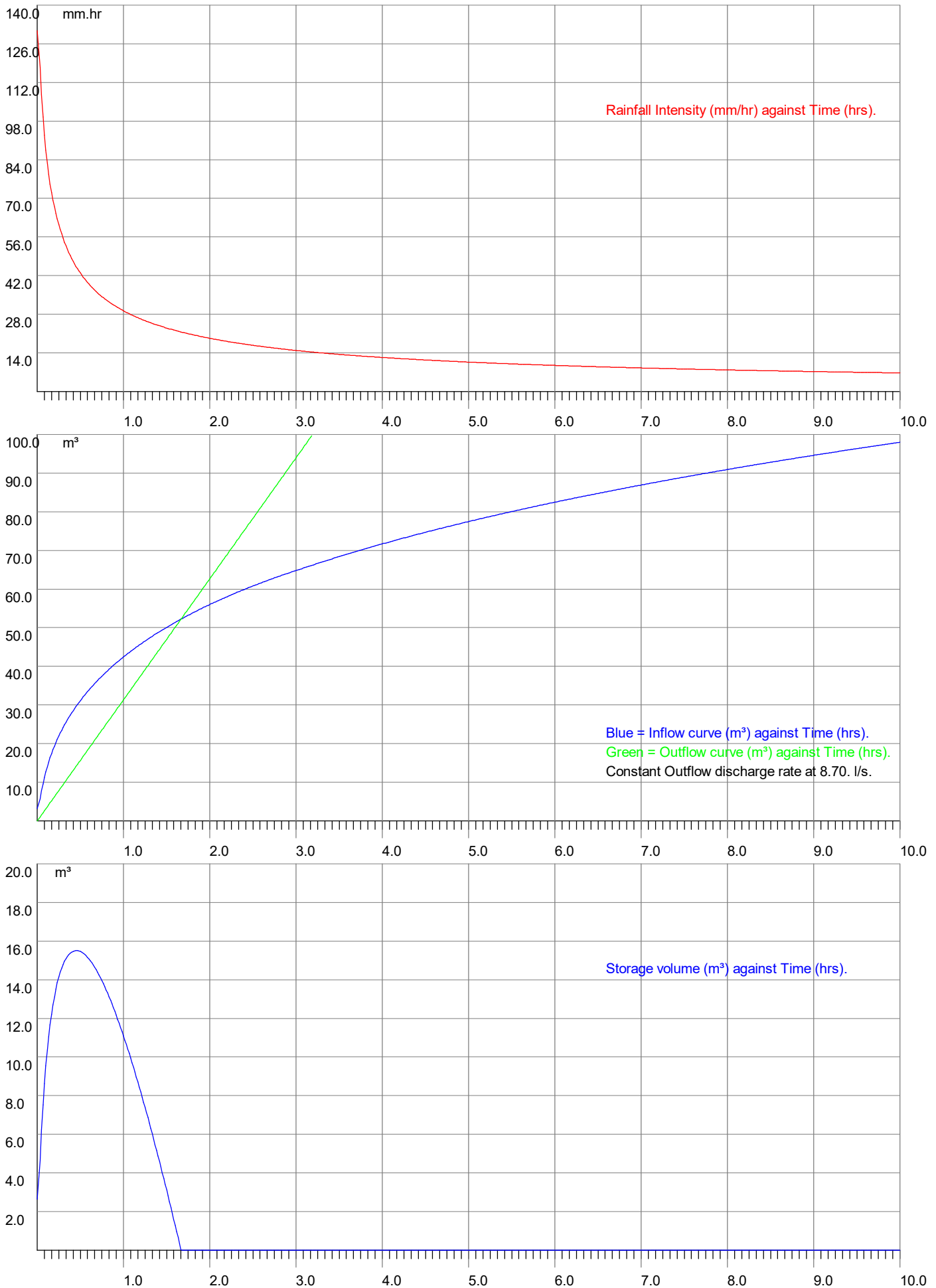
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Job No.		
Sheet no. 3		
Date 10/06/22		
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Project **30 yr event**

Title **Storage calcs for Littleborough,Rochdale**





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Job No.

Sheet no. **1**

Date **10/06/22**

Project **100yr+20%**

Title **Storage calcs for Littleborough,Rochdale**

By

Checked

Reviewed

Data:-

FSR Hydrology:-

Location = Littleborough,Rochdale

M5-60 (mm) = 19

Soil index = 0.45

Return period = 100

UCWI = 120.1

Grid reference = SD9316

r = 0.24

SAAR (mm/yr) = 1180

WRAP = 4

Climate change = 20

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

Runoff factor (RF) = 62.0, 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 = 1750 m²

Total area (TA) = 2340 m²

Mean pump disch. rate = 8.700 l/s

Additional flow = 0.00 l/s

Pervious area = 590 m²

Equiv area = 1451 m² (TA x RF).

