

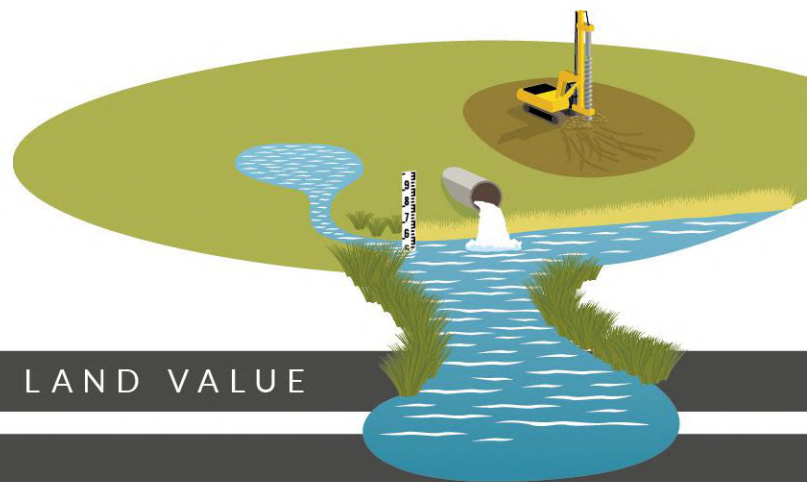
MILLWOOD SEN SCHOOL, RADCLIFFE

FLOOD RISK ASSESSMENT
& OUTLINE DRAINAGE STRATEGY

Job Number: FRA 23 1118

Date: September 2023

Client: ISG Ltd



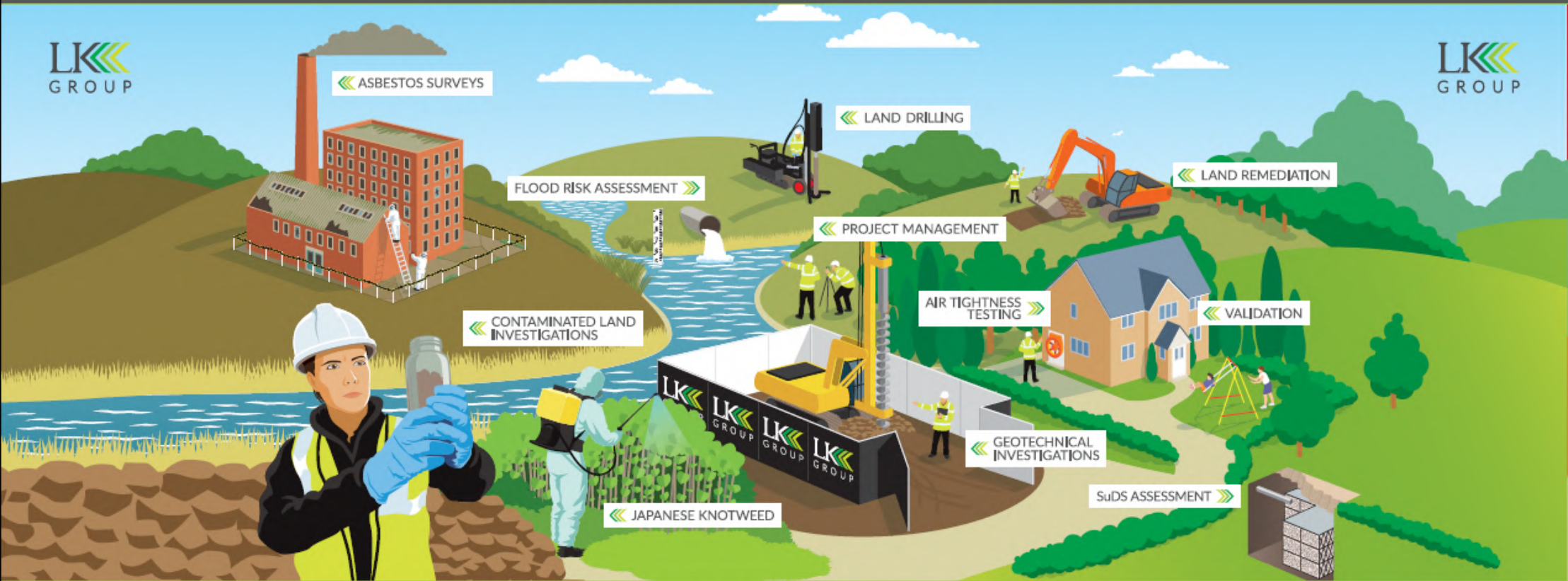
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LK Consult Document Verification			
Site Address	School Street, Radcliffe, Manchester, M26 3BW		
Report Title	Flood Risk Assessment & Outline Drainage Strategy		
Job Number	FRA 23 1118	Document Ref.	FRA 23 1118 - COM - R0
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Prepared By	Jenna Lowe – Flood Risk Engineer	Reviewed By	Mark Jones - Associate

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Revision No.	Date	Nature of Revision	Approved By

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EXECUTIVE SUMMARY

Scope and Background

This Flood Risk Assessment (FRA) and Outline Drainage Strategy has been undertaken by LKC to support a planning application for Millwood SEN School, Radcliffe. The development comprises the erection of a new classroom block.

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, and modelled data was available.

Bury Metropolitan Borough Council - Lead Local Flood Authority (LLFA) and United Utilities (UU) were also consulted concerning flood risk.

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

Flood Risk

The site is shown on the EA's Flood Zone Mapping website as being in Flood 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).

Mitigation

Design

Site falls will be arranged to allow reasonably level access for occupants and visitors and to allow the site to be free-draining in case of local ponding at times of heavy rainfall. Floor levels of the classroom block will be set as high as possible above the flood level giving regard to necessary access for the less-able.

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 surface water culvert in the footpath to the southwest of the school grounds if practical, alternatively the surface water sewer within School Street should be considered.

The proposed development will increase the proportion of the site covered by impermeable surfaces and will therefore generate more runoff. Attenuation will therefore be required including an allowance for climate change.

The outline drainage strategy considers the use of attenuation-based SuDS to be feasible with a potential discharge to the surface water culvert to the south of the school. The feasibility of the connection will need to be confirmed and will potentially be limited by the form of the attenuation and accessibility. The alternative would be a connection to the surface water sewer in School Street. Therefore, the most effective strategy, in line with the SuDS management train, would be to have a detention facility at the southern boundary.

The estimated volume to be retained on site for the 1 in 30-year storm event including an allowance for climate change is **32.7m³**.

The estimated volume to be retained on site for the 1 in 100-year storm event including an allowance for climate change is **51.2m³**.

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 School Street.

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1 Introduction

1.1 Background

LK Consult Ltd (LKC) were commissioned by ISG Ltd to carry out a Flood Risk Assessment (FRA) and Outline Drainage Strategy for Millwood SEN School, Radcliffe. The report was undertaken in support of a future planning application to extend the site to include a new classroom block associated with the school for educational use.

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

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

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

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	Western end of School Street, to the rear of Millwood School, Radcliffe, Manchester, M26 3BW. Centred at approximate National Grid Reference 377850E, 407120N.
Area	Approximately 2000m ² .
Topography	77.89 metres above ordnance datum (AOD) in the east of the site and 78.39m AOD in the northwest. The site is sloping down gently to the eastern boundary.
Current Land Use	<u>Site</u> Site is partially undeveloped with an area used as an existing surfaced play area. The site is served by land drainage. <u>Surrounding Area/ Boundary Treatment</u> North: Grassed area and playground. East: Millwood SEN School buildings. South: Traveller's site and Residential properties. West: Manchester, Bolton and Bury Canal and grassland beyond.
Proposed Development	Erection of new classroom block associated with the school.

Table 1-1: Summary of site details.

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

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

2 Site Setting

2.1 Vulnerability

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

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

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

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

The proposed development is for an educational end use and this is classified within the 'More 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 (BGS) data, EA data, historical mapping, and aerial photography to provide a summary of the environmental setting of the site. This is summarised in Table 2-1 below.

Summary of the Environmental Setting			
Geology	Superficial		Till, Devensian – Diamicton.
	Bedrock		Pennine Middle Coal Measures Formation - Mudstone, siltstone and sandstone.
	BGS Boreholes		BH Ref: SD70NE343, 250m SE: Made ground (yellowish brown Clay and stiff slightly sandy Clay) to 2.00m, slightly sandy Clay to 2.80m and medium dense clayey fine to medium Sand with occasional gravel to 3.30m. (Slight water entry at 2.90mbgl).
	Defra Soilscape Mapping		Type 17: Slowly permeable seasonally wet acid loamy and clayey soils.
Hydro-geology	Aquifer Designation	Superficial	Secondary Undifferentiated Aquifer.
		Bedrock	Secondary A Aquifer.
	Source Protection Zone (SPZ)		Site not within an SPZ.
Hydrology	All adjacent and internal surface water		The Manchester, Bolton, and Bury Canal (closed) is adjacent to the west of the site. The River Irwell (Roch to Croal) is located approximately 260m south of the site.
	Flooding		Flood Zone 1.
Site History			Historical mapping indicates that the site formerly Peel Park, consisted of a cricket ground and park grounds from the earliest available mapping in 1891. The operational Manchester, Bolton and Bury Canal towing path was located adjacent to the west of the site. Cotton mills were also located approximately 40m west of the site and bleach and dye works were located approximately 80m south of the site. The canal basin and a reservoir were located approximately 190m and 490m west and southwest of the site respectively. Residential properties are present approximately 220m east of the site from 1895. 1938 mapping indicates that the cricket and park grounds have been converted into a school. The school boundary and accompanying playing fields have been present since.

Table 2-1: Summary of the Environmental Setting.

2.4 Geo-Environmental Investigation

The investigation was undertaken on site by LK Consult Ltd in August 2023³.

The investigation involved the drilling of five window sample boreholes (referenced WS101 to WS105) to depths of 5.5mbgl.

Made ground was recorded in all window sample boreholes consisting of slightly gravelly slightly sandy SILT with frequent rootlets and occasional brick fragments and coal fragments and very loose density slightly silty sandy GRAVEL. Depths are recorded between 0.30 and 1.65mbgl.

Natural strata comprised gravelly sandy CLAY, very sandy silty CLAY and medium density silty SAND with occasional clay lenses (very wet strata at 3.00-4.00mbgl). Very stiff silty CLAY recorded between 4.70 and 5.45mbgl.

All sampling locations are shown in Appendix B.

Groundwater was recorded as detailed below:

- » WS102: water struck at 3.10mbgl
- » WS103: water struck at 1.00mbgl
- » WS104: water struck at 2.10mbgl

2.5 Site Reconnaissance

The site is relatively flat with a slight fall to the east.

Relevant features identified on site are summarised below:

- » The site consists mainly of mown grass with the occasional shrubs and trees.
- » Hardstanding across part of the eastern area of the site.
- » The grassed area is served by a land drainage system.
- » Site is bounded to the west by the canal and towpath.
- » There are contradictory plans of the drainage system serving the area ranging from a sustainable drainage system to allow soakage into the ground to formed soakaways to drain the school buildings.
- » There is a soakaway located to the west of the existing building adjacent to the east of the proposed classroom block.
- » Site observations indicate a more conventional herringbone drainage system.

2.6 Site and Access Levels

A topographic survey of the site has been undertaken to OS GPS datum, and information is included on the drawings in Appendix B. The site elevation ranges from 77.89m AOD in the east of the site to 78.39m AOD in the northwest. The site is sloping down gently towards the eastern boundary. The final site levels and ground floor levels of the classroom block have not yet been determined.

³ Report Name: Phase 2 Geo-Environmental Investigation and Risk Assessment report by LK Consult (Ref: LKC 23 1383, dated September 2023).

3 Consultation

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

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

For modelled levels refer to extracted Level table and node location map in Appendix C.

Source	Details	
EA	Flood Zone 1: Very Low risk, with annual probability of flooding from rivers and the sea of less than 0.1% (1 in 1000).	
	Modelled Levels for the River Irwell (approx. 550m SE) Nearest Node: 977186	<u>Defended Levels:</u> Level of 60.95m for 1% annual probability event. Level of 61.73m for 0.1% annual probability event. <u>Undefended Levels:</u> Level of 60.92m for 1% annual probability event. Level of 61.80m for 0.1% annual probability event.
	Records of Flooding	No records of flooding from any source.
	Records of Flood Warning Service	Not within a flood warning service area.
	Surface Water Flooding	Very Low risk of surface water flooding across the entire site. Low risk of surface water flooding adjacent the west of site associated with the disused canal. There is a low risk of surface water flooding to the east of the existing school building.
	Flooding from reservoirs	The site is not at risk from reservoirs.
Bury Metropolitan Borough Council (LLFA)	No information provided at the time of writing. The LLFA would follow the non-technical standards which state that where infiltration is not viable, surface water discharge rates for greenfield sites are noted as the peak runoff rate from the development to any highway drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event should never exceed the peak greenfield runoff rate for the same event.	
	Possible or known incidents of highway flooding	Unaware of any current flooding problems associated with School Street.

Table 3-1: Summary consultee information.

