Site Drainage Assessment & Sustainable Drainage Systems (SuDS)

Black Horse Yard, Church Walk, Hayes UB3 2RN

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Executive Summary

UK Flood Risk Consultants has been commissioned to undertake drainage assessment and develop a Sustainable Drainage Systems (SuDS) Strategy in support of a proposal consisting of a residential development with the erection of two detached dwellings located at Black Horse Yard, Church Walk, Hayes UB3 2RN.

The main sources of information to develop the SuDS strategy are the guidelines of the National Planning Policy Framework (NPPF, September 2023) and the Environment Agency's Flood Risk Assessment (FRA) Guidance Notes along with the best practice guidance in flood risk and drainage including the Non-Statutory Technical Standards for Sustainable Drainage Systems (March 2015).

The overall risk of surface water flooding to the site is low.

The surface runoff will be improved by implementing appropriate SuDS measures.

Due to underlying soil condition mostly composed of silt and clay with low infiltration capacity, the potential for a Soakaway to discharge the surface runoff from the site is low. Also, there are no watercourses in the vicinity of the site.

An open ground attenuation storage will not be feasible at the site due to the limited space available. Therefore, in line with the SuDS drainage hierarchy policy, two identical underground geo-cellular storages (Length = 4m, Width = 3m, Depth = 0.40m) will be implemented in order to temporarily store the runoff water from the site.

Thames Water sewer asset map shows that there is a surface water sewer on the road (i.e. Church Walk)**.** In line with the SuDS drainage hierarchy the controlled outflow from the attenuation storage will be discharged into this SW sewer using a 150mm linear pipe. In order to minimise the risk of flooding, the maximum discharge rate will be controlled by using a discharge control unit such as hydrobrake, so that it is not more than 0.40 litres/sec which is the greenfield runoff rate for the site.

In addition, permeable paving will be implemented in the front yard area and the side and rear patio area to further improve the surface runoff from the site.

The landowners will be fully responsible for the repair and management of the implemented SuDS throughout the lifetime of the proposed development.

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Abbreviations

Abbreviation	Description
mAOD	Metres Above Ordnance Datum
DEFRA	Department for Environment, Food, and Rural Affairs
EA	Environment Agency
FRA	Flood Risk Assessment
LLFA	Lead Local Flood Authority
NPPF	National Planning Policy Framework
SFRA	Strategic Flood Risk Assessment
SuDS	Sustainable Drainage Systems

1.0 Background

UK Flood Risk has been commissioned to undertake drainage assessment and develop a Sustainable Drainage Systems (SuDS) Strategy in support of a proposal consisting of a residential development with the erection of two detached dwellings located at Black Horse Yard, Church Walk, Hayes UB3 2RN.

The Sustainable Drainage Systems (SuDS) Strategy has been developed in accordance with the guidelines and the requirements of the National Planning Policy Framework (NPPF, December 2024) and the Environment Agency's Flood Risk Assessment (FRA) Guidance Notes along with the best practice guidance in flood risk and drainage including the Non-Statutory Technical Standards for Sustainable Drainage Systems (March 2015).

2.0 Surface Water Drainage Requirements

A surface water drainage assessment should be undertaken to demonstrate that surface water runoff from the proposed development can be effectively managed without increasing flood risk elsewhere. A surface water drainage assessment should include the following:

- Assessment of whether the development will increase the overall discharge from the site by calculating the change in area covered by roofs and hard-standing.
- Details of how overland flow from the new development can be intercepted to prevent flooding of adjacent land.
- Details of how additional onsite surface water attenuation can be provided to mitigate against known flooding problems or as a result of incapacity on the drainage systems.
- Demonstration that overland flows will not increase flood risk to both existing development and receiving watercourses.

3.0 General Description of the Site and the Proposals

3.1. Description of the site

The proposal site is located at Black Horse Yard, Church Walk, Hayes UB3 2RN approximately centred on the OS NGR TQ 09444 81187(**Appendix A Figure 1**). The site is located within the administrative boundary of London Borough of Hillingdon, which is also the Lead Local Flood Authority (LLFA) responsible for the management of surface water flooding in the area.

The site comprises small storage buildings along with hardstanding and soft landscaping area. The site occupies an area of approximately 362m^2. Approximately 75m^2 of area is occupied by the building footprints and 267m^2 is covered by hardstanding. Approximately 20m^2 area is covered by soft landscaping (**Appendix B**).

The access to the site is via Church Walk. The surrounding area consists of predominantly residential use (**Appendix A Figure 2)**.

The British Geological Survey's geological maps are provided in **Appendix C**. The geological maps show that the bedrock of the site comprises London Clay Formation - Clay, Silt and Sand that formed between 56 and 47.8 million years ago during the Palaeogene period. The superficial deposits consist of Boyn Hill Gravel Member - Sand and Gravel that formed between 423 and 126 thousand years ago during the Quaternary period.

There are no major watercourses in the vicinity of the site.

The site topography is relatively flat and level with the general elevations varying from 38.10mAOD to 38.17mAOD **(Appendix D).** Further details about the existing site are provided in **Appendix C**.

3.2. Proposed Development

The proposal comprises a residential development with the erection of two detached dwellings. The total footprint area of the proposed buildings is approximately 170m^2. Further details about the proposals have been provided in **Appendix C**.

4.0 Sustainable Drainage Systems Policy

4.1. Flood and Water Management Act 2010

The method of drainage of surface water from the site is bound by the Flood and Water Management Act 2010. Schedule 3 Paragraph 5 of the Flood and Water Management Act 2010 states that the following hierarchy is to be applied to surface water runoff in the following order or priority:

- Discharge into the ground (infiltration)
- Discharge to a surface water body (lake, river, drain);
- Discharge to a surface water sewer, highway drain or another drainage system; or Discharge into a combined sewer.

4.2. Drainage Hierarchy

Development proposals should aim to achieve greenfield run-off rates and ensure that surface water run-off is managed as close to its source as possible in line with the following drainage hierarchy as set out by the Non-Statutory Technical Standards for Sustainable Drainage Systems (March 2015):

1. rainwater harvesting (including a combination of green and blue roofs),
2. infiltration techniques and green roofs,
3. rainwater attenuation in open water features for gradual release,
4. rainwater discharge direct to a watercourse (unless not appropriate),
5. rainwater attenuation above ground (including blue roofs),
6. rainwater attenuation below ground,
7. rainwater discharge to a surface water sewer or drain,
8. rainwater discharge to a combined sewer.

4.3. Strategic Flood Risk Assessment (SFRA)

The West London Strategic Flood Risk Assessment (SFRA) undertaken by the boroughs of Barnet, Brent, Ealing, Harrow, Hillingdon and Hounslow is a comprehensive study that assesses the potential risks and impacts of flooding in the boroughs. The SFRA provides important information to support land use planning, development control, emergency planning, and community resilience. The SFRA considers a range of potential flood risks, including those from rivers, surface water, and groundwater sources. The study includes detailed flood risk maps that identify areas at risk of flooding and the potential consequences of flooding, such as property damage, business disruption, and loss of life.

The SFRA also provides guidance on flood risk management strategies and measures that can be implemented to mitigate the potential impacts of flooding. The SFRA has provided SuDS a high priority. SuDS are designed to manage and reduce the impact of surface water runoff in urban areas. SuDS incorporate several measures to slow down and manage the flow of rainwater. By doing so, they help prevent surface water runoff overwhelming drainage systems and causing flooding downstream.

5.0 Assessment of Surface Runoff Flood Risk

The surface water flooding arises when the infiltration capacity of land or the drainage capacity of a local sewer network is exceeded and the excess rainwater flows overland. The severity of surface water flooding depends on several factors such as the degree of saturation of the soil before the event, the permeability of soils and geology, hill slope steepness and the intensity of land use.

Information on the risk of surface water flooding is held by the Environment Agency. The Environment Agency’s Surface Water Flood Risk Maps are provided in **Appendix E Figure 1 and Figure 2** which indicate that the risk of surface water flooding to the site is 'low'.

6.0 Sustainable Drainage Systems (SuDS)

The London Borough of Hillingdon has a robust policy regarding the implementation of Sustainable Drainage Systems (SuDS) to manage surface water runoff and mitigate the risk of flooding, in alignment with the London Plan and national legislation. SuDS are designed to replicate natural drainage processes, reducing the volume and rate of surface water runoff, which can otherwise overwhelm traditional drainage systems.

The Borough requires that SuDS be integrated into the design of new developments and major redevelopments to ensure that the infrastructure can handle stormwater efficiently and sustainably. This is in line with the National Planning Policy Framework (NPPF) and London Plan policies, which emphasize the importance of managing surface water at source.

6.1. Existing Drainage

The proposal site comprises existing buildings along with hardstanding and soft landscaping area. The surface runoff from the hardstanding infiltrates into the nearby soft landscaping area. Most of the surface runoff from the soft landscaping area infiltrates into the ground. The excess runoff is discharged into the SW sewer located on the road (i.e. Church Walk).

6.2. Greenfield Runoff Estimation

The estimation of the Greenfield Runoff rate has been undertaken using the HR Wallingford's Greenfield Runoff Estimation tool available on the website: http://www.uksuds-.com/greenfieldrunoff_js.htm. The aim of the tool is to provide flow rate information based on a minimum amount of data so that anybody can use the tool. The methodology is built around the concept that a flow rate discharge constraint is needed for storm water runoff from a site, resulting in attenuation volume being needed. In addition, current drainage criteria include the requirement for the 100 year 6hr volume to be controlled. The tool is based on the results of simple model analysis and correlating the results against key known site parameters. As such the results need to be treated as providing indicative information only and should not be used to produce final designs of drainage systems without additional modelling being carried out.

The peak flow estimation can now be estimated using two different formulae.

1) The formula developed in IH124 (IH 1994) and use of the FSSR growth curve information for regions of the UK (FSSR 14),

2) The use of FEH statistical correlation equation revised in 2008.

However, only the IH124 method can be used without providing specific parameter values. Therefore, this method has been used for estimating greenfield runoff rate from the proposed development site.

Details about the parameters used in the estimation are provided in **Appendix F** and the results are summarised in **Table 1** below. A site area of 0.10ha has been used, which is the minimum site area required for this technique.

The proposed development has considered the greenfield runoff rates for addressing surface water discharge requirements from the developed site. The greenfield runoff rates have been utilised for developing the drainage strategy for the site.

Table 1 – Greenfield Runoff Rates

Events	Greenfield runoff rates (l/s) (Estimated)
Qbar	0.42
1 in 1 year	0.36
1 in 30 year	0.96
1 in 100 year	1.34

6.3. Estimation of Permeable and Impermeable Areas

The land cover type plays a significant role in the generation and behaviour of surface water runoff. Different land cover types affect how much rainwater is absorbed into the ground, how much runs off the surface, and how quickly this runoff reaches watercourses or drainage systems.

The changes in land cover have been summarised in **Table 2** below. It can be seen that the proposed development will lead a reduction in the impermeable area by approximately 141m^2. This means the surface runoff will not be increased as a result of the proposed development.

Table 2 Changes in Land Cover Areas

Land Cover	Pre-development, m^2	Post-development, m^2	Change, m^2
Impermeable Surface Area			
Hard standing	267	31	
Building footprint	75	170	
Total Impermeable	**342**	**201**	**(-) 141**
Permeable Surface Area			
Grass cover	20	58	
Permeable paving	0	103	
Total Permeable	**20**	**161**	**(+) 141**
Total Area	362	362	

6.4. Estimation of peak surface runoff rates

Pre-development Peak Runoff Rates (based on land cover)

The Rational Method has been used in order to estimate the peak surface runoff from the site.

The Rational Equation is given by:

Q = Ar x P x Ri

Where, Ar = Effective catchment area, m^2

P= Impermeability factor

Ri= Rainfall Intensity, mm/hr, Q= Peak surface runoff, m^3/s

The peak surface runoff rates for the existing site condition are summarised in **Table 3** below. An impermeability factor of 0.90 has been used for the site. Information on the maximum rainfall intensity for a range of return period events has been taken from the Micro Drainage Model developed for the site which is provided in **Appendix H**. The impermeable surface areas in **Table 2** have been used as catchment for the calculations.

Table 3 Estimation of Peak Runoff Rates from the site (Pre-development condition) based on the land cover area

Return Periods	Max Rainfall Intensity, Ri mm/hr	Catchment Area, A m²	Impermeability factor, P	# Peak Runoff, Q, m³/sec	Peak Runoff, Q, litres/sec
1/ 1 year	32.979	342	0.9	0.00282	2.82
1/2 year	42.605	342	0.9	0.00364	3.64
1/5 year	54.767	342	0.9	0.00468	4.68
1/10 year	63.716	342	0.9	0.00545	5.45
1/30 year	80.99	342	0.9	0.00692	6.92
1/50 year	90.546	342	0.9	0.00774	7.74
1/100 year	105.34	342	0.9	0.00901	9.01
1/100 year + 40% CC	147.48	342	0.9	0.01261	12.61

Q = (Ri/1000 x A x P)/3600

Ri taken from MicroDrainage model (**Appendix I**).

Post-development Peak Runoff Rates (with attenuation storage)

An outflow control rate of 0.40 litres/sec has been used with the implementation of the attenuation storage system. The surface runoff rates for the site post-development are summarised in **Table 4** below.

Table 4 Summary of Peak Runoff Rates from the site (Post-development condition with the provision of attenuation storage)

Return Periods	Peak Runoff Rates, Q, litre/sec
1/ 1 year	0.40
1/2 year	0.40
1/5 year	0.40
1/10 year	0.40
1/30 year	0.40
1/100 year	0.40
1/100 year + 40% CC	0.40

6.5. Hierarchy of SuDS Measures

The surface runoff from the site will be improved by implementing appropriate SuDS. The requirements for SuDS will ensure that any redevelopment or new development does not negatively contribute to the surface water flood risk of other properties and instead provides a positive benefit to the level of risk in the area. It will also ensure that appropriate measures are taken to increase the flood resilience of new properties and developments in surface water flood risk areas, such as those identified as being locally important flood risk areas.

The SuDS hierarchy and management train has been discussed in the SuDS Manual (C753) which aims to mimic the natural catchment processes as closely as possible. The general hierarchy of the SuDS measures is provided in **Table 5** below.

Table 5 General Hierarchy of SuDS Measures

Measures	Definition/Description
Prevention	The use of good site design and housekeeping measures to prevent runoff and pollution (e.g. rainwater harvesting/reuse).
Source control	Control of runoff at or very near its source (e.g. soakaways, porous and pervious surfaces, green roofs).
Site control	Management of water in a local area on site (e.g. routing water to large soakaways, infiltration or detention basins)
Regional control	Management of runoff from a site or several sites (e.g. balancing ponds, wetlands).

The Borough follows a SuDS hierarchy to determine the best solutions:

- Infiltration: Where possible, water should be allowed to soak into the ground (using techniques such as soakaways or permeable paving).
- Attenuation: If infiltration isn't feasible, SuDS that slow the flow of water, such as detention basins or attenuation ponds, should be used.
- Discharge to watercourses: Where neither infiltration nor attenuation is viable, surface water runoff can be discharged to a watercourse or sewer, but this must be done in a way that minimizes impact on flood risk.

6.6. Potential for Infiltration SuDS

Infiltration-based Sustainable Drainage Systems (SuDS) are often the preferred approach for managing surface water runoff, as they allow water to soak directly into the ground, mimicking natural processes. However, whether infiltration SuDS are a viable option depends on several factors related to the specific site conditions and local environmental factors. Infiltration is most effective in areas with permeable soils (e.g., sandy soils) that allow water to move through them easily. High groundwater tables can limit the ability to use infiltration SuDS. If the groundwater table is close to the surface, it can prevent water from being absorbed by the ground because the soil is already saturated. This can lead to surface water pooling or flooding.

Infiltration SuDS require space for installation. Techniques like soakaways and infiltration trenches require sufficient land area to allow water to seep into the ground without causing harm to the surrounding environment. In more densely developed urban areas like the site, space for large-scale infiltration systems may be limited. In these cases, smaller-scale solutions such as permeable paving could be more practical.

The British Geological Survey's geological map in **Appendix B** shows that the bedrock of the site comprises London Clay Formation, which is not considered appropriate for Infiltration SuDS such as a Soakaway. Also, field observations indicated that the underlying soil is mostly composed of silt and clay which has a low permeability potential. It implies that Infiltration SuDS like a Soakaway would not be appropriate due to the underlying soil condition.

In addition, information on the infiltration potential was obtained from the British Geological Survey. Infiltration SuDS GeoReport for the site is included in **Appendix H**. The Maps indicate the drainage potential of the ground, by considering subsurface permeability, depth to groundwater and the presence of floodplain deposits. The Suitability of Infiltration SuDS in terms of the Drainage Potential for the site is shown in **Figure 1** below. It can be seen that there are very significant constraints at the site. The site is located in an area with very significant potential for one or more hazards associated with infiltration.

The possibility of using infiltration-based SuDS at the site depends on a combination of soil characteristics, groundwater levels, topography, land availability, and pollution considerations. From the assessment of the Infiltration SuDS GeoReport for the site, information from the British Geological Survey map and field observations, it is reasonable to conclude that the potential for infiltration SuDS is very limited at the site due to poor soil conditions and high groundwater levels. Therefore, alternative SuDS techniques like attenuation storage have been considered.

Figure 1. Suitability of Infiltration SuDS in terms of the Drainage Potential.

In terms of the drainage potential, is the ground suitable for infiltration SuDS?

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White/pale	Highly compatible for infiltration SuDS. The subsurface is likely to be suitable for free-draining infiltration SuDS.
Light blue	Probably compatible for infiltration SuDS. The subsurface is probably suitable although the design may be influenced by the ground conditions.
Dark blue	Opportunities for bespoke infiltration SuDS. The subsurface is potentially suitable although the design will be influenced by the ground conditions.
Grey	Very significant constraints are indicated. There is a very significant potential for one or more hazards associated with infiltration.

6.7. General Assessment of SuDS Measures for the site

Table 6 below presents the feasibility assessment of several SuDS measures for the site.

Table 6 General Assessment of SuDS measures for the site

SuDS Measures	Issues/Description	Feasibility for the site
Source Control Porous and pervious materials/soakaways/green roof/infiltration trenches/disconnect downpipes to drain to lawns or infiltrate to soakaway.	Permeable paving improves the surface runoff from the site.	Yes. There is a potential for permeable paving in the front yard area to improve the surface runoff.
Site and Regional Control Infiltration/detention basins/ balancing ponds/ wetlands/underground storage/swales/retention ponds.	Open surface Balancing pond will not be feasible due to limited space available.	No. The potential for balancing pond is low as there is very limited space available for open ground balancing pond.

	Geo-cellular underground storage will improve the surface runoff conditions by temporarily storing the surface runoff from extreme rainfall event (1 in 100 year plus climate change).	Yes. A Geo-cellular underground storage system can be implemented in the front yard area in order to attenuate the surface runoff from the extreme event of 1 in 100 year plus climate change.

6.8. Proposed SuDS

Based on the general assessment of the potential SuDS measures above, underground attenuation storages will be implemented in order to attenuate the surface runoff from the design 1 in 100-year 6-hour rainfall event plus 40% Climate Change. In addition, permeable paving will be implemented in the front yard area and the side and rear patio area to further improve the surface runoff from the site.

7.0 Outline Drainage Design

7.1. Proposed Drainage System

Attenuation Storage

An open ground attenuation storage will not be feasible at the site due to the limited space available. Therefore, an underground geo-cellular storage will be implemented at each of the two sites in order to temporarily store storm water from the site.

The proposed scheme will therefore include an underground Geo-cellular attenuation storage for each of the buildings with the controlled outflow discharge by using a Hydrobrake. The size of the proposed attenuation storage is as follows:

Area = 24m^2, Depth = 0.40m for the two identical building sites.

Therefore, for each of the building sites, the following size is proposed.

Area = 12m^2, Depth = 0.40m (Length = 4m, Width = 3m, Depth = 0.40m)

The Greenfield Runoff rate for the site is 0.42 litres/sec (**Table 1**). Therefore, a maximum flow control of 0.40 litres per second has been adopted for all events up to and including 1% AEP + 40%CC with no flooding. The proposed SuDS drainage layout plan has been provided in **Appendix J.**

There are no open-surface watercourses near the site. Therefore, discharging the surface runoff to watercourses is not a viable option.

Also, discharging the surface runoff via infiltration such as a Soakaway will not viable due to underlying soil condition as discussed above.

Thames Water's sewer asset map shows that there is a Surface Water sewer on the road (i.e. Church Walk) (**Appendix G**)**.** Therefore, in line with the SuDS drainage hierarchy the controlled outflow from the attenuation storages will be discharged into this sewer using a 150mm linear pipe as shown in **Appendix J**.

Hydraulic Modelling

The proposed drainage scheme has been modelled by using Micro Drainage Source Control to understand the evolving flow regime under flood conditions and the potential for flooding. The catchment area used for the modelling is 0.020ha which is the total area of hard standing proposed development (**Table 2**).

The attenuation storage has been modelled considering the 1 in 100 year (1%AEP) plus 40% climate change event. Both summer and winter profiles of the storm events have been considered for a range of duration, from 15 minutes to 8640 minutes. All input parameters (i.e. rainfall and model details) have been provided in **Appendix K**. The summary of the model output for the 1 in 100 year plus 40% climate change event is provided in **Table 7** below.

It can be seen from **Table 7** that for the maximum volume of 9.50m^3 will be generated by the 120 minutes Winter event, and there will be no overflow and flooding for this event. Therefore, the proposed attenuation storage system will provide full storage for the surface water runoff generated from the 1 in 100 year plus 40% climate change design event.

Table 7 – Summary of Model Output (1 in 100 year plus 40% climate change).

Events	Rainfall mm/hr	Max Volume M^3	Discharge Volume M^3	Overflow Volume M^3	Flooded Volume M^3
120 min (Winter) 1 in 100 year plus 40% CC	34.920	9.50	11.70	0.0	0.0

The location and layout of the proposed storage and its dimensions (area and depth) can be changed to suit the site conditions. This will be to the client's discretion ensuring that the required attenuation storage volume is provided within the site. Thames Water's sewer asset map shows that there is a Surface Water sewer on Church Walk (**Appendix G**)**.** Therefore, in line with the SuDS drainage hierarchy the controlled outflow from the attenuation storage system will be discharged into this sewer using a 150mm linear drainage pipe as shown in **Appendix J**.

Exceedance Flow Paths

It is inevitable that as a result of heavy or extreme rainfall, the capacities of sewers and other drainage systems will be exceeded on occasion. Drainage exceedance will occur when the rate of surface water runoff exceeds the inlet capacity of the drainage system, when the receiving water or pipe system becomes overloaded, when the outfall becomes restricted due to flood levels in the receiving water, or due to poor maintenance of the SuDS features.

The proposed attenuation storage has been designed for the 1 in 100 year plus 40% climate change event. Any extreme event greater than this design event may lead to the situation where the rate of surface water runoff exceeds the inlet capacity of the drainage system. In such circumstances, the flow routes from the site will naturally follow to the south towards the rear garden area as this will be the only open area for the floodwater to flow across the site. The exceedance flow routes are shown in **Appendix L.**

7.2. SuDS Management and Maintenance Plan

The owners will be fully responsible for regular repair and maintenance of the proposed SuDS measures as required for the lifetime of the development. The SuDS at this site have been designed for easy maintenance to comprise:

Geo-cellular Storage System

Remedial work for repairing damage will be carried out whenever necessary. The repair and maintenance will include regular inspection of silt traps, manholes, pipework and pre-treatment devices, with removal of sediment and debris as required. **Table 8** provides further details on the regular maintenance of the Geo-cellular storage system.

Table 8 Regular Maintenance and remedial measures for Geo-cellular storage system

Regular Maintenance	Actions/Remedial measures
Monthly	• Inspect and identify any areas that are not operating correctly. If required, take remedial action. (for 3 months following installation) • Debris removal from catchment surface (where may cause risks to performance) • Inspect systems as specified by the manufacturer • Where rainfall infiltrates into blocks from above, check surface of filter for blockage by silt, algae or other matter. Remove and replace surface infiltration medium as necessary.
Six monthly	• Inspect and identify any areas that are not operating correctly. If required, take remedial action (following initial 3 month period).
Annually	• Remove sediment from pre-treatment structures (e.g. upstream silt- traps or Vortex flow control upstream) and

	geocellular system where required (High pressure water jetting) • Inspect and document the presence of wildlife.
Following all significant storms	• Inspect and carry out essential recovery works to return the feature to full working order.

Flow control structures

Remedial work for repairing any damage to flow control structures/devices will be carried out whenever necessary. **Table 9** provides further details on the regular maintenance of the flow control structures/devices.

Table 9 Regular Maintenance and remedial measures for flow control structures

Regular Maintenance	Actions/Remedial measures
Monthly	• Inspect and identify any areas that are not operating correctly. If required, take remedial action (for 3 months following installation).
Six monthly	• Inspect and identify any areas that are not operating correctly. If required, take remedial action. • Remove sediment from pre-treatment structures.
Following all significant storms	• Inspect and carry out essential recovery works to return the feature to full working order.

Permeable Paving

The landowners will be fully responsible for regular maintenance of the proposed permeable paving. **Table 10** provides further details on the regular maintenance of the proposed Permeable Paving.

Table 10 Regular Maintenance and remedial measures for permeable paving

Regular Maintenance	Actions/Remedial measures
Monthly	• Refer to manufacturer specifications, • For sealed systems, inspection of outfalls should be undertaken.
Six Monthly	• Brushing and vacuuming to manufacturer requirements. Re-grit where necessary after brushing.
As Required	• Inspect/check all inlets, outlets, inspection chambers, surface and overflows (where required) to ensure that they are in good condition, free from blockages and operating as designed. Take action where required (for 3 months following installation) • Removal of weeds where required, • Stabilizing and mowing of contributing areas where required.
Following all significant storm events	• Inspect and carry out essential recovery works to return the feature to full working order

8.0 Conclusion

The proposals a residential development with the erection of two detached dwellings located at Black Horse Yard, Church Walk, Hayes UB3 2RN.

The overall risk of surface water flooding to the site is low.

The surface runoff will be improved by implementing appropriate SuDS measures.

Due to underlying soil condition mostly composed of silt and clay with low infiltration capacity, the potential for a Soakaway to discharge the surface runoff from the site is low. Also, there are no watercourses in the vicinity of the site.

An open ground attenuation storage will not be feasible at the site due to the limited space available. Therefore, in line with the SuDS drainage hierarchy policy, two identical underground geo-cellular storages (Length = 4m, Width = 3m, Depth = 0.40m) will be implemented in order to temporarily store the runoff water from the site.

Thames Water sewer asset map shows that there is a surface water sewer on the road (i.e. Church Walk). In line with the SuDS drainage hierarchy the controlled outflow from the attenuation storage will be discharged into this SW sewer using a 150mm linear pipe. In order to minimise the risk of flooding, the maximum discharge rate will be controlled by using a discharge control unit such as hydrobrake, so that it is not more than 0.40 litres/sec which is the greenfield runoff rate for the site.

In addition, permeable paving will be implemented in the front yard area and the side and rear patio area to further improve the surface runoff from the site.

The landowners will be fully responsible for the repair and management of the implemented SuDS throughout the lifetime of the proposed development.

Appendix A Collection of Maps and Figures

Appendix B Geological Map of the Site

Appendix C Existing Site and Proposed Plans

Appendix D Topographic Map of the Site

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Appendix E Surface Water Flood Maps

Appendix F Greenfield Runoff Rates Estimation

Appendix G Sewer Assets Map Data

Appendix H GeoInfiltration Report

Appendix I Rainfall Runoff Summary

Appendix J Outline Sustainable Drainage Systems (SuDS) Plan

Appendix K Attenuation Storage Modelling Summary

Appendix L Exceedance Flow Routes

Appendix A Site Location Maps and Figures

Figure 1 Site Location Map

(Source: Ordnance Survey Online Maps)

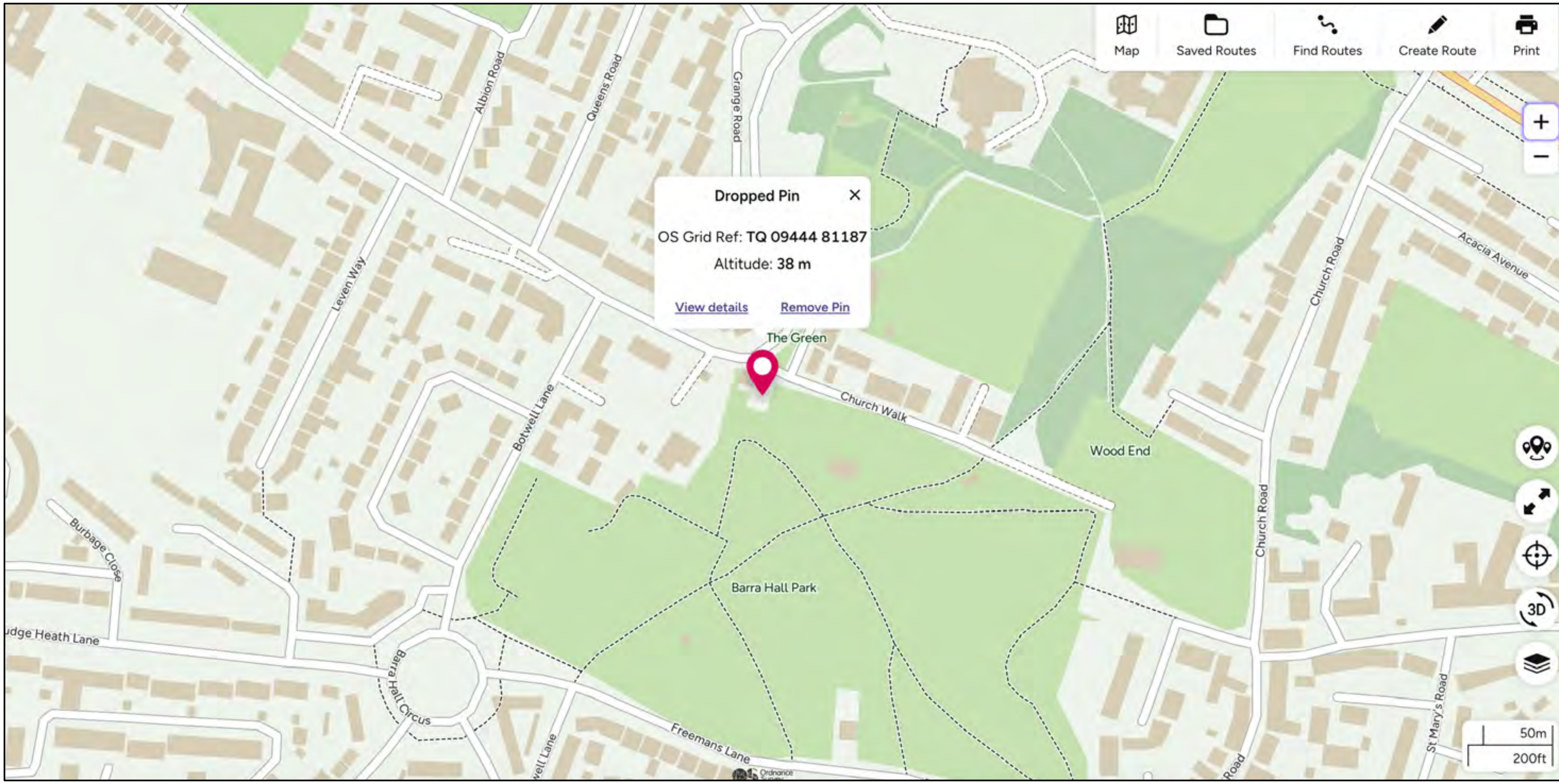


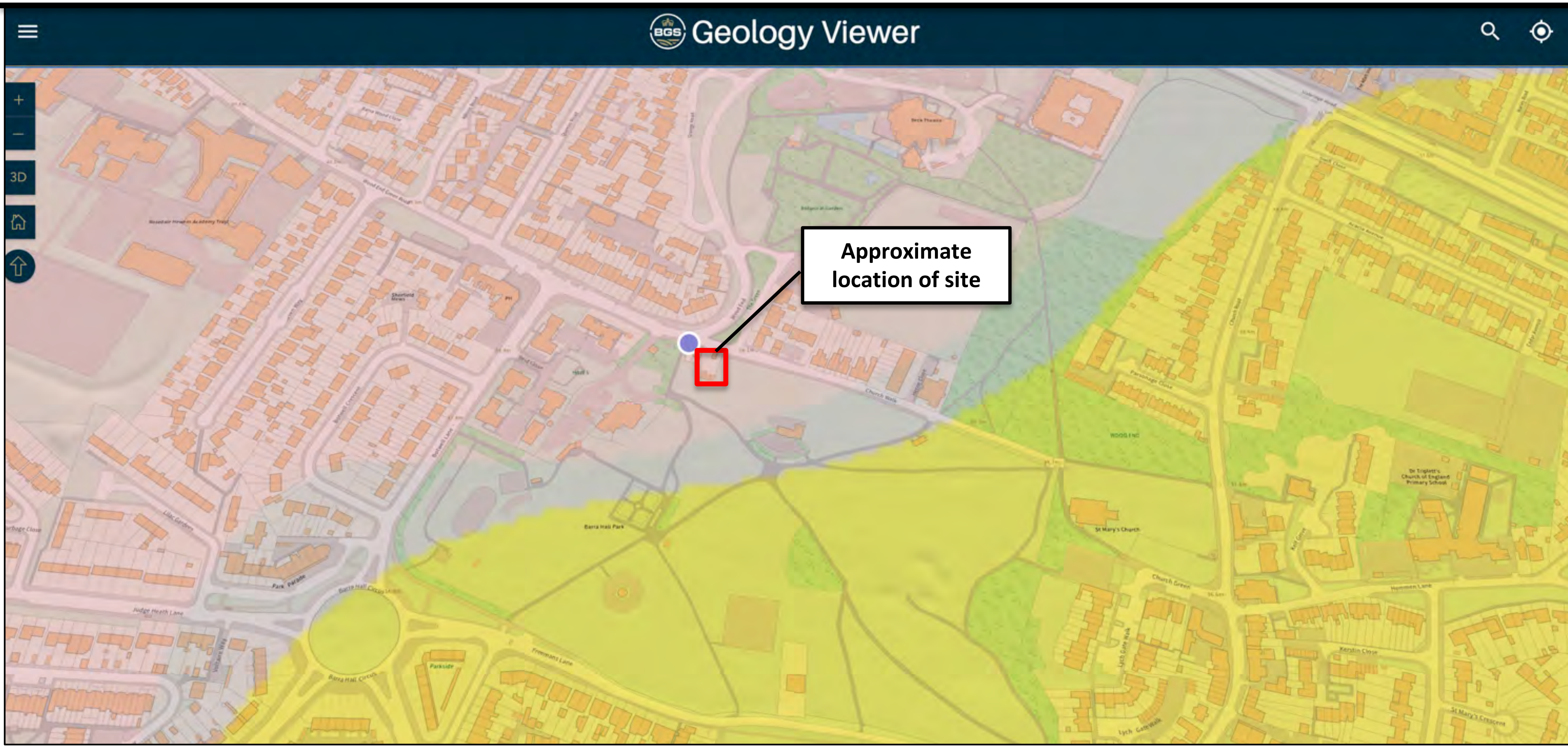
Figure 2 Site Location Map

(Source: Google Maps)