Areal reduction factor = 1.000

Climate change factor = 20

Calculated data:-

Time to max = 54.0 mins

Rainfall at max = 48.92 mm/hr

Pipeline storage = 0.0 m³

Offline storage = 0.0 m³

Calculated storage volume = 35.7 m³

Allowed discharge rate = 8.700 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 = 8.700 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	4545.6	1125	35.9	400 x 600	198.3	500 x 500	142.8
150	2020.3	1200	31.6	600 x 900	86.3	500 x 750	95.2
225	897.9	1275	28.0	800 x 1200	48.6	500 x 1000	71.4
300	505.1	1350	24.9			750 x 1000	47.6
375	323.2	1425	22.4			750 x 1200	39.7
450	224.5	1500	20.2			750 x 1500	31.7
525	164.9	1575	18.3			1000 x 1000	35.7
600	126.3	1650	16.7			1000 x 1200	29.7
675	99.8	1725	15.3			1000 x 1500	23.8
750	80.8	1800	14.0			1000 x 1800	19.8
825	66.8	1875	12.9			1000 x 2000	17.8
900	56.1	1950	12.0			1500 x 1500	15.9
975	47.8	2025	11.1			1500 x 1800	13.2
1050	41.2	2100	10.3			1500 x 2000	11.9



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Data:-

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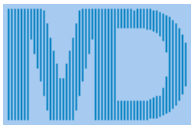
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Project **100yr+20%**

Title **Storage calcs for Littleborough,Rochdale**

Time (mins)	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)
10	110.0	26.631	5.220	21.411
20	82.0	39.650	10.440	29.210
30	67.0	48.668	15.660	33.008
40	58.0	55.795	20.880	34.915
50	51.0	61.746	26.100	35.646
60	46.0	66.876	31.320	35.556
70	42.0	71.392	36.540	34.852
80	39.0	75.427	41.760	33.667
90	36.0	79.069	46.980	32.089
100	34.0	82.385	52.200	30.185
110	32.0	85.423	57.420	28.003
120	30.0	88.221	62.640	25.581
130	29.0	90.809	67.860	22.949
140	28.0	93.210	73.080	20.130
150	26.0	95.445	78.300	17.145
160	25.0	97.530	83.520	14.010
170	24.0	99.479	88.740	10.739
180	23.0	101.304	93.960	7.344
190	22.0	103.071	99.180	3.891
200	22.0	104.852	104.400	0.452
210	21.0	106.568	109.620	0.000
220	20.0	108.224	114.840	0.000
230	20.0	109.824	120.060	0.000
240	19.0	111.372	125.280	0.000
250	19.0	112.872	130.500	0.000
260	18.0	114.328	135.720	0.000
270	18.0	115.743	140.940	0.000
280	17.0	117.118	146.160	0.000
290	17.0	118.456	151.380	0.000
300	17.0	119.761	156.600	0.000
310	16.0	121.032	161.820	0.000
320	16.0	122.273	167.040	0.000
330	15.0	123.485	172.260	0.000
340	15.0	124.669	177.480	0.000
350	15.0	125.827	182.700	0.000
360	15.0	126.960	187.920	0.000
370	14.0	128.069	193.140	0.000
380	14.0	129.156	198.360	0.000
390	14.0	130.221	203.580	0.000
400	14.0	131.265	208.800	0.000
410	13.0	132.290	214.020	0.000
420	13.0	133.296	219.240	0.000
430	13.0	134.283	224.460	0.000
440	13.0	135.254	229.680	0.000
450	13.0	136.207	234.900	0.000
460	12.0	137.144	240.120	0.000
470	12.0	138.066	245.340	0.000
480	12.0	138.973	250.560	0.000
490	12.0	139.865	255.780	0.000
500	12.0	140.743	261.000	0.000
510	11.0	141.608	266.220	0.000
520	11.0	142.460	271.440	0.000
530	11.0	143.300	276.660	0.000
540	11.0	144.127	281.880	0.000
550	11.0	144.943	287.100	0.000
560	11.0	145.747	292.320	0.000
570	11.0	146.540	297.540	0.000
580	11.0	147.322	302.760	0.000
590	10.0	148.095	307.980	0.000
600	10.0	148.857	313.200	0.000