Source	Details	
United Utilities (UU)	Likely conditions for connecting into their sewerage system	UU would request conditions for a separate system with only foul draining to foul / combined sewers and surface water draining to soakaway/SuDS, watercourse or surface water sewer. All surface water flow from the proposed development should drain in-line with the drainage hierarchy, as outlined in Paragraph 80 of the National Planning Practice Guidance. Surface water runoff generated from this development should discharge to the ground via infiltration system where feasible. If not feasible, UU would consider a connection to their surface water sewer in School Street will consider a pass forward flow to be agreed by the Lead Local Flood Authority. UU request that any agreed rate does not exceed 5l/s. Foul flow from this site will be allowed to drain into the public combined sewer system. UU's preferred point of discharge would be to the 150mm diameter public combined sewer within School Street at an unrestricted rate. UU confirmed that they did not have any record of internal or external sewer flooding of properties in the vicinity of the site as a result of overloaded sewers.
	Sewer map	There is a 150mm diameter surface water sewer adjacent to the south of the site in School Street running easterly. There is a 150mm diameter combined sewer southeast of the site in School Street running easterly. There is a 1100 / 900mm diameter culverted watercourse to the west of the site flowing in a south easterly direction towards School Street.
Strategic Flood Risk Assessment (SFRA)	Level 1 SFRA ⁴	The site has no history of flooding.
	Level 2 SFRA ⁵	The site has no history of flooding.
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: Summary consultee information (continued).

⁴ Strategic Flood Risk Assessment Level 1: GMCA; 'Level 1 SFRA for Greater Manchester' (2019), JBA Consulting.

⁵ Strategic Flood Risk Assessment Level 2: GMCA; 'Greater Manchester Level 2 Hybrid SFRA' (2020), JBA Consulting.

⁶ Preliminary Flood Risk Assessment: Bury Council; 'Preliminary Risk Assessment' (2017), 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).

A direct comparison was made between the provided EA flood levels at this location and the topographical levels.

The EA design flood levels are significantly lower than the site. It can be reasonably concluded on the evidence above that the site is in Flood Zone 1 for the purposes of this assessment.

Comparison of the modelling data and topographical survey indicates that the 1% (100-year) flood level would not affect any part of the site. Therefore, the actual flood position is much better than that indicated by the published flood map.

The extents of the 0.1% (1000-year) flood level remain outside of the development area.

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 adjacent the eastern boundary of the site that have the potential to flood during prolonged heavy rainfall. These areas need consideration within the detailed design or there is the potential to have areas of standing water in landscaped areas not positively drained if overland flow routes are not considered. Therefore, the risk of flooding from pluvial sources is Very Low but should be considered further during the detailed design.

Surface Water (Overland flow) – This relates to surface water entering the site. Surface water arising from the northwest of the study area is likely to be intercepted by the adjacent disused canal and therefore pose no threat to the development. If there was a drainage failure causing overland flow, it would flow towards the eastern boundary. Therefore, the flood risk of flooding from surface water sources is considered Very Low. A source of the potential surface water is the watercourse to the eastern boundary.

Groundwater – The BGS has groundwater records for the study area in the form of borehole records. The records show the water table is recorded at 2.90mbgl. Previous investigations have shown water at a shallower depth, this may be perched water. The shallow groundwater records indicate that water may enter any deep excavations or service trenches during construction and de-watering may be necessary. This makes it possible for groundwater flooding to occur. No evidence of shallow groundwater was observed during the walkover. Therefore, the flood risk associated with this groundwater sources is considered Low.

Sewers – UU sewer records show combined and surface water sewers within the vicinity of the study area. The Pre-development Enquiry states that no property on land within the vicinity of the site 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 sewers is considered Very Low.

Artificial sources – According to the EA online maps, the study area is not at risk from reservoir flooding. The water level in the canal is 1.5 to 2.0m below the site level. Therefore, the flood risk associated with artificial sources is considered Negligible.

4.3 Summary of Flood Risk

Source of Flooding	Risk Assessment Level
Fluvial	Very Low
Tidal	Negligible
Pluvial (Rainfall)	Very Low
Surface Water	Very Low
Groundwater	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 Negligible to Very Low risk of flooding from all sources except groundwater sources which poses a Low risk of flooding 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

The Groundwater Source Protection Zone mapping from the EA website shows that the site is not within any identified protection zones. A summary of the BGS superficial and bedrock aquifer descriptions and classifications supplemented by local records is shown in Table 5-1 below:

Classification	Description	Recorded Water Table Depth	Soakaway Potential
Till Superficial Deposits	Silty, sandy gravelly Clay and very sandy silty Clay	Approx. 1.0-3.1mbgl	Poor
Pennine Middle Coal Measures Bedrock	Sandstone Mudstone and Siltstone	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.

Although bands of sandy gravel are recorded these appear to be waterlogged. Infiltration methods such as soakaways are unlikely to be feasible given the silty CLAY recorded on site and shallow groundwater levels beneath the site recorded during the site investigation, but this may be investigated further at the detailed design stage, if required. There is an existing soakaway located on site which may explain the shallow water table level recorded during the site investigation.

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 east.

There is a culverted watercourse running adjacent to the southwest corner of the site of the site.

There is a surface water sewer running adjacent to the south of the site in School Street that flows into a combined sewer.

The proposed building is adjacent to the west of an existing soakaway. Its location will need to be confirmed during the detailed design phase.

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	3	Not likely to be feasible as the site is constrained by the shallow water table. The impermeable ground conditions and recorded shallow water table also make the use of infiltration unlikely. There is an existing soakaway shown on the school plans which may indicate why the water table across site is shallow with water perched above the clay-based layers below the granular layer.
b	Connection to Watercourse	1	Would potentially require third party access and LLFA consent dependant on the depth of the attenuation. The culverted watercourse turns to the southeast and crosses the traveller site this may cause disturbance to the residents before it was deep enough to make a connection by gravity.
c	Discharge into a sewer	2	A connection into the 150mm diameter surface water sewer in School Street would be possible – subject to approval from UU and the LLFA.

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

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

⁹ CIRIA C753 - The SUDS Manual. London 2015.

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

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

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

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

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

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

Notes

- ✓ Suitable for use given the nature and scale of the development.
- * Possibly suitable for use – not included in the client and architect design proposal at present.
- X Not suitable.

5.3 Surface Water Attenuation Requirements

In accordance with the non-statutory guidance, the flow from this development should be limited to a 'greenfield scenario' for estimating the attenuation volumes required.

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

Designated Areas	Plot Area
Total area (m ²)	2000
Impermeable Area (m ²)	180
Permeable Area (m ²)	1820
Contributing Catchment	
Developable Area (m ²)	2000
Impermeable Area (m ²)	1380
Permeable Area (m ²)	620

Table 5-4: Assumed plot areas.

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

5.3.1 Attenuation Estimate

Surface water storage and greenfield runoff estimations based on the HR Wallingford procedure (IH 124¹⁰) 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 1380m² and a greenspace of 620m². This gives the following runoff rates and attenuation requirements for this section based on the Wallingford IH 124 method:

» Q _{bar} :	1.360 l/s
» 1 in 1-year greenfield runoff rate:	1.160 l/s
» 1 in 30-year greenfield runoff rate:	2.290 l/s
» 1 in 100-year greenfield runoff rate:	2.870 l/s

Existing Peak Flows

» Q _{bar} :	1.900 l/s
» 1 in 1-year existing runoff rate:	1.300 l/s
» 1 in 30-year existing runoff rate:	3.400 l/s
» 1 in 100-year existing runoff rate:	4.300 l/s

5.3.2 Discharge Rate

Peak flow control

S3 For developments which were previously developed, the peak runoff rate from the development to any drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event must be as close as reasonably practicable to the

¹⁰ IH124 Flood Estimation of Small Catchments.

greenfield runoff rate from the development for the same rainfall event, but should never exceed the rate of discharge from the development prior to redevelopment for that event.

Volume control

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

The assumed runoff rate for a connection to the culverted watercourse should be as close to the greenfield runoff rate as practical. Thus 2.5l/s has been utilised for the estimated attenuation requirements. UU has specified an allowable discharge rate of up to 5l/s to their adjacent surface water sewer if this proves to be impractical.

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

The following attenuation has been estimated for the development using 2.5l/s runoff rate and utilises the FSR methodology¹¹ as:

- Attenuation storage volume: **32.7 m³** (1 in 30 year event + 25% Climate Change)
- Retention on site volume: **51.2 m³** (1 in 100 year + 30% Climate Change)

Attenuation storage aims to limit the peak rate of runoff from the development to the 2.5l/s runoff for a range of annual flow rate probabilities before discharging into a sewer. As the flow from the development would be restricted 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 be negligible.

The attenuation required for a 1 in 30-year storm event, requires a storage volume of **32.7 m³**. For the 1 in 100-year event, a storage capacity of **51.2 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 an attenuation tank or similar is deemed to be the most feasible and practical option for the development. The potential use of surface SuDS features may not be suitable considering the proposed development location. The attenuation tank will provide required storage volume to limit peak runoff arising from the development.

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

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.

¹¹ Flood Studies Report Wallingford NERC 1975.

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 potential foul drainage strategy is considered elsewhere.

6 Mitigation Measures

6.1 Proposed Site levels and Developments Level

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

This and the 0.1% annual probability (1 in 1000-year) are below the lowest existing ground level measured on site by approximately 16m. On this basis the finished floor levels (FFL) should be set at a nominal height above the finalised ground levels to allow for any overland flow from a drainage failure. No further mitigation measures are therefore recommended.

6.2 Safe Access

Safe and dry access is available via School Street (78.36m AOD) to the south at 17.44m above the 1% annual probability event (60.92m AOD). Therefore, no mitigation is proposed.

6.3 Flood Resistance and Resilience

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

6.4 Residual Risk

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

7 Conclusions

The site is mostly a grassed area but includes an area of existing playground. The proposal is for the erection of a new classroom block associated with the existing school.

The site is shown on published mapping to be located within the EA'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.

Negligible to Very Low Risks of flooding from all sources except groundwater flooding which poses a Low Risk of flooding have been identified from information provided by the BGS, LLFA and EA.

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 School Street.
- » Potential for soakaway use for rainwater disposal is low; however, this could be investigated further at the detailed design phase.
- » Surface water flow will likely need to be attenuated to the 2.5l/s runoff rate or a rate agreed with the LLFA.
- » Surface water arising from the site could potentially discharge into the culvert located to the southwest of the site. This would need to be confirmed dependant on the form of attenuation that is designed due to the topography of the site and the invert level of the culvert. If this proves impractical a connection to the surface water pipe within School Street should be considered, this should be discussed with Building Control.
- » Two different design drawings for the drainage within the area were supplied within the information pack but a visual inspection could not confirm the installation, this should be confirmed on site or otherwise. There is an existing soakaway identified on the site this may affect the building layout.
- » Land drainage has been installed across the area but does not reflect the design drawings.
- » A formal evacuation plan is not considered to be required.

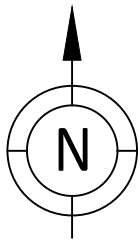
Further details on the proposed mitigation measures are provided in Section 6. All proposed measures should be agreed with the Local Authority prior to commencement of the development.

Appendix A

Figures, Plans and Drawings



Client: ISG Ltd				Title: Site Location & Boundary Plan			
Site: Millwood SEN School, Radcliffe				Scale (see scale bar): 1:15,000 & 1:1,000 @ A4			
Job No.: FRA 23 1118		Drawn By: JL	Checked By: MJ	Drawn: Aug 2023	Figure: 1		



KEY

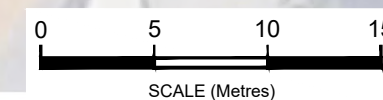
 Site Boundary

Sampling Locations and features annotated by LK Consult Ltd are approximate and are based upon observed measurements unless otherwise stated. Do not scale from this drawing and work from marked dimensions only. All dimensions and features should be confirmed on site by the Contractor. Where this drawing includes information provided to LK Consult Ltd by others, LK Consult Ltd gives no warranty, representation or assurance as to the accuracy of such information.



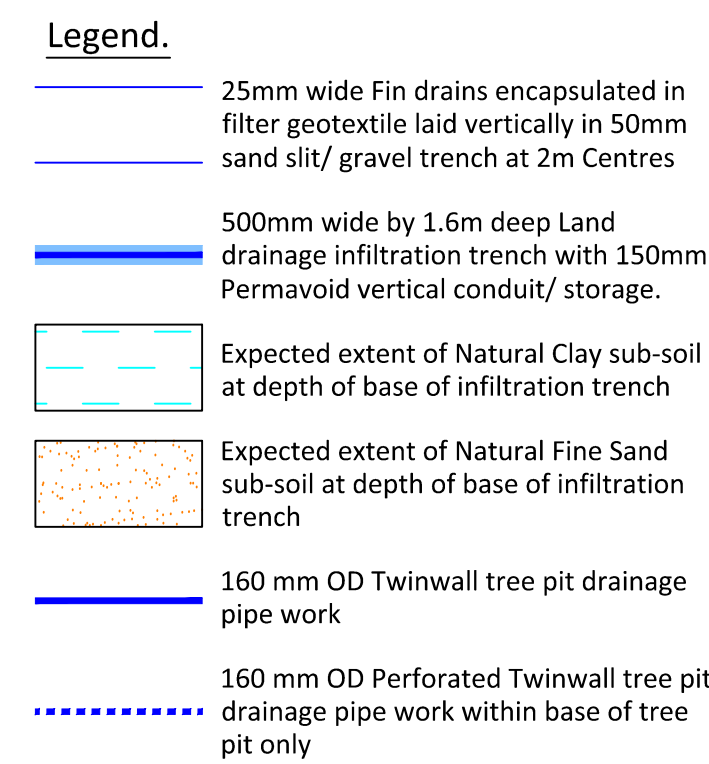
Client:		ISG Ltd	
Site:		Millwood SEN School, Radcliffe	
Title:		Proposed Development Plan	
Job No.:	FRA 23 1118	Scale (See Scale Bar):	See Scale Bar
Drawn By:	AC	Checked By:	HM
		Drawn:	Aug 2023
		Figure:	2
		Revision:	

Extract From: Bradshaw Gass & Hope LLP
Drawing Ref: Proposed Floor Plan, No.2128.26.301, Rev:P4 (19/05/2023)



Appendix B

Site Information



- [illegible]