Appendix B Geological Map of the Site

Figure 1 Geological Map of the Site

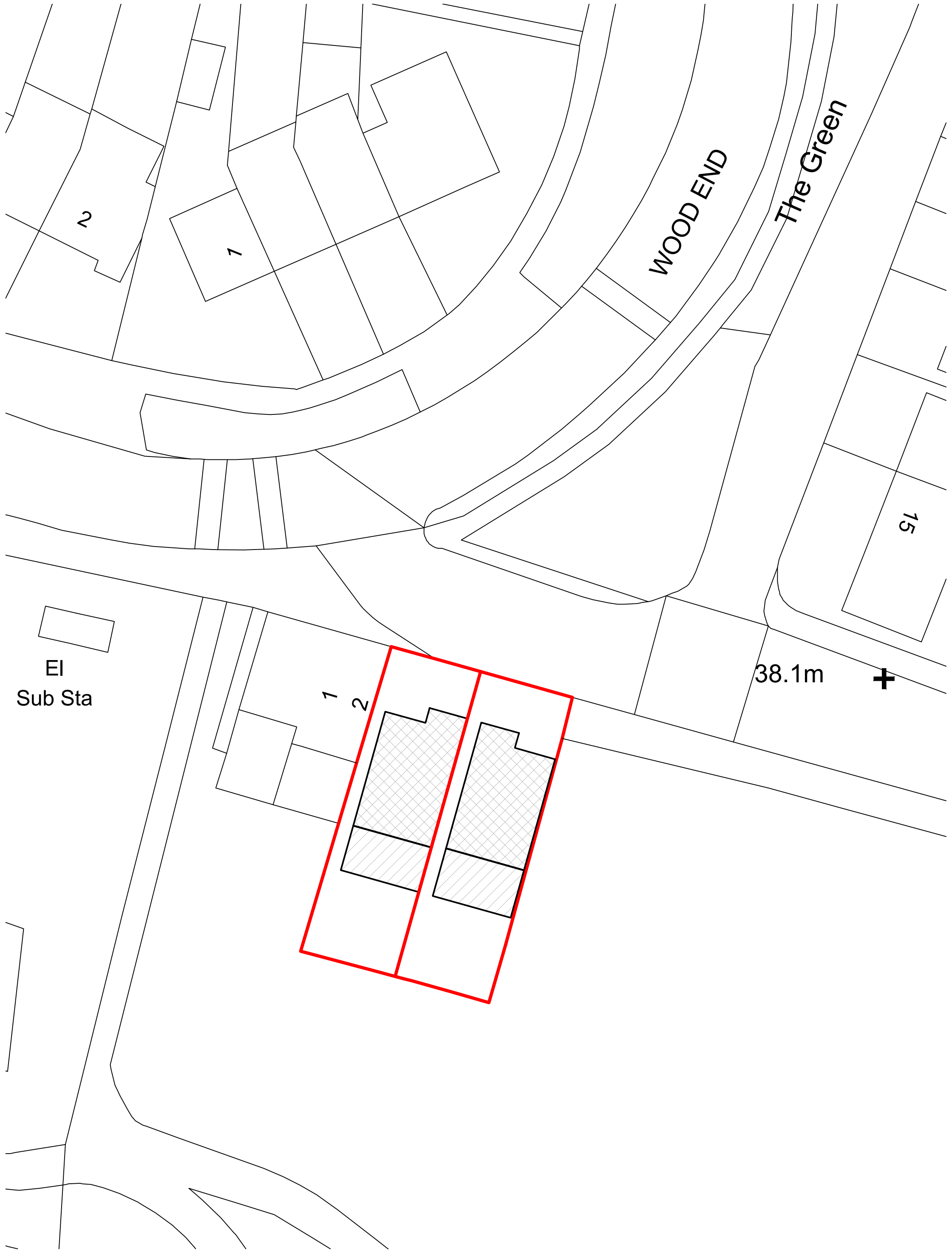
(Source: British Geological Survey Geological Britain Viewer)



Site Geology

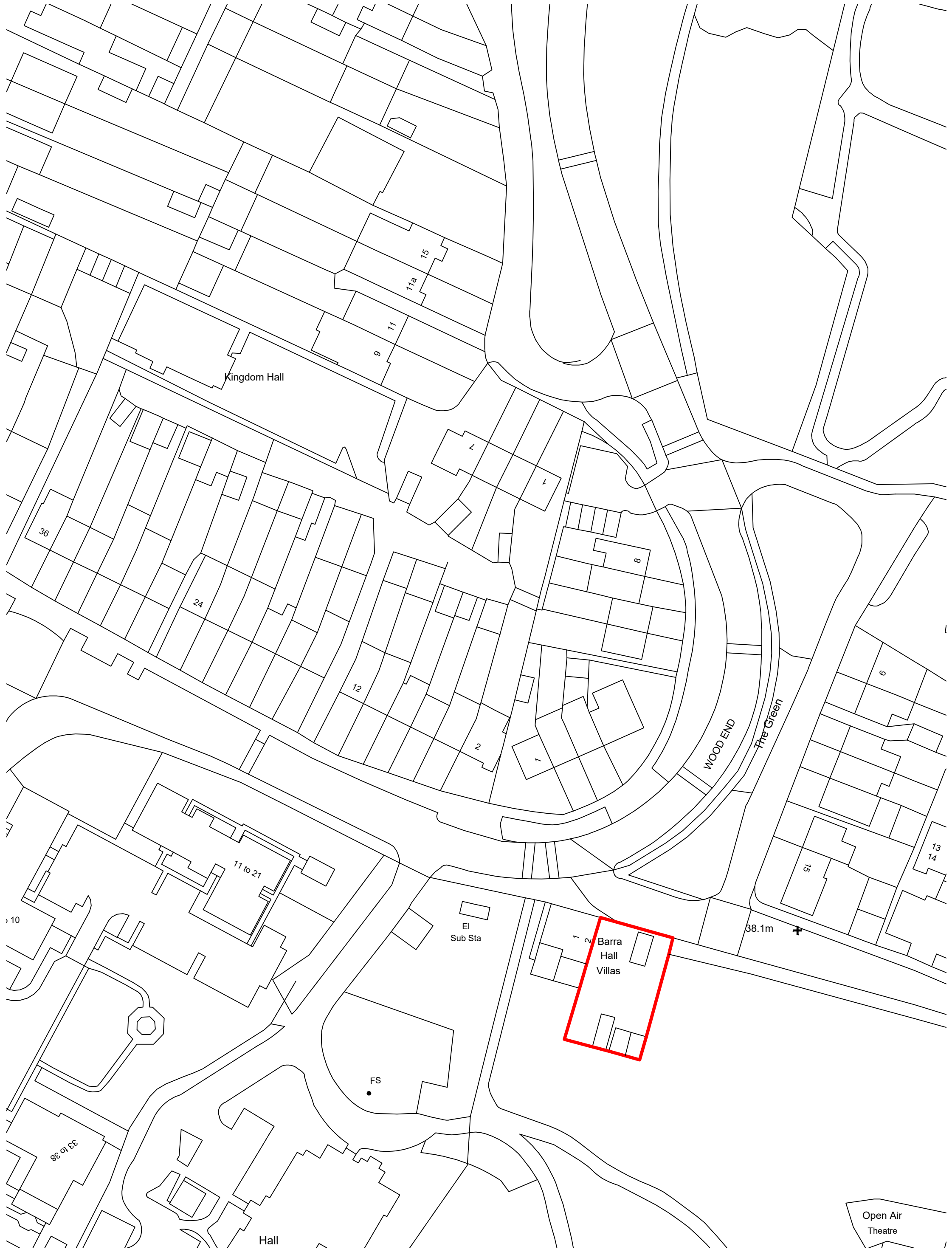
Bedrock geology description: London Clay Formation - Clay, silt and sand. Sedimentary bedrock formed between 56 and 47.8 million years ago during the Palaeogene period.
Superficial deposits description: Boyn Hill Gravel Member - Sand and gravel. Sedimentary superficial deposit formed between 423 and 126 thousand years ago during the Quaternary period.

Appendix C Existing Site and Proposed Plans



Block Plan

0 5 10 15 20 25
metres 1:500 scale



Site Location

0 10 20 30 40 50
metres 1:1250 scale

V - Design

Website: V-Design CAD Servies Ltd
Email Address: info@vdesigncad.co.uk

IMPORTANT NOTES:

Dimensions to be verified on site
DO NOT SCALE FROM THIS DRAWING.
Any areas indicated on this drawing are for guidance only.
No responsibility is taken for their accuracy.

Email: vishal.p@vdesigncad.co.uk Mobile: 07971083395

PROJECT:

Black Horse Yard,
Church Walk,
Hayes, UB3 2RN

CLIENT:

LEGENDS:

EXISTING:	PROPOSED:
Existing Wall	Proposed Wall
Internal Wall	Internal Wall (Timber Partition)
Site Boundary	Site Boundary
Windows	Windows
Doors	Doors

Drawing Title:

Block and Location Plans

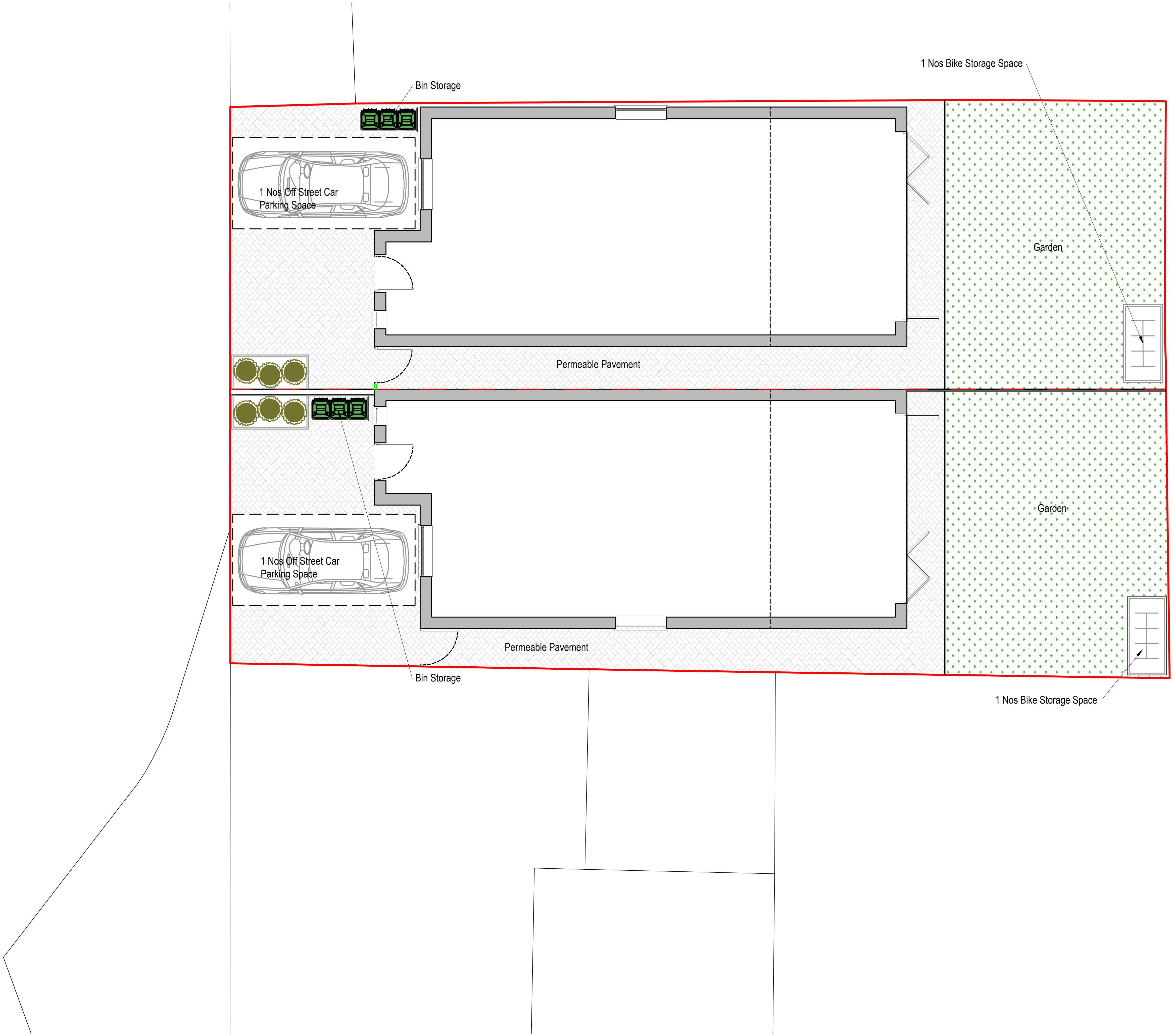
Scale: 1:500, 1:1250 | Paper Size: A3

REVISION/ COMMENTS :

No:	Comments:	Date:

Drawn By:	VP
Job Ref:	24035
Date:	Dec 2023
Drawing No.	PL - 01.1

N



V - Design

Company: V-Design CAD Servies Ltd
Website: www.vdesigncad.co.uk
Email Address: info@vdesigncad.co.uk
Tel : +44 20 3488 4890
Mobile: +44 7312015617

IMPORTANT NOTES:

Dimensions to be verified on site
DO NOT SCALE FROM THIS DRAWING.
Any areas indicated on this drawing are for guidance only.
No responsibility is taken for their accuracy.

Black Horse Yard,
Church Walk,
Hayes, UB3 2RN

LEGENDS:

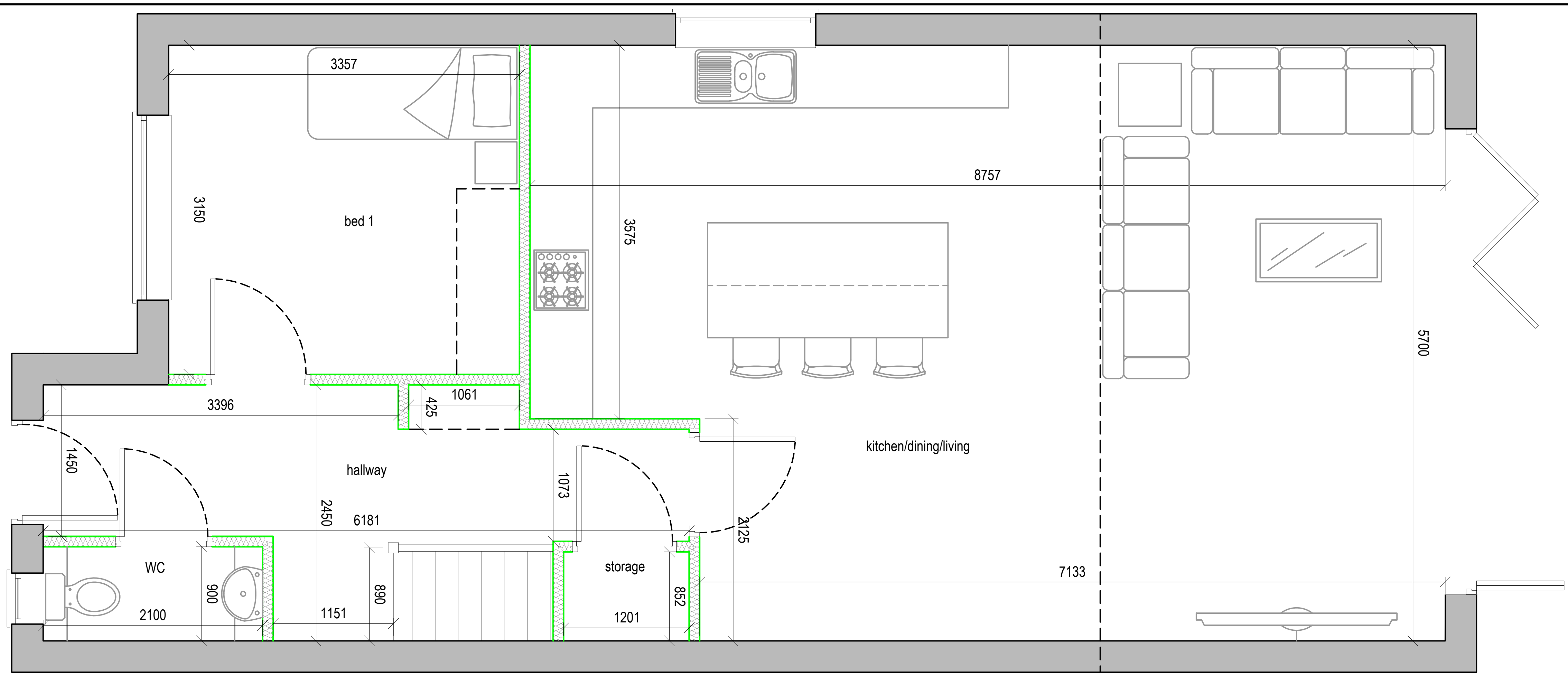
EXISTING:	PROPOSED:
Existing Wall	Cavity Wall
Internal Wall	Internal Wall (Timber Partition)
Site Boundary	Site Boundary
Windows	Windows
Doors	Doors

Drawing Title:
Site Plan
Scale: 1: 100 Paper Size: A3

REVISION/ COMMENTS :

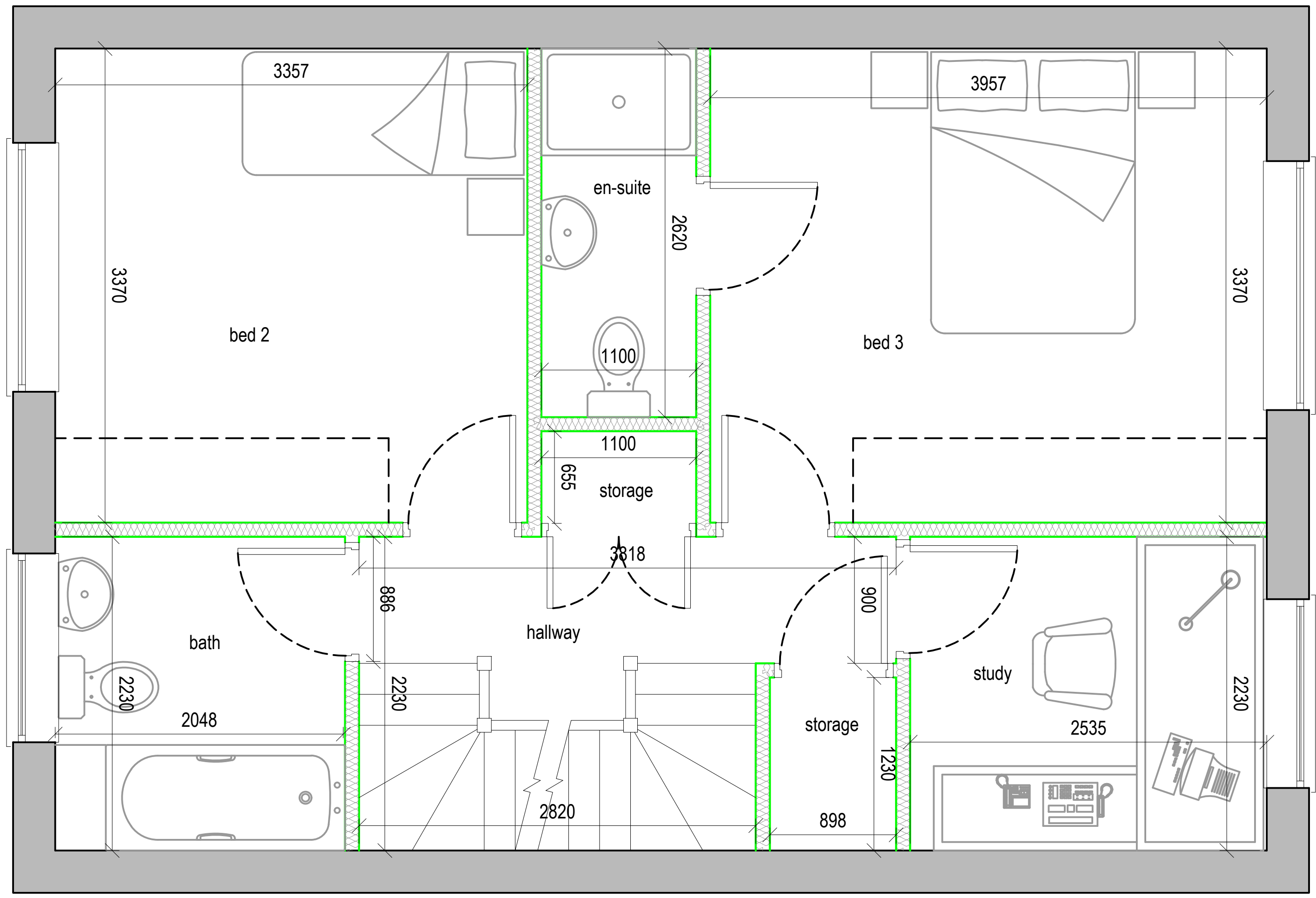
No:	Comments:	Date:

Drawn By: JM
Job Ref: 24035
Date: Dec 2024
Drawing No. PL - 02.1



Proposed Ground Floor Plan

0 0.5 1.0 1.5 2.0 2.5
metres 1:50 scale



Proposed First Floor Plan

0 0.5 1.0 1.5 2.0 2.5
metres 1:50 scale

V - Design

Company: V-Design CAD Servies Ltd
Website: www.vdesigncad.co.uk
Email Address: info@vdesigncad.co.uk
Tel : +44 20 3488 4890
Mobile: +44 7312015617

IMPORTANT NOTES:

Dimensions to be verified on site
DO NOT SCALE FROM THIS DRAWING.
Any areas indicated on this drawing are for guidance only.
No responsibility is taken for their accuracy.

Black Horse Yard,
Church Walk,
Hayes, UB3 2RN

LEGENDS:

EXISTING:	PROPOSED:
Existing Wall	Cavity Wall
Internal Wall	Internal Wall (Timber Partition)
Site Boundary	Site Boundary
Windows	Windows
Doors	Doors

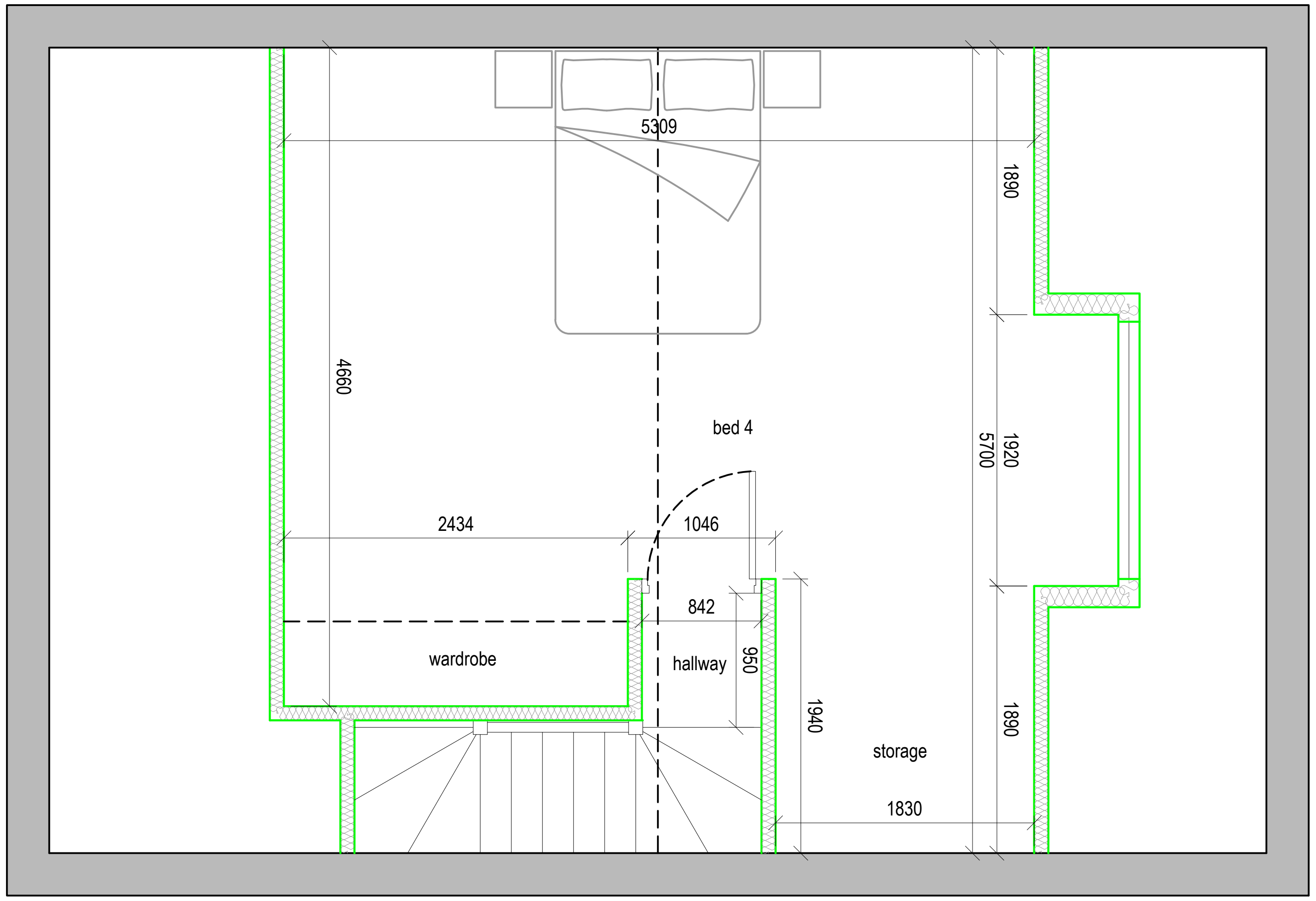
Drawing Title:
Proposed Ground Floor Plan

Scale: 1: 50 | Paper Size: A3

REVISION/ COMMENTS :

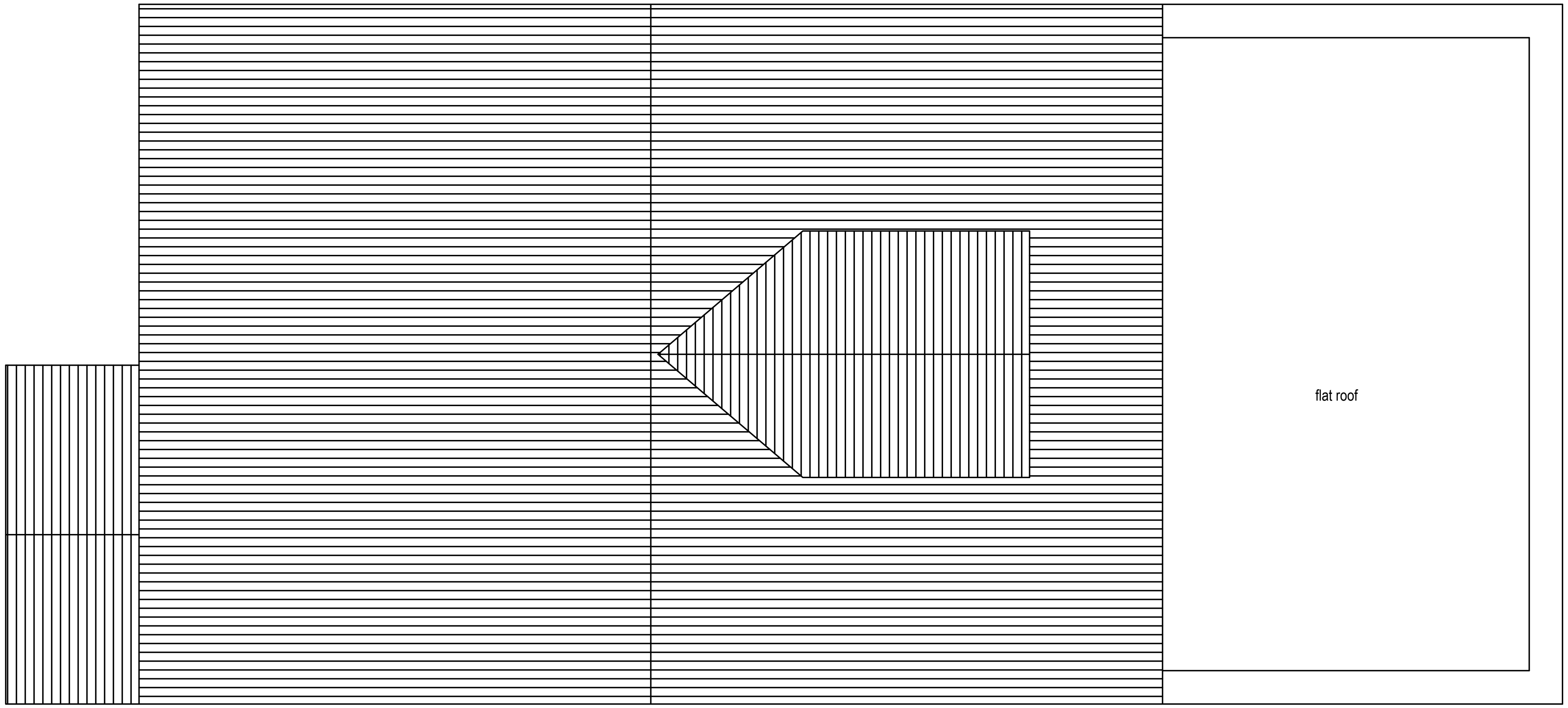
No:	Comments:	Date:

Drawn By:	JM
Job Ref:	24035
Date:	Dec 2024
Drawing No.	PL - 03.1



Proposed Loft Plan

0 0.5 1.0 1.5 2.0 2.5
metres 1:50 scale



Proposed Roof Plan

0 0.5 1.0 1.5 2.0 2.5
metres 1:50 scale

V - Design

Company: V-Design CAD Servies Ltd
Website: www.vdesigncad.co.uk
Email Address: info@vdesigncad.co.uk
Tel : +44 20 3488 4890
Mobile: +44 7312015617

IMPORTANT NOTES:

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DO NOT SCALE FROM THIS DRAWING.
Any areas indicated on this drawing are for guidance only.
No responsibility is taken for their accuracy.

Black Horse Yard,
Church Walk,
Hayes, UB3 2RN

LEGENDS:

EXISTING:	PROPOSED:
Existing Wall	Cavity Wall
Internal Wall	Internal Wall (Timber Partition)
Site Boundary	Site Boundary
Windows	Windows
Doors	Doors

Drawing Title:
Proposed Loft Plan

Scale: 1: 50 | Paper Size: A3

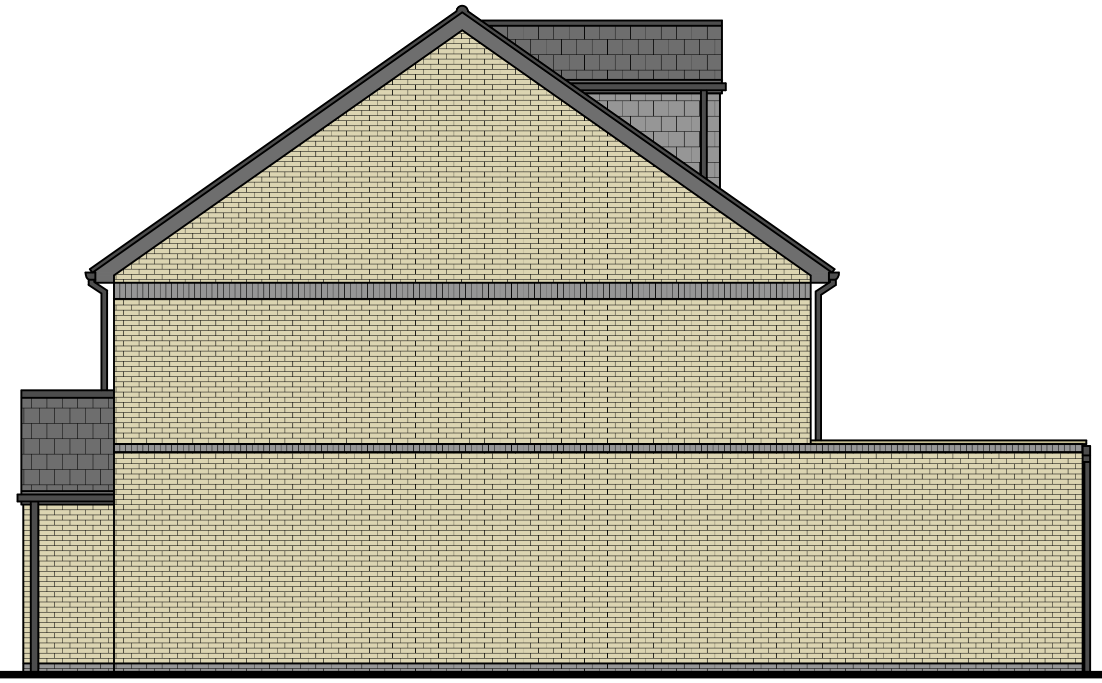
REVISION/ COMMENTS :

No:	Comments:	Date:

Drawn By: JM
Job Ref: 24035
Date: Dec 2024
Drawing No. PL - 05.1

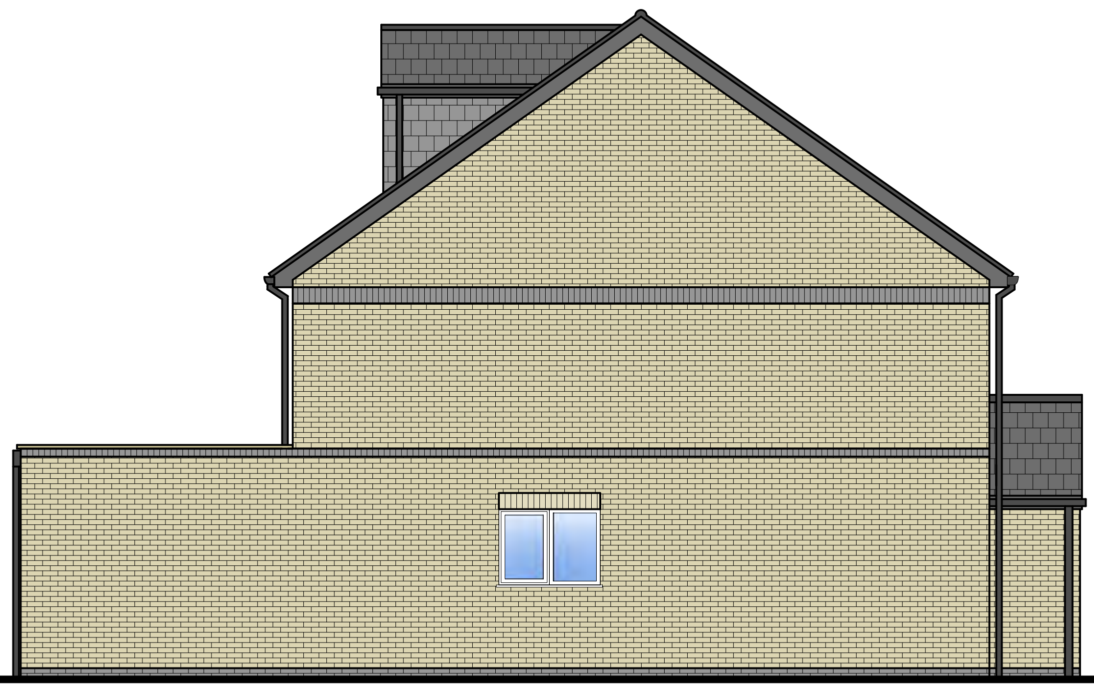
Front Elevation

0 1 2 3 4 5
metres 1:100 scale



Side Elevation

0 1 2 3 4 5
metres 1:100 scale



Side Elevation

0 1 2 3 4 5
metres 1:100 scale

Rear Elevation

0 1 2 3 4 5
metres 1:100 scale

V - Design

Company: V-Design CAD Servies Ltd
Website: www.vdesigncad.co.uk
Email Address: info@vdesigncad.co.uk
Tel : +44 20 3488 4890
Mobile: +44 7312015617

IMPORTANT NOTES:

Dimensions to be verified on site
DO NOT SCALE FROM THIS DRAWING.
Any areas indicated on this drawing are for guidance only.
No responsibility is taken for their accuracy.