Storage volume (m³) = 35.7 m³



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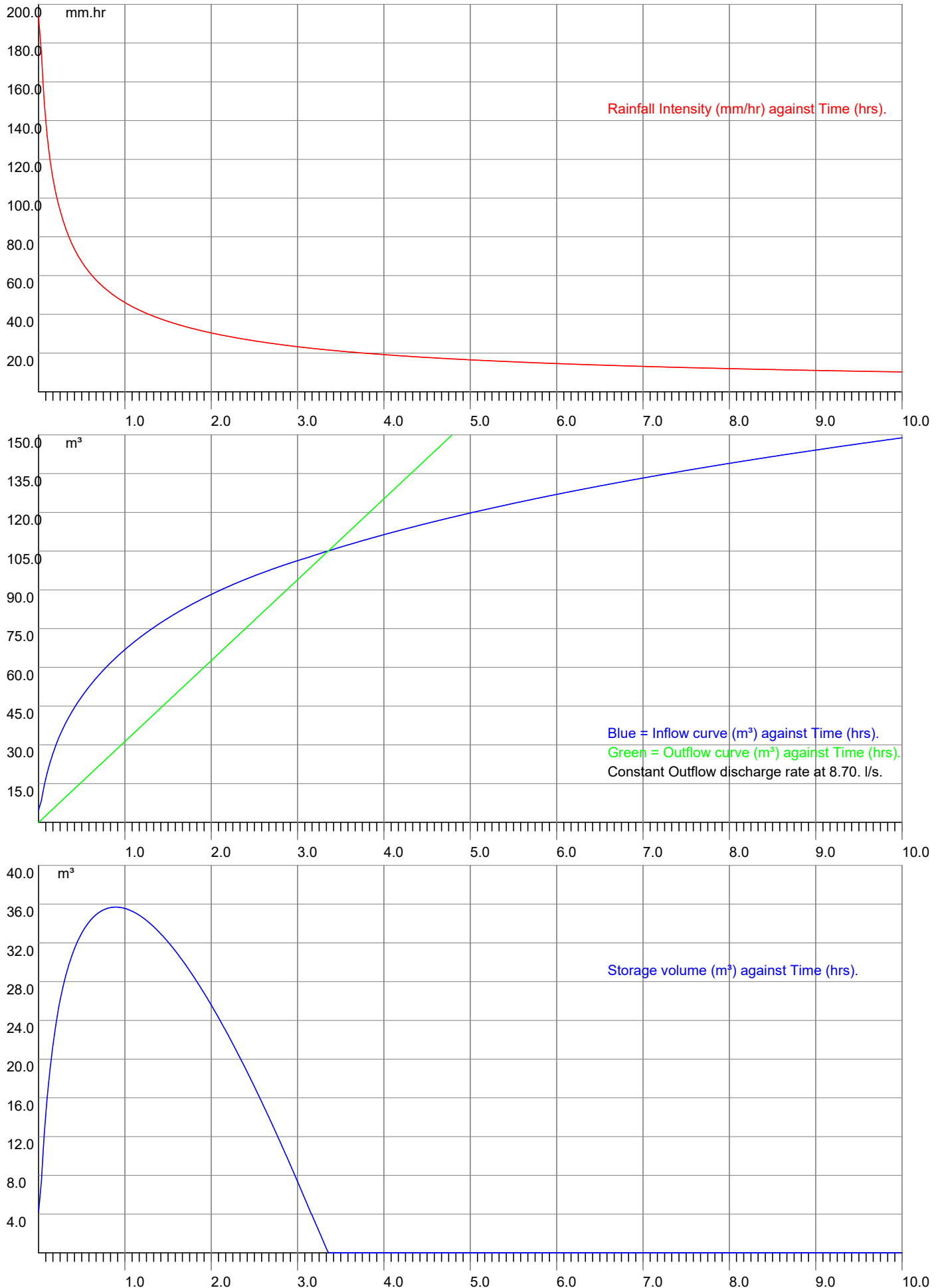
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Job No.		
Sheet no. 3		
Date 10/06/22		
By	Checked	Reviewed

Project **100yr+20%**
Title **Storage calcs for Littleborough,Rochdale**





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Job No.