FOR COMMENT			
REV	DESCRIPTION		DATE
 Warrington Building Services 100 Long Lane Warrington Cheshire WA1 1LH T: 01925 452 788 F: 01925 452 789 W: www.epg.co.uk E: enquiries@epg.co.uk			
PROJECT			
MILLWOOD S.E.N. SCHOOL RADCLIFF			
CLIENT			
I.S.G. / BARDON			
DRAWING TITLE			
SURFACE WATER MANAGEMENT SUSTAINABLE LAND-DRAINAGE LAYOUT & DETAILS			
SCALE		DATE	
1:200 & 1:20 @ A0		17/01/2012	
DRAWN BY PP		CHECKED BY PC	
REVISIONS		REVISION	
EPG/7703/02			

SDTONE 340-347

REPORT NO. 7294

SCHOOL STREET, RADCLIFFE

for
NORTH BRITISH HOUSING ASSOCIATION

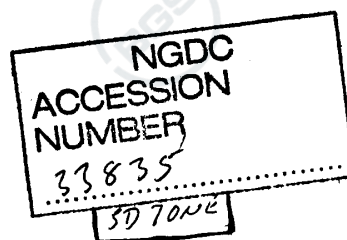
requested by
WRIGHT MOTTERSHAW
Errwood House
212 Moss Lane
Bramhall
Stockport
Cheshire
SK7 1BD

compiled by
G. HARWOOD BSc
A.W. WALKER BSc

STRATA SURVEYS LIMITED
Strata House
Holmes Chapel Road
Middlewich
Cheshire
CW10 OJB

Tel: 0606-834637
Fax: 0606-836657

8th October 1993





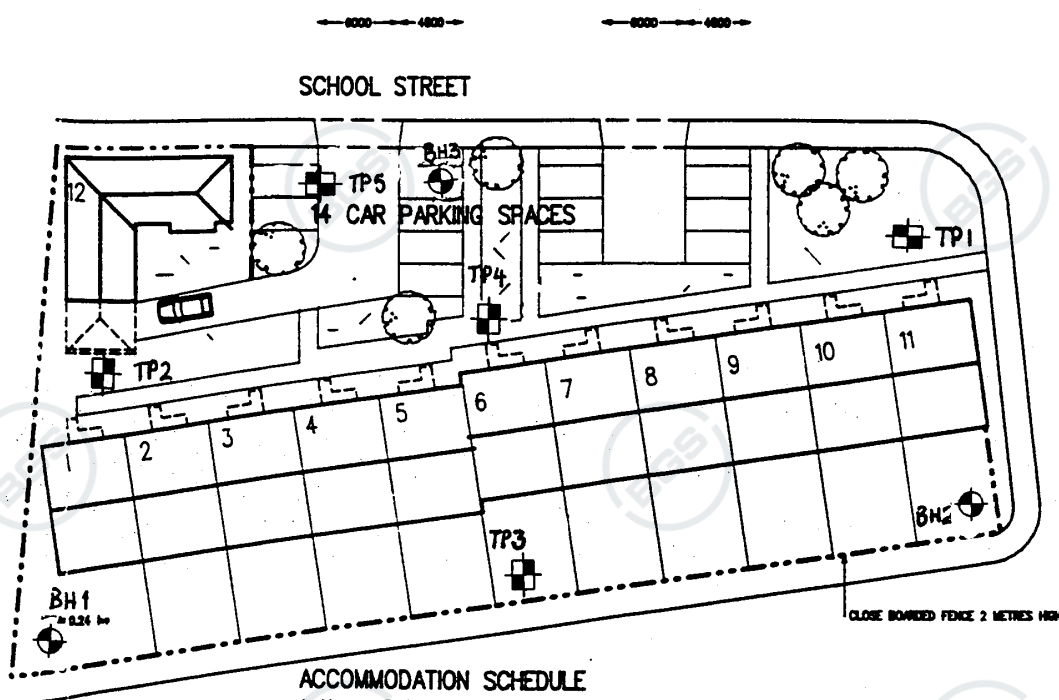
SD70NE 343

7812 0706

STRATA SURVEYS LTD., HOLMES CHAPEL ROAD, MIDDLEWICH, CHESHIRE. CW10 0JB Telephone: 0606 834637 Fax: 0606 836657					Trial Pit No. : 1 Sheet No. 1 Of 1. Depth 0 to 4 metres. Dates : 14-SEPT-93				
Job Number : 7294 Location : School Street, Radcliffe Client : Wright Mottershaw					Equipment and Methods JCB 3CX Hydraulic Excavator Engineer : GH				
Description of Strata	Red. Level	Legend	Thick- ness	Depth m	Sample Depths	Sample Types	NMC	Cu	Remarks
MADE GROUND (brick rubble)	100.01		(0.70)	0.00					
MADE GROUND (black topsoil with rotting roots)	99.31		(0.30)	0.70					
MADE GROUND (black ash)	99.01		(0.10)	1.00	1.00	D 1			
MADE GROUND (yellowish brown clay with fragments of pottery becoming grey with brick fragments with depth and red ash bands at 1.40m and 1.55m)	98.41		(0.50)	1.60	1.60	D 2			
Firm to stiff grey slightly sandy CLAY with fragments of rotting roots, and slight organic odour.	98.01		(0.40)	2.00	2.10	B_1			
Firm green yellow slightly sandy CLAY, with bands of blue grey fine to medium sand, becoming sandier with depth.	97.21		(0.80)	2.60	2.60	B_2			
Medium dense grey clayey fine to medium SAND with occasional gravel, with some pockets of soft to firm grey very sandy clay.	96.71		(0.50)	2.80	2.80	B_3			
End of Trial Pit				3.30	3.20				Slight water entry at 2.90m, blocked off with next scoop of the JCB bucket. End of Pit @ 3.30m
Key Pp Pocket Penetrometer Sample Types U Undisturbed D Disturbed B Bulk Disturbed N Water In-Situ Tests V Vane Test Pb Plate Bearing Test CBR In-Situ CBR Test					Progress / Water Levels Borehole Depth Water Level Water Strike General Remarks Level of the Pit is taken from a local site datum shown on Drawing No. 11. Water entering the base of the pit at 3.30m. Sides of the pit stable except for the layer of brick rubble.				
Sketch/Plan									

SD ZONE
340-347

136



ACCOMMODATION SCHEDULE

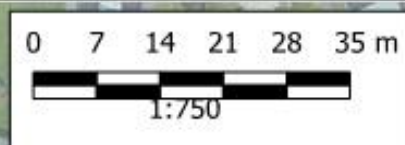
- 1-11 - 2-bed 3-person category 1 bungalows
- 12 - 2-bed 3-person category 1 disabled/wheelchair residence/bungalow



THE RATCLIFFE GROVES PARTNERSHIP CHARTERED ARCHITECTS

NBHA SCHOOL STREET RADCLIFFE	SCALE 1:500	DATE JULY'93
SITE LOCATION & PROPOSED SITE LAYOUT	DRAWN GJW	CHECKED
DRAWING TITLE	JOB NO 2693	DRAWING NO 04

105 MANCHESTER ROAD BURY LANCS BL9 0TD 061 797 6000
also at 83/84 LONG ACRE, COVENT GARDEN, LONDON, WC2E 9JL TEL 071 240 9827



KEY

- Site Location
- Till, Devensian

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Client	ISG Ltd		
For	Millwood SEN School		
For	Superficial Geology		
Ref No.	FRA 23 1118	Scale (see note 1a)	1:800 @ A4
Drawn By	JL	Checked By	MJ
		Issue	Aug 2023



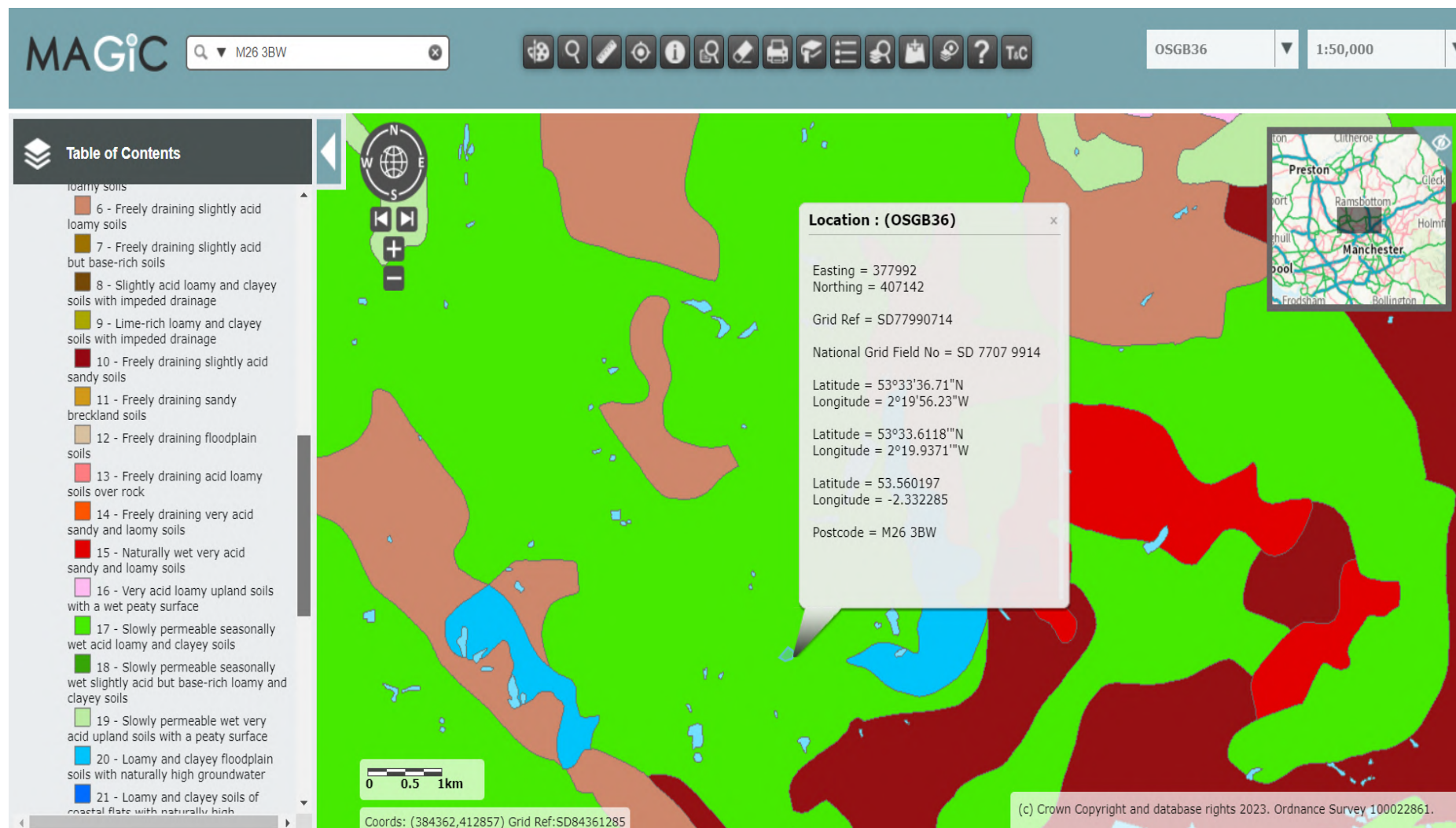
KEY

- Site Location
- Pennine Middle Coal Measures Formation

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Client		ISG Ltd	
Site		Millwood SEN School	
Title		Bedrock Geology	
Job No.	FRA 23 1118	Scale (see scale bar)	1:800 @ A4
Drawn By	JL	Checked By	MJ
		Date	Aug 2023
Figure		Rev	



Defra Soilscape Mapping - (c) Crown Copyright and database rights 2023. Ordnance Survey 100022861

Excavation Method

Drive-in Windowless Sampler
driven to 5.45mbgl.

Dimensions
Location (dGPS)

377841.5 E 407151.8 N

Ground Level (mOD)

78.58

Client

ISG

**Job
Number**

LKC 23 1383

Dates

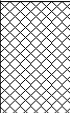
10/08/2023

Engineer

LKC

Sheet

1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.50-1.00	ES				(1.65)	MADE GROUND: Dark brown slightly gravelly slightly sandy SILT with occasional brick fragments, coal fragments, glass and rare clinker. Sand is fine to coarse. Gravel is fine to coarse, subangular to subrounded comprising sandstone. Occasional rootlets present at 0.00-0.30mbgl.			
1.20-1.65	SPT N=5		3,2/2,1,1,1						
				76.93	1.65 (0.35)	NO RECOVERY.			
2.00-2.45	SPT N=5		2,0/1,0,2,2						
				76.58	2.00 (0.45)	Brownish grey slightly sandy SILT with occasional rootlets. Sand is fine to coarse.			
				76.13	2.45 (0.55)	Brown gravelly sandy CLAY. Sand is fine to coarse. Gravel is fine to coarse, subangular to subrounded comprising sandstone. Approximately 10% recovery at 2.00-3.00mbgl. No accurate consistency or strength data available for this strata.			
3.00-3.45 3.00-3.50	SPT N=7 D		2,2/1,2,1,3						
				75.58	3.00 (0.50)	Very soft extremely low strength grey very sandy silty CLAY with occasional rootlets. Sand is fine to coarse. Strong organic odour.			
3.45 3.50-4.00	PP 5kPa D								
				75.08	3.50	Medium density grey silty SAND with occasional clay lenses. Sand is fine to coarse. Strata is wet.			
4.00-4.45	SPT N=13		3,2/3,3,3,4						
					(1.95)				
5.00-5.45	SPT N=20		5,5/5,5,5,5						
				73.13	5.45	Complete at 5.45m			

Remarks

Approximately 10% recovery at 2.00-3.00mbgl. No accurate consistency or strength data available for this strata.
Borehole stable.
Borehole wet within sand strata at 3.50-5.45mbgl.