Black Horse Yard,
Church Walk,
Hayes, UB3 2RN

LEGENDS:

EXISTING:	PROPOSED:
Existing Wall	Cavity Wall
Internal Wall	Internal Wall (Timber Partition)
Site Boundary	Site Boundary
Windows	Windows
Doors	Doors

Drawing Title:

Proposed Elevations

Scale: 1: 100 | Paper Size: A3

REVISION/ COMMENTS :

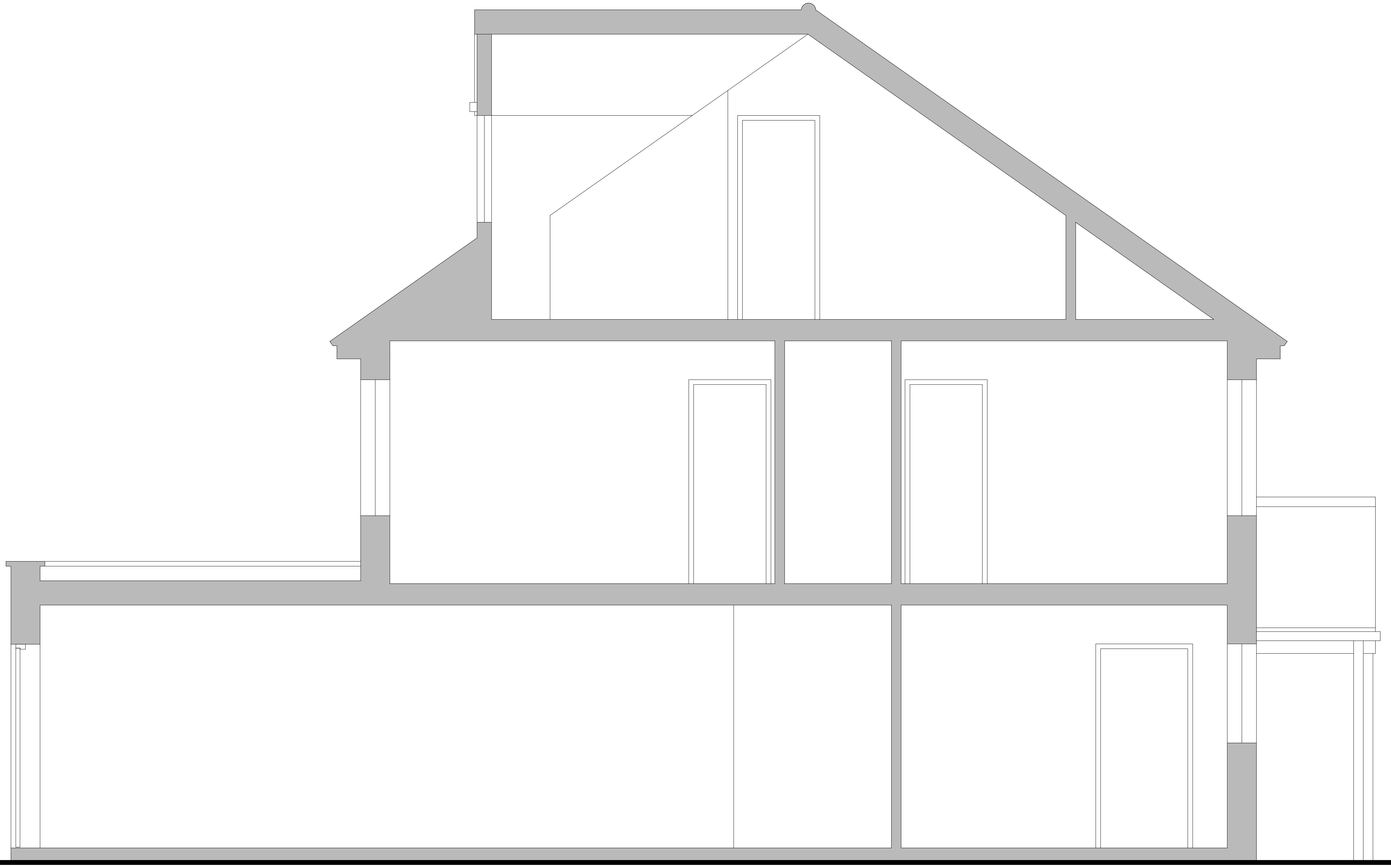
No:	Comments:	Date:

Drawn By: JM

Job Ref: 24035

Date: Dec 2024

Drawing No. PL - 06.1



Proposed Section

V - Design

Company: V-Design CAD Servies Ltd
Website: www.vdesigncad.co.uk
Email Address: info@vdesigncad.co.uk
Tel : +44 20 3488 4890
Mobile: +44 7312015617

IMPORTANT NOTES:

Dimensions to be verified on site
DO NOT SCALE FROM THIS DRAWING.
Any areas indicated on this drawing are for guidance only.
No responsibility is taken for their accuracy.

Black Horse Yard,
Church Walk,
Hayes, UB3 2RN

LEGENDS:

EXISTING:	PROPOSED:
Existing Wall	Cavity Wall
Internal Wall	Internal Wall (Timber Partition)
Site Boundary	Site Boundary
Windows	Windows
Doors	Doors

Drawing Title:
Proposed Section

Scale: 1: 50 | Paper Size: A3

REVISION/ COMMENTS :

No:	Comments:	Date:

Drawn By: JM
Job Ref: 24035
Date: Dec 2024
Drawing No. PL - 07.1

Proposed Street Scene

0 1 2 3 4 5 metres 1:100 scale

V - Design

Company: V-Design CAD Servies Ltd
Website: www.vdesigncad.co.uk
Email Address: info@vdesigncad.co.uk
Tel : +44 20 3488 4890
Mobile: +44 7312015617

IMPORTANT NOTES:

Dimensions to be verified on site
DO NOT SCALE FROM THIS DRAWING.
Any areas indicated on this drawing are for guidance only.
No responsibility is taken for their accuracy.

Black Horse Yard,
Church Walk,
Hayes, UB3 2RN

LEGENDS:

EXISTING:	PROPOSED:
Existing Wall	Cavity Wall
Internal Wall	Internal Wall (Timber Partition)
Site Boundary	Site Boundary
Windows	Windows
Doors	Doors

Drawing Title:

Proposed Section

Scale: 1: 50 | Paper Size: A3

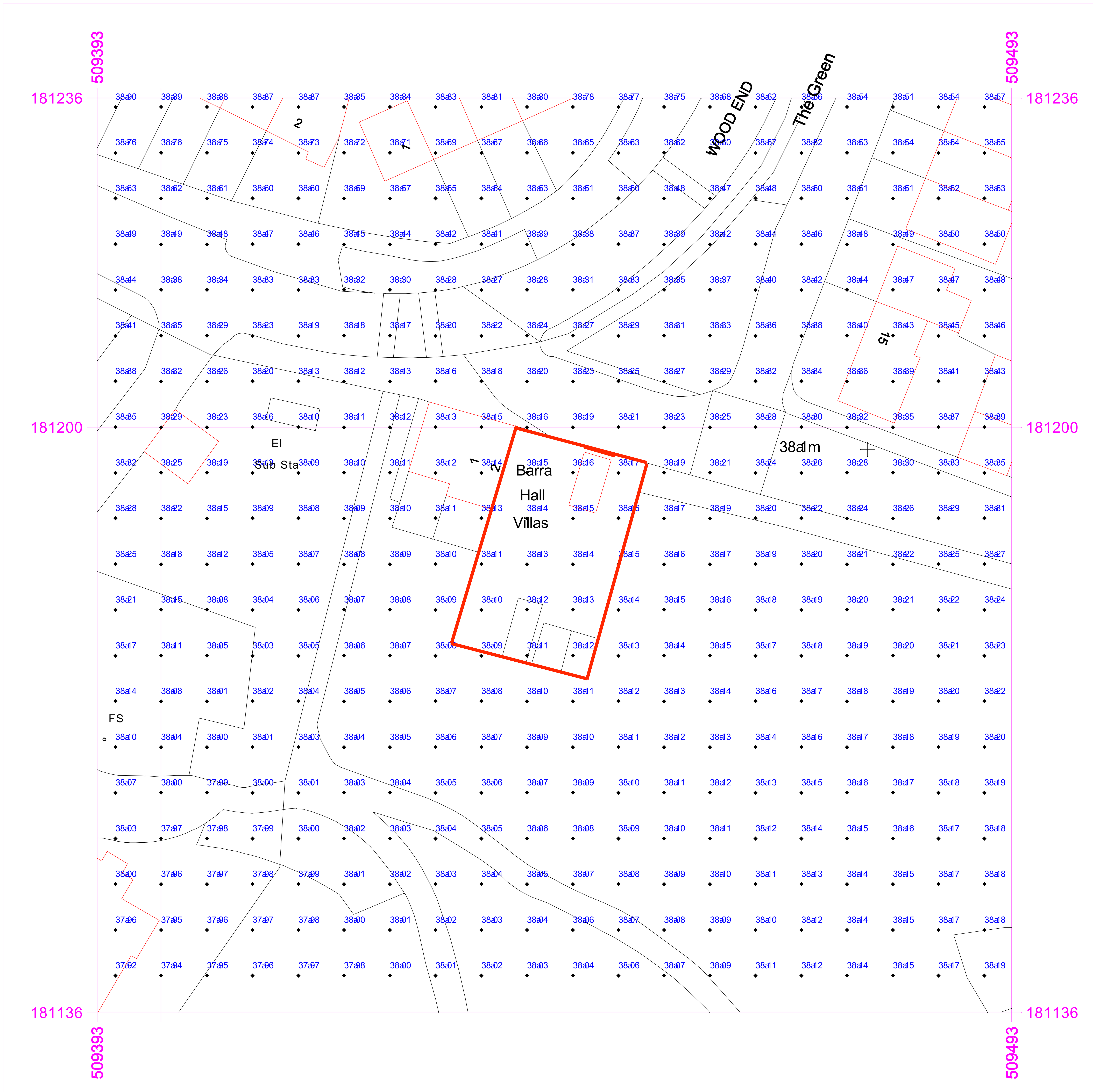
REVISION/ COMMENTS :

No:	Comments:	Date:

Drawn By: JM
Job Ref: 24035
Date: Dec 2024
Drawing No. PL - 08.1

Appendix D Topographic Map of the Site

Ordnance Survey ®
UKmapcentre.com



Serial number: 303763

0 5 10 15 20 25
metres

NORTH

Appendix E Surface Water Flood Maps

Figure 1 Environment Agency’s Surface Water Flood Risk Map

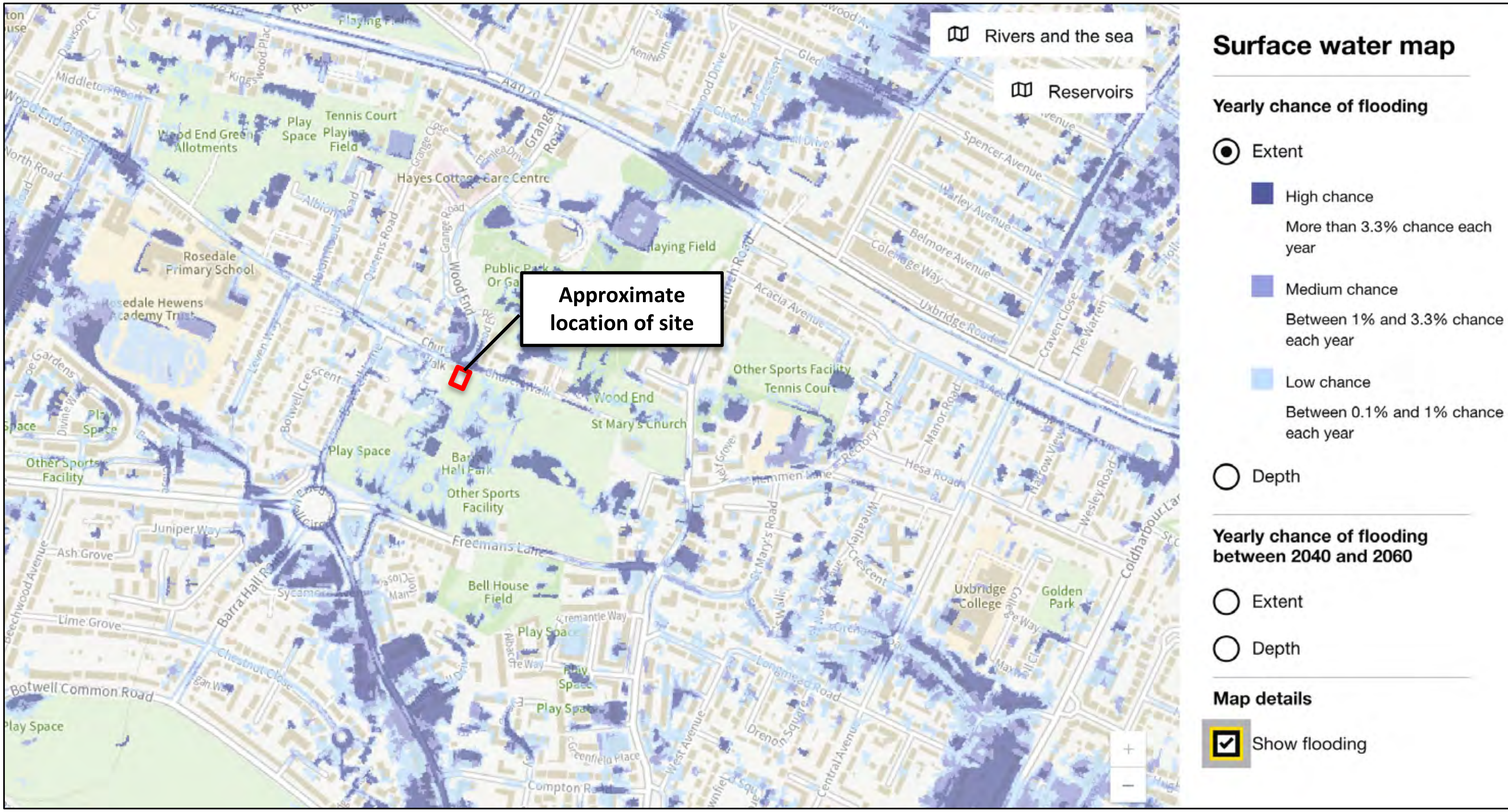
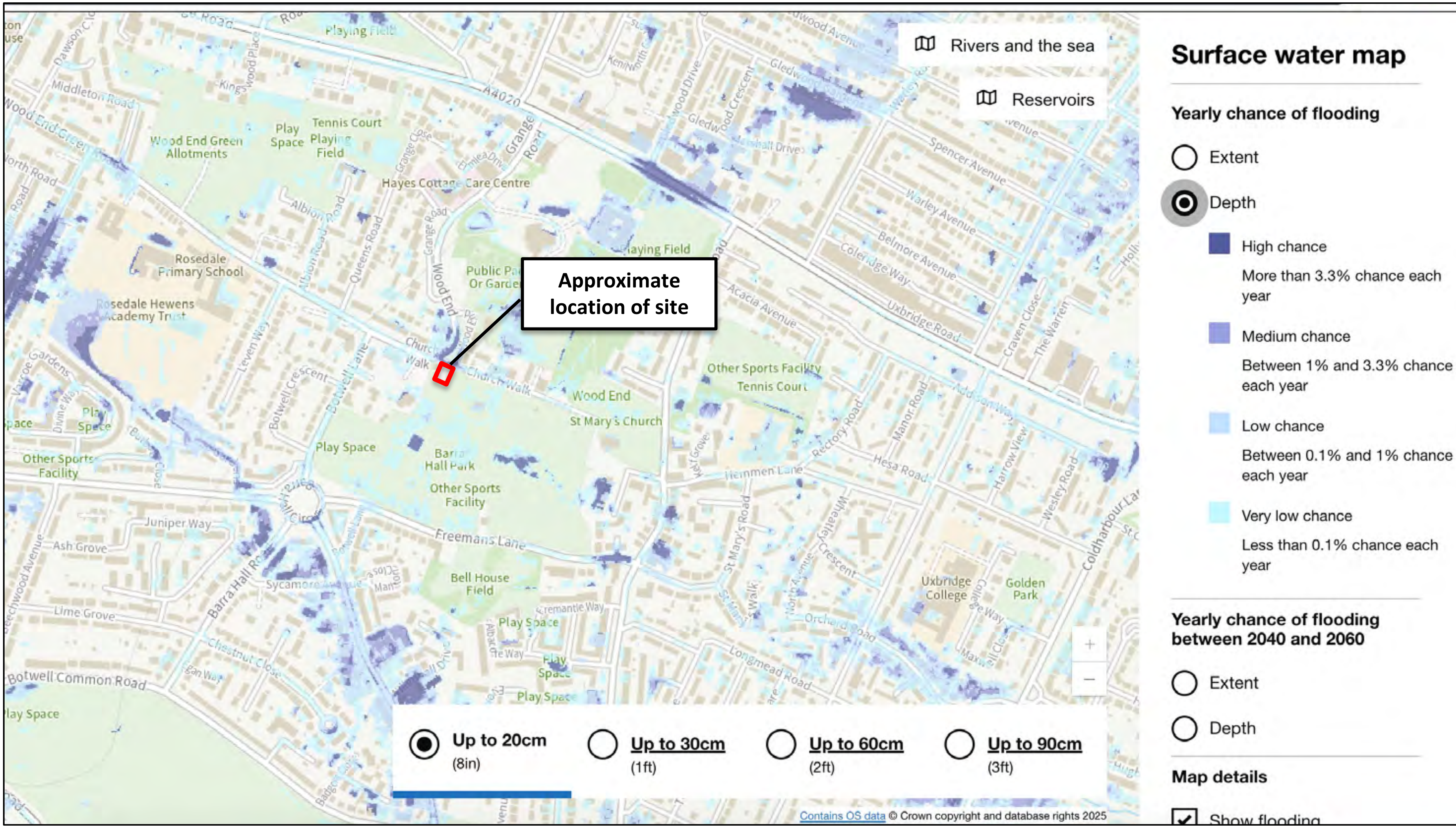


Figure 2 Environment Agency's Surface Water Flood Depth Map



hr wallingford

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Sohan Ghimire
Site name:	Black Horse Yard
Site location:	Church Walk, Hayes UB3 2RN

Site Details

Latitude:	51.51904° N
Longitude:	0.42414° W

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013) , the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Reference:	951986971
Date:	Feb 14 2025 11:23

Runoff estimation approach: IH124

Site characteristics

Total site area (ha): 0.10

Methodology

Q_{BAR} estimation method:	Calculate from SPR and SAAR
SPR estimation method:	Calculate from SOIL type

Soil characteristics

	Default	Edited
SOIL type:	4	4
HOST class:	N/A	N/A
SPR/SPRHOST:	0.47	0.47

Hydrological characteristics

	Default	Edited
SAAR (mm):	620	620
Hydrological region:	6	6
Growth curve factor 1 year:	0.85	0.85
Growth curve factor 30 years:	2.3	2.3

Notes

(1) Is Q_{BAR} < 2.0 l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is SPR/SPRHOST ≤ 0.3?

Growth curve factor 100 years:	3.19	3.19
Growth curve factor 200 years:	3.74	3.74

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited
Q_{BAR} (l/s):	0.42	0.42
1 in 1 year (l/s):	0.36	0.36
1 in 30 years (l/s):	0.96	0.96
1 in 100 year (l/s):	1.34	1.34
1 in 200 years (l/s):	1.57	1.57

Appendix G Sewer Asset Map Data

Asset Location Search

Thames Water Property Searches

UK Flood Risk
41 STANHAM ROAD,
DARTFORD
DA1 3AN

Search address supplied 1 Barra Hall Villas
Wood End
Hayes
UB3 2RN

Your reference Black Hose Yard

Our reference ALS/ALS Standard/2025_5119446

Search date 12 February 2025

Keeping you up-to-date

We have a new website and email address

Website URL: thameswater.co.uk/propertysearches

Email address: property.searches@thameswater.co.uk

Please do get in contact with us if you have any questions.

Thames Water Utilities Ltd
Property Searches,
Clearwater Court, Vastern Road, Reading RG1 8DB

property.searches@thameswater.co.uk
thameswater.co.uk/propertysearches

0800 009 4540

Search address supplied: 1 Barra Hall Villas, Wood End, Hayes, UB3 2RN

Dear Sir / Madam

An Asset Location Search is recommended when undertaking a site development. It is essential to obtain information on the size and location of clean water and sewerage assets to safeguard against expensive damage and allow cost-effective service design.

The following records were searched in compiling this report: - the map of public sewers & the map of waterworks. Thames Water Utilities Ltd (TWUL) holds all of these.

This search provides maps showing the position and size of Thames Water assets close to the proposed development and also manhole cover and invert levels, where available.

Please note that none of the charges made for this report relate to the provision of Ordnance Survey mapping information. The replies contained in this letter are given following inspection of the public service records available to this company. No responsibility can be accepted for any error or omission in the replies.

You should be aware that the information contained on these plans is current only on the day that the plans are issued. The plans should only be used for the duration of the work that is being carried out at the present time. Under no circumstances should this data be copied or transmitted to parties other than those for whom the current work is being carried out.

Thames Water do update these service plans on a regular basis and failure to observe the above conditions could lead to damage arising to new or diverted services at a later date.

Contact Us

If you have any further queries regarding this enquiry please feel free to contact a member of the team on 0800 009 4540, or use the contact details below:

Thames Water Utilities Ltd
Property Searches
Clearwater Court
Vastern Road
Reading
RG1 8DB

Email: property.searches@thameswater.co.uk
Web: thameswater.co.uk/propertysearches

Waste Water Services

Please provide a copy extract from the public sewer map.

Enclosed is a map showing the approximate lines of our sewers. Our plans do not show sewer connections from individual properties or any sewers not owned by Thames Water unless specifically annotated otherwise. Records such as "private" pipework are in some cases available from the Building Control Department of the relevant Local Authority. Where the Local Authority does not hold such plans it might be advisable to consult the property deeds for the site or contact neighbouring landowners. The public sewer map relates only to sewerage apparatus of Thames Water Utilities Ltd, it does not disclose details of cables and or communications equipment that may be running through or around such apparatus. The sewer level information contained in this response represents all of the level data available in our existing records. Should you require any further Information, please refer to the relevant section within the 'Further Contacts' page found later in this document.

For your guidance:

- The Company is not generally responsible for rivers, watercourses, ponds, culverts or highway drains. If any of these are shown on the copy extract they are shown for information only.
- Any private sewers or lateral drains which are indicated on the extract of the public sewer map as being subject to an agreement under Section 104 of the Water Industry Act 1991 are not an 'as constructed' record. It is recommended these details be checked with the developer.

Clean Water Services

Please provide a copy extract from the public water main map.

With regard to the fresh water supply, this site falls within the boundary of another water company. For more information, please redirect your enquiry to the following address:

Affinity Water Ltd
Tamblin Way

Hatfield
AL10 9EZ
Tel: 0345 3572401

For your guidance:

- Assets other than vested water mains may be shown on the plan, for information only.
- If an extract of the public water main record is enclosed, this will show known public water mains in the vicinity of the property. It should be possible to estimate the likely length and route of any private water supply pipe connecting the property to the public water network.

Further contacts:

Waste Water queries

Should you require verification of the invert levels of public sewers, by site measurement, you will need to approach the relevant Thames Water Area Network Office for permission to lift the appropriate covers. This permission will usually involve you completing a TWOSA form. You can do this by emailing customer.feedback@thameswater.co.uk with the email subject header 'Enquiry – TWOSA', along with details of the request.

If you have any questions regarding sewer connections, budget estimates, diversions or building over issues please direct them to our service desk which can be contacted by writing to:

Developer Services (Waste Water)
Thames Water
Clearwater Court
Vastern Road
Reading
RG1 8DB

Tel: 0800 009 3921
Email: developer.services@thameswater.co.uk

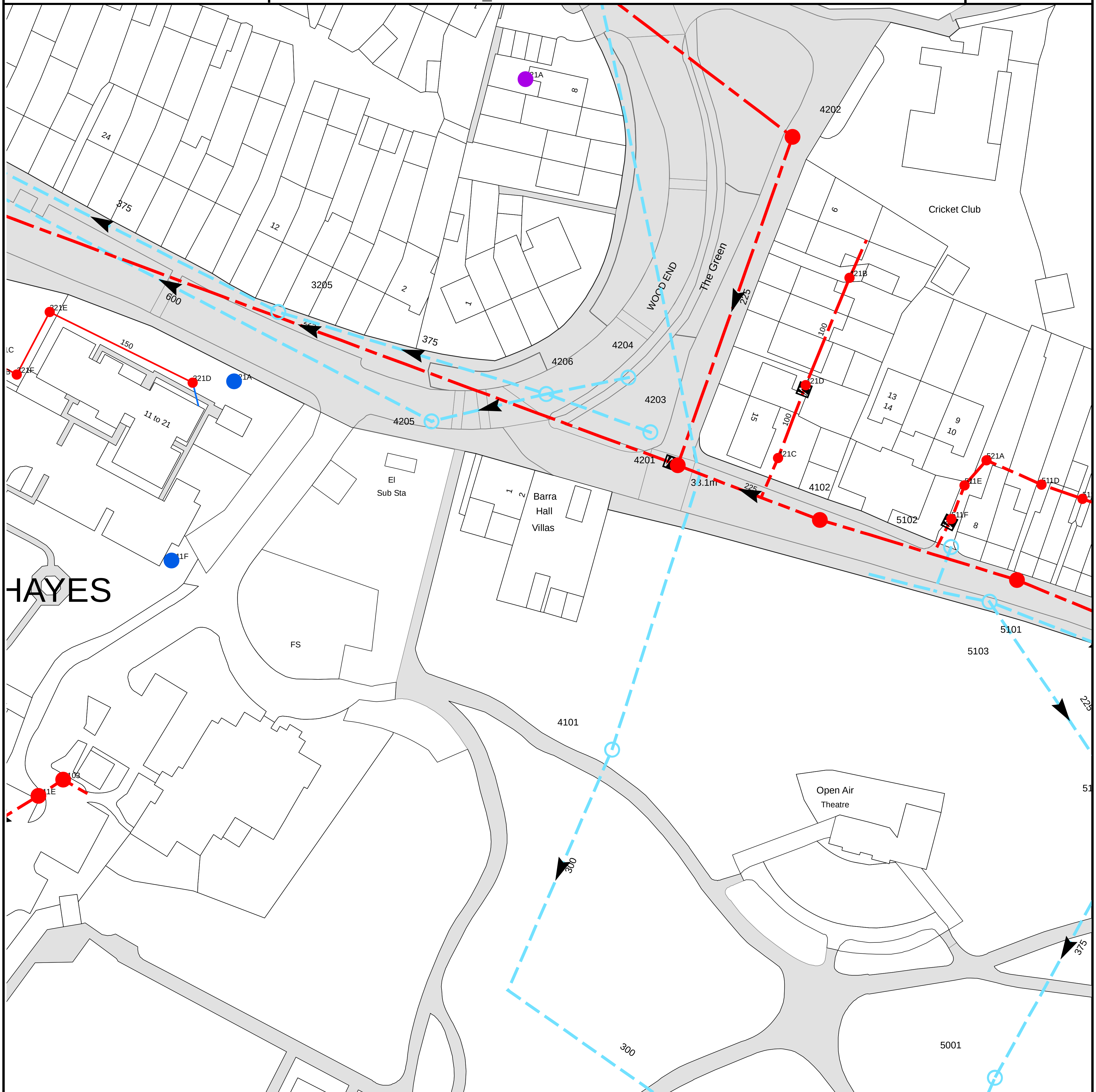
Clean Water queries

Should you require any advice concerning clean water connections, please contact:

Developer Services (Clean Water)
Thames Water
Clearwater Court
Vastern Road
Reading
RG1 8DB

Tel: 0800 009 3921
Email: developer.services@thameswater.co.uk

Asset Location Search Sewer Map - ALS/ALS Standard/2025_5119446



The width of the displayed area is 200 m and the centre of the map is located at OS coordinates 509442,181186

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

NB. Levels quoted in metres Ordnance Newlyn Datum. The value -9999.00 indicates that no survey information is available

Manhole Reference	Manhole Cover Level	Manhole Invert Level
421C	n/a	n/a
321E	n/a	37.44
3205	38.52	36.87
421A	n/a	n/a
311E	n/a	n/a
3103	n/a	n/a
4101	n/a	n/a
311F	n/a	n/a
4203	n/a	n/a
4205	38.35	36.7
4206	38.12	36.8
321D	n/a	n/a
321A	n/a	n/a
4204	n/a	n/a
321F	n/a	37.27
4201	38.17	36.02
4202	38.47	36.47
421D	n/a	n/a
4102	n/a	n/a
421B	n/a	n/a
5102	n/a	n/a
511F	n/a	n/a
511E	n/a	n/a
521A	n/a	n/a
5103	n/a	n/a
5001	n/a	n/a
5101	n/a	n/a
511D	n/a	n/a
511G	n/a	n/a
511C	n/a	n/a

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

Asset Location Search - Sewer Key

Public Sewer Types (Operated and maintained by Thames Water)

Foul Sewer: A sewer designed to convey waste water from domestic and industrial sources to a treatment works.

Surface Water Sewer: A sewer designed to convey surface water (e.g. rain water from roofs, yards and car parks) to rivers or watercourses.

Combined Sewer: A sewer designed to convey both waste water and surface water from domestic and industrial sources to a treatment works.

Storm Sewer
Sludge Sewer
Foul Trunk Sewer
Surface Trunk Sewer
Combined Trunk Sewer
Foul Rising Main
Surface Water Rising Main
Combined Rising Main
Vacuum
Thames Water Proposed
Vent Pipe
Gallery

Other Sewer Types (Not operated and maintained by Thames Water)

Sewer
Culverted Watercourse
Proposed
Decommissioned Sewer
Content of this drainage network is currently unknown
Ownership of this drainage network is currently unknown

Sewer Fittings

A feature in a sewer that does not affect the flow in the pipe. Example: a vent is a fitting as the function of a vent is to release excess gas.

Air Valve
Meter
Dam Chase
Vent
Fitting

Operational Controls

A feature in a sewer that changes or diverts the flow in the sewer. Example: A hydrobrake limits the flow passing downstream.

Ancillary
Drop Pipe
Control Valve
Weir

End Items

End symbols appear at the start or end of a sewer pipe. Examples: an Undefined End at the start of a sewer indicates that Thames Water has no knowledge of the position of the sewer upstream of that symbol. Outfall on a surface water sewer indicates that the pipe discharges into a stream or river.

Inlet
Outfall
Undefined End

Other Symbols

Symbols used on maps which do not fall under other general categories.

Change of Characteristic Indicator
Public / Private Pumping Station
Invert Level
Summit

Areas

Lines denoting areas of underground surveys, etc.

Agreement
Chamber
Operational Site

Ducts or Crossings

Casement
Conduit Bridge
Subway
Tunnel

Ducts may contain high voltage cables. Please check with Thames Water.

Notes:

1) All levels associated with the plans are to Ordnance Datum Newlyn.
2) All measurements on the plan are metric.
3) Arrows (on gravity fed sewers) or flecks (on rising mains) indicate the direction of flow.
4) Most private pipes are not shown on our plans, as in the past, this information has not been recorded.
5) 'na' or '0' on a manhole indicates that data is unavailable.
6) The text appearing alongside a sewer line indicates the internal diameter of the pipe in milimeters. Text next to a manhole indicates the manhole reference number and should not be taken as a measurement. If you are unsure about any text or symbology, please contact Property Searches on 0800 009 4540.

Appendix H Geo Infiltration Data Assessment

GeoReports

British Geological Survey

Sohan Ghimire
41
41 Stanham Road
Dartford
DA1 3AN

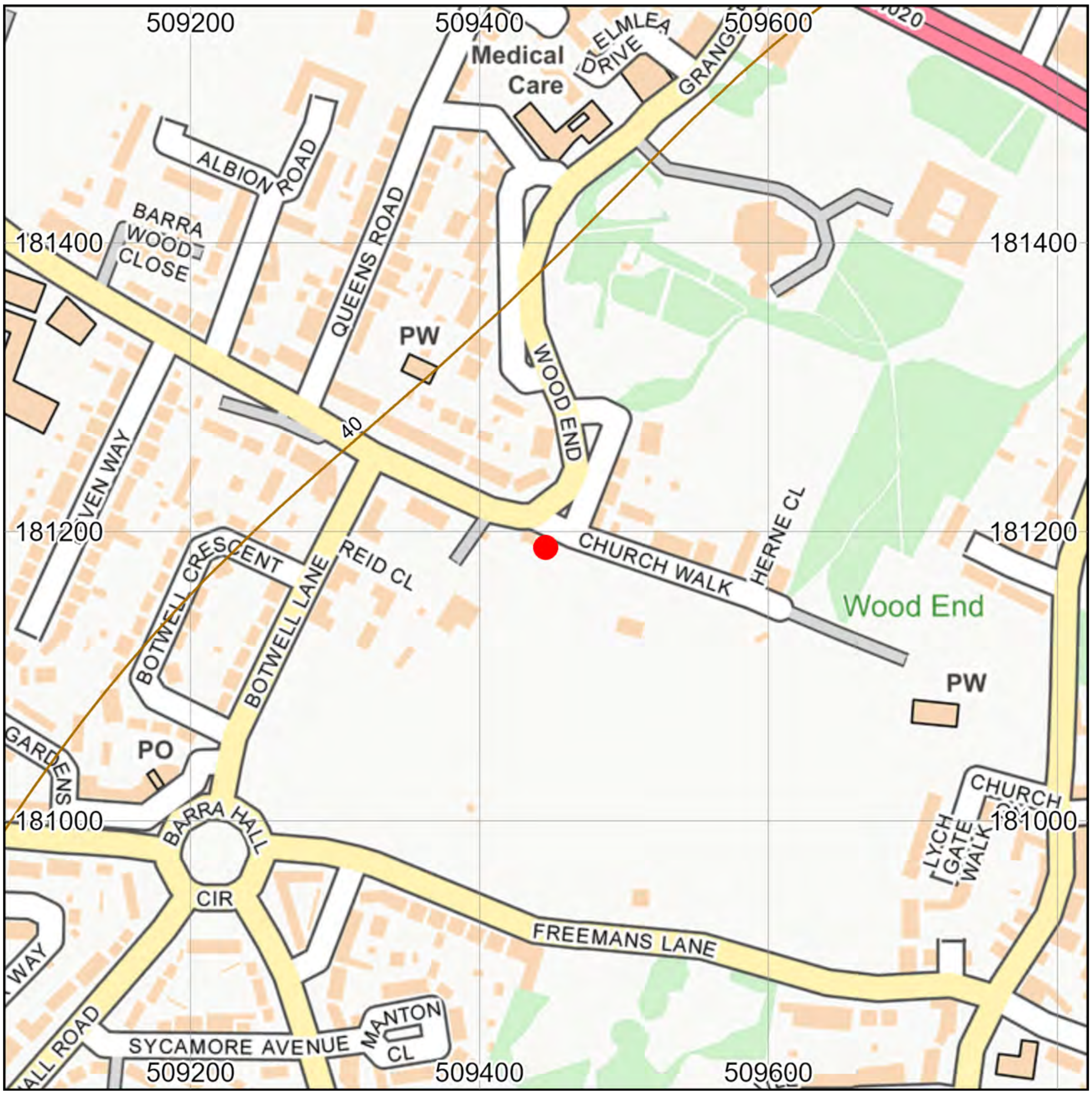
Infiltration SuDS GeoReport:

This report provides information on the suitability of the subsurface for the installation of infiltration sustainable drainage systems (SuDS). It provides information on the properties of the subsurface with respect to significant constraints, drainage, ground stability and groundwater quality protection.

Report Id: ***BGS_341791/59047***

Client reference:

Search location



Contains OS data © Crown Copyright and database right 2025. OS OpenMap Local: Scale: 1:5 000 (1cm = 50 m)

Search location indicated in red

Point centred at: 509446,181189

Assessment for an infiltration sustainable drainage system

Introduction

Sustainable drainage systems (SuDS) are drainage solutions that manage the volume and quality of surface water close to where it falls as rain. They aim to reduce flow rates to rivers, increase local water storage capacity and reduce the transport of pollutants to the water environment. There are four main types of SuDS, which are often designed to be used in sequence. They comprise:

- **source control:** systems that control the rate of runoff
- **pre-treatment:** systems that remove sediments and pollutants
- **retention:** systems that delay the discharge of water by providing surface storage
- **infiltration:** systems that mimic natural recharge to the ground.

This report focuses on infiltration SuDS. It provides subsurface information on the properties of the ground with respect to drainage, ground stability and groundwater quality protection. It is intended principally for those involved in the preliminary assessment of the suitability of the ground for infiltration SuDS, and those involved in assessing proposals from others for sustainable drainage, but it may also be useful to help house-holders judge whether or not further professional advice should be sought. If in doubt, users should consult a suitably-qualified professional about the results in this report before making any decisions based upon it.

This GeoReport is structured in two parts:

- **Part 1. Summary data**.

  Comprises three maps that summarise the data contained within Part 2.

- **Part 2. Detailed data**.