Sheet no. **1**

Date **10/06/22**

Project **100yr +40%**

Title **Storage calcs for Littleborough,Rochdale**

By

Checked

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Data:-

FSR Hydrology:-

Location = Littleborough,Rochdale

M5-60 (mm) = 19

Soil index = 0.45

Return period = 100

UCWI = 120.1

Grid reference = SD9316

r = 0.24

SAAR (mm/yr) = 1180

WRAP = 4

Climate change = 40

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

Runoff factor (RF) = 62.0, 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 = 1750 m²

Total area (TA) = 2340 m²

Mean pump disch. rate = 8.700 l/s

Additional flow = 0.00 l/s

Pervious area = 590 m²

Equiv area = 1451 m² (TA x RF).

Areal reduction factor = 1.000

Climate change factor = 40

Calculated data:-

Time to max = 66.0 mins

Rainfall at max = 50.92 mm/hr

Pipeline storage = 0.0 m³

Offline storage = 0.0 m³

Calculated storage volume = 46.8 m³

Allowed discharge rate = 8.700 l/s

Available MH storage = 0.0 m³

Fixed 6 hour data:-

Rainfall event = 6 hours

Rainfall rate = 17.00 mm/hr

Calculated storage volume = 0.0 m³

Allowed discharge rate = 8.700 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	5960.7	1125	47.1	400 x 600	260.0	500 x 500	187.2
150	2649.2	1200	41.4	600 x 900	113.2	500 x 750	124.8
225	1177.4	1275	36.7	800 x 1200	63.7	500 x 1000	93.6
300	662.3	1350	32.7			750 x 1000	62.4
375	423.9	1425	29.4			750 x 1200	52.0
450	294.4	1500	26.5			750 x 1500	41.6
525	216.3	1575	24.0			1000 x 1000	46.8
600	165.6	1650	21.9			1000 x 1200	39.0
675	130.8	1725	20.0			1000 x 1500	31.2
750	106.0	1800	18.4			1000 x 1800	26.0
825	87.6	1875	17.0			1000 x 2000	23.4
900	73.6	1950	15.7			1500 x 1500	20.8
975	62.7	2025	14.5			1500 x 1800	17.3
1050	54.1	2100	13.5			1500 x 2000	15.6



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Data:-

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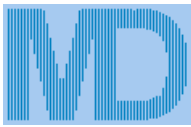
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Project	100yr +40%
Title	Storage calcs for Littleborough,Rochdale

Time (mins)	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)
10	128.0	31.069	5.220	25.849
20	96.0	46.258	10.440	35.818
30	78.0	56.779	15.660	41.119
40	67.0	65.094	20.880	44.214
50	60.0	72.036	26.100	45.936
60	54.0	78.022	31.320	46.702
70	49.0	83.291	36.540	46.751
80	45.0	87.998	41.760	46.238
90	42.0	92.247	46.980	45.267
100	40.0	96.116	52.200	43.916
110	37.0	99.661	57.420	42.241
120	35.0	102.925	62.640	40.285
130	34.0	105.943	67.860	38.083
140	32.0	108.745	73.080	35.665
150	31.0	111.352	78.300	33.052
160	29.0	113.785	83.520	30.265
170	28.0	116.059	88.740	27.319
180	27.0	118.188	93.960	24.228
190	26.0	120.249	99.180	21.069
200	25.0	122.328	104.400	17.928
210	24.0	124.329	109.620	14.709
220	24.0	126.261	114.840	11.421
230	23.0	128.127	120.060	8.067
240	22.0	129.934	125.280	4.654
250	22.0	131.685	130.500	1.185
260	21.0	133.383	135.720	0.000
270	21.0	135.033	140.940	0.000
280	20.0	136.637	146.160	0.000
290	20.0	138.199	151.380	0.000
300	19.0	139.721	156.600	0.000
310	19.0	141.204	161.820	0.000
320	18.0	142.652	167.040	0.000
330	18.0	144.065	172.260	0.000
340	18.0	145.447	177.480	0.000
350	17.0	146.798	182.700	0.000
360	17.0	148.120	187.920	0.000
370	17.0	149.414	193.140	0.000
380	16.0	150.682	198.360	0.000
390	16.0	151.924	203.580	0.000
400	16.0	153.143	208.800	0.000
410	16.0	154.338	214.020	0.000
420	15.0	155.512	219.240	0.000
430	15.0	156.664	224.460	0.000
440	15.0	157.796	229.680	0.000
450	15.0	158.908	234.900	0.000
460	14.0	160.001	240.120	0.000
470	14.0	161.077	245.340	0.000
480	14.0	162.135	250.560	0.000
490	14.0	163.176	255.780	0.000
500	14.0	164.201	261.000	0.000
510	13.0	165.210	266.220	0.000
520	13.0	166.204	271.440	0.000
530	13.0	167.183	276.660	0.000
540	13.0	168.148	281.880	0.000
550	13.0	169.100	287.100	0.000
560	13.0	170.038	292.320	0.000
570	12.0	170.963	297.540	0.000
580	12.0	171.876	302.760	0.000
590	12.0	172.777	307.980	0.000
600	12.0	173.666	313.200	0.000