**Scale
(approx)**

1:40

**Logged
By**

JW

Figure No.

LKC 23 1383.WS101

Excavation Method

Drive-in Windowless Sampler
driven to 5.45mbgl.

Dimensions
Location (dGPS)

377831 E 407137.9 N

Ground Level (mOD)

78.59

Client

ISG

Job
Number

LKC 23 1383

Dates

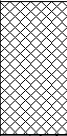
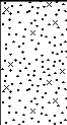
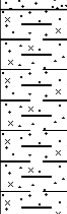
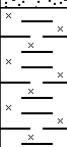
10/08/2023

Engineer

LKC

Sheet

1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.70-1.00	ES			77.89	(0.70)	MADE GROUND: Dark brown slightly gravelly slightly sandy SILT with occasional brick fragments, coal fragments and glass fragments. Sand is fine to coarse. Gravel is fine to coarse, subangular to subrounded comprising sandstone. Occasional rootlets present to c. 0.30mbgl.			
1.00-1.20	D			77.59	(0.30)	Brown slightly silty SAND. Sand is fine to coarse.			
1.20-1.65	SPT N=3		1,0/0,1,1,1		(0.70)	Medium density grey silty SAND with occasional clay lenses. Sand is fine to coarse. Strata is damp.			
1.70-2.00	D			76.89	1.70	Firm consistency medium strength brown slightly sandy silty CLAY with occasional sand lenses. Sand is fine to coarse. Slight organic odour.			
2.00-2.45	PP 64kPa SPT N=11		10,8/3,3,2,3		(1.10)				
2.50-2.80	D			75.79	2.80	Loose to medium density grey silty SAND with occasional clay lenses. Sand is fine to coarse. Strata is wet. Approximately 20% recovery at 3.00-4.00mbgl. Strata very wet at 3.00-4.00mbgl.		Σ1	
3.00-3.45	SPT N=4		1,0/1,0,1,2 Water strike(1) at 3.10m.		(1.90)				
3.50-4.00	D								
4.00-4.45	SPT N=10		1,2/1,2,2,5						
5.00-5.45	SPT N=26		5,3/3,8,9,6	73.89	4.70	Very stiff grey silty CLAY.			
					(0.75)	Limited sample available at 4.870-5.45mbgl. Unable to undertake pocket penetrometer test.			
				73.14	5.45	Complete at 5.45m			

Remarks

Borehole stable.
Groundwater strike at 3.10mbgl. Strata damp / wet at 1.00-1.70mbgl and 2.80-4.70mbgl.
Approximately 10% recovery at 2.00-3.00mbgl. No accurate consistency or strength data available for this strata.

Scale
(approx)

1:40

Logged
By

JW

Figure No.

LKC 23 1383.WS102

Excavation Method

Drive-in Windowless Sampler
driven to 5.45mbgl.

Dimensions
Location (dGPS)

377850.6 E 407127 N

Ground Level (mOD)

78.59

Client

ISG

Job
Number
LKC 23 1383

Dates

10/08/2023

Engineer

LKC

Sheet

1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.00-0.30	ES				(0.30)	MADE GROUND: Dark brown slightly gravelly slightly sandy SILT with occasional coal fragments, glass and rare brick fragments. Sand is fine to coarse. Gravel is fine to coarse, subangular to subrounded comprising sandstone.			
0.50-1.00	ESD			78.29	0.30				
			Water strike(1) at 1.00m.		(1.60)	Very loose density grey and brown slightly silty sandy GRAVEL with occasional coal fragments, ash, clinker and rare brick fragments. Sand is fine to coarse. Gravel is fine to coarse, subangular to subrounded of sandstone and quartzite.		Σ1	
1.20-1.65	SPT N=1		1,0/0,1,0,0						
1.70-1.90	ES				1.90	Firm consistency medium strength grey very sandy silty CLAY with occasional rootlets. Sand is fine to coarse. Moderate organic odour.			
2.00-2.45	PP 44kPa SPT N=4		0,0/0,1,1,2	76.69	(0.80)				
2.50-2.70	D				2.70	Loose to medium density grey silty SAND with occasional clay lenses. Sand is fine to coarse. Strata is wet			
3.00-3.45	SPT N=11		2,3/2,4,2,3	75.89					
3.50-4.00	D				(2.75)	Band of silt present at 4.90-5.30mbgl.			
4.00-4.45	SPT N=8		1,2/1,2,2,3						
5.00-5.45	SPT N=24		3,3/3,5,8,8		5.45	Complete at 5.45m			
				73.14					

Remarks

Borehole stable.
Groundwater strike at 1.00mbgl. Borehole is wet within sand strata a 2.70-5.45mbgl.

Scale
(approx)

1:40

Logged
By

JW

Figure No.

LKC 23 1383.WS103

Excavation Method

Drive-in Windowless Sampler
driven to 5.45mbgl.

Dimensions
Location (dGPS)

377823.5 E 407106.4 N

Ground Level (mOD)

78.77

Client

ISG

Job
Number

LKC 23 1383

Dates

10/08/2023

Engineer

LKC

Sheet

1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.30-1.00	ES			78.47	(0.30) 0.30	MADE GROUND: Dark brown slightly gravelly slightly sandy SILT with frequent rootlets occasional brick fragments, coal fragments and rare glass fragments. Sand is fine to coarse. Gravel is fine to coarse, subangular to subrounded comprising sandstone.			
1.20-1.65	SPT N=0		1,0/0,0,0,0		(1.30)	MADE GROUND: Dark brownish grey very gravelly slightly sandy SILT with occasional brick fragments, clinker, ash and coal fragments. Sand is fine to coarse. Gravel is fine to coarse, subangular to subrounded comprising sandstone.			
1.80-2.00	ESD			77.17	1.60	Brown slightly gravelly very silty SAND. Sand is fine to medium. Sand is fine to coarse. Gravel is fine to medium, subangular to subrounded comprising sandstone.			
2.00-2.45	SPT N=5		1,1/1,1,1,2 Water strike(1) at 2.10m.	76.77	2.00	Brown slightly gravelly slightly silty SAND with occasional clay lenses. Strata is slightly damp. Sand is fine to coarse. Gravel is fine to medium, subangular to subrounded comprising sandstone.			
2.50-3.00	D								
3.00-3.45	SPT N=12		1,0/4,4,2,2		(3.00)				
4.00-4.45	SPT N=8		3,2/2,2,2,2						
4.50-5.00	D								
5.00-5.45	SPT N=30		5,5/7,6,7,10	73.77	5.00	Complete at 5.45m			

Remarks

Borehole stable.
Groundwater strike at 2.10mbgl.

Scale
(approx)

1:40

Logged
By

JW

Figure No.

LKC 23 1383.WS104

Excavation Method

Drive-in Windowless Sampler
driven to 5.45mbgl.

Dimensions
Location (dGPS)

377844 E 407086.3 N

Ground Level (mOD)

78.55

Client

ISG

**Job
Number**

LKC 23 1383

Dates

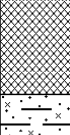
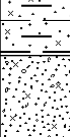
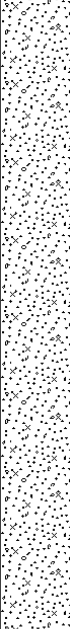
10/08/2023

Engineer

LKC

Sheet

1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.50-1.00	ES			78.25	(0.30) 0.30	MADE GROUND: Dark brown slightly gravelly slightly sandy SILT with frequent rootlets occasional brick fragments, coal fragments and rare glass fragments. Sand is fine to coarse. Gravel is fine to coarse, subangular to subrounded comprising sandstone.			
1.20-1.65	SPT N=6		1,1/2,2,1,1	77.35	(0.90) 1.20	MADE GROUND: Dark brown slightly gravelly sandy SILT with occasional Rootlets, brick fragments, coal fragments timber and rare metal fragments. Sand is fine to coarse. Gravel is fine to coarse, subangular to subrounded comprising sandstone. Slight organic odour.			
1.65-1.80 1.80-2.00	PP 88kPa ES D			76.85	(0.50) 1.70	Stiff consistency high strength brown and grey mottled slightly sandy silty CLAY. Sand is fine to coarse.			
2.00-2.45	SPT N=6		1,1/1,1,1,3			Brown slightly gravelly slightly silty SAND with occasional clay lenses. Sand is fine to coarse. Gravel is fine to medium, subangular to subrounded comprising sandstone. Strata is damp.			
3.00-3.45	SPT N=3		0,0/0,1,1,1						
3.50-4.00	D				(3.75)				
4.00-4.45	SPT N=13		3,4/4,3,3,3						
5.00-5.45	SPT N=24		3,3/3,5,7,9	73.10	5.45	Complete at 5.45m			

Remarks

Borehole stable.
Borehole damp within sand strata at 1.70-5.45mbgl.

Scale (approx)

1:40

Logged By

JW

Figure No.

LKC 23 1383.WS105





Appendix C

Environment Agency Data



KEY

Site Location

High Risk

Medium Risk

Low Risk

Sampling locations and features annotated by LK Consult Ltd are approximate and are based upon observed measurements unless otherwise stated. Do not scale from this drawing and work from marked dimensions only. All dimensions and features should be confirmed on site by the Contractor. Where this drawing includes information provided to LK Consult Ltd by others, LK Consult Ltd gives no warranty, representation or assurance as to the accuracy of such information.



Client
ISG Ltd

Site
Millwood SEN School

Topic
Surface Water Risk

Job No:
FRA 23 1118

Scale (note scale bar)
1:800 @ A4

Drawn By:
JL

Checked By:
MJ

Date:
Aug 2023

Engineer

Rev



Flood map for planning

Location (easting/northing)
377916/407140

Scale
1:10,000

Created
9 Aug 2023

-  Selected area
-  Main river
-  Flood zone 3
-  Flood zone 2



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Modelled data

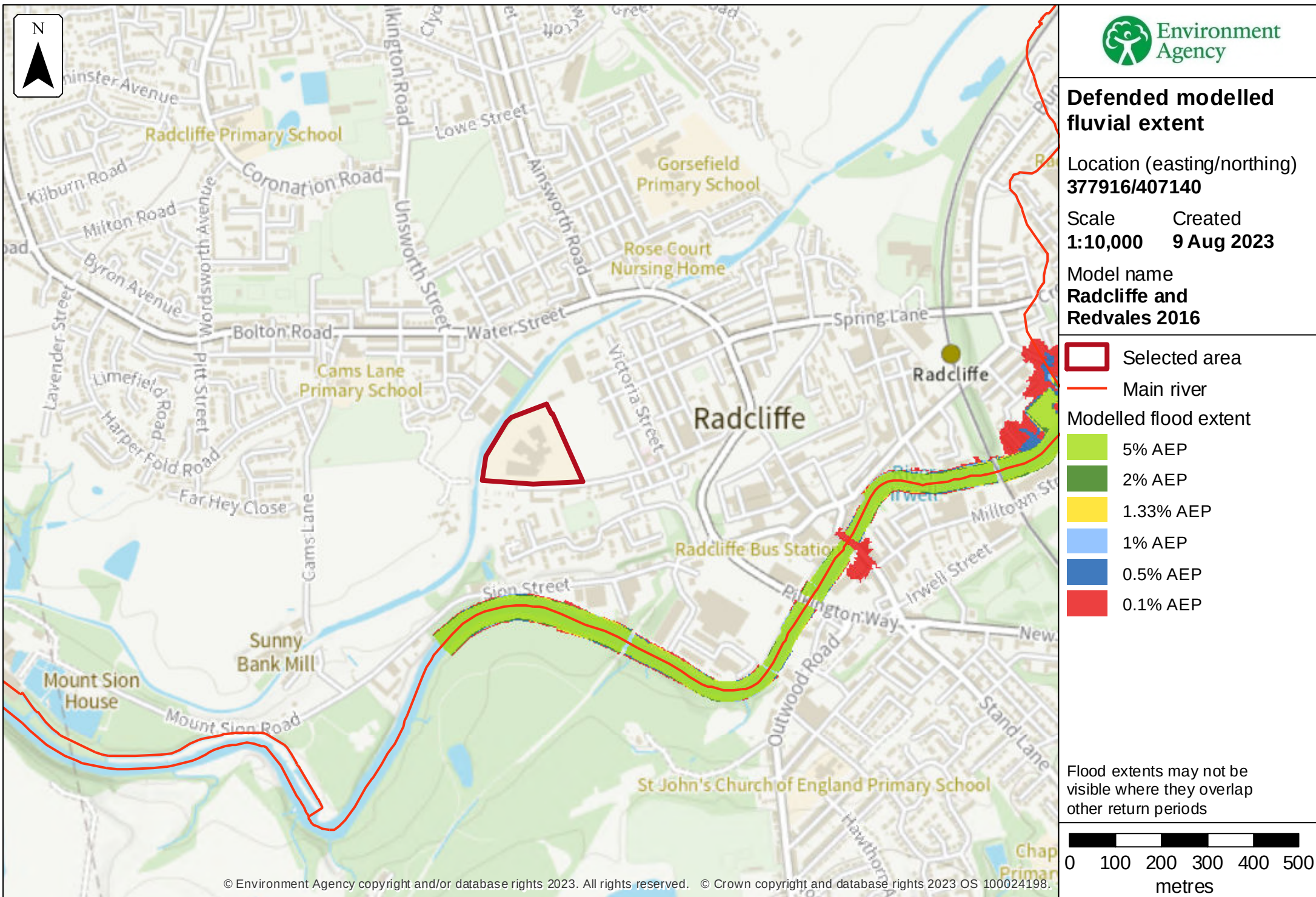
This section provides details of different scenarios we have modelled and includes the following (where available):