  Comprises a further 24 maps in four thematic sections:

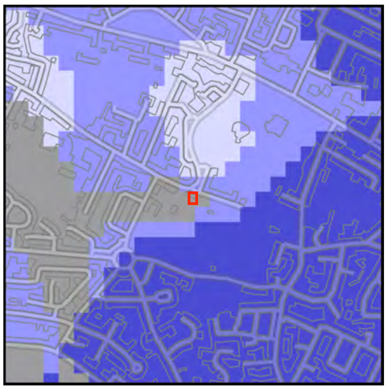
  - **Very significant constraints.** Maps highlight areas where infiltration may result in adverse impacts due to factors including: ground instability (soluble rocks, non-coal shallow mining and landslide hazards); persistent shallow groundwater, or the presence of made ground, which may represent a ground stability or contamination hazard.
  - **Drainage potential**. Maps indicate the drainage potential of the ground, by considering subsurface permeability, depth to groundwater and the presence of floodplain deposits.
  - **Ground stability**. Maps indicate the presence of hazards that have the potential to cause ground instability resulting in damage to some buildings and structures, if water is infiltrated to the ground.
  - **Groundwater protection**. Maps provide key indicators to help determine whether the groundwater may be susceptible to deterioration in quality as a result of infiltration.

This report considers the suitability of the subsurface for the installation of infiltration SuDS, such as soakaways, infiltration basins or permeable pavements. It provides subsurface data to indicate whether, and which type of infiltration system may be appropriate. It does not state that infiltration SuDS are, or are not, appropriate as this is highly dependent on the design of the individual system. This report therefore describes the subsurface conditions at the site, allowing the reader to determine the suitability of the site for infiltration SuDS.

The map and text data in this report is similar to that provided in the '*Infiltration SuDS Map: Detailed'* national map product. For further information about the data, consult the '*User Guide for the Infiltration SuDS Map: Detailed'*, available from http://nora.nerc.ac.uk/16618/.

PART 1: SUMMARY DATA

This section provides a summary of the data.

In terms of the drainage potential, is the ground suitable for infiltration SuDS?	
 Contains OS data © Crown Copyright and database right 2025	Highly compatible for infiltration SuDS. The subsurface is likely to be suitable for free-draining infiltration SuDS.
	Probably compatible for infiltration SuDS. The subsurface is probably suitable although the design may be influenced by the ground conditions.
	Opportunities for bespoke infiltration SuDS. The subsurface is potentially suitable although the design will be influenced by the ground conditions.
	Very significant constraints are indicated. There is a very significant potential for one or more hazards associated with infiltration.
Is ground instability likely to be a problem?	
 Contains OS data © Crown Copyright and database right **2025**	Increased infiltration is very unlikely to result in ground instability.
	Ground instability problems may be present or anticipated, but increased infiltration is unlikely to result in ground instability.
	Ground instability problems are probably present. Increased infiltration may result in ground instability.
	There is a very significant potential for one or more geohazards associated with infiltration.
Is the groundwater susceptible to deterioration in quality?	
 Contains OS data © Crown Copyright and database right 2025	The groundwater is not expected to be especially vulnerable to contamination.
	The groundwater may be vulnerable to contamination.
	The groundwater is likely to be vulnerable to contaminants.
	Made ground is present at the surface. Infiltration may increase the possibility of remobilising pollutants.

PART 2: DETAILED DATA

This section provides further information about the properties of the ground and will help assess the suitability of the ground for infiltration SuDS.

Section 1. Very significant constraints

Where maps are overlain by grey polygons, geological or hydrogeological hazards may exist that could be made worse by infiltration. The following hazards are considered:

- soluble rocks
- landslides
- shallow mining (not including coal)
- shallow groundwater
- made ground

For more information read ‘Explanation of terms’ at the end of this report.

<table>
<tr><th colspan="2">Soluble rock hazard</th></tr>
<tr><td rowspan="2">
Contains OS data © Crown Copyright and database right 2025</td><td>Very significant soluble rock hazard.
Soluble rocks are present with a very significant possibility of localised subsidence that could be initiated or made worse by infiltration. The site investigation should consider whether the potential for or the consequences of subsidence as a result of infiltration are significant.</td></tr>
<tr><td>Very significant soluble rock hazards are not present; however this hazard may still need to be considered. See Part 3.</td></tr>
<tr><th colspan="2">Landslide hazard</th></tr>
<tr><td rowspan="2">
Contains OS data © Crown Copyright and database right 2025</td><td>Very significant landslide hazard.
Slope instability problems are almost certainly present and may be active. An increase in moisture content as a result of infiltration may cause the slope to fail. The site investigation should consider whether the potential for or the consequences of landslide as a result of infiltration are significant.</td></tr>
<tr><td>Very significant landslide hazards are not present; however this hazard may still need to be considered. See Part 3.</td></tr>
</table>

Shallow mining hazard (not including coal)

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Very significant mining hazard.

Shallow mining is likely to be present with a very significant possibility of localised subsidence that could be initiated or made worse by increased infiltration. Also, infiltration may increase the possibility of remobilising pollutants. The site investigation should consider whether the potential for or consequences of subsidence and/or remobilisation of pollutants as a result of infiltration are significant.

Very significant mining hazards are not present; however this hazard may still need to be considered. See Part 3.

Persistent shallow groundwater

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Very high likelihood of persistent or seasonally shallow groundwater.

Persistent or seasonally shallow groundwater is likely to be present. Infiltration may increase the likelihood of soakaway inundation, or groundwater emergence at the surface. The site investigation should consider whether the potential for or the consequences of groundwater level rise as a result of infiltration are significant.

See Part 2 for the likely depth to water table.

Made ground

Contains OS data © Crown Copyright and database right **2025**

Made ground present.

Made ground is present at the surface. Infiltration may affect ground stability or increase the possibility of remobilising pollutants. The site investigation should consider whether the potential for or consequences of ground instability and/or pollutant leaching as a result of infiltration are significant.

None recorded

Section 2. Drainage potential

The following pages contain maps that will help you assess the drainage potential of the ground by considering the:

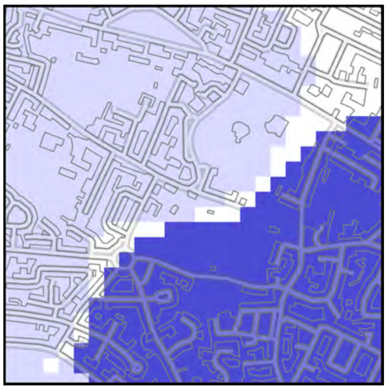
- depth to water table
- permeability of the superficial deposits
- thickness of the superficial deposits
- permeability of the bedrock
- presence of floodplains

Superficial deposits are not present everywhere and therefore some areas of the *superficial deposit permeability* map may not be coloured. Where this is the case, the *bedrock permeability* map shows the likely permeability of the ground. Superficial deposits in some places are very thin and hence in these places you may wish to consider both the permeability of the superficial deposits and the permeability of the bedrock. The *superficial thickness* map will tell you whether the superficial deposits are thin (< 3 m thick) or thick (>3 m). Where they are over 3 m thick, the permeability of the bedrock may not be relevant.

For more information read 'Explanation of terms' at the end of this report.

Depth to groundwater table	
 Contains OS data © Crown Copyright and database right 2025	Groundwater is likely to be **more than 5 m** below the ground surface throughout the year.
	Groundwater is likely to be between **3 and 5 m** below the ground surface for at least part of the year.
	Groundwater is likely to be **less than 3 m** below the ground surface for at least part of the year.

Superficial deposit permeability



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Superficial deposits are likely to be **free-draining**.

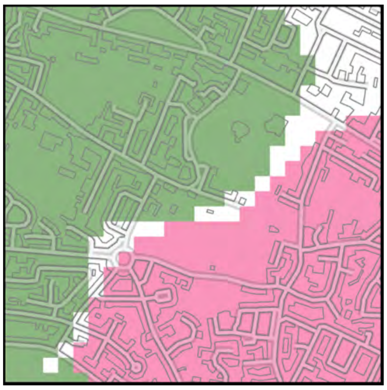
The superficial deposit permeability is **spatially variable**, but likely to permit moderate infiltration.

Superficial deposits are likely to be **poorly draining**.

These maps show the permeability range that is summarised above.

- Very Low
- Low
- Moderate
- High
- Very High

Minimum



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Maximum

Contains OS data © Crown Copyright and database right 2025

Superficial deposit thickness

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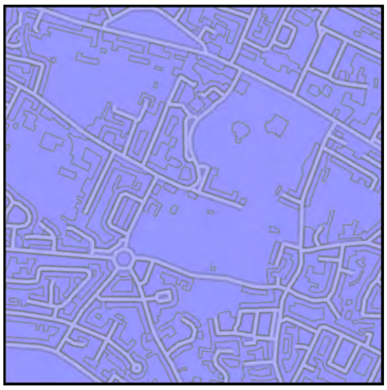
The thickness of superficial deposits is **< 3 m** and hence the permeability of the ground may be dependent on both the superficial deposits (where present) and underlying bedrock (see below).

The thickness of superficial deposits is **> 3 m** and hence the permeability of the superficial deposits is likely to determine the permeability of the ground.

Bedrock permeability



Contains OS data © Crown Copyright and database right **2025**

Bedrock deposits are likely to be **free-draining**.

The bedrock permeability is **spatially variable**, but likely to permit moderate infiltration.

Bedrock deposits are likely to be **poorly draining**.

These maps show the permeability range that is summarised above.

Key

- Very Low
- Low
- Moderate
- High
- Very High

Minimum

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Maximum

Contains OS data © Crown Copyright and database right 2025

Geological indicators of flooding

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Superficial floodplain deposits or low-lying coastal areas have been identified. Groundwater levels may rise in response to high river or tide levels, potentially causing inundation of subsurface infiltration SuDS.

Section 3. Ground stability

The following pages contain maps that will help you assess whether infiltration may impact the stability of the ground. They consider hazards associated with:

- soluble rocks
- landslides
- shallow mining
- running sands
- swelling clays
- compressible ground, and
- collapsible ground

In the following maps, geohazards that are identified in green are unlikely to prevent infiltration SuDS from being installed, but they should be considered during design. For more information read 'Explanation of terms' at the end of this report.

Soluble rocks

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(pale yellow)	Increased infiltration is unlikely to result in subsidence.
(light green)	Increased infiltration is unlikely to cause localised subsidence, but potential impacts should be considered.
(dark green)	Increased infiltration may result in localised subsidence. The potential for or the consequences of subsidence associated with soluble rocks should be considered.
(grey)	Very significant possibility of localised subsidence that could be initiated or made worse by infiltration.

Landslides

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	Increased infiltration is unlikely to lead to slope instability.
	Slope instability problems may be present or anticipated, but increased infiltration is unlikely to cause instability
	Slope instability problems are probably present or have occurred in the past, and increased infiltration may result in slope instability.
	Slope instability problems are almost certainly present and may be active. An increase in moisture content as a result of infiltration may cause the slope to fail.

Shallow mining

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	Increased infiltration is unlikely to lead to subsidence.
	Shallow mining is possibly present. Increased infiltration is unlikely to cause a geohazard, but potential impacts should be considered.
	Shallow mining could be present with a significant possibility that localised subsidence could be initiated or made worse by increased infiltration.
	Shallow mining is likely to be present, with a very significant possibility that localised subsidence may be initiated or made worse by increased infiltration.

Running sand

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	Increased infiltration is unlikely to cause ground collapse associated with running sands.
	Running sand is possibly present. Increased infiltration is unlikely to cause a geohazard, but potential impacts should be considered.
	Significant possibility for running sand problems. Increased infiltration may result in a geohazard.

Swelling clays	
 Contains OS data © Crown Copyright and database right 2025	Increased infiltration is unlikely to cause shrink-swell ground movement.
	Ground is susceptible to shrink-swell ground movement. Increased infiltration is unlikely to cause a geohazard, but potential impacts should be considered.
	Ground is susceptible to shrink-swell ground movement. Increased infiltration may result in a geohazard.
Compressible ground	
 Contains OS data © Crown Copyright and database right 2025	Increased infiltration is unlikely to lead to ground compression.
	Compressibility and uneven settlement hazards are probably present. Increased infiltration may result in a geohazard.
Collapsible ground	
 Contains OS data © Crown Copyright and database right 2025	Increased infiltration is unlikely to result in subsidence.
	Deposits with potential to collapse when loaded and saturated are possibly present in places. Increased infiltration is unlikely to cause a geohazard, but potential impacts should be considered.
	Deposits with potential to collapse when loaded and saturated are probably present in places. Increased infiltration may result in a geohazard.

Section 4. Groundwater quality protection

The following pages contain maps showing some of the information required to ensure the protection of groundwater quality. Data presented includes:

- groundwater source protection zones (Environment Agency data)
- predominant flow mechanism
- made ground

For more information read ‘Explanation of terms’ at the end of this report.

Groundwater source protection zones

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Derived in part from Source Protection Zone data provided under licence from the Environment Agency © Environment Agency 2025.

- Groundwater is not within a source protection zone.
- Source protection zone IV
- Source protection zone III
- Source protection zone II
- Source protection zone I

Predominant flow mechanism

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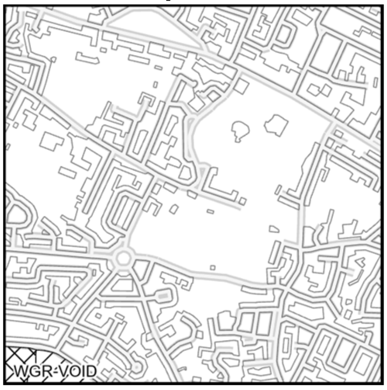
- Water is likely to percolate through the unsaturated zone to the groundwater through either the pore space in granular media or through porespace and fractures; these processes have some potential for contaminant removal and breakdown.
- Water is likely to percolate through the unsaturated zone to the groundwater through fractures, a process which has little potential for contaminant removal and breakdown.

Made ground	
 Contains OS data © Crown Copyright and database right 2025	Made ground is present at the surface. Infiltration may increase the possibility of remobilising pollutants.

Section 5. Geological Maps

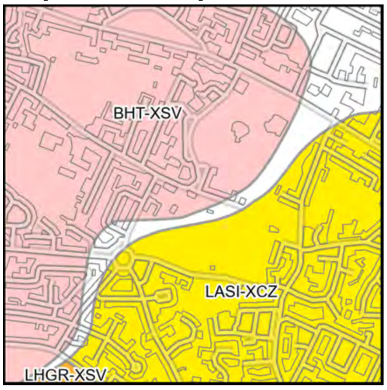
The following maps show the artificial, superficial and bedrock geology within the area of interest.

Artificial deposits



Contains OS data © Crown Copyright and database right 2025

Superficial deposits



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Bedrock

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Fault

Coal, ironstone or mineral vein

Note: Faults and Coals, ironstone & mineral veins are shown for illustration and to aid interpretation of the map. Not all such features are shown and their absence on the map face does not necessarily mean that none are present

Key to Artificial deposits:

Map colour	Computer Code	Rock name	Rock type
	WMGR-ARTDP	INFILLED GROUND	ARTIFICIAL DEPOSIT
	WGR-VOID	WORKED GROUND (UNDIVIDED)	VOID

Key to Superficial deposits:

Map colour	Computer Code	Rock name	Rock type
	LASI-XCZ	LANGLEY SILT MEMBER	CLAY AND SILT
	LHGR-XSV	LYNCH HILL GRAVEL MEMBER	SAND AND GRAVEL
	BHT-XSV	BOYN HILL GRAVEL MEMBER	SAND AND GRAVEL

Key to Bedrock geology:

Map colour	Computer Code	Rock name	Rock type
	LC-XCZS	LONDON CLAY FORMATION	CLAY, SILT AND SAND

Limitations of this report:

- This report is concerned with the potential for infiltration-to-the-ground to be used as a SuDS technique at the site described. It only considers the subsurface beneath the search area and does NOT consider potential surface or subsurface impacts outside of that area.
- This report is NOT an alternative for an on-site investigation or soakaway test, which might reach a different conclusion.
- This report must NOT be used to justify disposal of foul waste or grey water.
- This report is based on and limited to an interpretation of the records held by the British Geological Survey (BGS) at the time the search is performed. The datasets used (with the exception of that showing depth to water table) are based on 1:50 000 digital geological maps and not site-specific data.
- Other more specific and detailed ground instability information for the site may be held by BGS, and an assessment of this could result in a modified assessment.
- To interpret the maps correctly, the report must be viewed and printed in colour.
- The search does NOT consider the suitability of sites with regard to:
  - previous land use,
  - potential for, or presence of contaminated land
  - presence of perched water tables
  - shallow mining hazards relating to coal mining. Searches of coal mining should be carried out via The Coal Authority Mine Reports Service: www.coalminingreports.co.uk.
  - made ground, where not recorded
  - proximity to landfill sites (searches for landfill sites or contaminated land should be carried out through consultation with local authorities/Environment Agency)
  - zones around private water supply boreholes that are susceptible to groundwater contamination.
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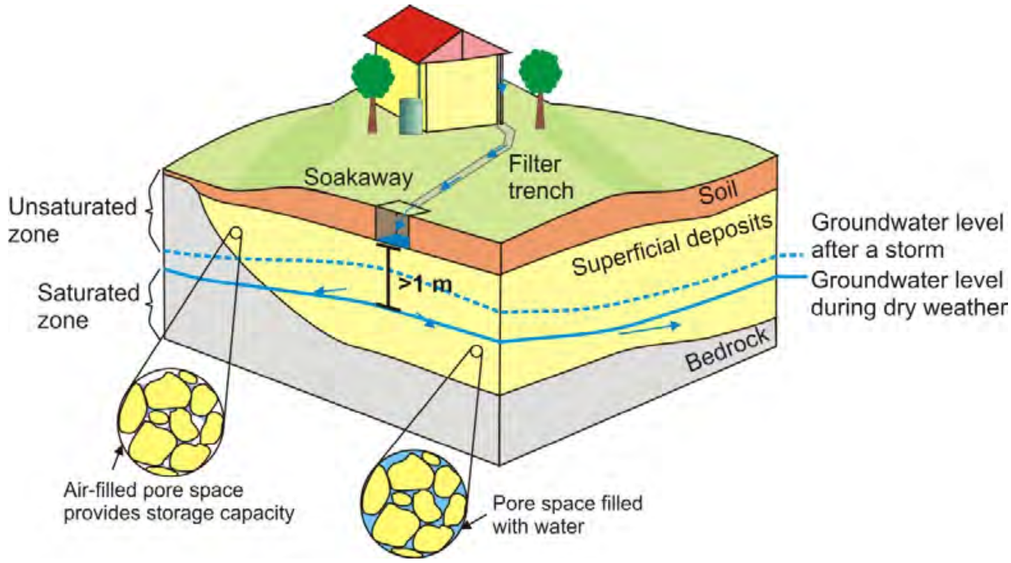
Explanation of terms

Depth to groundwater

In the shallow subsurface, the ground is commonly unsaturated with respect to water. Air fills the spaces within the soil and the underlying superficial deposits and bedrock. At some depth below the ground surface, there is a level below which these spaces are full of water. This level is known as the groundwater level, and the water below it is termed the groundwater. When water is infiltrated, the groundwater level may rise temporarily. To ensure that there is space in the unsaturated zone to accommodate this, there should be a minimum thickness of 1 m between the base of the infiltration system and the water table. An estimate of the *depth to groundwater* is therefore useful in determining whether the ground is suitable for infiltration.



Groundwater flooding

Groundwater flooding occurs when a rise in groundwater level results in very shallow groundwater or the emergence of groundwater at the surface. If infiltration systems are installed in areas that are susceptible to groundwater flooding, it is possible that the system could become inundated. The susceptibility map seeks to identify areas where the geological conditions and water tables indicate that groundwater level rise could occur under certain circumstances. A high susceptibility to groundwater flooding classification does not mean that groundwater flooding has ever occurred in the past, or will do so in the future as the susceptibility maps do not contain information on how often flooding may occur. The susceptibility maps are designed for planning; identifying areas where groundwater flooding might be an issue that needs to be taken into account.

Geological indicators of flooding

In floodplain deposits, groundwater level can be influenced by the water level in the adjacent river. Groundwater level may increase during periods of fluvial flood and therefore this should be taken into account when designing infiltration systems on such deposits. The *geological indicators of flooding* dataset shows where there is geological evidence (floodplain deposits) that flooding has occurred in the past.

For further information on flood-risk, the likely frequency of its recurrence in relation to any proposed development of the site, and the status of any flood prevention measures in place, you are advised to contact the local office of the Environment Agency (England and Wales) at www.environment-agency.gov.uk/ or the Scottish Environment Protection Agency (Scotland) at www.sepa.org.uk.

Artificial ground

Artificial ground comprises deposits and excavations that have been created or modified by human activity. It includes ground that is worked (quarries and road cuttings), infilled (back-filled quarries), landscaped (surface re-shaping), disturbed (near surface mineral workings) or classified as made ground (embankments and spoil heaps). The composition and properties of artificial ground are often unknown. In particular, the permeability and chemical composition of the artificial ground should be determined to ensure that the ground will drain and that any contaminants present will not be remobilised.

Superficial permeability

Superficial deposits are those geological deposits that were formed during the most recent period of geological time (as old as 2.6 million years before present). They generally comprise relatively thin deposits of gravel, sand, silt and clay and are present beneath the pedological soil in patches or larger spreads over much of Britain. The ease with which water can percolate through these deposits is controlled by their permeability and varies widely depending on their composition. Those deposits comprising clays and silts are less permeable and thus infiltration is likely to be slow, such that water may pool on the surface. In comparison, deposits comprising sands and gravels are more permeable allowing water to percolate freely.

Bedrock permeability

Bedrock forms the main mass of rock forming the Earth. It is present everywhere, commonly beneath superficial deposits. Where the superficial deposits are thin or absent, the ease with which water will percolate into the ground depends on the permeability of the bedrock.

Natural ground instability
Natural ground instability refers to the propensity for upward, lateral or downward movement of the ground that can be caused by a number of natural geological hazards (e.g. ground dissolution/compressible ground). Some movements associated with particular hazards may be gradual and of millimetre or centimetre scale, whilst others may be sudden and of metre or tens of metres scale. Significant natural ground instability has the potential to cause damage to buildings and structures, especially when the drainage characteristics of a site are altered. It should be noted, however, that many buildings, particularly more modern ones, are built to such a standard that they can remain unaffected in areas of significant ground movement.

Shrink-swell
A shrinking and swelling clay changes volume significantly according to how much water it contains. All clay deposits change volume as their water content varies, typically swelling in winter and shrinking in summer, but some do so to a greater extent than others. Contributory circumstances could include drought, leaking service pipes, tree roots drying-out the ground or changes to local drainage patterns, such as the creation of soakaways. Shrinkage may remove support from the foundations of buildings and structures, whereas clay expansion may lead to uplift (heave) or lateral stress on part or all of a structure; any such movements may cause cracking and distortion.

Landslides (slope stability)
A landslide is a relatively rapid outward and downward movement of a mass of ground on a slope, due to the force of gravity. A slope is under stress from gravity but will not move if its strength is greater than this stress. If the balance is altered so that the stress exceeds the strength, then movement will occur. The stability of a slope can be reduced by removing ground at the base of the slope, by placing material on the slope, especially at the top, or by increasing the water content of the materials forming the slope. Increase in subsurface water content beneath a soakaway could increase susceptibility to landslide hazards. The assessment of landslide hazard refers to the stability of the present land surface. It does not encompass a consideration of the stability of excavations.

Soluble rocks (dissolution)
Some rocks are soluble in water and can be progressively removed by the flow of water through the ground. This process tends to create cavities, potentially leading to the collapse of overlying materials and possibly subsidence at the surface. The release of water into the subsurface from infiltration systems may increase the dissolution of rock or destabilise material above or within a cavity. Dissolution cavities may create a pathway for rapid transport of contaminated water to an aquifer or water course.

Compressible ground
Many ground materials contain water-filled pores (the spaces between solid particles). Ground is compressible if a building (or other load) can cause the water in the pore space to be squeezed out, causing the ground to decrease in thickness. If ground is extremely compressible the building may sink. If the ground is not uniformly compressible, different parts of the building may sink by different amounts, possibly causing tilting, cracking or distortion. The compressibility of the ground may alter as a result of changes in subsurface water content caused by the release of water from soakaways.

Collapsible deposits
Collapsible ground comprises certain fine-grained materials with large pore spaces (the spaces between solid particles). It can collapse when it becomes saturated by water and/or a building (or other structure) places too great a load on it. If the material below a building collapses it may cause the building to sink. If the collapsible ground is variable in thickness or distribution, different parts of the building may sink by different amounts, possibly causing tilting, cracking or distortion. The subsurface underlying a soakaway will experience an increase in water content that may affect the stability of the ground. This hazard is most likely to be encountered only in parts of southern England.

Running sand
Running sand conditions occur when loosely-packed sand, saturated with water, flows into an excavation, borehole or other type of void. The pressure of the water filling the spaces between the sand grains reduces the contact between the grains and they are carried along by the flow. This can lead to subsidence of the surrounding ground. Running sand is potentially hazardous during the drainage system installation. During installation, excavation of the ground may create a space into which sand can flow, potentially causing subsidence of surrounding ground.

Shallow mining hazards (non coal)
Current or past underground mining for coal or for other commodities can give rise to cavities at shallow or intermediate depths, which may cause fracturing, general settlement, or the formation of crown-holes in the ground above. Spoil from mineral workings may also present a pollution hazard. The release of water into the subsurface from soakaways may destabilise material above or within a cavity. Cavities arising as a consequence of mining may also create a pathway for rapid transport of contaminated water to an aquifer or watercourse. The mining hazards map is derived from the geological map and considers the potential for subsidence associated with mining on the basis of geology type. Therefore if mining is known to occur within a certain rock, the map will highlight the potential for a hazard within the area covered by that geology.

For more information regarding underground and opencast **coal mining**, the location of mine entries (shafts and adits) and matters relating to subsidence or other ground movement induced by **coal mining** please contact the Coal Authority, Mining Reports, 200 Lichfield Lane, Mansfield, Nottinghamshire, NG18 4RG; telephone 0845 762 6848 or at www.coal.gov.uk**.** For more information regarding other types of mining (i.e. non-coal), please contact the British Geological Survey.

Groundwater source protection zones

In England and Wales, the Environment Agency has defined areas around wells, boreholes and springs that are used for the abstraction of public drinking water as source protection zones. In conjunction with Groundwater Protection Policy the zones are used to restrict activities that may impact groundwater quality, thereby preventing pollution of underlying aquifers, such that drinking water quality is upheld. The Environment Agency can provide advice on the location and implications of source protection zones in your area (www.environment-agency.gov.uk/)

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- The data, information and related records supplied in this Report by BGS can only be indicative and should not be taken as a substitute for specialist interpretations, professional advice and/or detailed site investigations. You must seek professional advice before making technical interpretations on the basis of the materials provided.
- Geological observations and interpretations are made according to the prevailing understanding of the subject at the time. The quality of such observations and interpretations may be affected by the availability of new data, by subsequent advances in knowledge, improved methods of interpretation, and better access to sampling locations.
- Raw data may have been transcribed from analogue to digital format, or may have been acquired by means of automated measuring techniques. Although such processes are subjected to quality control to ensure reliability where possible, some raw data may have been processed without human intervention and may in consequence contain undetected errors.
- Detail, which is clearly defined and accurately depicted on large-scale maps, may be lost when small-scale maps are derived from them.
- Although samples and records are maintained with all reasonable care, there may be some deterioration in the long term.
- The most appropriate techniques for copying original records are used, but there may be some loss of detail and dimensional distortion when such records are copied.
- Data may be compiled from the disparate sources of information at BGS's disposal, including material donated to BGS by third parties, and may not originally have been subject to any verification or other quality control process.
- Data, information and related records, which have been donated to BGS, have been produced for a specific purpose, and that may affect the type and completeness of the data recorded and any interpretation. The nature and purpose of data collection, and the age of the resultant material may render it unsuitable for certain applications/uses. You must verify the suitability of the material for your intended usage.
- If a report or other output is produced for you on the basis of data you have provided to BGS, or your own data input into a BGS system, please do not rely on it as a source of information about other areas or geological features, as the report may omit important details.
- The topography shown on any map extracts is based on the latest OS mapping and is not necessarily the same as that used in the original compilation of the BGS geological map, and to which the geological linework available at that time was fitted.
- Note that for some sites, the latest available records may be historical in nature, and while every effort is made to place the analysis in a modern geological context, it is possible in some cases that the detailed geology at a site may differ from that described.

Report issued by
BGS Enquiry Service

Appendix I Rainfall Runoff Summary

Summary of Results for 1 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	37.445	0.045	0.3	0.0	0.3	1.1	O K
30 min Summer	37.453	0.053	0.3	0.0	0.3	1.3	O K
60 min Summer	37.458	0.058	0.4	0.0	0.4	1.4	O K
120 min Summer	37.460	0.060	0.4	0.0	0.4	1.4	O K
180 min Summer	37.458	0.058	0.4	0.0	0.4	1.4	O K
240 min Summer	37.455	0.055	0.3	0.0	0.3	1.3	O K
360 min Summer	37.450	0.050	0.3	0.0	0.3	1.2	O K
480 min Summer	37.445	0.045	0.3	0.0	0.3	1.1	O K
600 min Summer	37.441	0.041	0.3	0.0	0.3	1.0	O K
720 min Summer	37.438	0.038	0.3	0.0	0.3	0.9	O K
960 min Summer	37.433	0.033	0.2	0.0	0.2	0.8	O K
1440 min Summer	37.428	0.028	0.2	0.0	0.2	0.7	O K
2160 min Summer	37.423	0.023	0.1	0.0	0.1	0.6	O K
2880 min Summer	37.421	0.021	0.1	0.0	0.1	0.5	O K
4320 min Summer	37.417	0.017	0.1	0.0	0.1	0.4	O K
5760 min Summer	37.415	0.015	0.1	0.0	0.1	0.4	O K
7200 min Summer	37.414	0.014	0.1	0.0	0.1	0.3	O K
8640 min Summer	37.413	0.013	0.1	0.0	0.1	0.3	O K
10080 min Summer	37.412	0.012	0.0	0.0	0.0	0.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	32.979	0.0	1.2	0.0	17
30 min Summer	21.307	0.0	1.6	0.0	29
60 min Summer	13.306	0.0	2.0	0.0	44
120 min Summer	8.133	0.0	2.4	0.0	78
180 min Summer	6.066	0.0	2.7	0.0	112
240 min Summer	4.920	0.0	2.9	0.0	144
360 min Summer	3.639	0.0	3.3	0.0	208
480 min Summer	2.931	0.0	3.5	0.0	270
600 min Summer	2.478	0.0	3.7	0.0	332
720 min Summer	2.160	0.0	3.9	0.0	390
960 min Summer	1.739	0.0	4.2	0.0	510
1440 min Summer	1.282	0.0	4.6	0.0	750
2160 min Summer	0.945	0.0	5.1	0.0	1104
2880 min Summer	0.761	0.0	5.5	0.0	1468
4320 min Summer	0.561	0.0	6.0	0.0	2204
5760 min Summer	0.451	0.0	6.5	0.0	2944
7200 min Summer	0.382	0.0	6.9	0.0	3616
8640 min Summer	0.333	0.0	7.2	0.0	4368
10080 min Summer	0.296	0.0	7.5	0.0	5136

Summary of Results for 1 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Winter	37.451	0.051	0.3	0.0	0.3	1.2	O K
30 min Winter	37.460	0.060	0.4	0.0	0.4	1.4	O K
60 min Winter	37.465	0.065	0.4	0.0	0.4	1.6	O K
120 min Winter	37.464	0.064	0.4	0.0	0.4	1.5	O K
180 min Winter	37.460	0.060	0.4	0.0	0.4	1.4	O K
240 min Winter	37.456	0.056	0.4	0.0	0.4	1.3	O K
360 min Winter	37.448	0.048	0.3	0.0	0.3	1.1	O K
480 min Winter	37.441	0.041	0.3	0.0	0.3	1.0	O K
600 min Winter	37.437	0.037	0.3	0.0	0.3	0.9	O K
720 min Winter	37.433	0.033	0.2	0.0	0.2	0.8	O K
960 min Winter	37.429	0.029	0.2	0.0	0.2	0.7	O K
1440 min Winter	37.424	0.024	0.1	0.0	0.1	0.6	O K
2160 min Winter	37.420	0.020	0.1	0.0	0.1	0.5	O K
2880 min Winter	37.417	0.017	0.1	0.0	0.1	0.4	O K
4320 min Winter	37.415	0.015	0.1	0.0	0.1	0.3	O K
5760 min Winter	37.413	0.013	0.1	0.0	0.1	0.3	O K
7200 min Winter	37.412	0.012	0.0	0.0	0.0	0.3	O K
8640 min Winter	37.411	0.011	0.0	0.0	0.0	0.3	O K
10080 min Winter	37.410	0.010	0.0	0.0	0.0	0.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Winter	32.979	0.0	1.4	0.0	17
30 min Winter	21.307	0.0	1.8	0.0	30
60 min Winter	13.306	0.0	2.2	0.0	48
120 min Winter	8.133	0.0	2.7	0.0	84
180 min Winter	6.066	0.0	3.0	0.0	120
240 min Winter	4.920	0.0	3.3	0.0	154
360 min Winter	3.639	0.0	3.7	0.0	218
480 min Winter	2.931	0.0	3.9	0.0	280
600 min Winter	2.478	0.0	4.2	0.0	340
720 min Winter	2.160	0.0	4.3	0.0	400
960 min Winter	1.739	0.0	4.7	0.0	514
1440 min Winter	1.282	0.0	5.2	0.0	764
2160 min Winter	0.945	0.0	5.7	0.0	1100
2880 min Winter	0.761	0.0	6.1	0.0	1496
4320 min Winter	0.561	0.0	6.8	0.0	2140
5760 min Winter	0.451	0.0	7.3	0.0	2920
7200 min Winter	0.382	0.0	7.7	0.0	3744
8640 min Winter	0.333	0.0	8.0	0.0	4424
10080 min Winter	0.296	0.0	8.4	0.0	5240

Summary of Results for 2 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	37.459	0.059	0.4	0.0	0.4	1.4	O K
30 min Summer	37.469	0.069	0.4	0.0	0.4	1.7	O K
60 min Summer	37.475	0.075	0.4	0.0	0.4	1.8	O K
120 min Summer	37.476	0.076	0.4	0.0	0.4	1.8	O K
180 min Summer	37.473	0.073	0.4	0.0	0.4	1.8	O K
240 min Summer	37.469	0.069	0.4	0.0	0.4	1.7	O K
360 min Summer	37.461	0.061	0.4	0.0	0.4	1.5	O K
480 min Summer	37.454	0.054	0.3	0.0	0.3	1.3	O K
600 min Summer	37.449	0.049	0.3	0.0	0.3	1.2	O K
720 min Summer	37.445	0.045	0.3	0.0	0.3	1.1	O K
960 min Summer	37.439	0.039	0.3	0.0	0.3	0.9	O K
1440 min Summer	37.432	0.032	0.2	0.0	0.2	0.8	O K
2160 min Summer	37.426	0.026	0.2	0.0	0.2	0.6	O K
2880 min Summer	37.423	0.023	0.1	0.0	0.1	0.5	O K
4320 min Summer	37.419	0.019	0.1	0.0	0.1	0.5	O K
5760 min Summer	37.417	0.017	0.1	0.0	0.1	0.4	O K
7200 min Summer	37.415	0.015	0.1	0.0	0.1	0.4	O K
8640 min Summer	37.414	0.014	0.1	0.0	0.1	0.3	O K
10080 min Summer	37.413	0.013	0.1	0.0	0.1	0.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	42.605	0.0	1.6	0.0	17
30 min Summer	27.281	0.0	2.0	0.0	30
60 min Summer	16.796	0.0	2.5	0.0	46
120 min Summer	10.115	0.0	3.0	0.0	80
180 min Summer	7.477	0.0	3.4	0.0	114
240 min Summer	6.024	0.0	3.6	0.0	148
360 min Summer	4.427	0.0	4.0	0.0	210
480 min Summer	3.552	0.0	4.3	0.0	272
600 min Summer	2.994	0.0	4.5	0.0	332
720 min Summer	2.603	0.0	4.7	0.0	392
960 min Summer	2.088	0.0	5.0	0.0	512
1440 min Summer	1.529	0.0	5.5	0.0	752
2160 min Summer	1.120	0.0	6.0	0.0	1108
2880 min Summer	0.898	0.0	6.5	0.0	1472
4320 min Summer	0.657	0.0	7.1	0.0	2200
5760 min Summer	0.527	0.0	7.6	0.0	2936
7200 min Summer	0.444	0.0	8.0	0.0	3672
8640 min Summer	0.386	0.0	8.3	0.0	4304
10080 min Summer	0.343	0.0	8.6	0.0	5136