Storage volume (m³) = 46.8 m³



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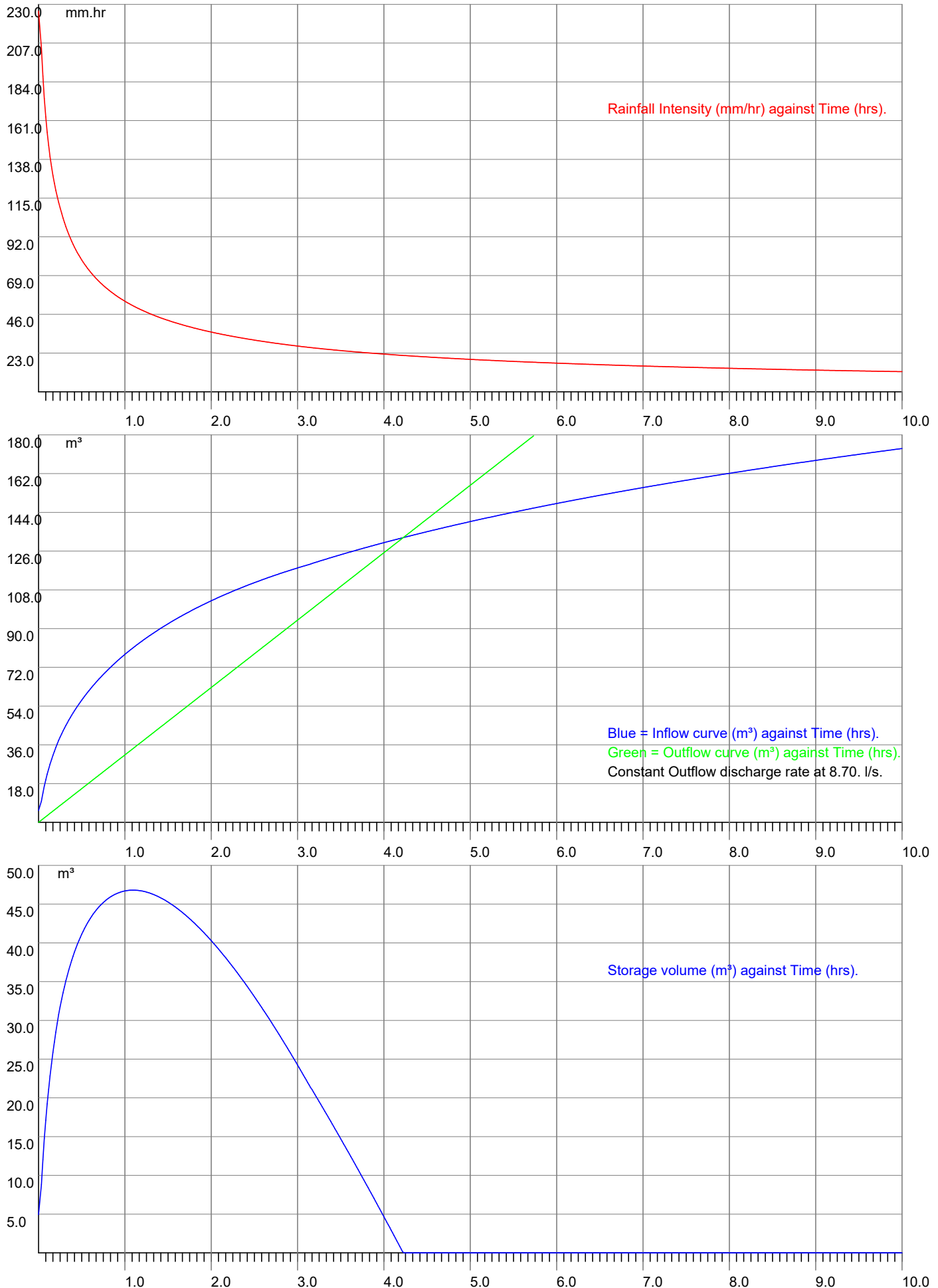
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Project **100yr +40%**
Title **Storage calcs for Littleborough,Rochdale**





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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 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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