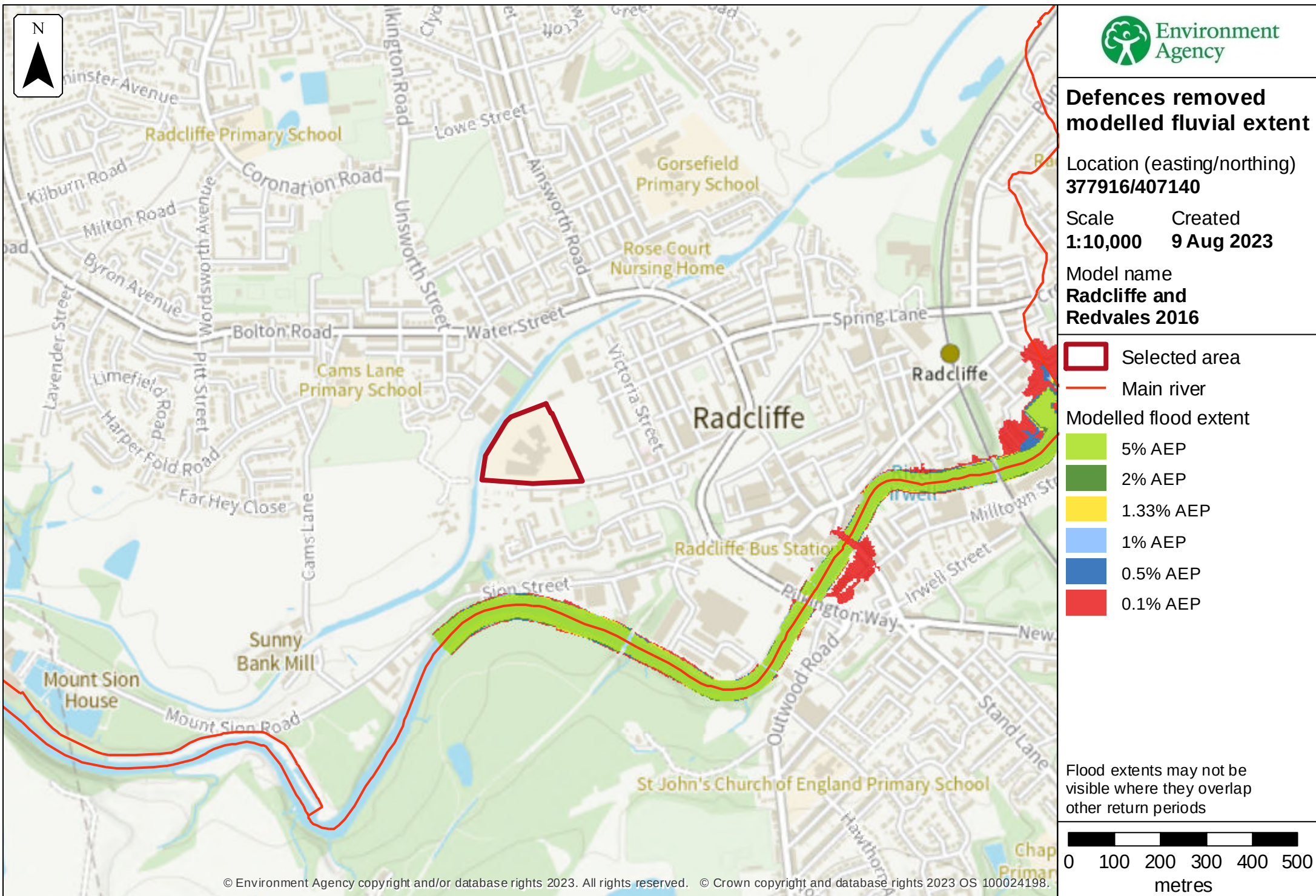
- outline maps showing the area at risk from flooding in different modelled scenarios
- modelled node point map(s) showing the points used to get the data to model the scenarios and table(s) providing details of the flood risk for different return periods
- map(s) showing the approximate water levels for the return period with the largest flood extent for a scenario and table(s) of sample points providing details of the flood risk for different return periods

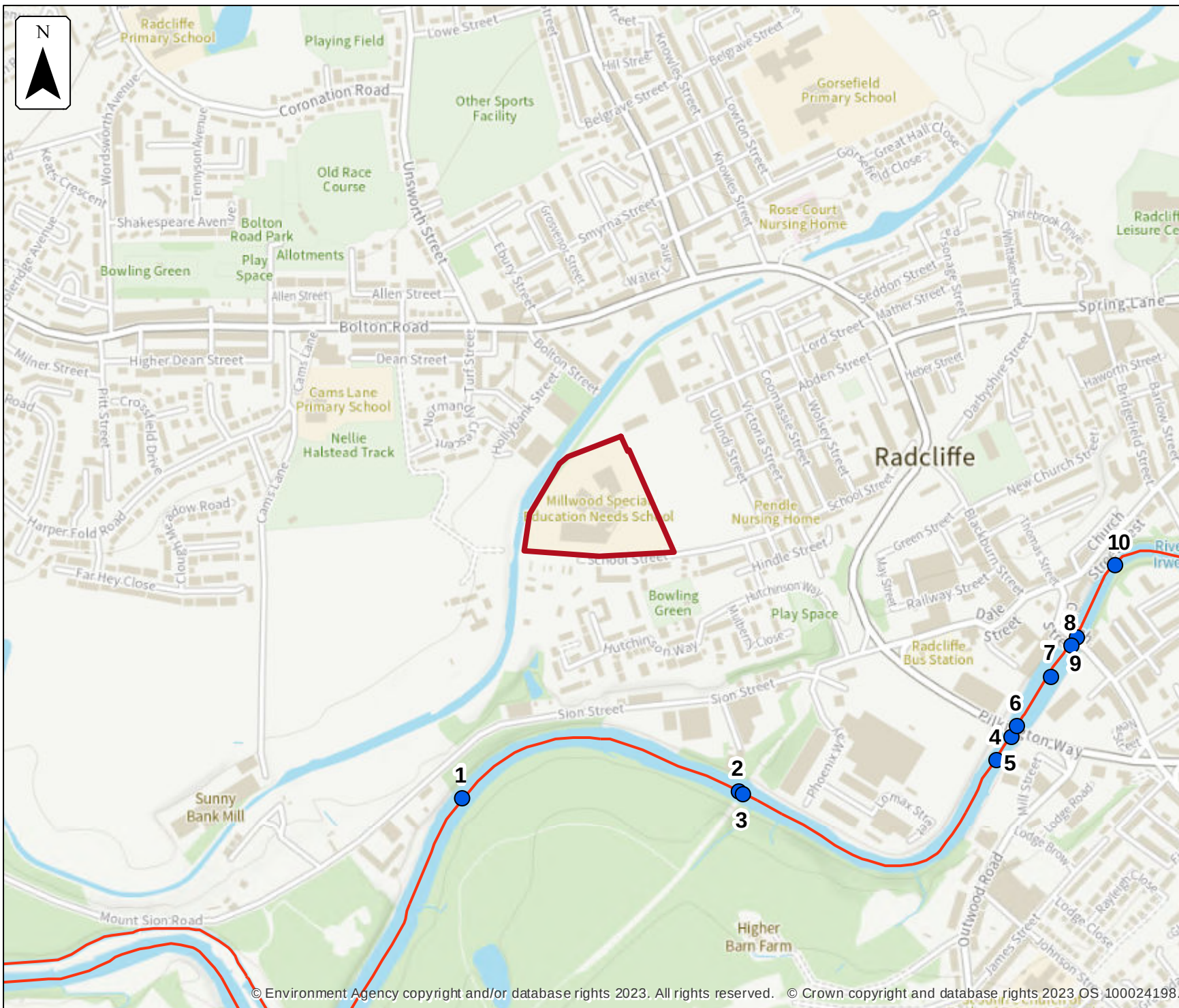
Modelled scenarios

The following scenarios are included:

- Defended modelled fluvial: risk of flooding from rivers where there are flood defences
- Defences removed modelled fluvial: risk of flooding from rivers where flood defences have been removed
- No defences exist modelled fluvial: risk of flooding from rivers where there are no flood defences







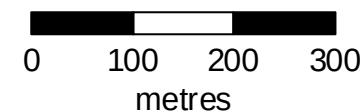
Defended modelled fluvial node locations

Location (easting/northing)
377916/407140

Scale Created
1:7,500 9 Aug 2023

Model name
Radcliffe and Redvales 2016

-  Selected area
-  Modelled location
-  Main river



Modelled node locations data

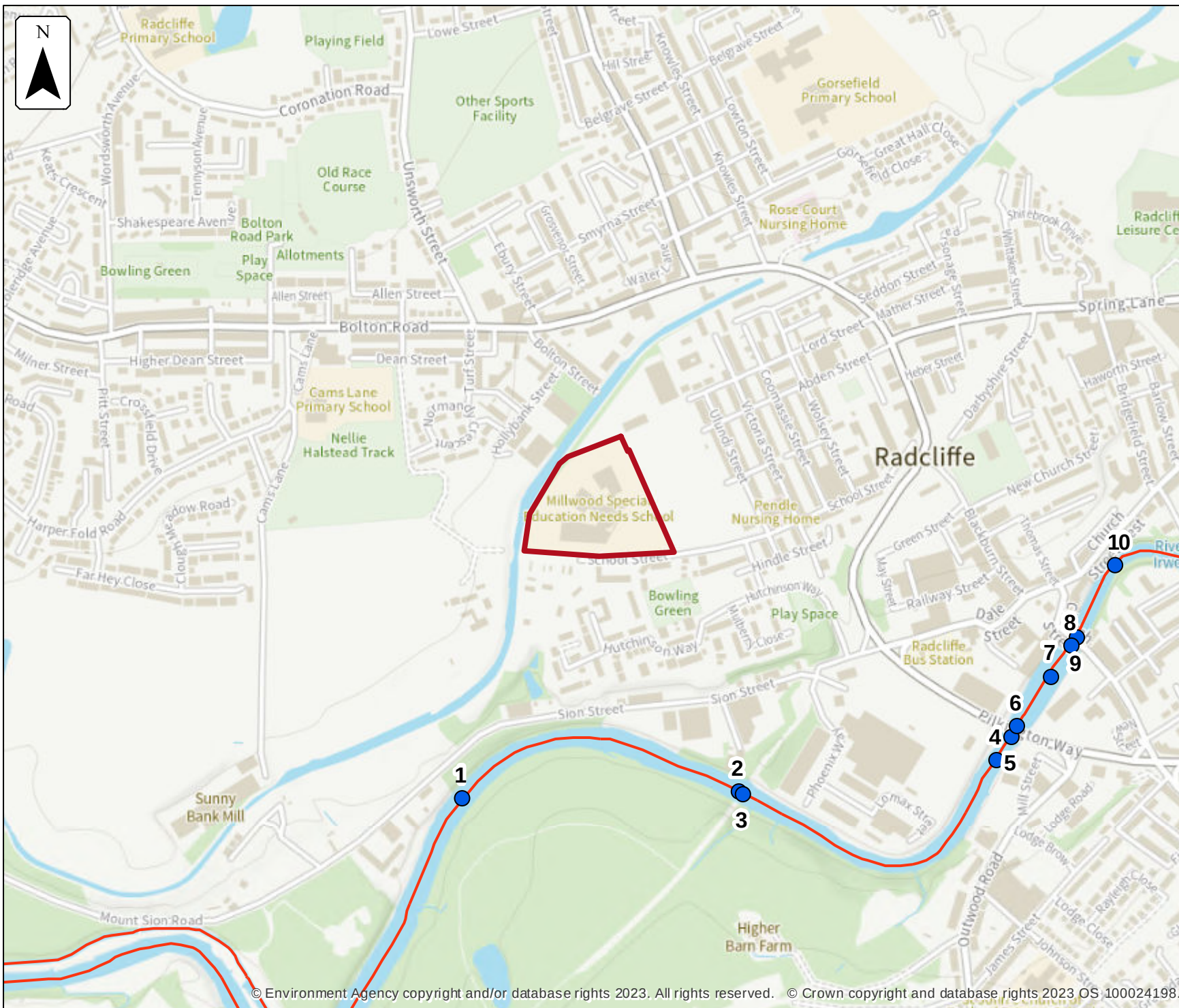
Defended

Label	Modelled location ID	Easting	Northing	5% AEP		2% AEP		1.33% AEP		1% AEP		0.5% AEP		0.1% AEP	
				Level	Flow	Level	Flow	Level	Flow	Level	Flow	Level	Flow	Level	Flow
1	977135	377721	406717	59.56	334.07	59.87	393.78	60.01	424.27	60.12	448.21	60.37	504.59	60.87	608.05
2	977186	378123	406727	60.29	334.09	60.65	393.80	60.82	424.30	60.95	448.22	61.23	504.59	61.73	610.59
3	977155	378131	406723	60.31	334.09	60.67	393.80	60.84	424.30	60.97	448.22	61.25	504.59	61.76	610.59
4	977189	378499	406773	60.46	334.10	60.81	393.82	60.97	424.32	61.10	448.23	61.38	504.60	61.87	611.21
5	977188	378520	406807	60.74	334.11	61.12	393.82	61.30	424.32	61.44	448.24	61.75	504.60	62.29	611.46
6	977109	378529	406821	60.74	334.11	61.12	393.82	61.30	424.32	61.44	448.24	61.75	504.60	62.30	611.46
7	977166	378579	406894	61.04	334.12	61.43	393.83	61.62	424.32	61.76	448.24	62.07	504.61	62.63	612.0
8	977173	378609	406939	61.10	334.12	61.48	393.84	61.66	424.33	61.79	448.24	62.10	504.61	62.63	612.08
9	977119	378616	406951	61.33	334.12	61.82	393.84	62.06	424.33	62.25	448.24	62.70	504.61	63.69	612.08
10	977162	378671	407055	61.49	334.13	62.0	393.84	62.25	424.33	62.45	448.25	62.91	504.62	63.92	613.90

Data in this table comes from the Radcliffe and Redvales 2016 model.