Summary of Results for 2 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Winter	37.466	0.066	0.4	0.0	0.4	1.6	O K
30 min Winter	37.479	0.079	0.4	0.0	0.4	1.9	O K
60 min Winter	37.484	0.084	0.4	0.0	0.4	2.0	O K
120 min Winter	37.483	0.083	0.4	0.0	0.4	2.0	O K
180 min Winter	37.477	0.077	0.4	0.0	0.4	1.9	O K
240 min Winter	37.470	0.070	0.4	0.0	0.4	1.7	O K
360 min Winter	37.459	0.059	0.4	0.0	0.4	1.4	O K
480 min Winter	37.451	0.051	0.3	0.0	0.3	1.2	O K
600 min Winter	37.444	0.044	0.3	0.0	0.3	1.1	O K
720 min Winter	37.440	0.040	0.3	0.0	0.3	1.0	O K
960 min Winter	37.433	0.033	0.2	0.0	0.2	0.8	O K
1440 min Winter	37.427	0.027	0.2	0.0	0.2	0.6	O K
2160 min Winter	37.422	0.022	0.1	0.0	0.1	0.5	O K
2880 min Winter	37.419	0.019	0.1	0.0	0.1	0.5	O K
4320 min Winter	37.416	0.016	0.1	0.0	0.1	0.4	O K
5760 min Winter	37.414	0.014	0.1	0.0	0.1	0.3	O K
7200 min Winter	37.413	0.013	0.1	0.0	0.1	0.3	O K
8640 min Winter	37.412	0.012	0.0	0.0	0.0	0.3	O K
10080 min Winter	37.411	0.011	0.0	0.0	0.0	0.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Winter	42.605	0.0	1.8	0.0	17
30 min Winter	27.281	0.0	2.3	0.0	30
60 min Winter	16.796	0.0	2.8	0.0	50
120 min Winter	10.115	0.0	3.4	0.0	88
180 min Winter	7.477	0.0	3.8	0.0	124
240 min Winter	6.024	0.0	4.0	0.0	158
360 min Winter	4.427	0.0	4.5	0.0	220
480 min Winter	3.552	0.0	4.8	0.0	282
600 min Winter	2.994	0.0	5.0	0.0	344
720 min Winter	2.603	0.0	5.2	0.0	404
960 min Winter	2.088	0.0	5.6	0.0	522
1440 min Winter	1.529	0.0	6.1	0.0	762
2160 min Winter	1.120	0.0	6.8	0.0	1124
2880 min Winter	0.898	0.0	7.2	0.0	1464
4320 min Winter	0.657	0.0	7.9	0.0	2228
5760 min Winter	0.527	0.0	8.5	0.0	2848
7200 min Winter	0.444	0.0	8.9	0.0	3744
8640 min Winter	0.386	0.0	9.3	0.0	4384
10080 min Winter	0.343	0.0	9.7	0.0	5096

Summary of Results for 5 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	37.476	0.076	0.4	0.0	0.4	1.8	O K
30 min Summer	37.491	0.091	0.4	0.0	0.4	2.2	O K
60 min Summer	37.498	0.098	0.4	0.0	0.4	2.3	O K
120 min Summer	37.499	0.099	0.4	0.0	0.4	2.4	O K
180 min Summer	37.495	0.095	0.4	0.0	0.4	2.3	O K
240 min Summer	37.489	0.089	0.4	0.0	0.4	2.1	O K
360 min Summer	37.479	0.079	0.4	0.0	0.4	1.9	O K
480 min Summer	37.469	0.069	0.4	0.0	0.4	1.7	O K
600 min Summer	37.461	0.061	0.4	0.0	0.4	1.5	O K
720 min Summer	37.456	0.056	0.4	0.0	0.4	1.3	O K
960 min Summer	37.448	0.048	0.3	0.0	0.3	1.1	O K
1440 min Summer	37.438	0.038	0.3	0.0	0.3	0.9	O K
2160 min Summer	37.430	0.030	0.2	0.0	0.2	0.7	O K
2880 min Summer	37.426	0.026	0.2	0.0	0.2	0.6	O K
4320 min Summer	37.421	0.021	0.1	0.0	0.1	0.5	O K
5760 min Summer	37.419	0.019	0.1	0.0	0.1	0.4	O K
7200 min Summer	37.417	0.017	0.1	0.0	0.1	0.4	O K
8640 min Summer	37.416	0.016	0.1	0.0	0.1	0.4	O K
10080 min Summer	37.415	0.015	0.1	0.0	0.1	0.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	54.767	0.0	2.0	0.0	17
30 min Summer	34.779	0.0	2.6	0.0	31
60 min Summer	21.222	0.0	3.2	0.0	50
120 min Summer	12.655	0.0	3.8	0.0	84
180 min Summer	9.294	0.0	4.2	0.0	118
240 min Summer	7.451	0.0	4.5	0.0	152
360 min Summer	5.448	0.0	4.9	0.0	216
480 min Summer	4.359	0.0	5.2	0.0	278
600 min Summer	3.666	0.0	5.5	0.0	336
720 min Summer	3.181	0.0	5.7	0.0	398
960 min Summer	2.542	0.0	6.1	0.0	518
1440 min Summer	1.853	0.0	6.7	0.0	752
2160 min Summer	1.350	0.0	7.3	0.0	1108
2880 min Summer	1.078	0.0	7.7	0.0	1472
4320 min Summer	0.785	0.0	8.5	0.0	2204
5760 min Summer	0.627	0.0	9.0	0.0	2936
7200 min Summer	0.526	0.0	9.5	0.0	3656
8640 min Summer	0.456	0.0	9.8	0.0	4376
10080 min Summer	0.404	0.0	10.2	0.0	5128

Summary of Results for 5 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Winter	37.486	0.086	0.4	0.0	0.4	2.1	O K
30 min Winter	37.503	0.103	0.4	0.0	0.4	2.5	O K
60 min Winter	37.511	0.111	0.4	0.0	0.4	2.7	O K
120 min Winter	37.510	0.110	0.4	0.0	0.4	2.6	O K
180 min Winter	37.503	0.103	0.4	0.0	0.4	2.5	O K
240 min Winter	37.494	0.094	0.4	0.0	0.4	2.3	O K
360 min Winter	37.477	0.077	0.4	0.0	0.4	1.9	O K
480 min Winter	37.464	0.064	0.4	0.0	0.4	1.5	O K
600 min Winter	37.456	0.056	0.4	0.0	0.4	1.3	O K
720 min Winter	37.449	0.049	0.3	0.0	0.3	1.2	O K
960 min Winter	37.440	0.040	0.3	0.0	0.3	1.0	O K
1440 min Winter	37.431	0.031	0.2	0.0	0.2	0.7	O K
2160 min Winter	37.425	0.025	0.2	0.0	0.2	0.6	O K
2880 min Winter	37.421	0.021	0.1	0.0	0.1	0.5	O K
4320 min Winter	37.418	0.018	0.1	0.0	0.1	0.4	O K
5760 min Winter	37.416	0.016	0.1	0.0	0.1	0.4	O K
7200 min Winter	37.414	0.014	0.1	0.0	0.1	0.3	O K
8640 min Winter	37.413	0.013	0.1	0.0	0.1	0.3	O K
10080 min Winter	37.412	0.012	0.0	0.0	0.0	0.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Winter	54.767	0.0	2.3	0.0	17
30 min Winter	34.779	0.0	2.9	0.0	31
60 min Winter	21.222	0.0	3.6	0.0	58
120 min Winter	12.655	0.0	4.2	0.0	90
180 min Winter	9.294	0.0	4.7	0.0	128
240 min Winter	7.451	0.0	5.0	0.0	164
360 min Winter	5.448	0.0	5.5	0.0	228
480 min Winter	4.359	0.0	5.8	0.0	288
600 min Winter	3.666	0.0	6.1	0.0	348
720 min Winter	3.181	0.0	6.4	0.0	408
960 min Winter	2.542	0.0	6.8	0.0	530
1440 min Winter	1.853	0.0	7.5	0.0	764
2160 min Winter	1.350	0.0	8.2	0.0	1104
2880 min Winter	1.078	0.0	8.7	0.0	1496
4320 min Winter	0.785	0.0	9.5	0.0	2132
5760 min Winter	0.627	0.0	10.1	0.0	2936
7200 min Winter	0.526	0.0	10.6	0.0	3592
8640 min Winter	0.456	0.0	11.0	0.0	4280
10080 min Winter	0.404	0.0	11.4	0.0	5000

Summary of Results for 10 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	37.490	0.090	0.4	0.0	0.4	2.2	O K
30 min Summer	37.508	0.108	0.4	0.0	0.4	2.6	O K
60 min Summer	37.518	0.118	0.4	0.0	0.4	2.8	O K
120 min Summer	37.519	0.119	0.4	0.0	0.4	2.9	O K
180 min Summer	37.515	0.115	0.4	0.0	0.4	2.8	O K
240 min Summer	37.509	0.109	0.4	0.0	0.4	2.6	O K
360 min Summer	37.496	0.096	0.4	0.0	0.4	2.3	O K
480 min Summer	37.484	0.084	0.4	0.0	0.4	2.0	O K
600 min Summer	37.475	0.075	0.4	0.0	0.4	1.8	O K
720 min Summer	37.467	0.067	0.4	0.0	0.4	1.6	O K
960 min Summer	37.456	0.056	0.4	0.0	0.4	1.3	O K
1440 min Summer	37.443	0.043	0.3	0.0	0.3	1.0	O K
2160 min Summer	37.434	0.034	0.2	0.0	0.2	0.8	O K
2880 min Summer	37.428	0.028	0.2	0.0	0.2	0.7	O K
4320 min Summer	37.423	0.023	0.1	0.0	0.1	0.6	O K
5760 min Summer	37.420	0.020	0.1	0.0	0.1	0.5	O K
7200 min Summer	37.418	0.018	0.1	0.0	0.1	0.4	O K
8640 min Summer	37.417	0.017	0.1	0.0	0.1	0.4	O K
10080 min Summer	37.416	0.016	0.1	0.0	0.1	0.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	63.716	0.0	2.4	0.0	17
30 min Summer	40.640	0.0	3.0	0.0	31
60 min Summer	24.848	0.0	3.7	0.0	54
120 min Summer	14.806	0.0	4.4	0.0	86
180 min Summer	10.852	0.0	4.9	0.0	120
240 min Summer	8.681	0.0	5.2	0.0	154
360 min Summer	6.328	0.0	5.7	0.0	220
480 min Summer	5.052	0.0	6.1	0.0	284
600 min Summer	4.241	0.0	6.3	0.0	344
720 min Summer	3.675	0.0	6.6	0.0	402
960 min Summer	2.930	0.0	7.0	0.0	520
1440 min Summer	2.128	0.0	7.6	0.0	762
2160 min Summer	1.545	0.0	8.3	0.0	1120
2880 min Summer	1.230	0.0	8.8	0.0	1472
4320 min Summer	0.892	0.0	9.6	0.0	2204
5760 min Summer	0.710	0.0	10.2	0.0	2936
7200 min Summer	0.595	0.0	10.7	0.0	3648
8640 min Summer	0.514	0.0	11.1	0.0	4400
10080 min Summer	0.455	0.0	11.5	0.0	5136

Summary of Results for 10 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Winter	37.501	0.101	0.4	0.0	0.4	2.4	O K
30 min Winter	37.523	0.123	0.4	0.0	0.4	2.9	O K
60 min Winter	37.535	0.135	0.4	0.0	0.4	3.2	O K
120 min Winter	37.534	0.134	0.4	0.0	0.4	3.2	O K
180 min Winter	37.527	0.127	0.4	0.0	0.4	3.0	O K
240 min Winter	37.517	0.117	0.4	0.0	0.4	2.8	O K
360 min Winter	37.497	0.097	0.4	0.0	0.4	2.3	O K
480 min Winter	37.480	0.080	0.4	0.0	0.4	1.9	O K
600 min Winter	37.467	0.067	0.4	0.0	0.4	1.6	O K
720 min Winter	37.458	0.058	0.4	0.0	0.4	1.4	O K
960 min Winter	37.447	0.047	0.3	0.0	0.3	1.1	O K
1440 min Winter	37.435	0.035	0.2	0.0	0.2	0.8	O K
2160 min Winter	37.427	0.027	0.2	0.0	0.2	0.6	O K
2880 min Winter	37.423	0.023	0.1	0.0	0.1	0.6	O K
4320 min Winter	37.419	0.019	0.1	0.0	0.1	0.5	O K
5760 min Winter	37.417	0.017	0.1	0.0	0.1	0.4	O K
7200 min Winter	37.415	0.015	0.1	0.0	0.1	0.4	O K
8640 min Winter	37.414	0.014	0.1	0.0	0.1	0.3	O K
10080 min Winter	37.413	0.013	0.1	0.0	0.1	0.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Winter	63.716	0.0	2.7	0.0	17
30 min Winter	40.640	0.0	3.4	0.0	31
60 min Winter	24.848	0.0	4.2	0.0	58
120 min Winter	14.806	0.0	5.0	0.0	94
180 min Winter	10.852	0.0	5.5	0.0	132
240 min Winter	8.681	0.0	5.8	0.0	168
360 min Winter	6.328	0.0	6.4	0.0	236
480 min Winter	5.052	0.0	6.8	0.0	298
600 min Winter	4.241	0.0	7.1	0.0	356
720 min Winter	3.675	0.0	7.4	0.0	412
960 min Winter	2.930	0.0	7.9	0.0	530
1440 min Winter	2.128	0.0	8.6	0.0	764
2160 min Winter	1.545	0.0	9.3	0.0	1120
2880 min Winter	1.230	0.0	9.9	0.0	1472
4320 min Winter	0.892	0.0	10.8	0.0	2156
5760 min Winter	0.710	0.0	11.4	0.0	2832
7200 min Winter	0.595	0.0	12.0	0.0	3640
8640 min Winter	0.514	0.0	12.4	0.0	4312
10080 min Winter	0.455	0.0	12.8	0.0	4952

Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	37.516	0.116	0.4	0.0	0.4	2.8	O K
30 min Summer	37.542	0.142	0.4	0.0	0.4	3.4	O K
60 min Summer	37.559	0.159	0.4	0.0	0.4	3.8	O K
120 min Summer	37.561	0.161	0.4	0.0	0.4	3.9	O K
180 min Summer	37.557	0.157	0.4	0.0	0.4	3.8	O K
240 min Summer	37.549	0.149	0.4	0.0	0.4	3.6	O K
360 min Summer	37.534	0.134	0.4	0.0	0.4	3.2	O K
480 min Summer	37.519	0.119	0.4	0.0	0.4	2.9	O K
600 min Summer	37.506	0.106	0.4	0.0	0.4	2.5	O K
720 min Summer	37.494	0.094	0.4	0.0	0.4	2.3	O K
960 min Summer	37.476	0.076	0.4	0.0	0.4	1.8	O K
1440 min Summer	37.455	0.055	0.3	0.0	0.3	1.3	O K
2160 min Summer	37.441	0.041	0.3	0.0	0.3	1.0	O K
2880 min Summer	37.434	0.034	0.2	0.0	0.2	0.8	O K
4320 min Summer	37.427	0.027	0.2	0.0	0.2	0.6	O K
5760 min Summer	37.423	0.023	0.1	0.0	0.1	0.5	O K
7200 min Summer	37.421	0.021	0.1	0.0	0.1	0.5	O K
8640 min Summer	37.419	0.019	0.1	0.0	0.1	0.4	O K
10080 min Summer	37.417	0.017	0.1	0.0	0.1	0.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	80.990	0.0	3.0	0.0	18
30 min Summer	52.018	0.0	3.9	0.0	32
60 min Summer	31.905	0.0	4.8	0.0	60
120 min Summer	18.989	0.0	5.7	0.0	94
180 min Summer	13.874	0.0	6.2	0.0	128
240 min Summer	11.059	0.0	6.6	0.0	160
360 min Summer	8.021	0.0	7.2	0.0	228
480 min Summer	6.383	0.0	7.6	0.0	292
600 min Summer	5.344	0.0	8.0	0.0	356
720 min Summer	4.620	0.0	8.3	0.0	418
960 min Summer	3.670	0.0	8.8	0.0	532
1440 min Summer	2.651	0.0	9.5	0.0	764
2160 min Summer	1.912	0.0	10.3	0.0	1124
2880 min Summer	1.516	0.0	10.9	0.0	1472
4320 min Summer	1.092	0.0	11.8	0.0	2200
5760 min Summer	0.865	0.0	12.4	0.0	2936
7200 min Summer	0.721	0.0	13.0	0.0	3664
8640 min Summer	0.622	0.0	13.4	0.0	4344
10080 min Summer	0.549	0.0	13.8	0.0	5136

Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Winter	37.530	0.130	0.4	0.0	0.4	3.1	O K
30 min Winter	37.561	0.161	0.4	0.0	0.4	3.9	O K
60 min Winter	37.582	0.182	0.4	0.0	0.4	4.4	O K
120 min Winter	37.584	0.184	0.4	0.0	0.4	4.4	O K
180 min Winter	37.577	0.177	0.4	0.0	0.4	4.3	O K
240 min Winter	37.566	0.166	0.4	0.0	0.4	4.0	O K
360 min Winter	37.542	0.142	0.4	0.0	0.4	3.4	O K
480 min Winter	37.520	0.120	0.4	0.0	0.4	2.9	O K
600 min Winter	37.500	0.100	0.4	0.0	0.4	2.4	O K
720 min Winter	37.484	0.084	0.4	0.0	0.4	2.0	O K
960 min Winter	37.462	0.062	0.4	0.0	0.4	1.5	O K
1440 min Winter	37.444	0.044	0.3	0.0	0.3	1.1	O K
2160 min Winter	37.432	0.032	0.2	0.0	0.2	0.8	O K
2880 min Winter	37.427	0.027	0.2	0.0	0.2	0.6	O K
4320 min Winter	37.422	0.022	0.1	0.0	0.1	0.5	O K
5760 min Winter	37.419	0.019	0.1	0.0	0.1	0.4	O K
7200 min Winter	37.417	0.017	0.1	0.0	0.1	0.4	O K
8640 min Winter	37.416	0.016	0.1	0.0	0.1	0.4	O K
10080 min Winter	37.415	0.015	0.1	0.0	0.1	0.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Winter	80.990	0.0	3.4	0.0	18
30 min Winter	52.018	0.0	4.3	0.0	32
60 min Winter	31.905	0.0	5.3	0.0	60
120 min Winter	18.989	0.0	6.4	0.0	110
180 min Winter	13.874	0.0	7.0	0.0	138
240 min Winter	11.059	0.0	7.4	0.0	176
360 min Winter	8.021	0.0	8.1	0.0	248
480 min Winter	6.383	0.0	8.6	0.0	314
600 min Winter	5.344	0.0	9.0	0.0	376
720 min Winter	4.620	0.0	9.3	0.0	434
960 min Winter	3.670	0.0	9.9	0.0	540
1440 min Winter	2.651	0.0	10.7	0.0	778
2160 min Winter	1.912	0.0	11.6	0.0	1124
2880 min Winter	1.516	0.0	12.2	0.0	1472
4320 min Winter	1.092	0.0	13.2	0.0	2192
5760 min Winter	0.865	0.0	13.9	0.0	2936
7200 min Winter	0.721	0.0	14.5	0.0	3744
8640 min Winter	0.622	0.0	15.0	0.0	4344
10080 min Winter	0.549	0.0	15.5	0.0	5168

Summary of Results for 50 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	37.530	0.130	0.4	0.0	0.4	3.1	O K
30 min Summer	37.561	0.161	0.4	0.0	0.4	3.9	O K
60 min Summer	37.582	0.182	0.4	0.0	0.4	4.4	O K
120 min Summer	37.586	0.186	0.4	0.0	0.4	4.5	O K
180 min Summer	37.581	0.181	0.4	0.0	0.4	4.3	O K
240 min Summer	37.574	0.174	0.4	0.0	0.4	4.2	O K
360 min Summer	37.557	0.157	0.4	0.0	0.4	3.8	O K
480 min Summer	37.540	0.140	0.4	0.0	0.4	3.4	O K
600 min Summer	37.525	0.125	0.4	0.0	0.4	3.0	O K
720 min Summer	37.512	0.112	0.4	0.0	0.4	2.7	O K
960 min Summer	37.490	0.090	0.4	0.0	0.4	2.2	O K
1440 min Summer	37.463	0.063	0.4	0.0	0.4	1.5	O K
2160 min Summer	37.446	0.046	0.3	0.0	0.3	1.1	O K
2880 min Summer	37.437	0.037	0.3	0.0	0.3	0.9	O K
4320 min Summer	37.429	0.029	0.2	0.0	0.2	0.7	O K
5760 min Summer	37.424	0.024	0.2	0.0	0.2	0.6	O K
7200 min Summer	37.422	0.022	0.1	0.0	0.1	0.5	O K
8640 min Summer	37.420	0.020	0.1	0.0	0.1	0.5	O K
10080 min Summer	37.418	0.018	0.1	0.0	0.1	0.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	90.546	0.0	3.4	0.0	18
30 min Summer	58.344	0.0	4.4	0.0	32
60 min Summer	35.838	0.0	5.4	0.0	60
120 min Summer	21.319	0.0	6.4	0.0	100
180 min Summer	15.553	0.0	7.0	0.0	132
240 min Summer	12.377	0.0	7.4	0.0	164
360 min Summer	8.956	0.0	8.0	0.0	232
480 min Summer	7.116	0.0	8.5	0.0	298
600 min Summer	5.950	0.0	8.9	0.0	362
720 min Summer	5.139	0.0	9.2	0.0	424
960 min Summer	4.075	0.0	9.8	0.0	540
1440 min Summer	2.935	0.0	10.5	0.0	766
2160 min Summer	2.112	0.0	11.4	0.0	1124
2880 min Summer	1.671	0.0	12.0	0.0	1472
4320 min Summer	1.200	0.0	12.9	0.0	2204
5760 min Summer	0.948	0.0	13.6	0.0	2936
7200 min Summer	0.789	0.0	14.2	0.0	3664
8640 min Summer	0.680	0.0	14.7	0.0	4312
10080 min Summer	0.599	0.0	15.1	0.0	5136

Summary of Results for 50 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Winter	37.547	0.147	0.4	0.0	0.4	3.5	O K
30 min Winter	37.583	0.183	0.4	0.0	0.4	4.4	O K
60 min Winter	37.609	0.209	0.4	0.0	0.4	5.0	O K
120 min Winter	37.615	0.215	0.4	0.0	0.4	5.2	O K
180 min Winter	37.607	0.207	0.4	0.0	0.4	5.0	O K
240 min Winter	37.596	0.196	0.4	0.0	0.4	4.7	O K
360 min Winter	37.570	0.170	0.4	0.0	0.4	4.1	O K
480 min Winter	37.545	0.145	0.4	0.0	0.4	3.5	O K
600 min Winter	37.523	0.123	0.4	0.0	0.4	2.9	O K
720 min Winter	37.503	0.103	0.4	0.0	0.4	2.5	O K
960 min Winter	37.474	0.074	0.4	0.0	0.4	1.8	O K
1440 min Winter	37.450	0.050	0.3	0.0	0.3	1.2	O K
2160 min Winter	37.435	0.035	0.2	0.0	0.2	0.9	O K
2880 min Winter	37.429	0.029	0.2	0.0	0.2	0.7	O K
4320 min Winter	37.423	0.023	0.1	0.0	0.1	0.6	O K
5760 min Winter	37.420	0.020	0.1	0.0	0.1	0.5	O K
7200 min Winter	37.418	0.018	0.1	0.0	0.1	0.4	O K
8640 min Winter	37.416	0.016	0.1	0.0	0.1	0.4	O K
10080 min Winter	37.415	0.015	0.1	0.0	0.1	0.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Winter	90.546	0.0	3.8	0.0	18
30 min Winter	58.344	0.0	4.9	0.0	32
60 min Winter	35.838	0.0	6.0	0.0	60
120 min Winter	21.319	0.0	7.2	0.0	114
180 min Winter	15.553	0.0	7.8	0.0	142
240 min Winter	12.377	0.0	8.3	0.0	180
360 min Winter	8.956	0.0	9.0	0.0	254
480 min Winter	7.116	0.0	9.6	0.0	322
600 min Winter	5.950	0.0	10.0	0.0	386
720 min Winter	5.139	0.0	10.3	0.0	446
960 min Winter	4.075	0.0	10.9	0.0	558
1440 min Winter	2.935	0.0	11.8	0.0	780
2160 min Winter	2.112	0.0	12.8	0.0	1128
2880 min Winter	1.671	0.0	13.5	0.0	1496
4320 min Winter	1.200	0.0	14.5	0.0	2244
5760 min Winter	0.948	0.0	15.3	0.0	2944
7200 min Winter	0.789	0.0	15.9	0.0	3672
8640 min Winter	0.680	0.0	16.4	0.0	4408
10080 min Winter	0.599	0.0	16.9	0.0	5080

Summary of Results for 100 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	37.553	0.153	0.4	0.0	0.4	3.7	O K
30 min Summer	37.591	0.191	0.4	0.0	0.4	4.6	O K
60 min Summer	37.620	0.220	0.4	0.0	0.4	5.3	O K
120 min Summer	37.628	0.228	0.4	0.0	0.4	5.5	O K
180 min Summer	37.622	0.222	0.4	0.0	0.4	5.3	O K
240 min Summer	37.613	0.213	0.4	0.0	0.4	5.1	O K
360 min Summer	37.594	0.194	0.4	0.0	0.4	4.7	O K
480 min Summer	37.576	0.176	0.4	0.0	0.4	4.2	O K
600 min Summer	37.559	0.159	0.4	0.0	0.4	3.8	O K
720 min Summer	37.543	0.143	0.4	0.0	0.4	3.4	O K
960 min Summer	37.515	0.115	0.4	0.0	0.4	2.8	O K
1440 min Summer	37.479	0.079	0.4	0.0	0.4	1.9	O K
2160 min Summer	37.454	0.054	0.3	0.0	0.3	1.3	O K
2880 min Summer	37.443	0.043	0.3	0.0	0.3	1.0	O K
4320 min Summer	37.432	0.032	0.2	0.0	0.2	0.8	O K
5760 min Summer	37.426	0.026	0.2	0.0	0.2	0.6	O K
7200 min Summer	37.423	0.023	0.1	0.0	0.1	0.6	O K
8640 min Summer	37.421	0.021	0.1	0.0	0.1	0.5	O K
10080 min Summer	37.420	0.020	0.1	0.0	0.1	0.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	105.342	0.0	3.9	0.0	18
30 min Summer	68.175	0.0	5.1	0.0	32
60 min Summer	41.961	0.0	6.3	0.0	62
120 min Summer	24.943	0.0	7.5	0.0	114
180 min Summer	18.161	0.0	8.2	0.0	142
240 min Summer	14.419	0.0	8.6	0.0	172
360 min Summer	10.402	0.0	9.3	0.0	238
480 min Summer	8.247	0.0	9.9	0.0	306
600 min Summer	6.884	0.0	10.3	0.0	370
720 min Summer	5.937	0.0	10.7	0.0	434
960 min Summer	4.697	0.0	11.3	0.0	558
1440 min Summer	3.371	0.0	12.1	0.0	782
2160 min Summer	2.417	0.0	13.0	0.0	1124
2880 min Summer	1.907	0.0	13.7	0.0	1476
4320 min Summer	1.363	0.0	14.7	0.0	2204
5760 min Summer	1.074	0.0	15.5	0.0	2936
7200 min Summer	0.892	0.0	16.0	0.0	3672
8640 min Summer	0.766	0.0	16.5	0.0	4312
10080 min Summer	0.674	0.0	17.0	0.0	5032

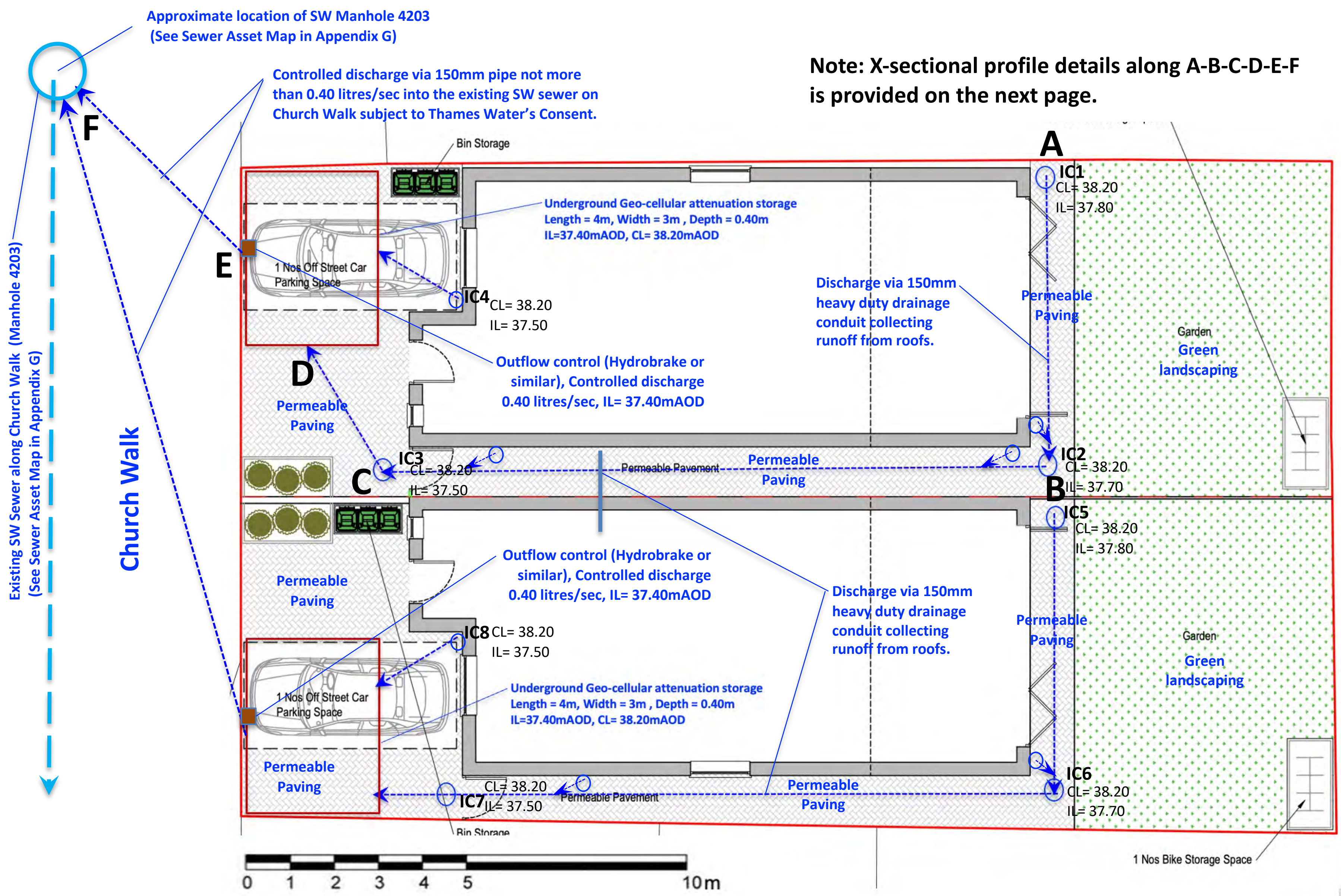
Summary of Results for 100 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Winter	37.573	0.173	0.4	0.0	0.4	4.1	O K
30 min Winter	37.617	0.217	0.4	0.0	0.4	5.2	O K
60 min Winter	37.651	0.251	0.4	0.0	0.4	6.0	O K
120 min Winter	37.666	0.266	0.4	0.0	0.4	6.4	O K
180 min Winter	37.658	0.258	0.4	0.0	0.4	6.2	O K
240 min Winter	37.644	0.244	0.4	0.0	0.4	5.9	O K
360 min Winter	37.617	0.217	0.4	0.0	0.4	5.2	O K
480 min Winter	37.589	0.189	0.4	0.0	0.4	4.5	O K
600 min Winter	37.562	0.162	0.4	0.0	0.4	3.9	O K
720 min Winter	37.539	0.139	0.4	0.0	0.4	3.3	O K
960 min Winter	37.500	0.100	0.4	0.0	0.4	2.4	O K
1440 min Winter	37.459	0.059	0.4	0.0	0.4	1.4	O K
2160 min Winter	37.441	0.041	0.3	0.0	0.3	1.0	O K
2880 min Winter	37.432	0.032	0.2	0.0	0.2	0.8	O K
4320 min Winter	37.425	0.025	0.2	0.0	0.2	0.6	O K
5760 min Winter	37.421	0.021	0.1	0.0	0.1	0.5	O K
7200 min Winter	37.419	0.019	0.1	0.0	0.1	0.5	O K
8640 min Winter	37.418	0.018	0.1	0.0	0.1	0.4	O K
10080 min Winter	37.416	0.016	0.1	0.0	0.1	0.4	O K

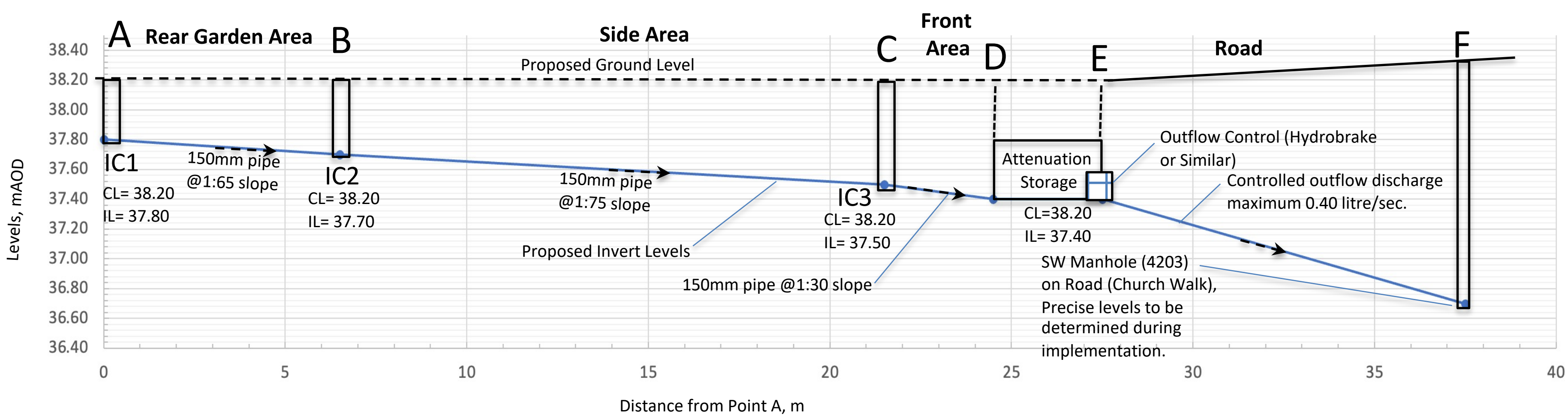
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Winter	105.342	0.0	4.4	0.0	18
30 min Winter	68.175	0.0	5.7	0.0	32
60 min Winter	41.961	0.0	7.0	0.0	60
120 min Winter	24.943	0.0	8.4	0.0	118
180 min Winter	18.161	0.0	9.1	0.0	170
240 min Winter	14.419	0.0	9.7	0.0	188
360 min Winter	10.402	0.0	10.5	0.0	262
480 min Winter	8.247	0.0	11.1	0.0	332
600 min Winter	6.884	0.0	11.6	0.0	398
720 min Winter	5.937	0.0	12.0	0.0	462
960 min Winter	4.697	0.0	12.6	0.0	578
1440 min Winter	3.371	0.0	13.6	0.0	780
2160 min Winter	2.417	0.0	14.6	0.0	1144
2880 min Winter	1.907	0.0	15.4	0.0	1500
4320 min Winter	1.363	0.0	16.5	0.0	2208
5760 min Winter	1.074	0.0	17.3	0.0	2944
7200 min Winter	0.892	0.0	18.0	0.0	3664
8640 min Winter	0.766	0.0	18.5	0.0	4488
10080 min Winter	0.674	0.0	19.0	0.0	4952

Appendix J Outline Sustainable Drainage Systems (SuDS) Plan

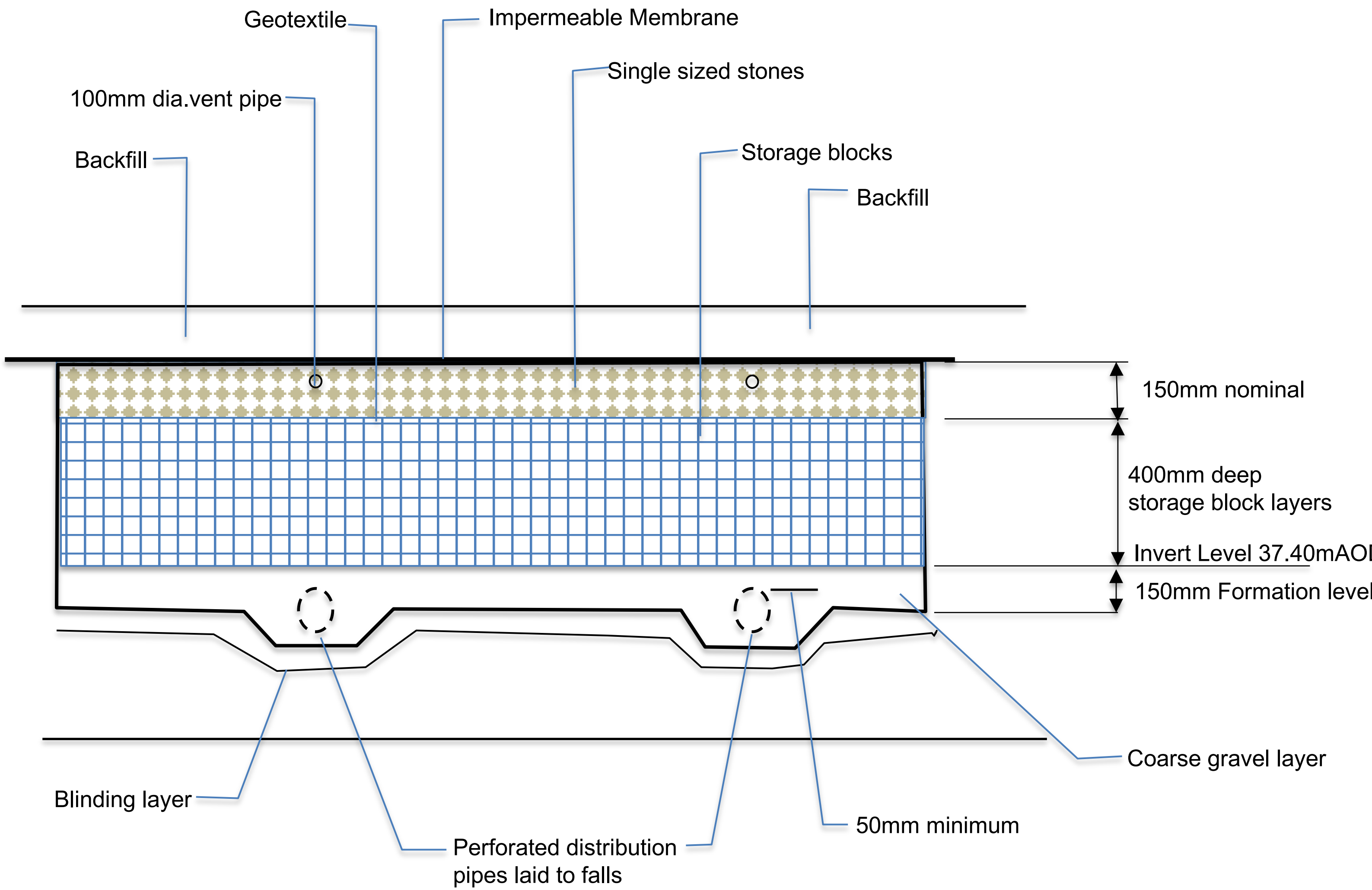
Appendix J Outline Sustainable Drainage Systems (SuDS) Plan



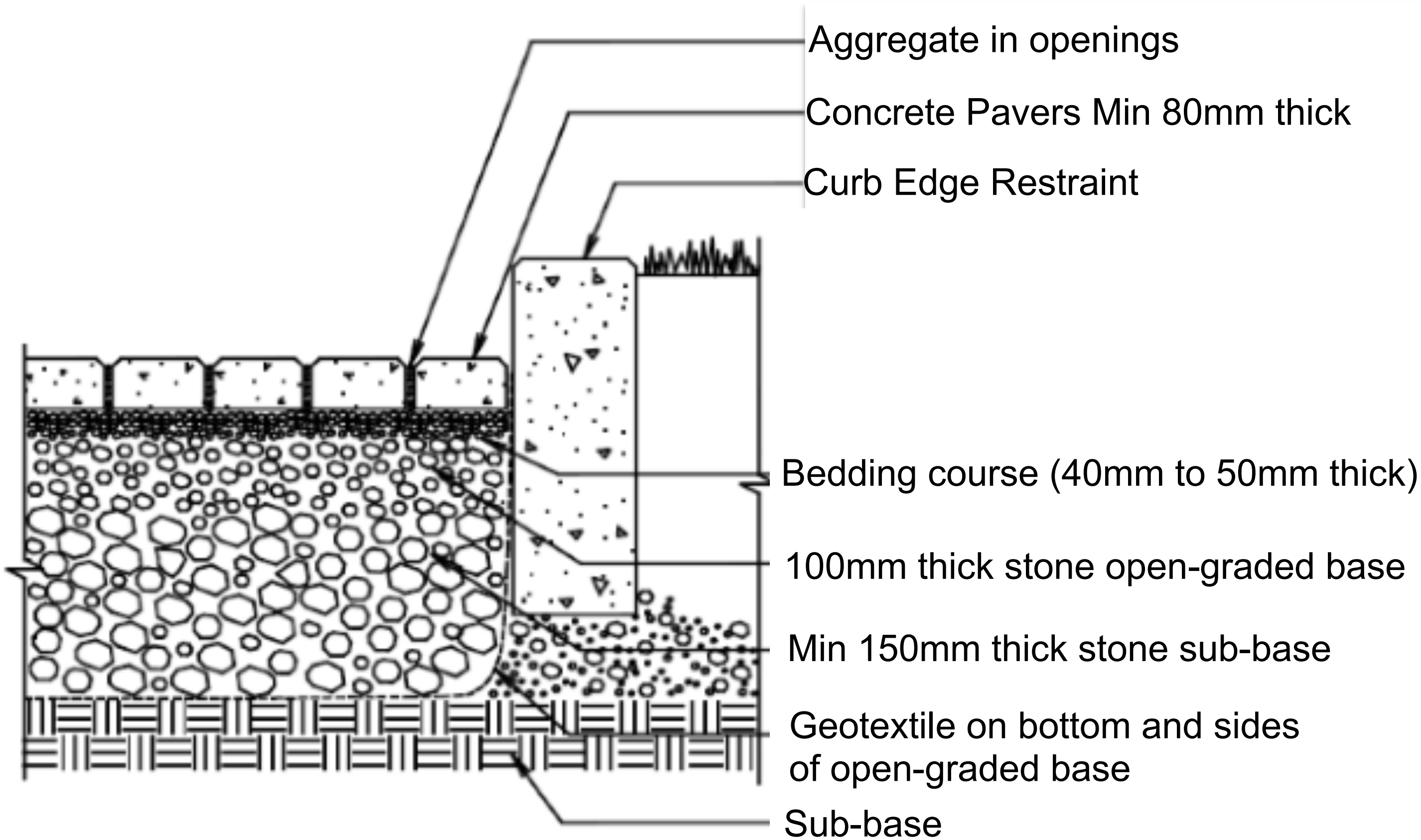
Cross-sectional details of proposed attenuation storage and outfall



Cross-section Details of Attenuation Storage



Appendix J Outline Drainage Plan
(Permeable Block Paving Details)



Typical Permeable Block Paving Sectional Details

Easy Flood Risk		Page 1
55 Shepherds Lane Dartford DA1 2NL		Micro Drainage
Date 14/02/2025 08:23 File Blackhorseyard.SRCX	Designed by sheph Checked by	
Innovyze	Source Control 2020.1	

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	37.618	0.218	0.4	0.0	0.4	5.2	O K
30 min Summer	37.676	0.276	0.4	0.0	0.4	6.6	O K
60 min Summer	37.723	0.323	0.4	0.0	0.4	7.7	O K
120 min Summer	37.746	0.346	0.4	0.0	0.4	8.3	O K
180 min Summer	37.743	0.343	0.4	0.0	0.4	8.2	O K
240 min Summer	37.734	0.334	0.4	0.0	0.4	8.0	O K
360 min Summer	37.714	0.314	0.4	0.0	0.4	7.5	O K
480 min Summer	37.695	0.295	0.4	0.0	0.4	7.1	O K
600 min Summer	37.676	0.276	0.4	0.0	0.4	6.6	O K
720 min Summer	37.655	0.255	0.4	0.0	0.4	6.1	O K
960 min Summer	37.616	0.216	0.4	0.0	0.4	5.2	O K
1440 min Summer	37.554	0.154	0.4	0.0	0.4	3.7	O K
2160 min Summer	37.495	0.095	0.4	0.0	0.4	2.3	O K
2880 min Summer	37.465	0.065	0.4	0.0	0.4	1.6	O K
4320 min Summer	37.445	0.045	0.3	0.0	0.3	1.1	O K
5760 min Summer	37.435	0.035	0.2	0.0	0.2	0.8	O K
7200 min Summer	37.430	0.030	0.2	0.0	0.2	0.7	O K
8640 min Summer	37.427	0.027	0.2	0.0	0.2	0.6	O K
10080 min Summer	37.424	0.024	0.2	0.0	0.2	0.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	147.479	0.0	5.5	0.0	18
30 min Summer	95.446	0.0	7.1	0.0	33
60 min Summer	58.745	0.0	8.8	0.0	62
120 min Summer	34.920	0.0	10.5	0.0	120
180 min Summer	25.425	0.0	11.4	0.0	170
240 min Summer	20.187	0.0	12.1	0.0	198
360 min Summer	14.563	0.0	13.1	0.0	260
480 min Summer	11.546	0.0	13.8	0.0	330
600 min Summer	9.638	0.0	14.4	0.0	400
720 min Summer	8.311	0.0	14.9	0.0	466
960 min Summer	6.576	0.0	15.8	0.0	590
1440 min Summer	4.720	0.0	17.0	0.0	836
2160 min Summer	3.383	0.0	18.3	0.0	1172
2880 min Summer	2.669	0.0	19.2	0.0	1500
4320 min Summer	1.909	0.0	20.6	0.0	2204
5760 min Summer	1.503	0.0	21.6	0.0	2936
7200 min Summer	1.249	0.0	22.5	0.0	3672
8640 min Summer	1.073	0.0	23.2	0.0	4360
10080 min Summer	0.943	0.0	23.7	0.0	5136

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Winter	37.646	0.246	0.4	0.0	0.4	5.9	O K
30 min Winter	37.711	0.311	0.4	0.0	0.4	7.5	O K
60 min Winter	37.765	0.365	0.4	0.0	0.4	8.8	O K
120 min Winter	37.796	0.396	0.4	0.0	0.4	9.5	O K
180 min Winter	37.796	0.396	0.4	0.0	0.4	9.5	O K
240 min Winter	37.784	0.384	0.4	0.0	0.4	9.2	O K
360 min Winter	37.759	0.359	0.4	0.0	0.4	8.6	O K
480 min Winter	37.734	0.334	0.4	0.0	0.4	8.0	O K
600 min Winter	37.707	0.307	0.4	0.0	0.4	7.4	O K
720 min Winter	37.679	0.279	0.4	0.0	0.4	6.7	O K
960 min Winter	37.618	0.218	0.4	0.0	0.4	5.2	O K
1440 min Winter	37.527	0.127	0.4	0.0	0.4	3.1	O K
2160 min Winter	37.463	0.063	0.4	0.0	0.4	1.5	O K
2880 min Winter	37.447	0.047	0.3	0.0	0.3	1.1	O K
4320 min Winter	37.433	0.033	0.2	0.0	0.2	0.8	O K
5760 min Winter	37.427	0.027	0.2	0.0	0.2	0.6	O K
7200 min Winter	37.424	0.024	0.1	0.0	0.1	0.6	O K
8640 min Winter	37.422	0.022	0.1	0.0	0.1	0.5	O K
10080 min Winter	37.420	0.020	0.1	0.0	0.1	0.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Winter	147.479	0.0	6.2	0.0	18
30 min Winter	95.446	0.0	8.0	0.0	32
60 min Winter	58.745	0.0	9.9	0.0	62
120 min Winter	34.920	0.0	11.7	0.0	118
180 min Winter	25.425	0.0	12.8	0.0	174
240 min Winter	20.187	0.0	13.6	0.0	224
360 min Winter	14.563	0.0	14.7	0.0	278
480 min Winter	11.546	0.0	15.5	0.0	356
600 min Winter	9.638	0.0	16.2	0.0	434
720 min Winter	8.311	0.0	16.7	0.0	508
960 min Winter	6.576	0.0	17.7	0.0	636
1440 min Winter	4.720	0.0	19.0	0.0	866
2160 min Winter	3.383	0.0	20.5	0.0	1164
2880 min Winter	2.669	0.0	21.5	0.0	1500
4320 min Winter	1.909	0.0	23.1	0.0	2204
5760 min Winter	1.503	0.0	24.2	0.0	2936
7200 min Winter	1.249	0.0	25.2	0.0	3656
8640 min Winter	1.073	0.0	25.9	0.0	4376
10080 min Winter	0.943	0.0	26.6	0.0	5136

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.700	Shortest Storm (mins)	15
Ratio R	0.433	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.020

Time From:	(mins) To:	Area (ha)
0	4	0.020

Model Details

Storage is Online Cover Level (m) 38.200

Tank or Pond Structure

Invert Level (m) 37.400

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	24.0	0.400	24.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SCL-0033-4000-0400-4000
Design Head (m)	0.400
Design Flow (l/s)	0.4
Flush-Flo™	Calculated
Objective	Minimise blockage risk
Application	Surface
Sump Available	Yes
Diameter (mm)	33
Invert Level (m)	37.400
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.400	0.4	Kick-Flo®	0.260	0.3
Flush-Flo™	0.117	0.4	Mean Flow over Head Range	-	0.4

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.4	1.200	0.6	3.000	1.0	7.000	1.4
0.200	0.4	1.400	0.7	3.500	1.0	7.500	1.5
0.300	0.4	1.600	0.7	4.000	1.1	8.000	1.5
0.400	0.4	1.800	0.8	4.500	1.2	8.500	1.6
0.500	0.4	2.000	0.8	5.000	1.2	9.000	1.6
0.600	0.5	2.200	0.8	5.500	1.3	9.500	1.7
0.800	0.5	2.400	0.9	6.000	1.3		
1.000	0.6	2.600	0.9	6.500	1.4		

Hydro-Brake® Optimum Overflow Control

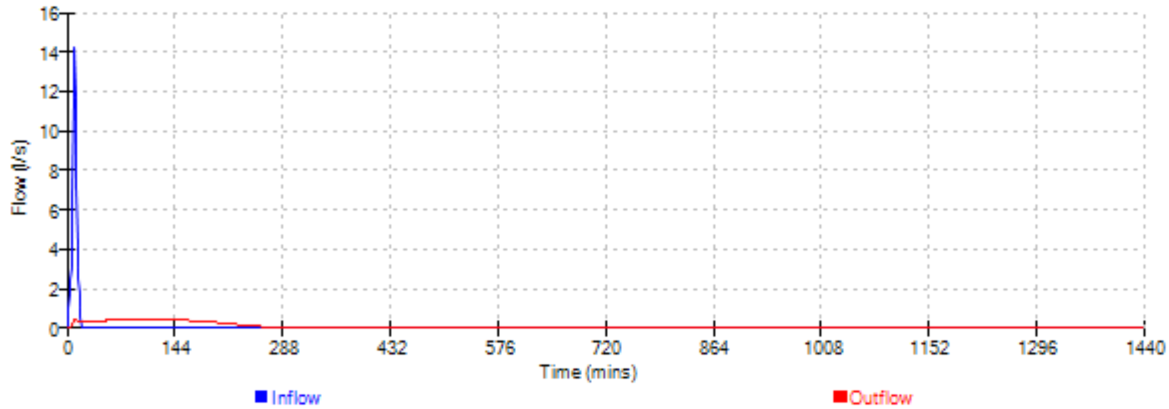
Unit Reference	MD-SCL-0033-4000-0400-4000
Design Head (m)	0.400
Design Flow (l/s)	0.4
Flush-Flo™	Calculated
Objective	Minimise blockage risk
Application	Surface
Sump Available	Yes
Diameter (mm)	33
Invert Level (m)	37.800
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

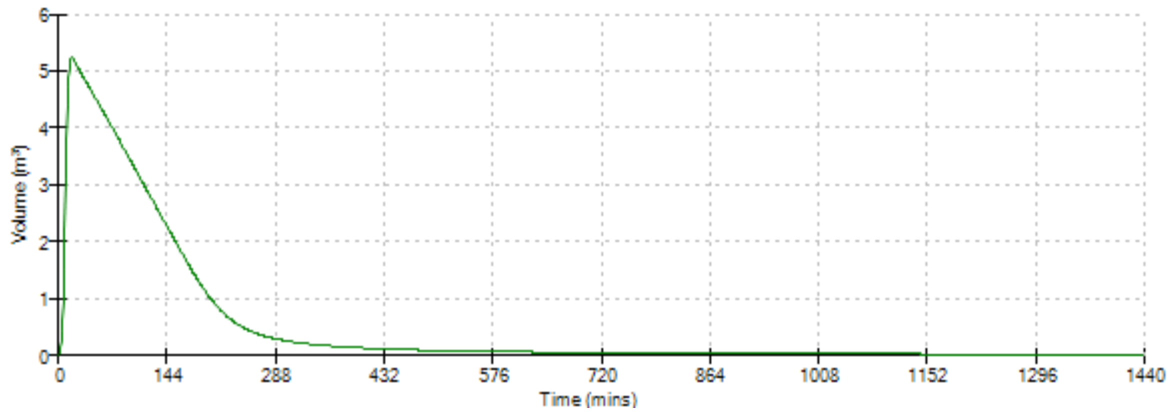
Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.400	0.4	Kick-Flo®	0.260	0.3
Flush-Flo™	0.117	0.4	Mean Flow over Head Range	-	0.4

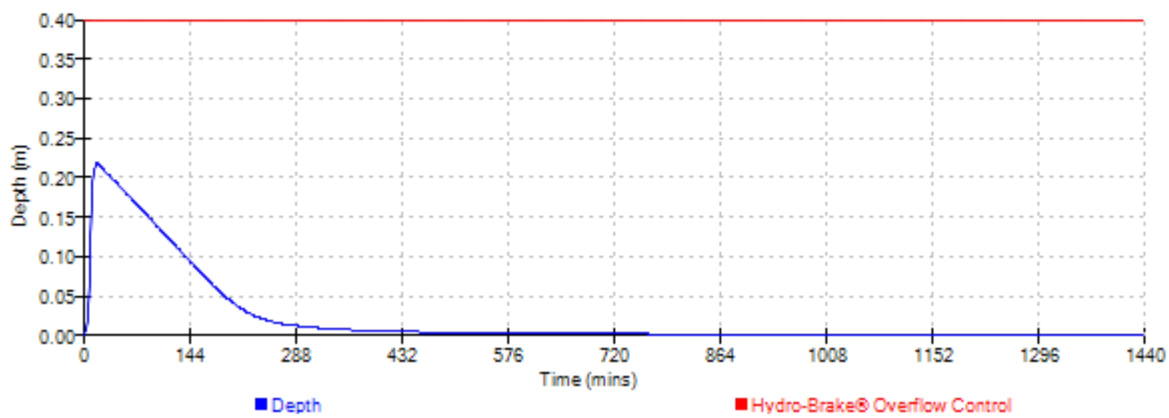
The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.4	1.200	0.6	3.000	1.0	7.000	1.4
0.200	0.4	1.400	0.7	3.500	1.0	7.500	1.5
0.300	0.4	1.600	0.7	4.000	1.1	8.000	1.5
0.400	0.4	1.800	0.8	4.500	1.2	8.500	1.6
0.500	0.4	2.000	0.8	5.000	1.2	9.000	1.6
0.600	0.5	2.200	0.8	5.500	1.3	9.500	1.7
0.800	0.5	2.400	0.9	6.000	1.3		
1.000	0.6	2.600	0.9	6.500	1.4		

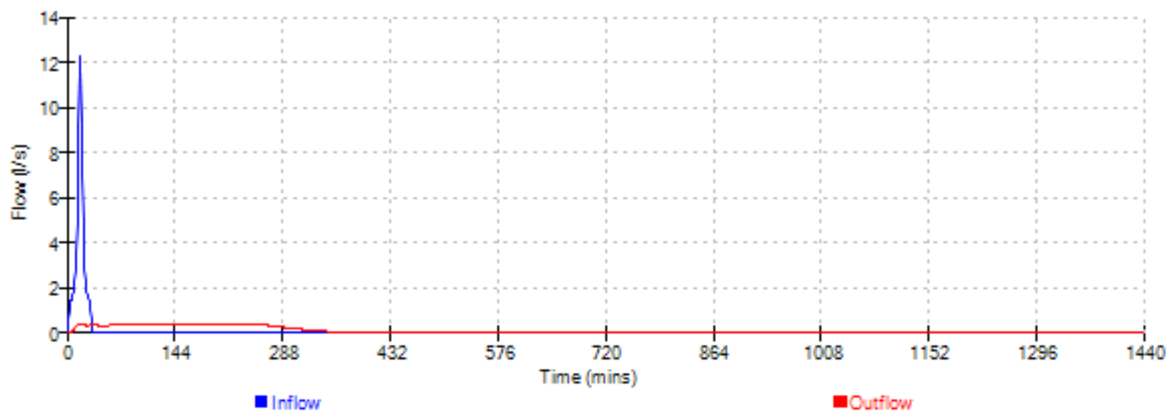
Event: 15 min Summer

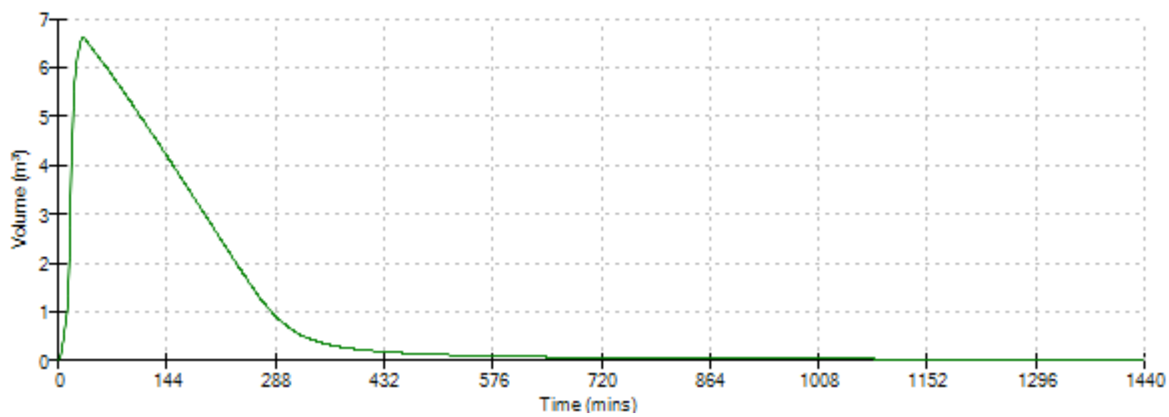


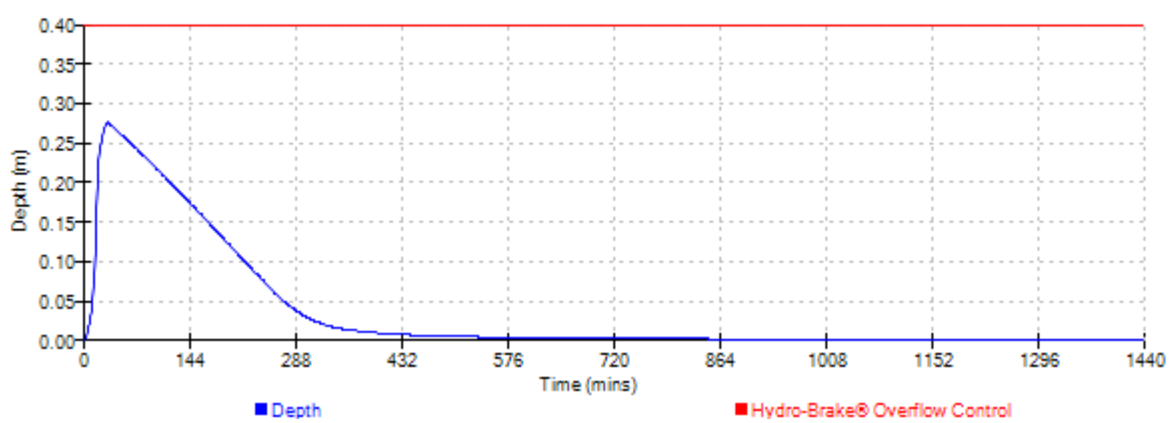




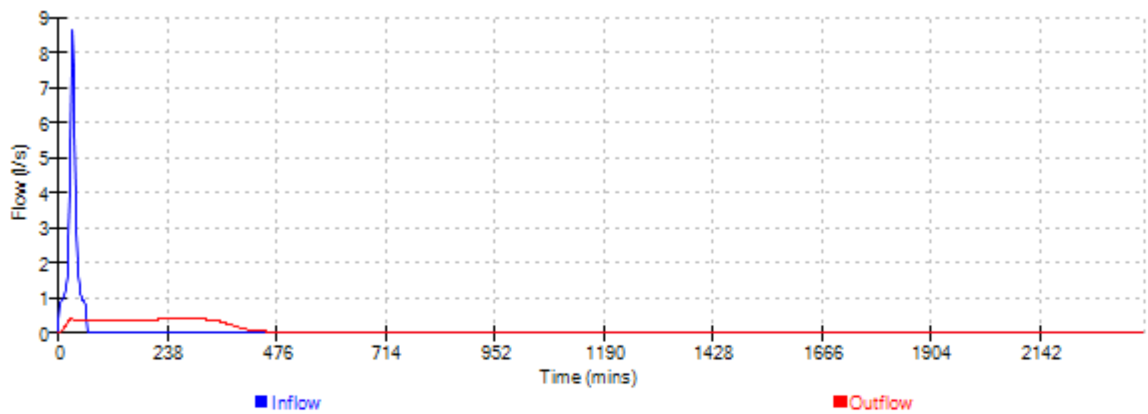
Event: 30 min Summer

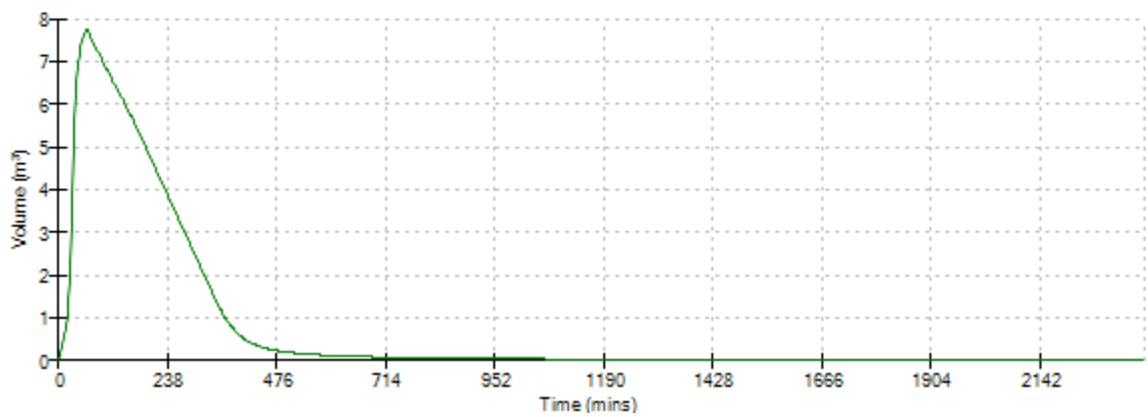


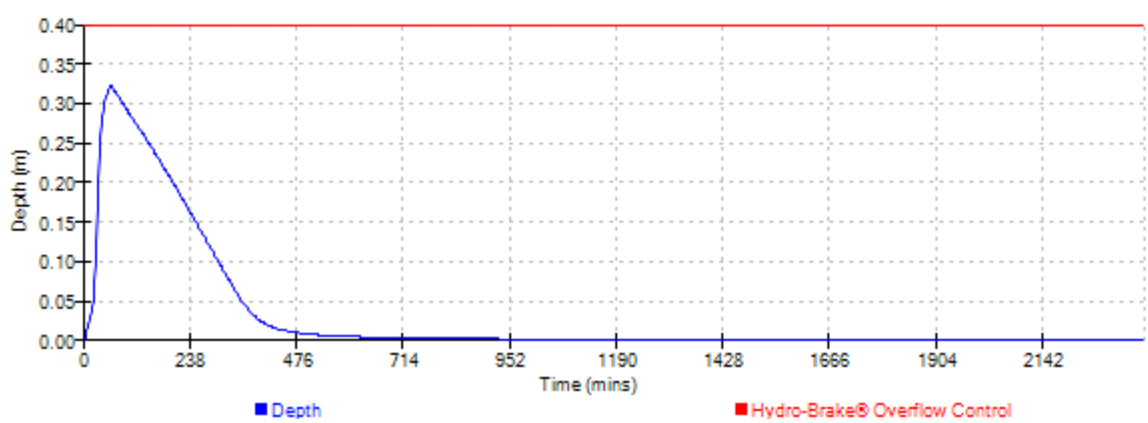




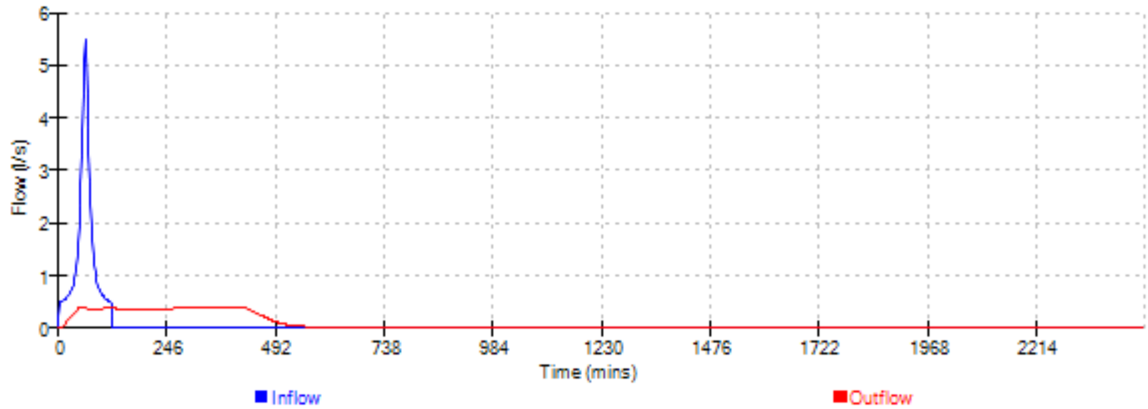
Event: 60 min Summer

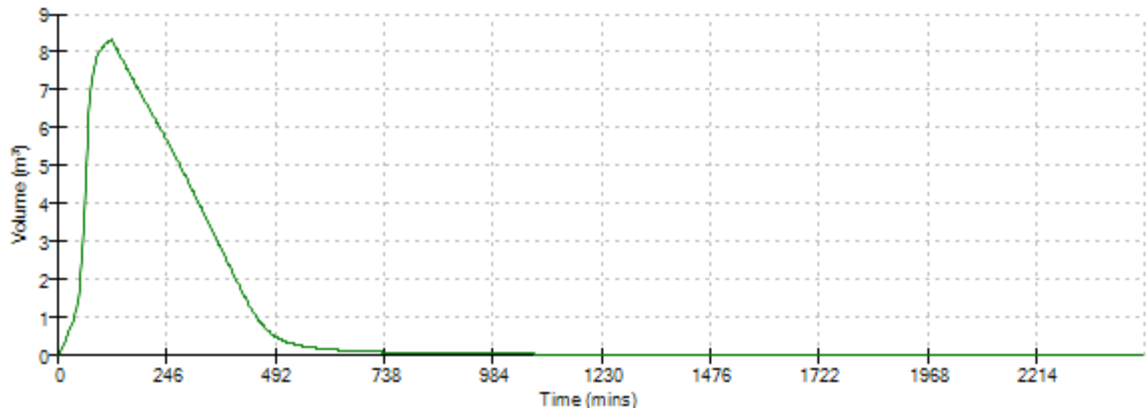


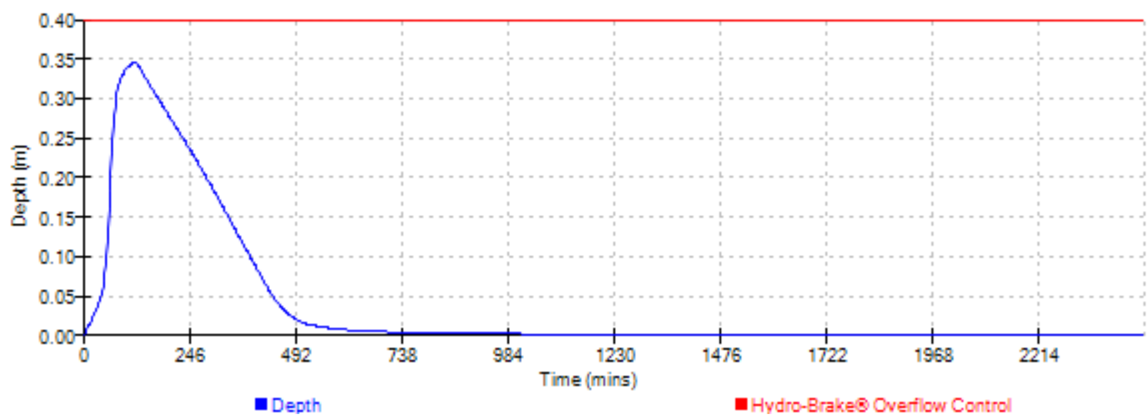




Event: 120 min Summer

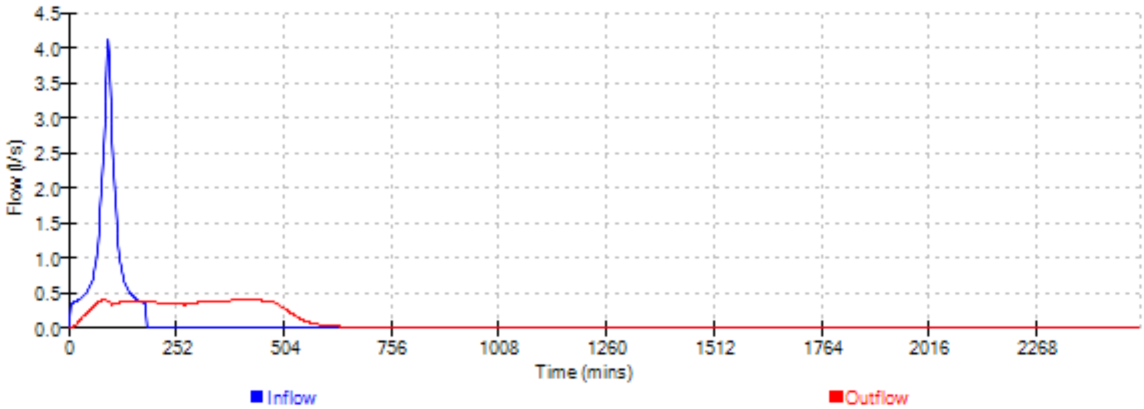


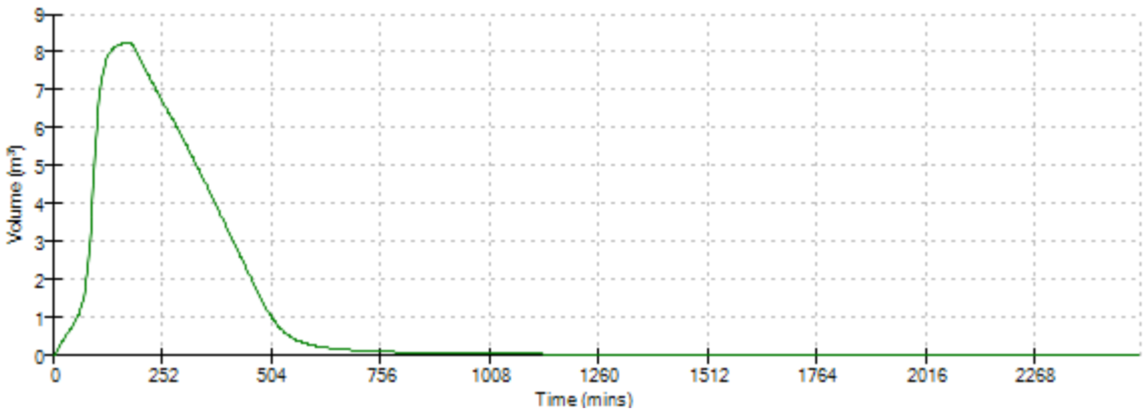


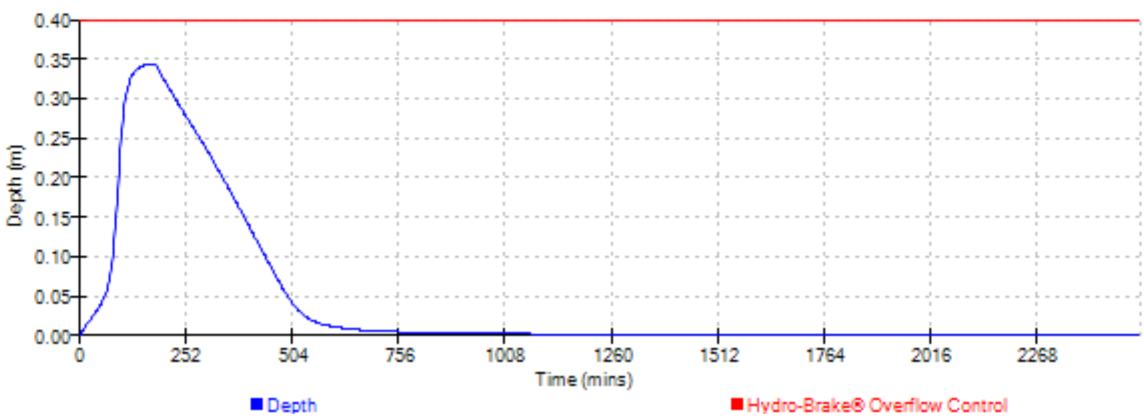


Easy Flood Risk		Page 10
55 Shepherds Lane Dartford DA1 2NL		
Date 14/02/2025 08:23 File Blackhorseyard.SRCX	Designed by sheph Checked by	
Innovyze	Source Control 2020.1	