Level values are shown in mAOD, and flow values are shown in cubic metres per second.

Any blank cells show where a particular scenario has not been modelled for this location.



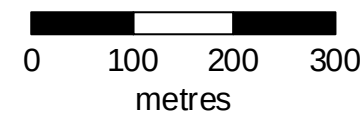
**Defences removed
modelled fluvial
node locations**

Location (easting/northing)
377916/407140

Scale Created
1:7,500 9 Aug 2023

Model name
**Radcliffe and
Redvales 2016**

-  Selected area
-  Modelled location
-  Main river



Modelled node locations data

Defences removed

Label	Modelled location ID	Easting	Northing	5% AEP		2% AEP		1.33% AEP		1% AEP		0.5% AEP		0.1% AEP	
				Level	Flow	Level	Flow	Level	Flow	Level	Flow	Level	Flow	Level	Flow
1	977135	377721	406717	59.54	331.23	59.85	390.69	60.0	422.16	60.10	443.97	60.36	500.48	60.94	623.04
2	977186	378123	406727	60.28	331.26	60.63	390.70	60.81	422.19	60.92	444.01	61.21	500.50	61.80	623.10
3	977155	378131	406723	60.29	331.26	60.65	390.70	60.83	422.19	60.94	444.01	61.23	500.50	61.83	623.10
4	977189	378499	406773	60.44	331.28	60.79	390.71	60.96	422.21	61.08	444.02	61.36	500.52	61.94	623.11
5	977188	378520	406807	60.72	331.28	61.10	390.72	61.29	422.21	61.42	444.02	61.72	500.52	62.36	623.12
6	977109	378529	406821	60.72	331.28	61.10	390.72	61.29	422.21	61.42	444.02	61.73	500.52	62.38	623.12
7	977166	378579	406894	61.02	331.29	61.41	390.73	61.60	422.22	61.73	444.03	62.05	500.53	62.71	623.10
8	977173	378609	406939	61.09	331.29	61.46	390.74	61.64	422.22	61.77	444.03	62.08	500.53	62.70	621.13
9	977119	378616	406951	61.31	331.29	61.79	390.74	62.04	422.22	62.22	444.03	62.67	500.53	63.82	621.13
10	977162	378671	407055	61.47	331.29	61.97	390.75	62.23	422.22	62.41	444.03	62.88	500.54	64.04	623.14

Data in this table comes from the Radcliffe and Redvales 2016 model.

Level values are shown in mAOD, and flow values are shown in cubic metres per second.

Any blank cells show where a particular scenario has not been modelled for this location.

Appendix D

Consultee Correspondence

LKGroup**Unit 29 Eton Business Park
Unit 29, Eton Business Park,
Radcliffe, Greater Manchester
M26 2ZS****FAO:****How to contact us:****United Utilities Water Limited
Property Searches
Haweswater House
Lingley Mere Business Park
Great Sankey
Warrington
WA5 3LP****Telephone: 0370 7510101****E-mail: propertysearches@uuplc.co.uk****Your Ref: FRA 23 1118
Our Ref: UUPS-ORD-509399
Date: 10/08/2023****Dear Sirs****Location: Millwood SEN School**

I acknowledge with thanks your request dated 09/08/2023 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.



Refo	Cover	Func	Invert	Size x	Size y	Shape	Matl	Length	Grad
849802	SW	0	300	450			VC	13.90011	
9007	CO	77.38	75.43	225			VC	10.10497	
7312	CO	77.38	75.43	225			VC	14.27888	1 in 96
9804	SW	75.26	71.91	600			VC	36.39946	1 in 5
1306	CO	78.8	75.03	375			VC	4.123106	1 in 52
9814	CO	63.64	59.21	1200			VC	9.550396	1 in 480
7305	SW	79.27	77.4	225			VC	2.211102	1 in 48
9006	SW	0	450				VC	21.86326	
7308	SW	77.8	75.3	300			VC	49.6181	0
1303	CO	76.99	75.39	375			VC	21.47991	1 in 165
9908	SW	77.89	72.44	525			VC	60.26703	1 in 670
7401	CO	81.76	78.08	375			VC	18.06829	1 in 17
0909	SW	83.42	79.17	525			VC	14.65808	
6307	SW	0	1100				VC	65.94075	1 in 507
7313	CO	0	225				VC	13.02147	1 in 65
7207	SW	79.78	77.8	225			VC	9.407789	1 in 105
0008	CO	77.41	75.26	300			VC	24.39738	
9906	FO	77.34	75.17	150			VC	7.147377	1 in 89
1010	CO	77.34	75.17	300			VC	15.64967	1 in 782
8305	CO	76.47	75.1	225			VC	41.4387	1 in 73
6205	CO	80.25	74.62	150			VC	20.89061	1 in 46
1004	CO	77.36	75.3	225			VC	23	1 in 121
7304	CO	80.9	76.35	150			VC	13.72044	1 in 162
9803	CO	78.77	76.7	300			VC	61.9198	1 in 31
8313	CO	77.89	75.17	300			VC	15.61816	1 in 600
8301	SW	77.84	75.17	300			VC	37.81532	1 in 189
8309	CO	77.81	75.17	300			VC	38.42731	1 in 1
9406	CO	77.23	73.74	650			VC	27.74041	1 in 103
8801	CO	65.98	58.88	750			VC	5.494321	1 in 121
9919	FO	75.27	75.17	150			VC	24.57168	1 in 22
9901	SW	73.47	73.47	300			PVC	7.701531	
1910	FO	0	100				VC	3.05277	
6414	CO	77.44	73.67	300			VC	27.71709	1 in 126
1007	CO	77.44	73.67	300			VC	22	1 in 244
7303	CO	81.08	77.38	375			VC	34.3285	1 in 106
0301	CO	79.37	76.77	150			VC	13.28167	1 in 150
0916	FO	79.37	76.77	150			VC	57.73788	
9904	FO	78.04	75.17	150			VC	9.781227	1 in 488
9814	SW	72.46	75.17	300			VC	47.01964	1 in 277
1102	CO	78.31	75.17	300			VC	9.574963	1 in 160
1011	CO	77.26	75.17	300			VC	25.07987	1 in 157
1305	CO	78.04	75.17	300			VC	111.7587	1 in 285
0804	CO	64.09	59.9	1050			VC	7.940157	1 in 265
9815	CO	63.64	59.9	1050			VC	20.26104	
8315	CO	78.31	75.17	300			VC	14.31762	1 in 311
1101	CO	78.31	75.17	300			VC	18.69462	1 in 95
9909	CO	78.04	75.17	300			VC	5.434151	1 in 123
9002	CO	78.04	75.17	300			VC	10.14292	1 in 203
9418	CO	78.2	75.17	300			VC	29.95805	1 in 216
9810	CO	63.65	59.93	1200			VC	42.44997	1 in 157
7301	CO	79.31	75.17	300			VC	11.6647	1 in 115
1901	FO	78.04	75.17	300			VC	26.40076	1 in 115
8301	SW	75.68	75.17	300			VC	2.643218	1 in 264
6101	CO	78.79	75.17	1100			VC	45.39624	1 in 170
7206	SW	79.27	77.87	225			VC	46	
9907	CO	77.64	75.17	300			VC	59.03389	1 in 103
0803	CO	64.44	59.93	1200			VC	27.86857	1 in 103
9001	CO	78.12	76.67	150			VC	4.339551	
7306	CO	80.21	76.36	225			VC	27.86857	
8802	CO	66.03	59.93	1200			VC	23.25941	
9904	FO	0	150				VC	28.84441	
7306	CO	80.21	76.36	225			VC	21.38831	1 in 102
0925	CO	77.38	73.3	150			VC	14.31762	
1002	CO	77.38	73.3	150			PSC	6.470562	
0303	CO	79.08	75.25	375			VC	7.862783	
7201	CO	80.21	76.36	225			VC	23.14269	1 in 129
9912	SW	74.25	75.17	150			PVC	5.196314	
0921	FO	0	100				VC	27.01851	
0926	FO	0	100				VC	11.32715	
8301	SW	78.16	75.91	100			VC	27.20294	1 in 136
1913	CO	81.68	75.17	300			VC	26.01922	
7302	CO	79.68	76.08	225			VC	20.77332	1 in 2077
9905	FO	0	150				VC	37.80212	1 in 34
8313	SW	78.16	75.17	300			VC	8.770547	
1203	CO	79.68	76.08	225			VC	12	
6292	SW	0	375				VC	4.63389	
9911	SW	77.8	72.29	525			VC	25.53882	1 in 108
1012	SW	78.81	77.17	1100			VC	1.949028	
9805	SW	0	825				VC	27.20294	
8313	SW	78.16	75.17	300			VC	53.17277	1 in 17
8804	FO	0	100				VC	7.471352	
7204	CO	78.16	75.17	300			VC	11.22087	1 in 1122
8802	CO	64.14	59.93	1200			VC	34.53983	1 in 152
7801	CO	67.91	59.93	1200			VC	12.01795	1 in 175
7220	CO	77.43	73.4	375			VC	70.26379	1 in 413
9815	CO	63.64	59.22	1200			VC	13.54402	1 in 123
6207	CO	81.48	76.36	225			VC	30.2219	
0911	FO	0	100				VC	24.04163	
9809	CO	64.04	59.93	1200			VC	12.64911	1 in 253
0302	CO	79	71.83	708			VC	30.2219	
9003	SW	74.8	75.17	300			VC	12.64911	1 in 253
7306	CO	80.11	77.81	300			VC	30.2219	
1908	SW	79.68	77.93	375			VC	12.64911	1 in 253
1003	CO	77.43	73.4	375			VC	30.2219	
8204	CO	78.58	76.89	300			VC	4.123106	1 in 206
8001	SW	79.92	76.84	300			VC	102.5449	1 in 96
7208	CO	80.21	76.36	225			VC	28.84441	1 in 34
6208	CO	81.28	76.83	225			VC	44.01136	1 in 41
6201	CO	81.34	76.83	225			VC	19.69772	1 in 35
9903	FO	0	100				VC	53.37453	
0918	FO	0	100				VC	11.1223	
0492	CO	72.1	70.8				BR	29.15476	1 in 108
0827	FO	0	100				VC	4.447526	
6302	CO	84.19	78.56	375			VC	24.74802	1 in
9811	CO	63.71	59.35	950			VC	19.89318	130.252722
8901	SW	78.31	76.5	850			VC	20.82905	1 in 15
1413	SW	78.51	76.82	300			VC	17.86545	1 in 200
1914	CO	77.24	72.31	100			PVC	9.903863	
0491	CO	77.24	72.31	100			VC	24.5153	1 in 117
1219	CO	77.24	72.31	100			VC	29.69567	
8302	SW	79.49	75.84	300			VC	22.09179	1 in 116
8900	CO	78.87	77.37	300			VC	71.1169	1 in 82
0922	FO	0	150				PSC	1.997858	
6206	CO	80.21	76.36	225			VC	4.509328	
7402	CO	81.31	77.22	600			BR	9.32914	1 in 932
6202	CO	81.34	76.89	150			VC	20.61553	1 in 258
7802	CO	67.59	58.82	725			BR	34.36568	1 in 1146
6203	CO	81.22	76.81	225			VC	13.52839	1 in 127
9810	CO	63.64	59.93	1200			VC	51.94293	
9005	SW	74.58	75.17	300			VC	31.78688	1 in 103
6304	CO	84.02	78.68	375			VC	21.82555	1 in
7311	CO	0	225				VC	18	167.888881
8304	CO	79	76.04	300			VC	14.77066	1 in 246
8300	CO	79.47	75.68	100			BR	52.97416	1 in 55
9905	FO	0	150				VC	47.68176	
1909	SW	78.16	75.17	300			VC	50.12221	
7216	CO	77.43	73.4	375			VC	1.744833	
8902	SW	79.3	75.17	300			VC	34.22406	1 in 149
1801	CO	64.74	59.93	1200			VC	31.20921	1 in 522
7301	CO	81.18	77.31	375			VC	27.00877	
9004	CO	78.16	75.17	300			VC	10.15038	1 in 78
7294	CO	78.61	75.03	300			VC	45	
8051	SW	0	150				VC	119	
8803	SW	0	225				VC	64.77654	
7305	CO	80.11	77.93	300			VC	26.01922	1 in 50
7403	CO	81.02	77.16	600			VC	76.16498	1 in 50
0002	CO	77.38	76.38	150			VC	61.20457	1 in 97
7202	CO	80.94	76.38	225			VC	23.02173	1 in 35
6303	SW	75.53	75.53	600			VC	12.3767	1 in 155
9913	SW	74.04	75.17	300			VC	9.170621	1 in 92
9008	SW	74.04	75.17	300			VC	35.02686	
1202	CO	78.88	71.38	708			BR	106.4519	1 in 190
7314	CO	0	225				VC	5	
6291	SW	78.62	76.77	300			VC	36.23534	
8203	CO	78.62	76.77	300			VC	26.17623	
0915	FO	0	150				VC	5.350796	
0003	CO	77.05	75.46	225			VC	1.08423	
0001	CO	77.12	75.72	225			VC	15.89071	
1907	SW	78.16	75.17	300			VC	33.95033	
0902	FO	0	150				VC	36.84844	
6209	CO	81.74	79.28	1050			VC	90.47652	1 in 532
1006	SW	0	150		</				

Jenna Lowe

From: wastewaterdeveloperservices@uuplc.co.uk
Sent: 09 August 2023 16:40
To: Jenna Lowe
Subject: 04463732 FRA QUERY - FRA 23 1118 - Millwood SEN School, Radcliffe

Hi Jenna

'I 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 (Uuw) 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 Uuw 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.*

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

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

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

Kind regards Jill



Jill Ellis
Customer Advisor Advanced
Developer Services & Metering
Customer Services
Direct Tel: 01925 233 064
Tel: 0345 072 6067
[unitedutilities.com](https://www.unitedutilities.com)

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Did you know we now have a live chat facility available to you Mon to Friday 8 -5pm. You just click on the orange live chat box on our webpage and one of our advisors will be ready to chat to you and help you with your enquiry <https://www.unitedutilities.com/builders-developers/> or you can email us at

----- Original Message -----

From: Jenna Lowe [j.lowe@thelkgroup.com]

Sent: 09/08/2023 09:35

To: wastewaterdeveloperservices@uuplc.co.uk

Subject: FRA QUERY - FRA 23 1118 - Millwood SEN School, Radcliffe

Dear Sir/Madam,

LK Consult Ltd. has been commissioned to undertake a Flood Risk Assessment (FRA) and Sustainable Drainage Systems (SuDS) Strategy, for Millwood SEN School, School Street, Radcliffe, M26 3BW, centred at approximate National Grid Reference 377833E , 407124N.

The area of interest appears to be within Flood Zone 1.

BGS data indicates that the site is within an area underlain by Till, Devensian – Diamicton superficial deposits and Pennine Middle Coal Measures Formation - Mudstone, siltstone and sandstone bedrock.

The site location and Wastewater Pre-Development Enquiry form are attached to this email.

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

1. Records of any historic flood events and potential sources of flooding from foul and surface water sewers on site and in the area.
2. Any restrictions to discharge into the sewers

If you have any queries, please do not hesitate to get in touch.

We are, of course, happy to pay your reasonable charge for this service. Please let me know by return what information is available, 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 would also be appreciated.

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

Regards

Jenna



Jenna Lowe MSc, BSc. (Hons)
Flood Risk Engineer
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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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Jenna Lowe

From: Jenna Lowe
Sent: 09 August 2023 09:24
To: Smith, Frances; Southgate, Andrew
Subject: FRA QUERY - FRA 23 1118 - Millwood SEN School, Radcliffe
Attachments: FRA 23 1118 - Figure 1 Location and Boundary.pdf

Dear Sir/Madam,

LK Consult Ltd. has been commissioned to undertake a Flood Risk Assessment (FRA) and Sustainable Drainage Systems (SuDS) Strategy, for Millwood SEN School, School Street, Radcliffe, M26 3BW, centred at approximate National Grid Reference 377833E , 407124N.

The area of interest appears to be within Flood Zone 1.

BGS data indicates that the site is within an area underlain by Till, Devensian – Diamicton superficial deposits and Pennine Middle Coal Measures Formation - Mudstone, siltstone and sandstone bedrock.

The site location is attached to this email.

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

- 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.
- 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 applied to ordinary watercourses and sewers in the area.
- Highway drainage restrictions and records.
- Indications if the site is within the Critical Drainage Area.
- Policies that may relate to Sustainable Drainage Systems (SuDS).

If you have any queries, please do not hesitate to get in touch.

We are, of course, happy to pay your reasonable charge for this service. Please let me know by return what information is available, 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 would also be appreciated.

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

Regards
Jenna



Jenna Lowe MSc, BSc. (Hons)

Flood Risk Engineer

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

Appendix E

Calculations



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HY 11.0

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				Sheet no. 1	
				Date 12/09/23	
Project greenfield				By	Checked
Title IoH 124 Runoff calcs for Millwood School					Reviewed

Hydrological Data:-

FSR Hydrology:-

Location	= Millwood School	Grid reference	= SD7807
M5-60 (mm)	= 18.7	r	= 0.33
Soil runoff	= 0.45	SAAR (mm/yr)	= 1020
WRAP	= 4	Area	= England & Wales
Hydrological area	= 10	Hydrological zone	= 7

Soil classification for WRAP type 4

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

Design data:-

Area = 0.002 Km² - 0.2 Ha - 2000 m²

Calculation method:-

Runoff is calculated from:-

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

where

AREA = Site area in Km²
 SAAR = Standard Average Annual Rainfall (mm/yr)
 SOIL = Soil value derived from Winter Rainfall Acceptance Potential
 Q_{BAR(rural)} = Runoff (cumecs)

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

Calculated data:-

For areas less than 50Ha, a modified calculation which multiplies the 50Ha runoff value by the ratio of the site area to 50Ha is used
Reducing factor used for these calculations is 0.004

Mean Annual Peak Flow $Q_{\text{BAR(rural)}} = 1.36 \text{ l/s}$



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Job No.		
Sheet no. 2		
Date 12/09/23		
By	Checked	Reviewed

Project greenfield			
Title IoH 124 Runoff calcs for Millwood School			

Values for $Q_{BAR(rural)}$

Ret. per. 1yr	m ³ /hr	1/s	1/s/ha	Ret. per. 100yr+20%	m ³ /hr	1/s	1/s/ha
2yr	4.570	1.269	6.347	100yr+30%	13.414	3.726	18.631
5yr	5.945	1.652	8.258	100yr+40%	14.446	4.013	20.064
10yr	6.781	1.884	9.418	200yr	11.793	3.276	16.379
30yr	8.255	2.293	11.465	200yr + 30%	15.331	4.258	21.292
50yr	9.090	2.525	12.625	500yr	13.414	3.726	18.631
100yr	10.319	2.866	14.331	1000yr	14.937	4.149	20.746

Growth factors -

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

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



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Job No.		
Sheet no. 1		
Date 12/09/23		
By	Checked	Reviewed

Project **Qbar**

Title **Peak runoff calculations for Millwood School**

Area data:-

FSR data

M5-60 = 18.7

Soil index = 0.45

WRAP value = 4

r = 0.33

SAAR = 1020

Nat grid = SD7807

Site data:-

Ret. period (yrs) = 2.333

Time of entry = 7.00

Impervious area drained = 180 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 = 1820 m²

Soil type = Clay

Climate change factor = 0.0 %

Calculated data:-

Calculated runoff factor = 40.0%

Rainfall rate = 57.4 mm/Hr

UCWI = 104.6

Runoff rate (gross) = 1.9 l/s

Methods

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

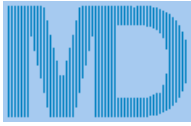
Runoff factor = $(0.829 \times \text{PIMP}) + (25 \times \text{SOIL}) + (0.078 \times \text{UCWI}) - 20.7$

where

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

UCWI = Calculated value for Wetness Index

Calculations produced by MasterDrain Surface Water design program



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Job No.		
Sheet no. 1		
Date 12/09/23		
By	Checked	Reviewed

Project **1 in 1 yr**

Title **Peak runoff calculations for Millwood School**

Area data:-

FSR data

M5-60 = 18.7

Soil index = 0.45

WRAP value = 4

r = 0.33

SAAR = 1020

Nat grid = SD7807

Site data:-

Ret. period (yrs) = 1

Time of entry = 10.00

Impervious area drained = 180 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 = 1820 m²

Soil type = Clay

Climate change factor = 0.0 %

Calculated data:-

Calculated runoff factor = 40.0%

Rainfall rate = 40.5 mm/Hr

UCWI = 104.6

Runoff rate (gross) = 1.3 l/s

Methods

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

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

where

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

UCWI = Calculated value for Wetness Index

Calculations produced by MasterDrain Surface Water design program



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Job No.		
Sheet no. 1		
Date 12/09/23		
By	Checked	Reviewed

Project	30yr event
Title	Peak runoff calculations for Millwood School

Area data:-

FSR data

M5-60 = 18.7

Soil index = 0.45

WRAP value = 4

r = 0.33

SAAR = 1020

Nat grid = SD7807

Site data:-

Ret. period (yrs) = 30

Time of entry = 6.00

Impervious area drained = 180 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 = 1820 m²

Soil type = Clay

Climate change factor = 0.0 %

Calculated data:-

Calculated runoff factor = 40.0%

Rainfall rate = 101.2 mm/Hr

UCWI = 104.6

Runoff rate (gross) = 3.4 l/s

Methods

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

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

where

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

UCWI = Calculated value for Wetness Index

Calculations produced by MasterDrain Surface Water design program



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email: m.jones@thelkgroup.com

Job No.		
Sheet no. 1		
Date 12/09/23		
By	Checked	Reviewed

Project	100 yr event
Title	Peak runoff calculations for Millwood School

Area data:-

FSR data

M5-60 = 18.7

Soil index = 0.45

WRAP value = 4

r = 0.33

SAAR = 1020

Nat grid = SD7807

Site data:-

Ret. period (yrs) = 100

Time of entry = 6.00

Impervious area drained = 180 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 = 1820 m²

Soil type = Clay

Climate change factor = 0.0 %

Calculated data:-

Calculated runoff factor = 40.0%

Rainfall rate = 128.0 mm/Hr

UCWI = 104.6

Runoff rate (gross) = 4.3 l/s

Methods

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

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

where

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

UCWI = Calculated value for Wetness Index

Calculations produced by MasterDrain Surface Water design program



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Job No.		
Sheet no. 1		
Date 12/09/23		
By	Checked	Reviewed

Project **30yr event +25%**

Title **Storage calcs for Millwood School**

Data:-

FSR Hydrology:-

Location = Millwood School

M5-60 (mm) = 18.7

Soil index = 0.45

Return period = 30

UCWI = 107.1

Grid reference = SD7807

r = 0.33

SAAR (mm/yr) = 1020

WRAP = 4

Climate change = 25

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

Runoff factor (RF) = 56.0, 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 = 1380 m²

Total area (TA) = 2000 m²

Mean disch. rate = 2.500 l/s

Additional flow = 0.00 l/s

Pervious area = 620 m²

Equiv area = 1120 m² (TA x RF).

Areal reduction factor = 1.000

Climate change factor = 25

Calculated data:-

Time to max = 100.0 mins

Rainfall at max = 25.53 mm/hr

Pipeline storage = 0.0 m³

Offline storage = 0.0 m³

Calculated storage volume = 32.7 m³

Allowed discharge rate = 2.500 l/s

Available MH storage = 0.0 m³

Fixed 6 hour data:-

Rainfall event = 6 hours

Rainfall rate = 10.00 mm/hr

Calculated storage volume = 13.8 m³

Allowed discharge rate = 2.500 l/s

Rainfall intensities calculated using the Wallingford Procedure

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

Diam	Len	Diam	Len	Ovoid	Len	Box culvert	Len
100	4158.0	1125	32.9	400 x 600	181.4	500 x 500	130.6
150	1848.0	1200	28.9	600 x 900	79.0	500 x 750	87.1
225	821.3	1275	25.6	800 x 1200	44.4	500 x 1000	65.3
300	462.0	1350	22.8			750 x 1000	43.5
375	295.7	1425	20.5			750 x 1200	36.3
450	205.3	1500	18.5			750 x 1500	29.0
525	150.9	1575	16.8			1000 x 1000	32.7
600	115.5	1650	15.3			1000 x 1200	27.2
675	91.3	1725	14.0			1000 x 1500	21.8
750	73.9	1800	12.8			1000 x 1800	18.1
825	61.1	1875	11.8			1000 x 2000	16.3
900	51.3	1950	10.9			1500 x 1500	14.5
975	43.7	2025	10.1			1500 x 1800	12.1
1050	37.7	2100	9.4			1500 x 2000	10.9



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Data:-

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Job No.

Sheet no.