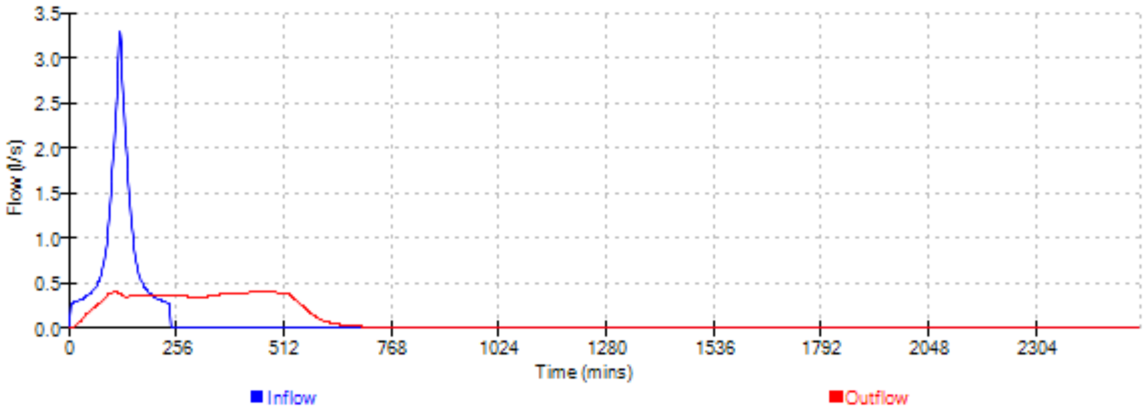
Event: 180 min Summer

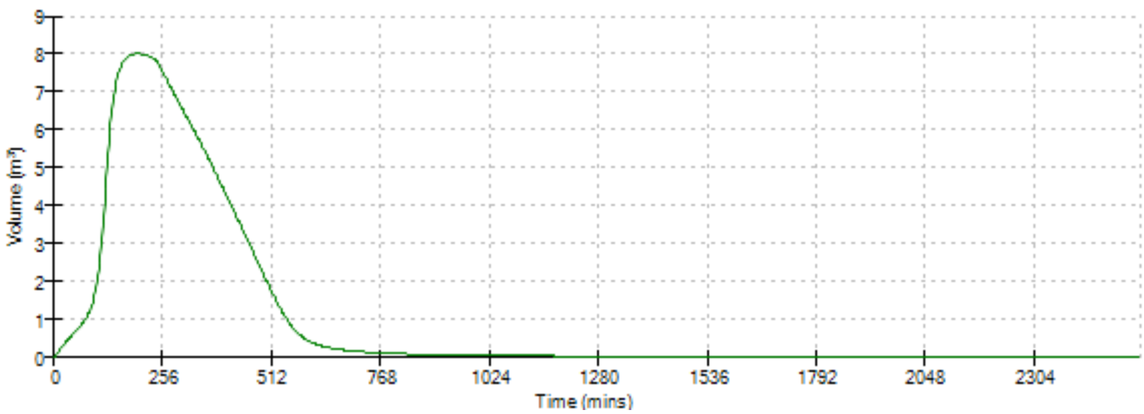


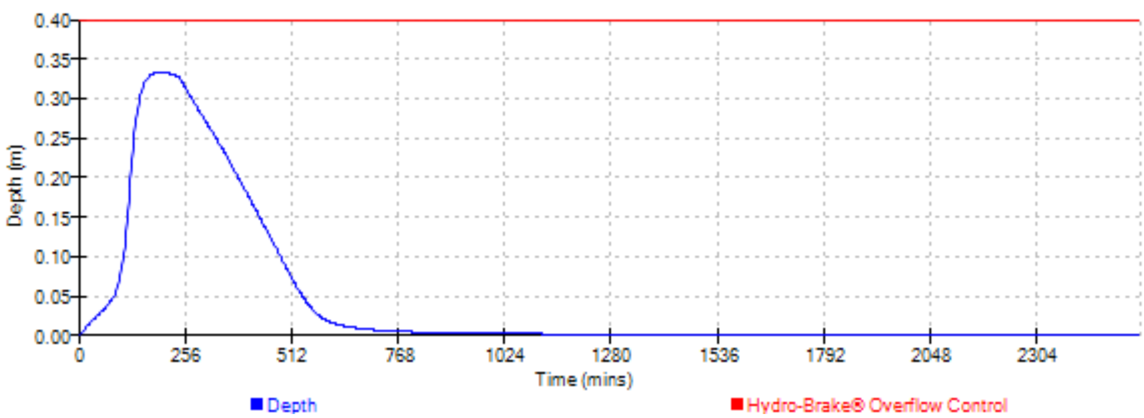




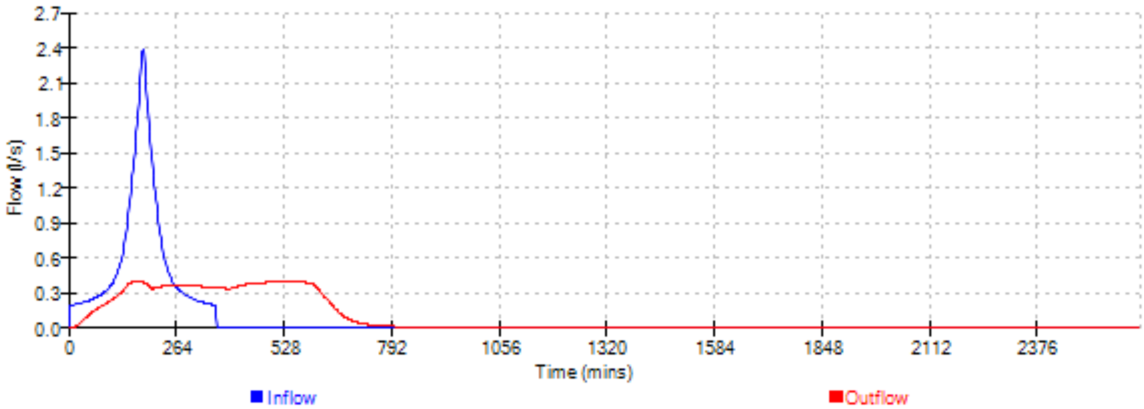
Event: 240 min Summer

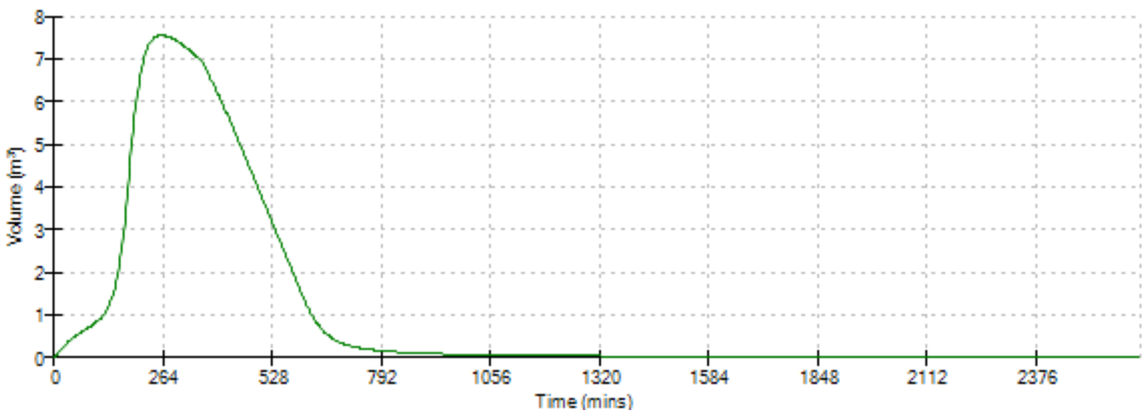


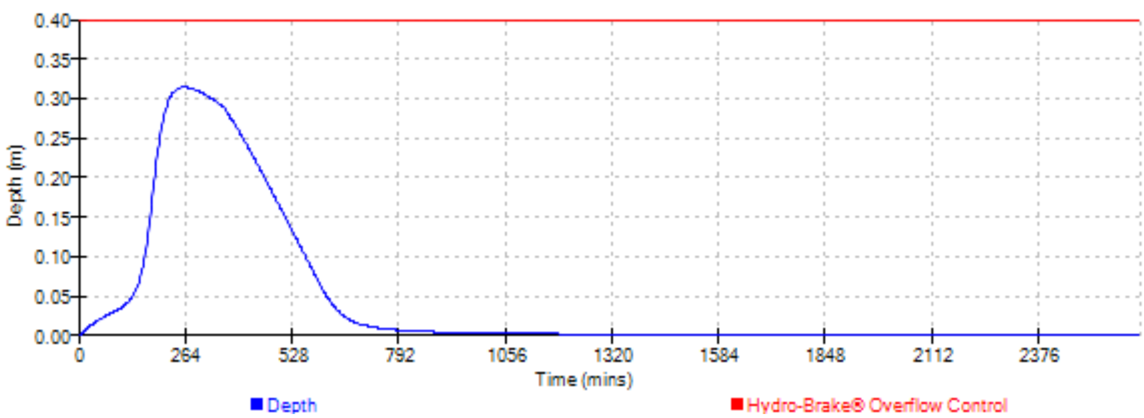




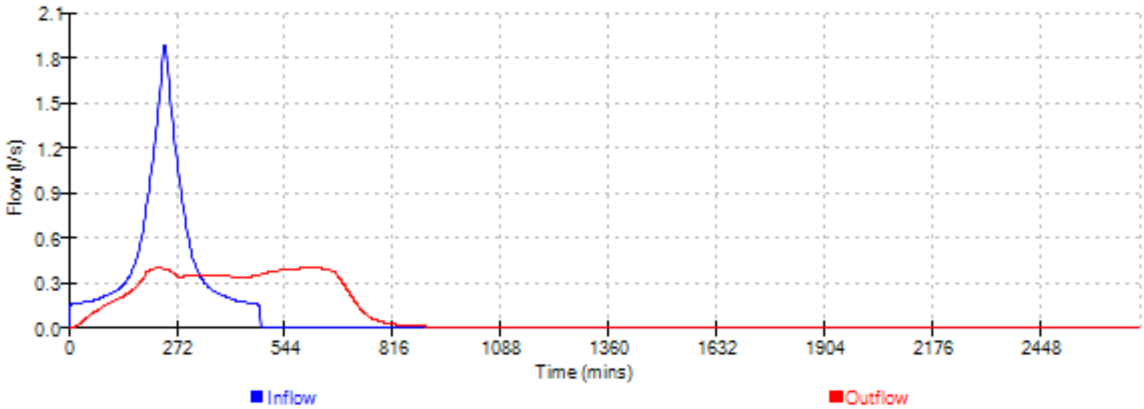
Event: 360 min Summer

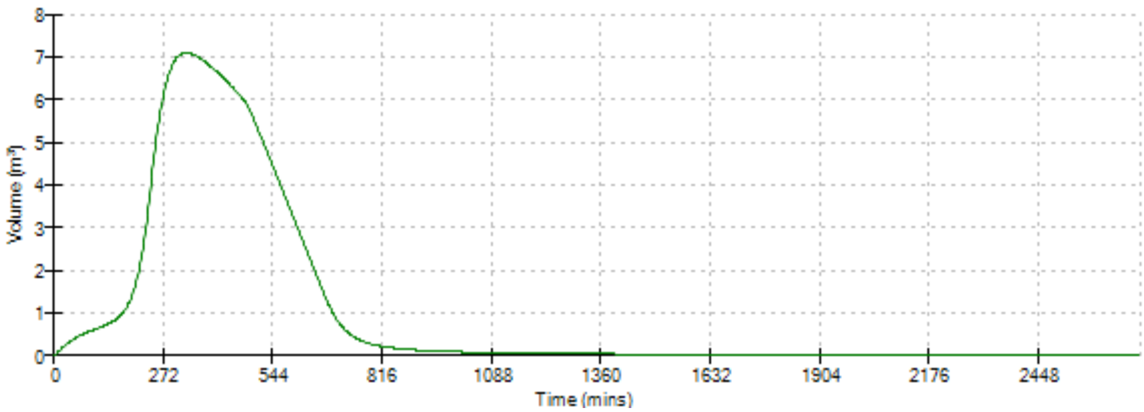


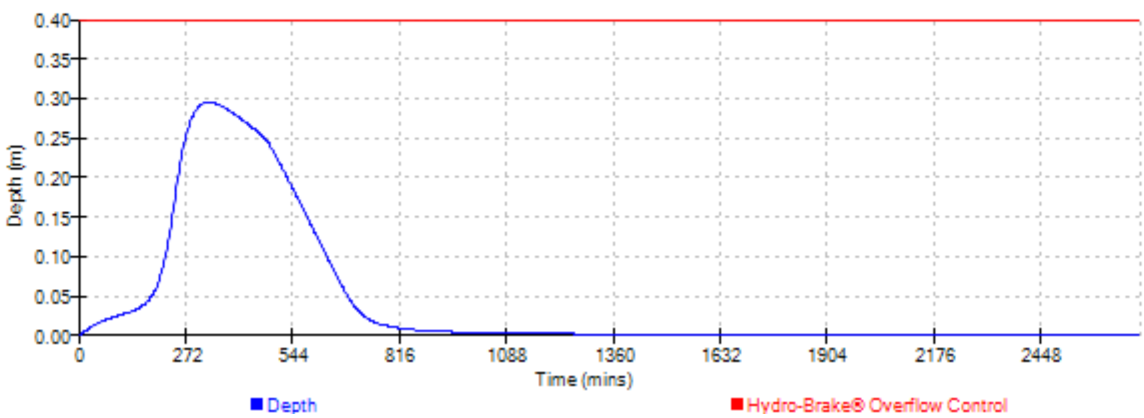




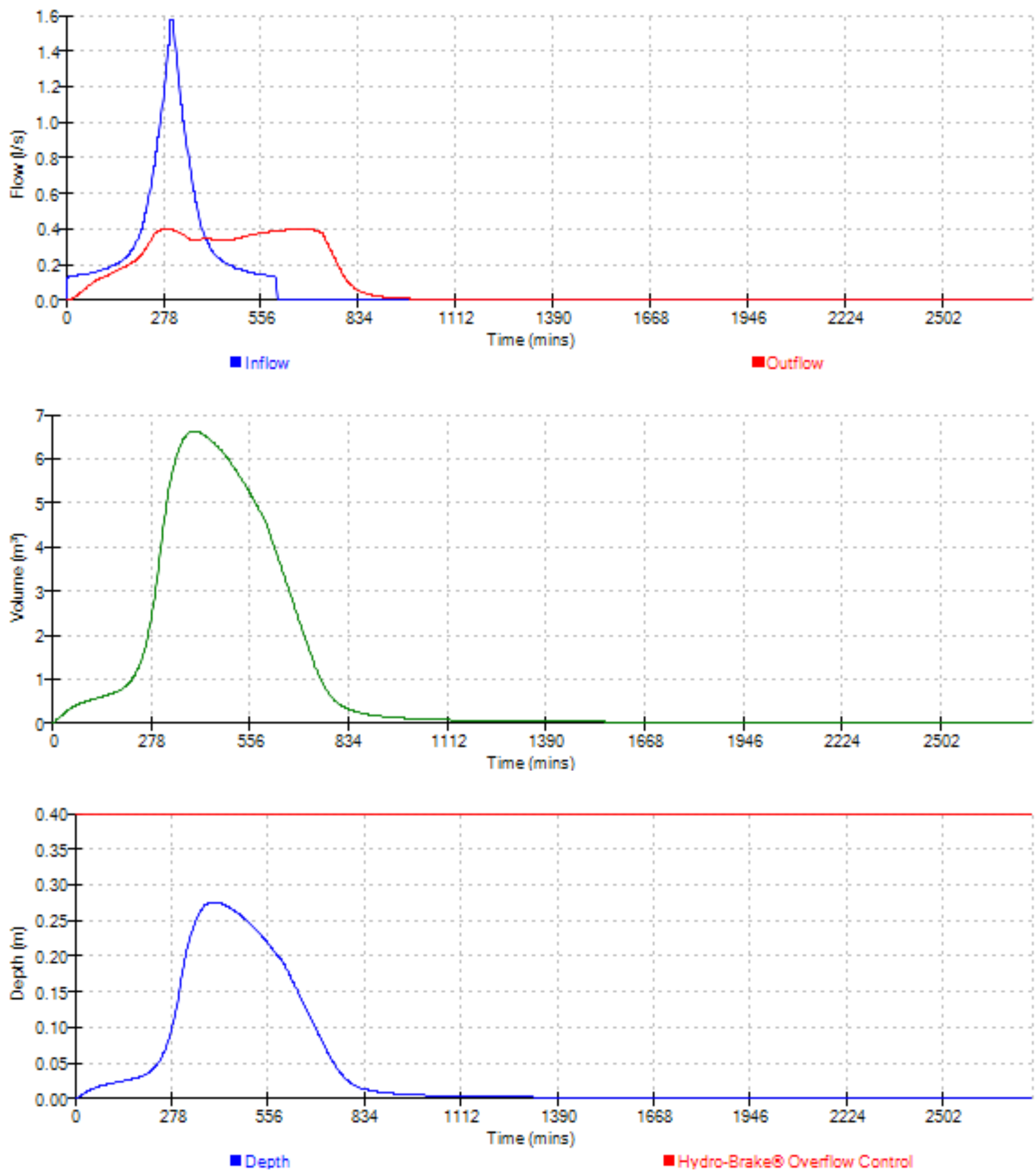
Event: 480 min Summer



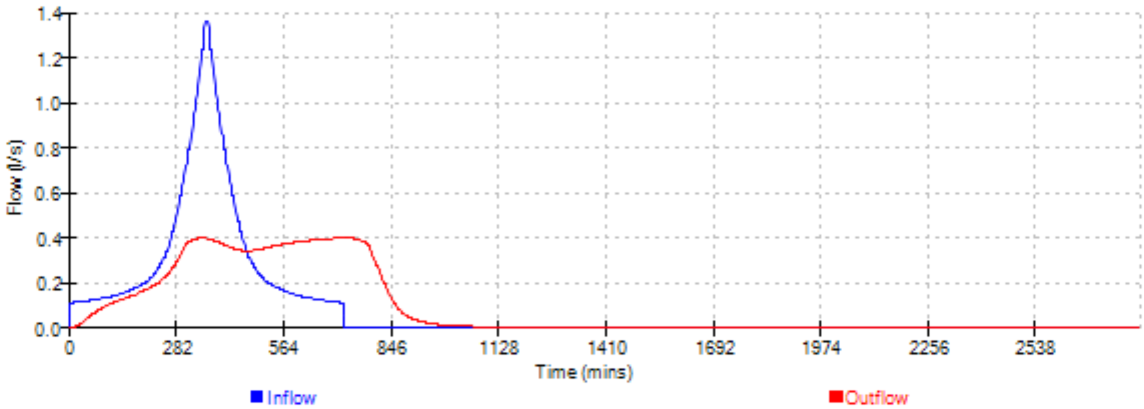


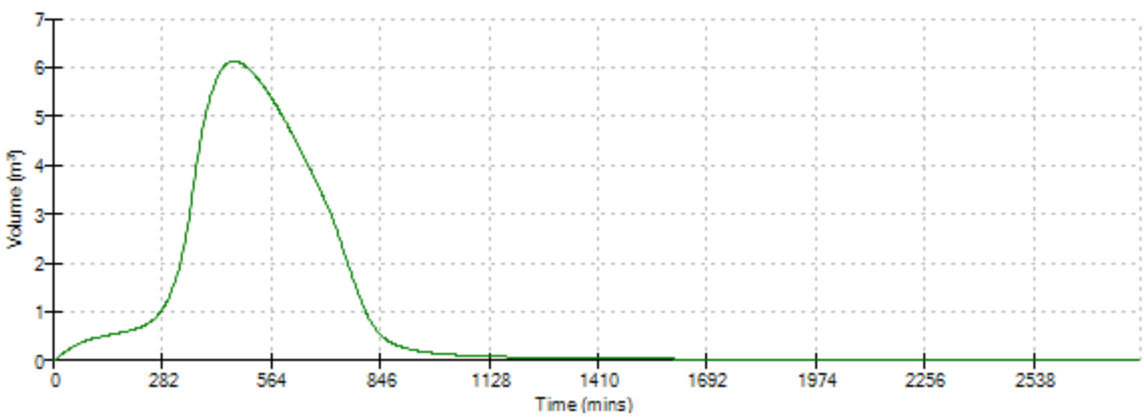


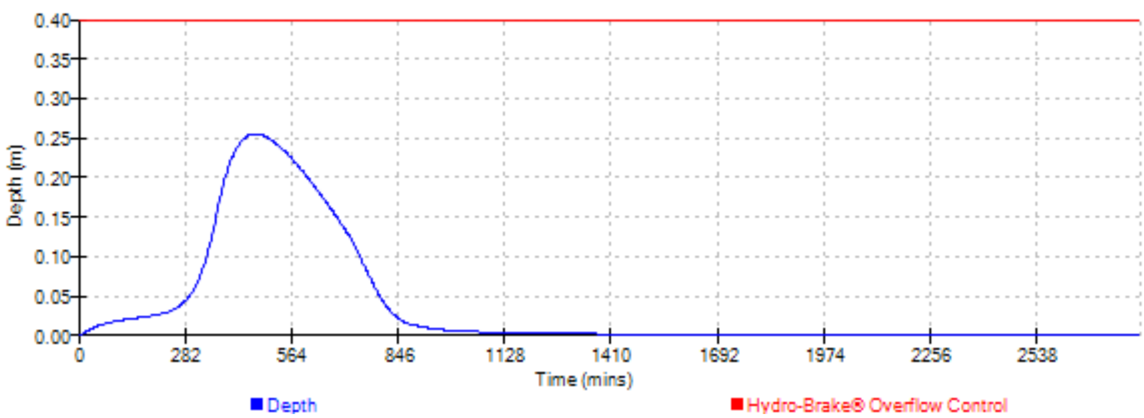
Event: 600 min Summer



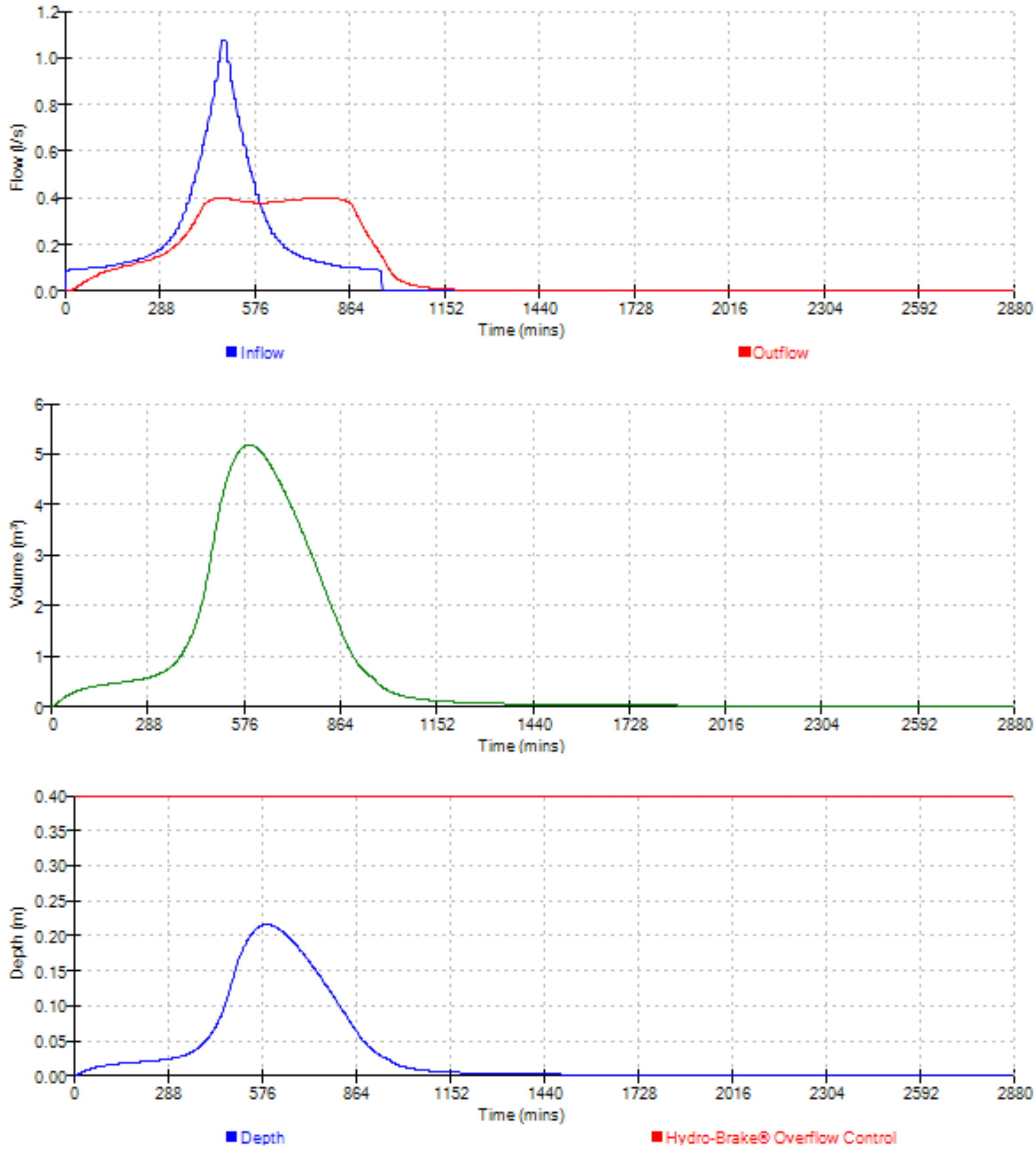
Event: 720 min Summer



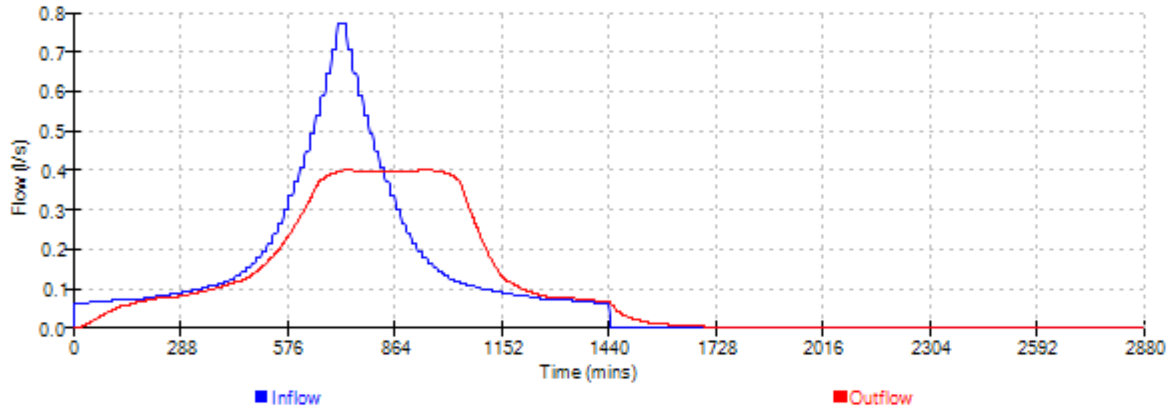


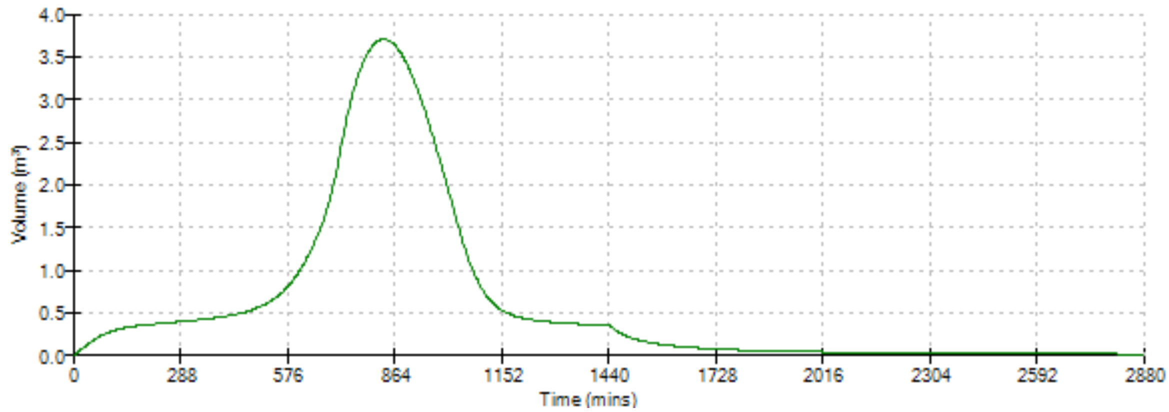


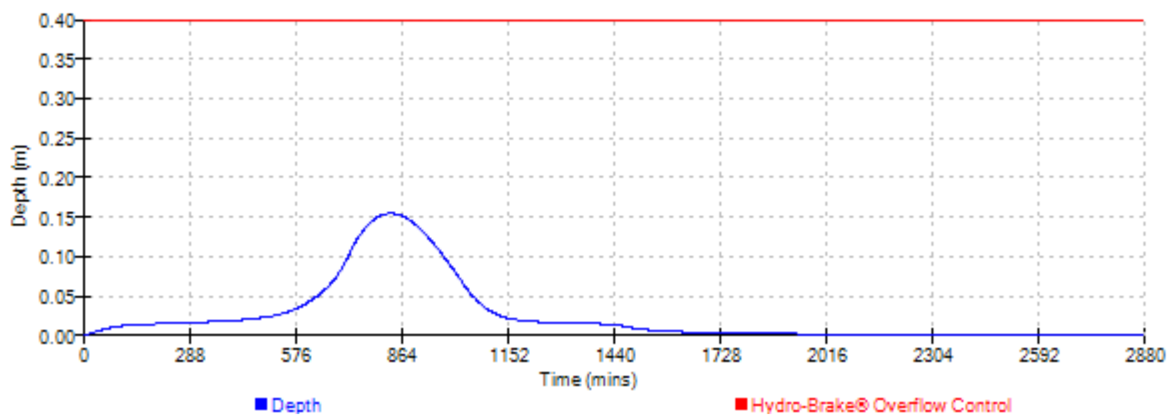
Event: 960 min Summer



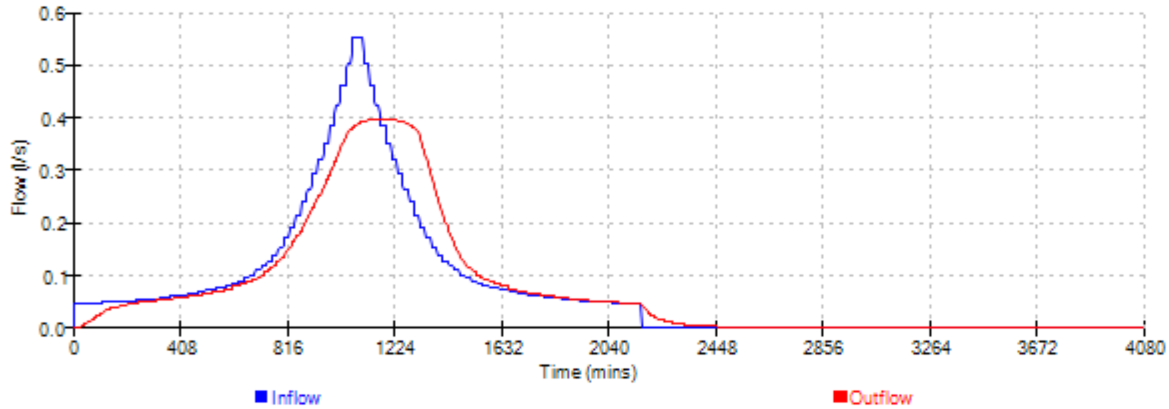
Event: 1440 min Summer

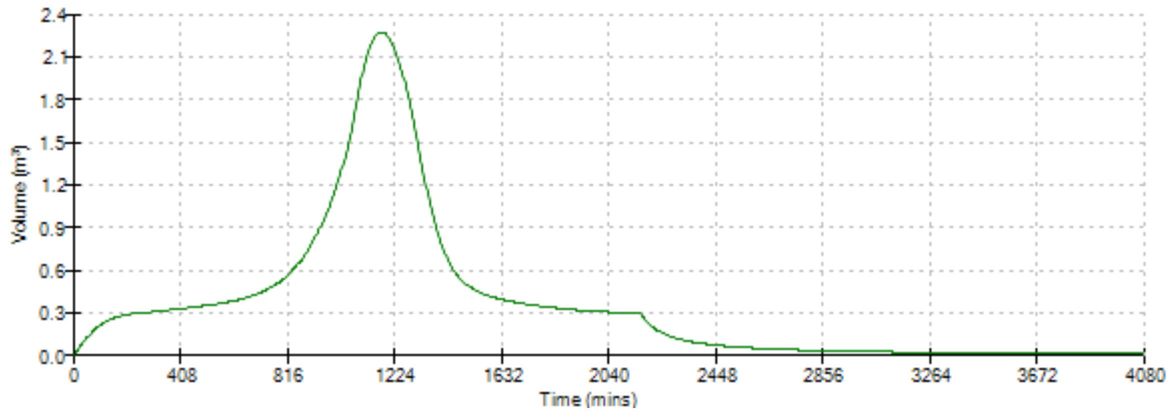


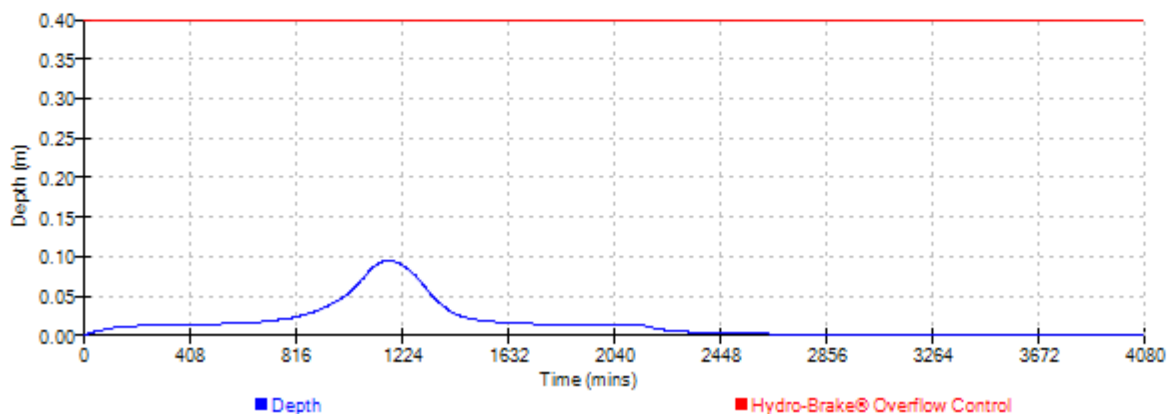




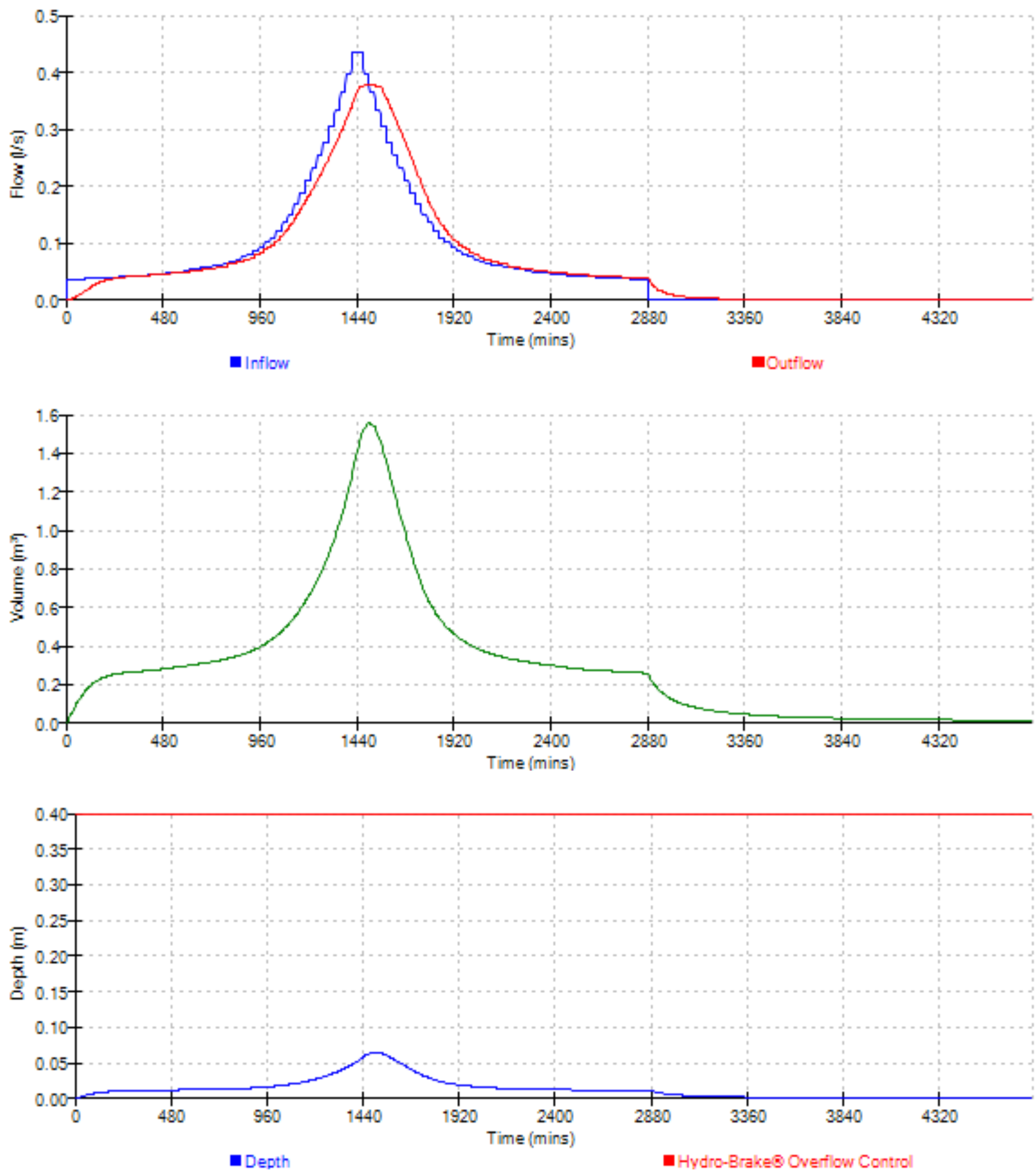