2

Date

12/09/23

Project
30yr event +25%

Title
Storage calcs for Millwood School

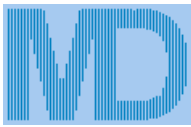
By

Checked

Reviewed

Time (mins)	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)
10	102.0	18.965	1.500	17.465
20	71.0	26.422	3.000	23.422
30	56.0	31.225	4.500	26.725
40	47.0	34.846	6.000	28.846
50	40.0	37.783	7.500	30.283
60	36.0	40.269	9.000	31.269
70	32.0	42.431	10.500	31.931
80	30.0	44.350	12.000	32.350
90	27.0	46.078	13.500	32.578
100	26.0	47.651	15.000	32.651
110	24.0	49.095	16.500	32.595
120	23.0	50.432	18.000	32.432
130	21.0	51.676	19.500	32.176
140	20.0	52.840	21.000	31.840
150	19.0	53.933	22.500	31.433
160	18.0	54.964	24.000	30.964
170	18.0	55.940	25.500	30.440
180	17.0	56.865	27.000	29.865
190	16.0	57.745	28.500	29.245
200	16.0	58.584	30.000	28.584
210	15.0	59.385	31.500	27.885
220	15.0	60.152	33.000	27.152
230	14.0	60.887	34.500	26.387
240	14.0	61.592	36.000	25.592
250	13.0	62.270	37.500	24.770
260	13.0	62.923	39.000	23.923
270	13.0	63.552	40.500	23.052
280	12.0	64.205	42.000	22.205
290	12.0	64.828	43.500	21.328
300	12.0	65.433	45.000	20.433
310	11.0	66.024	46.500	19.524
320	11.0	66.599	48.000	18.599
330	11.0	67.161	49.500	17.661
340	11.0	67.709	51.000	16.709
350	10.0	68.246	52.500	15.746
360	10.0	68.770	54.000	14.770
370	10.0	69.283	55.500	13.783
380	10.0	69.786	57.000	12.786
390	10.0	70.278	58.500	11.778
400	9.0	70.760	60.000	10.760
410	9.0	71.234	61.500	9.734
420	9.0	71.698	63.000	8.698
430	9.0	72.154	64.500	7.654
440	9.0	72.601	66.000	6.601
450	9.0	73.041	67.500	5.541
460	9.0	73.473	69.000	4.473
470	8.0	73.898	70.500	3.398
480	8.0	74.316	72.000	2.316
490	8.0	74.728	73.500	1.228
500	8.0	75.132	75.000	0.132
510	8.0	75.531	76.500	0.000
520	8.0	75.924	78.000	0.000
530	8.0	76.310	79.500	0.000
540	8.0	76.691	81.000	0.000
550	8.0	77.067	82.500	0.000
560	7.0	77.437	84.000	0.000
570	7.0	77.803	85.500	0.000
580	7.0	78.163	87.000	0.000
590	7.0	78.518	88.500	0.000
600	7.0	78.869	90.000	0.000

Storage volume (m³) = 32.7 m³



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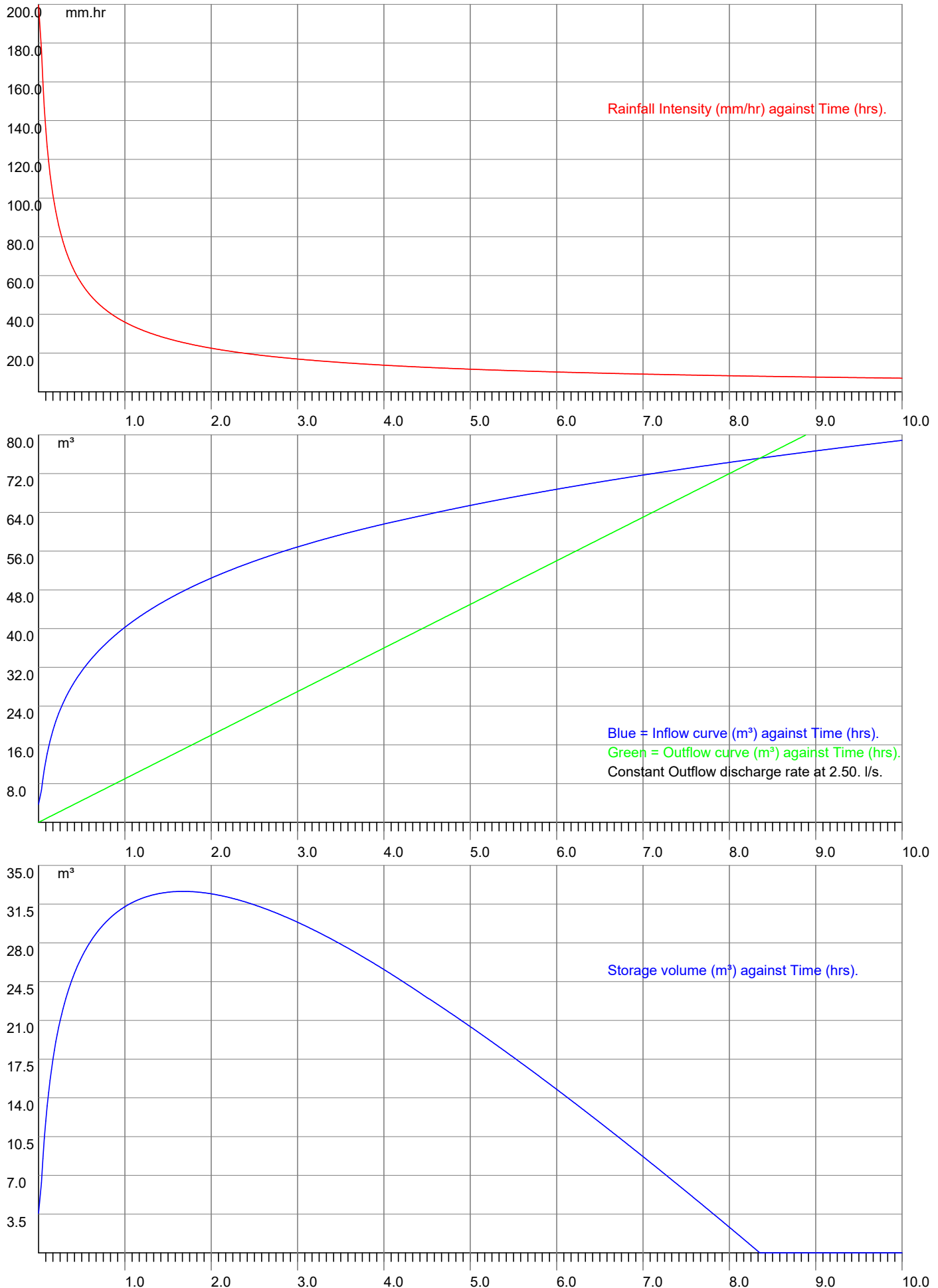
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Project **30yr event +25%**
Title **Storage calcs for Millwood School**





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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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Project	100yr+30%
Title	Storage calcs for Millwood School

Data:-

FSR Hydrology:-

Location = Millwood School

M5-60 (mm) = 18.7

Soil index = 0.45

Return period = 100

UCWI = 107.1

Grid reference = SD7807

r = 0.33

SAAR (mm/yr) = 1020

WRAP = 4

Climate change = 30

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

Runoff factor (RF) = 56.0, 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 = 1380 m²

Total area (TA) = 2000 m²

Mean disch. rate = 2.500 l/s

Additional flow = 0.00 l/s

Pervious area = 620 m²

Equiv area = 1120 m² (TA x RF).

Areal reduction factor = 1.000

Climate change factor = 30

Calculated data:-

Time to max = 140.0 mins

Rainfall at max = 27.62 mm/hr

Pipeline storage = 0.0 m³

Offline storage = 0.0 m³

Calculated storage volume = 51.2 m³

Allowed discharge rate = 2.500 l/s

Available MH storage = 0.0 m³

Fixed 6 hour data:-

Rainfall event = 6 hours

Rainfall rate = 14.00 mm/hr

Calculated storage volume = 37.8 m³

Allowed discharge rate = 2.500 l/s

Rainfall intensities calculated using the Wallingford Procedure

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

Diam	Len	Diam	Len	Ovoid	Len	Box culvert	Len
100	6519.3	1125	51.5	400 x 600	284.4	500 x 500	204.8
150	2897.5	1200	45.3	600 x 900	123.8	500 x 750	136.5
225	1287.8	1275	40.1	800 x 1200	69.6	500 x 1000	102.4
300	724.4	1350	35.8			750 x 1000	68.3
375	463.6	1425	32.1			750 x 1200	56.9
450	321.9	1500	29.0			750 x 1500	45.5
525	236.5	1575	26.3			1000 x 1000	51.2
600	181.1	1650	23.9			1000 x 1200	42.7
675	143.1	1725	21.9			1000 x 1500	34.1
750	115.9	1800	20.1			1000 x 1800	28.4
825	95.8	1875	18.5			1000 x 2000	25.6
900	80.5	1950	17.1			1500 x 1500	22.8
975	68.6	2025	15.9			1500 x 1800	19.0
1050	59.1	2100	14.8			1500 x 2000	17.1



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Data:-

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Date

12/09/23

Project
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Title
Storage calcs for Millwood School

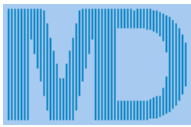
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Time (mins)	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)
10	135.0	25.250	1.500	23.750
20	96.0	35.654	3.000	32.654
30	76.0	42.373	4.500	37.873
40	64.0	47.442	6.000	41.442
50	55.0	51.546	7.500	44.046
60	49.0	55.007	9.000	46.007
70	44.0	58.008	10.500	47.508
80	41.0	60.658	12.000	48.658
90	38.0	63.033	13.500	49.533
100	35.0	65.185	15.000	50.185
110	33.0	67.151	16.500	50.651
120	31.0	68.960	18.000	50.960
130	29.0	70.635	19.500	51.135
140	28.0	72.193	21.000	51.193
150	26.0	73.648	22.500	51.148
160	25.0	75.011	24.000	51.011
170	24.0	76.294	25.500	50.794
180	23.0	77.504	27.000	50.504
190	22.0	78.647	28.500	50.147
200	21.0	79.730	30.000	49.730
210	21.0	80.758	31.500	49.258
220	20.0	81.735	33.000	48.735
230	19.0	82.666	34.500	48.166
240	19.0	83.554	36.000	47.554
250	18.0	84.401	37.500	46.901
260	18.0	85.212	39.000	46.212
270	17.0	85.987	40.500	45.487
280	17.0	86.834	42.000	44.834
290	16.0	87.628	43.500	44.128
300	16.0	88.399	45.000	43.399
310	15.0	89.150	46.500	42.650
320	15.0	89.881	48.000	41.881
330	15.0	90.594	49.500	41.094
340	14.0	91.290	51.000	40.290
350	14.0	91.969	52.500	39.469
360	14.0	92.632	54.000	38.632
370	14.0	93.281	55.500	37.781
380	13.0	93.916	57.000	36.916
390	13.0	94.537	58.500	36.037
400	13.0	95.145	60.000	35.145
410	13.0	95.741	61.500	34.241
420	12.0	96.326	63.000	33.326
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450	12.0	98.013	67.500	30.513
460	11.0	98.556	69.000	29.556
470	11.0	99.088	70.500	28.588
480	11.0	99.612	72.000	27.612
490	11.0	100.126	73.500	26.626
500	11.0	100.633	75.000	25.633
510	11.0	101.131	76.500	24.631
520	10.0	101.621	78.000	23.621
530	10.0	102.103	79.500	22.603
540	10.0	102.578	81.000	21.578
550	10.0	103.046	82.500	20.546
560	10.0	103.507	84.000	19.507
570	10.0	103.962	85.500	18.462
580	10.0	104.410	87.000	17.410
590	10.0	104.851	88.500	16.351
600	9.0	105.287	90.000	15.287

Storage volume (m³) = 51.2 m³



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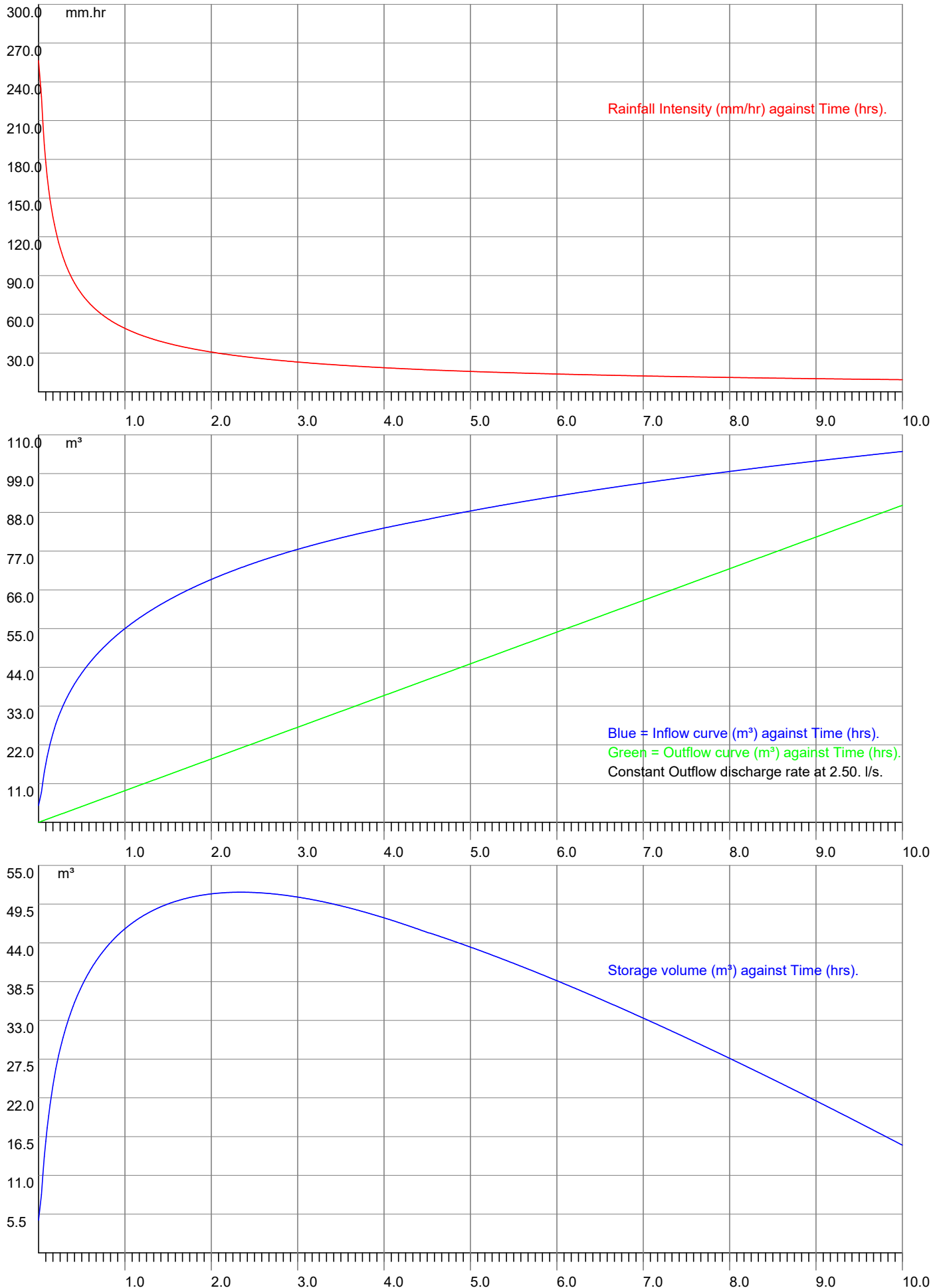
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