Event: 2160 min Summer







Event: 2880 min Summer



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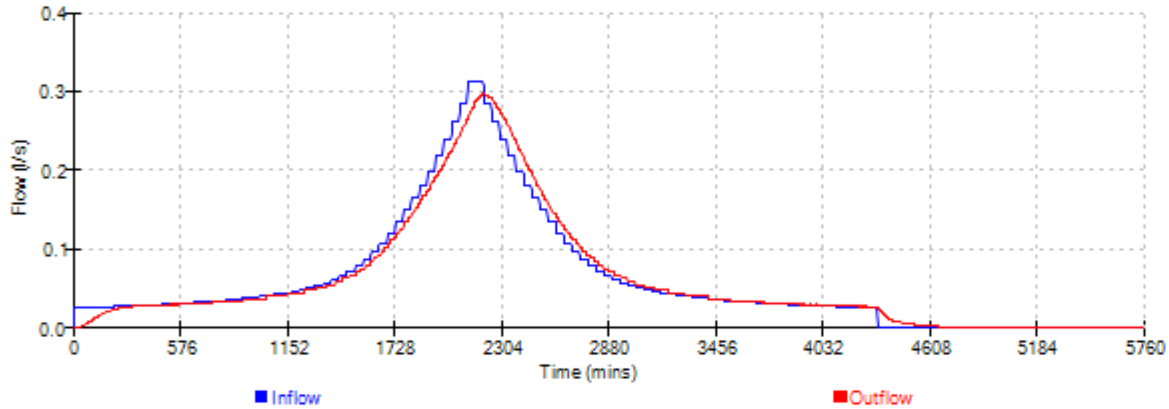

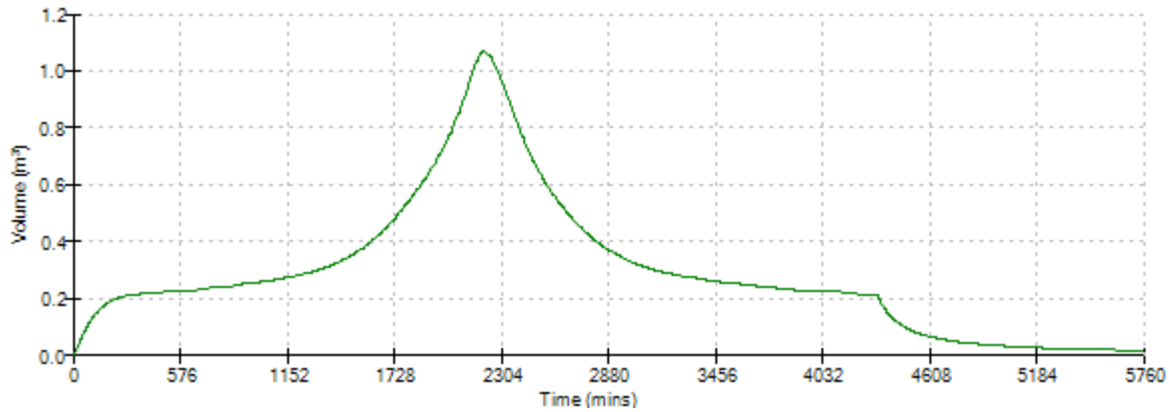

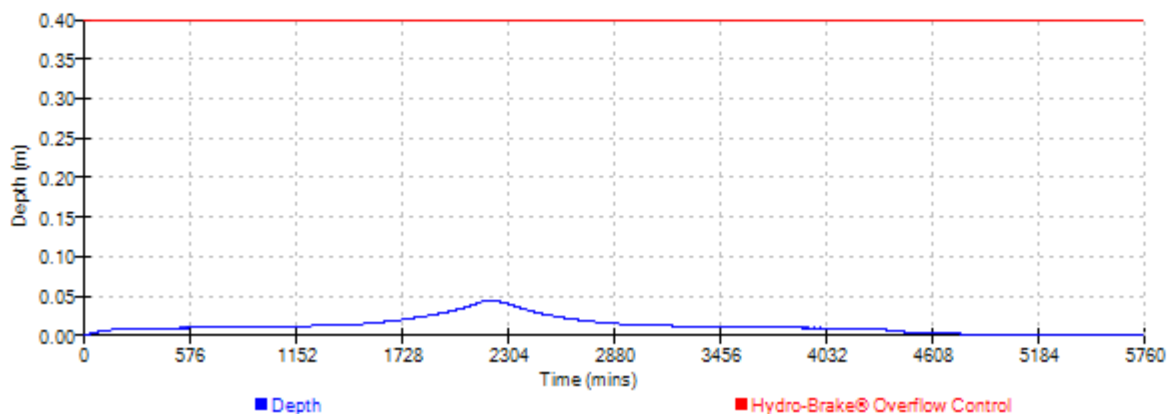

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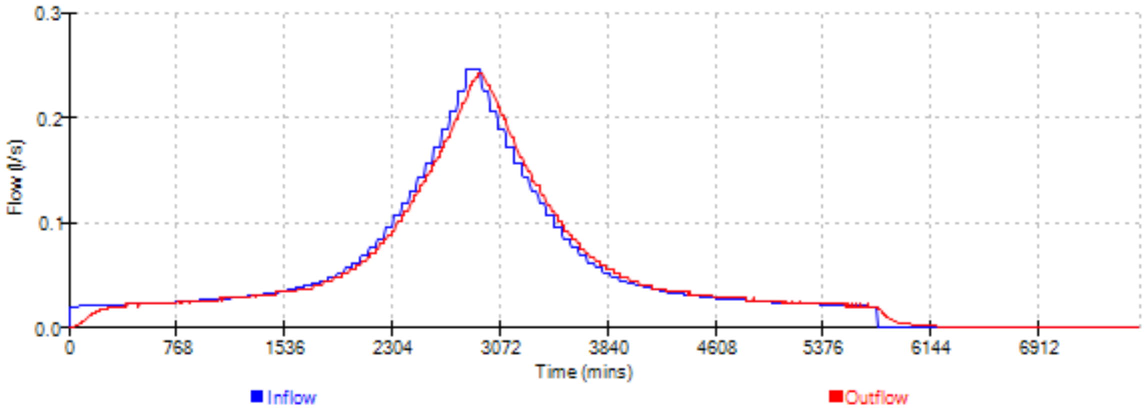

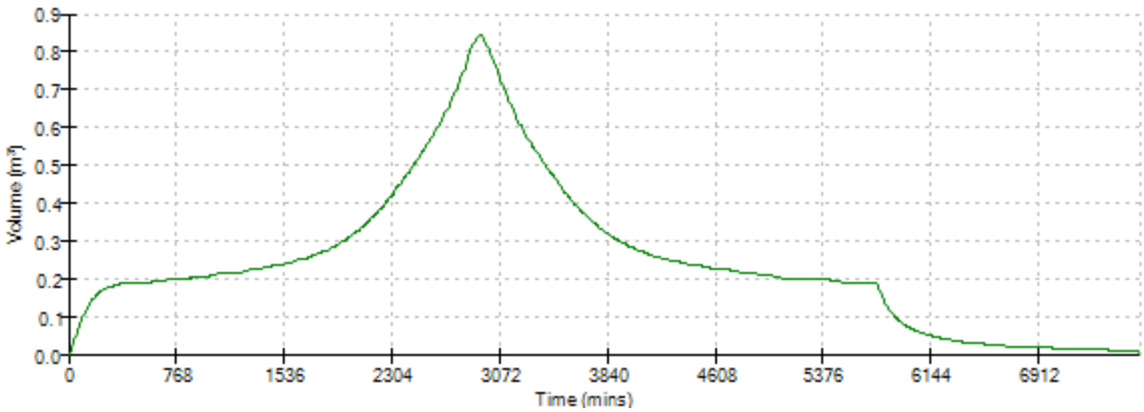

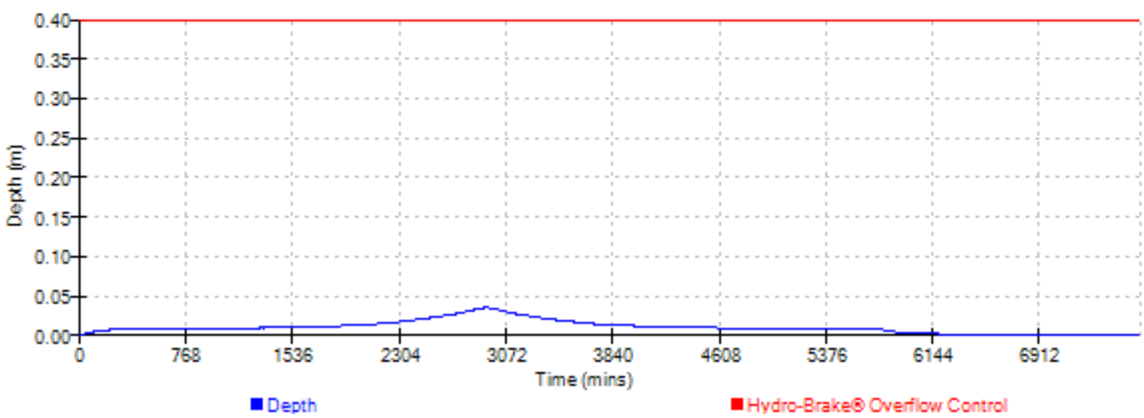

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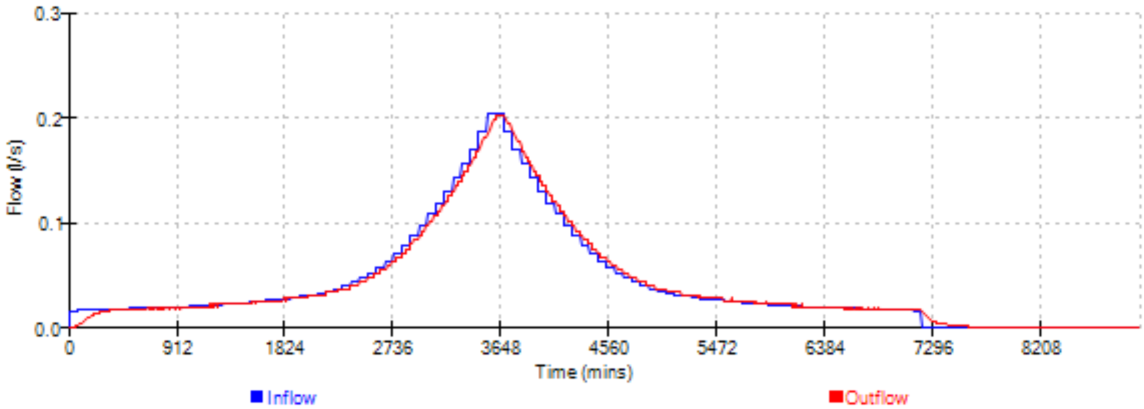
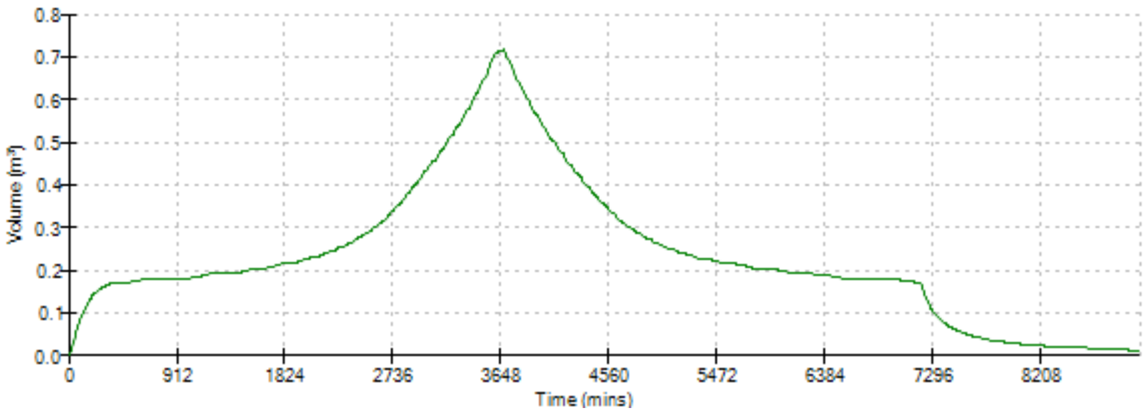
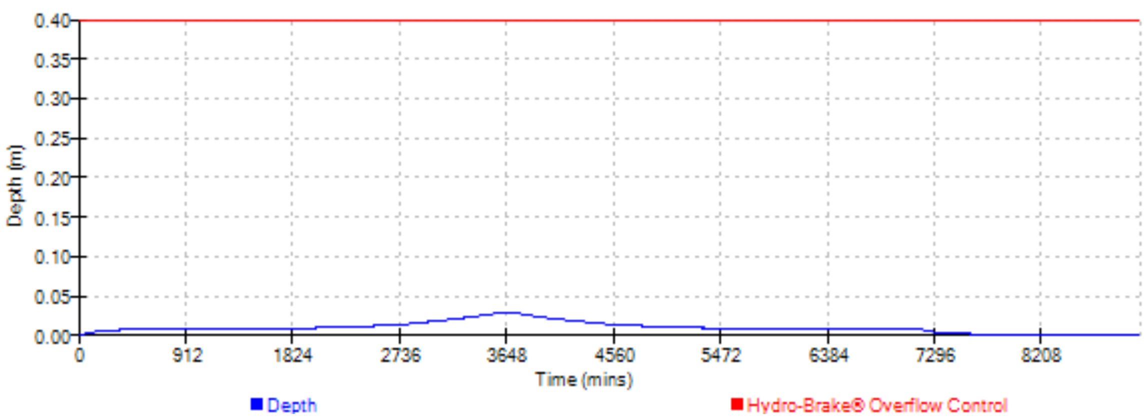
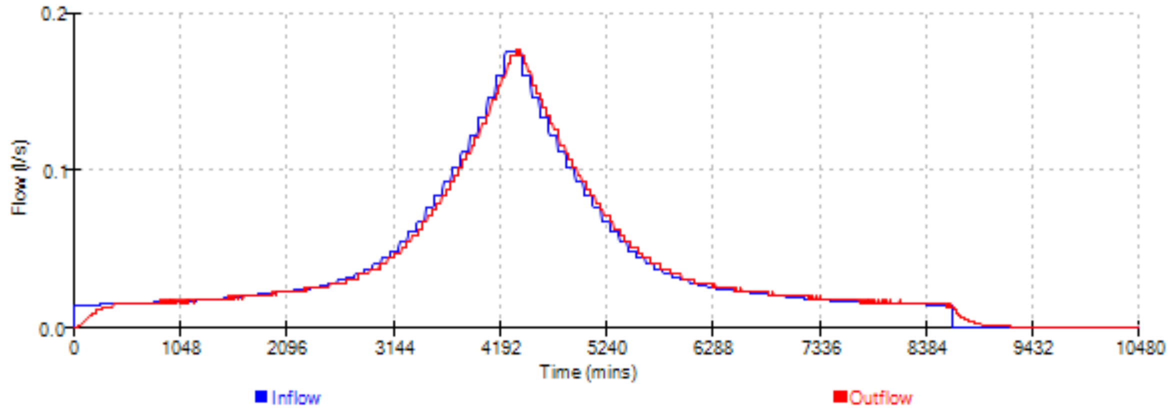
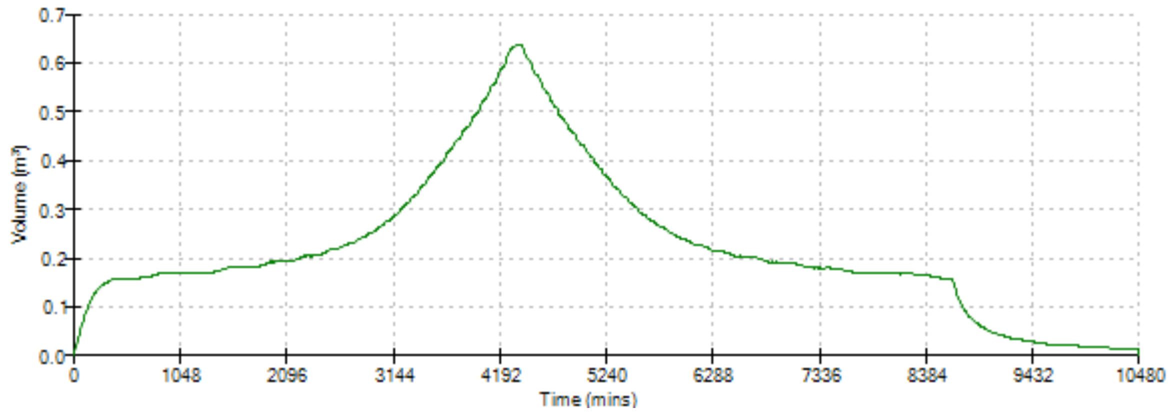


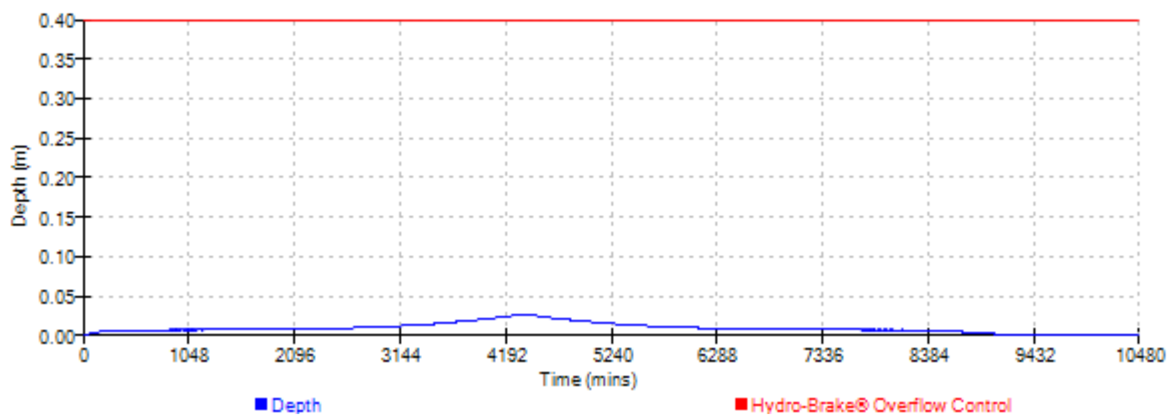




<u>Event: 8640 min Summer</u>







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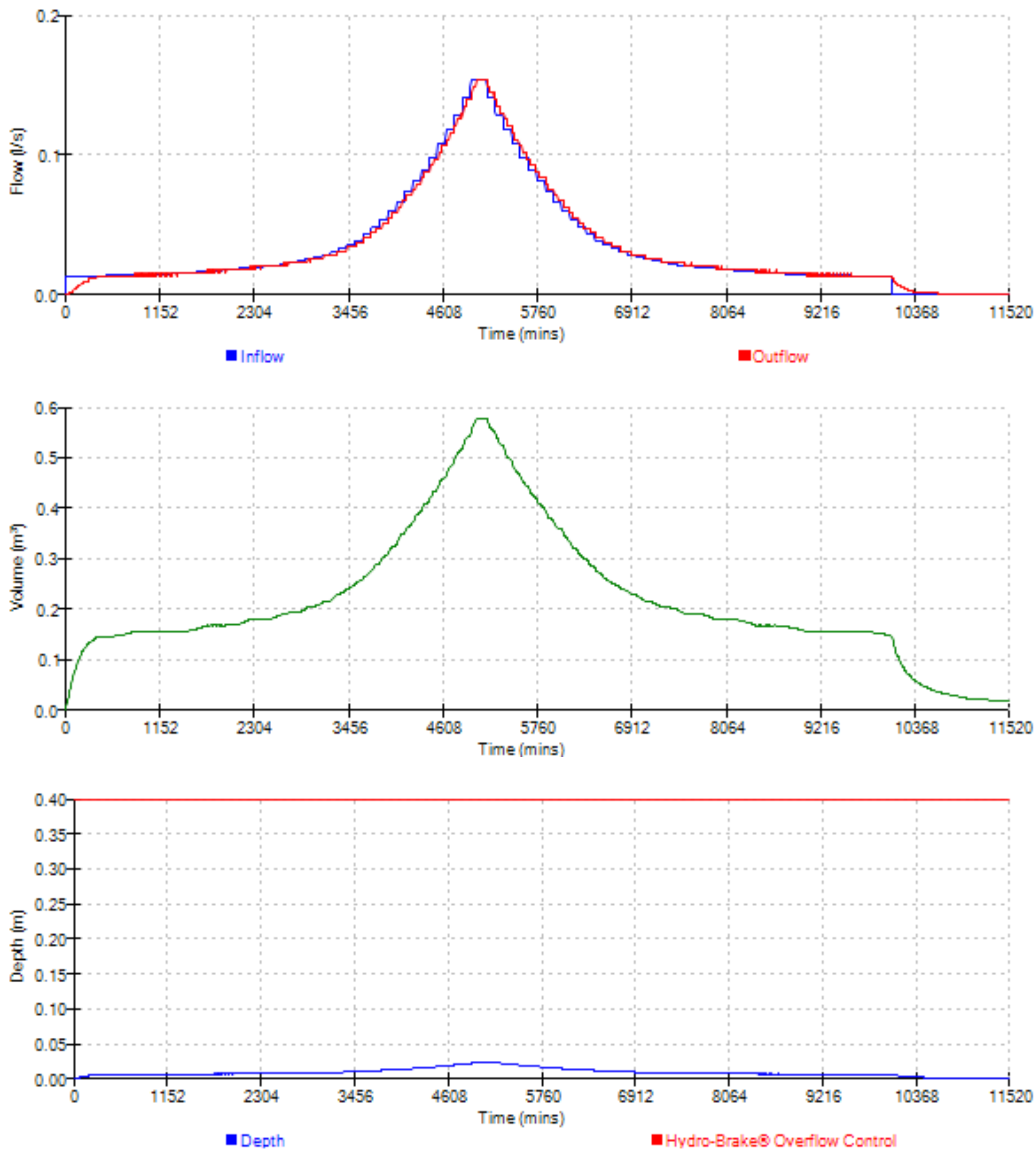
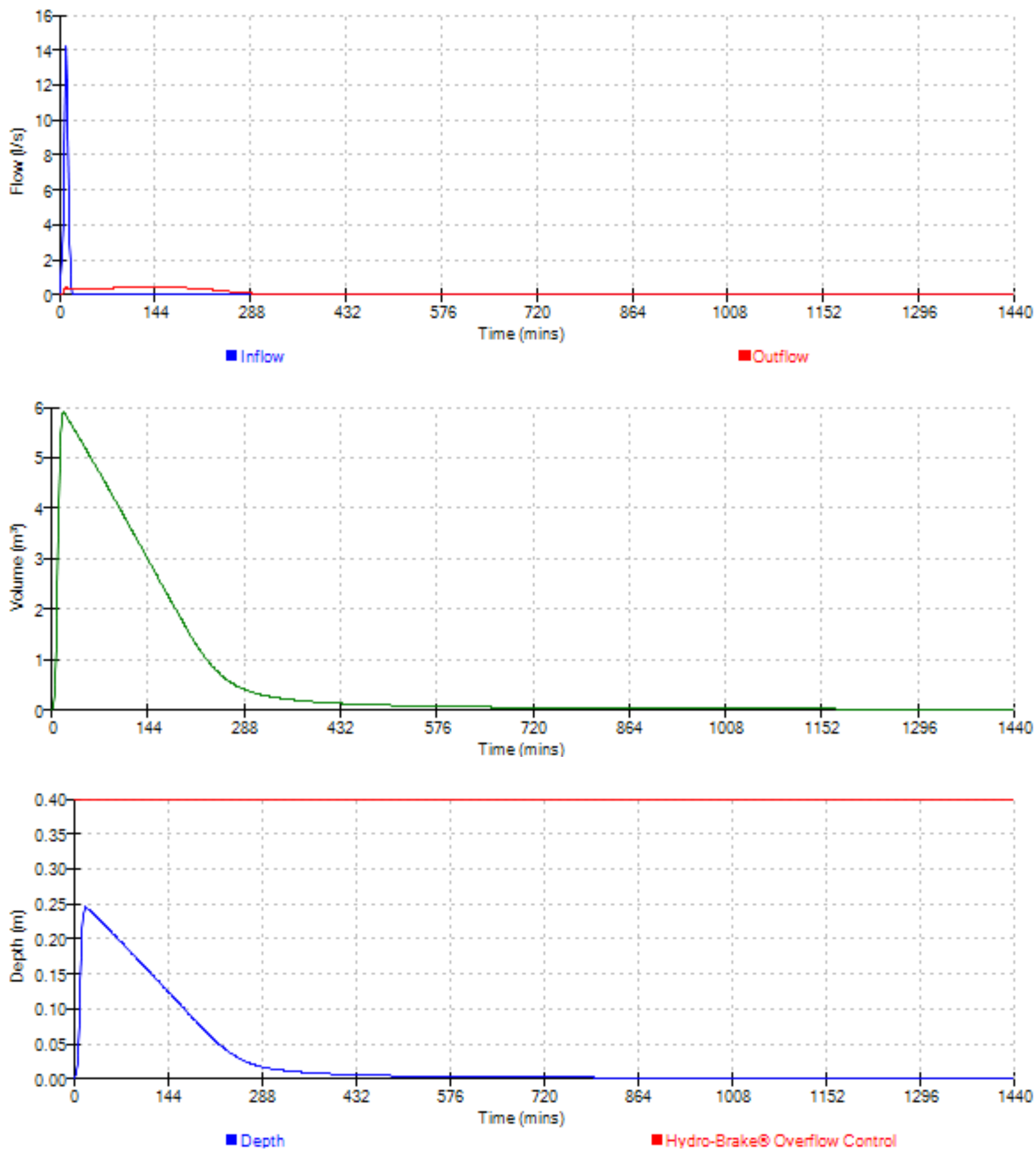


Event: 15 min Winter



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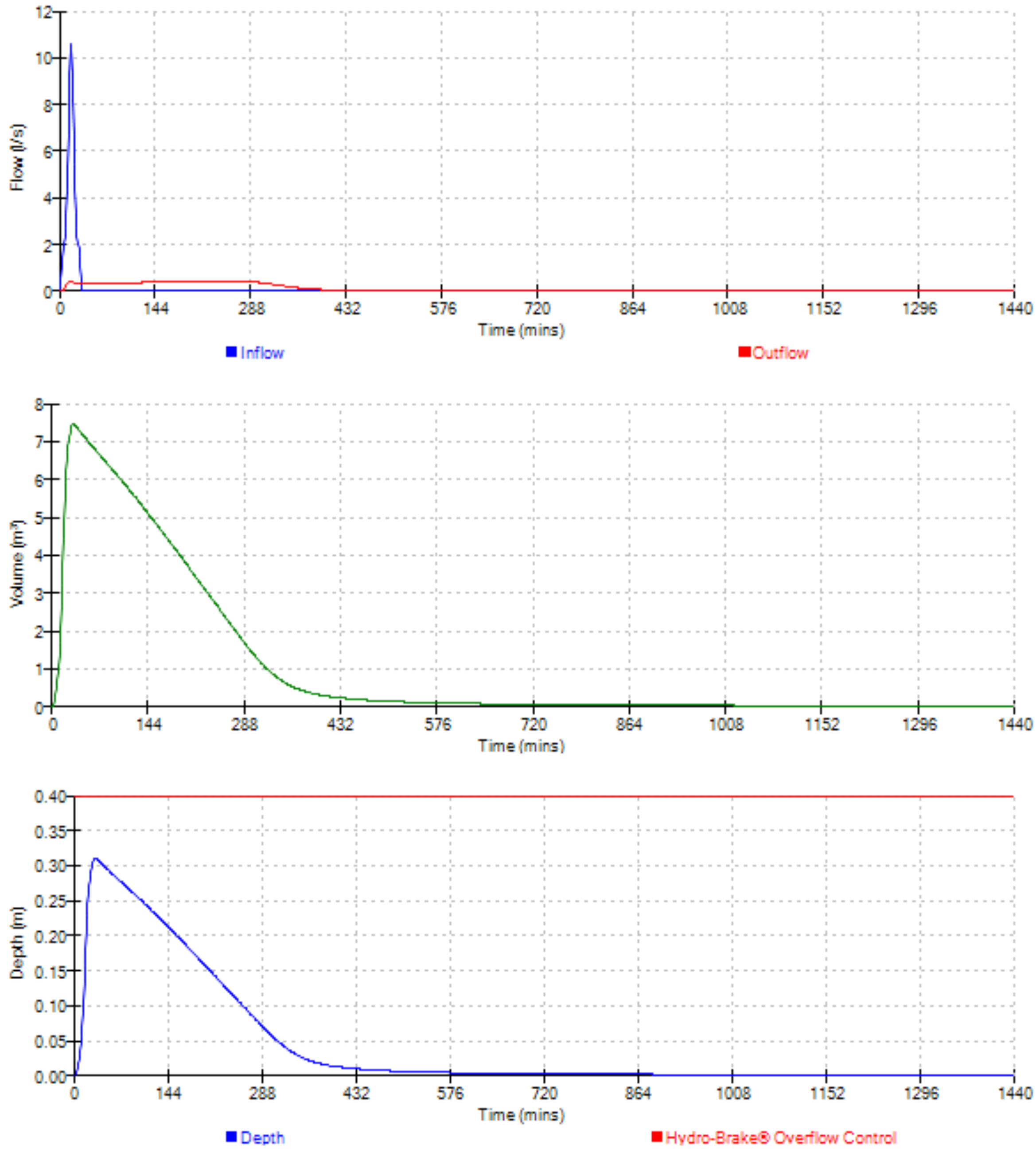
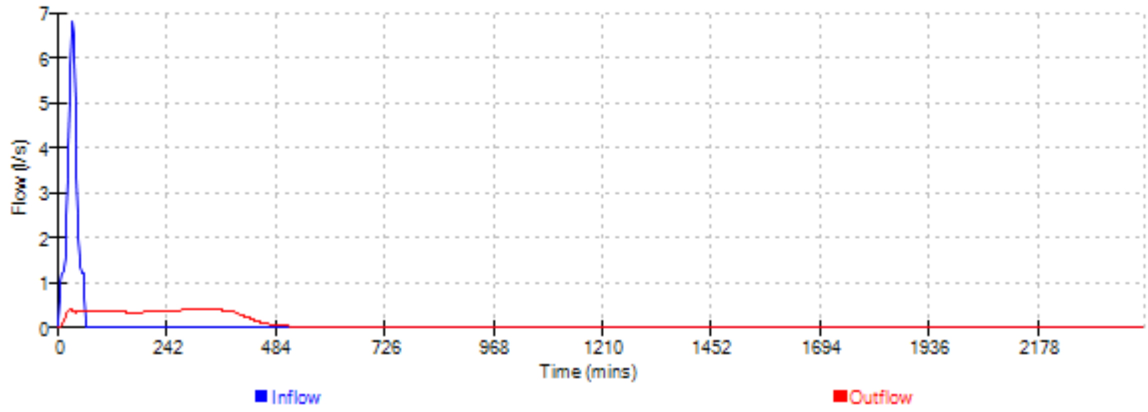
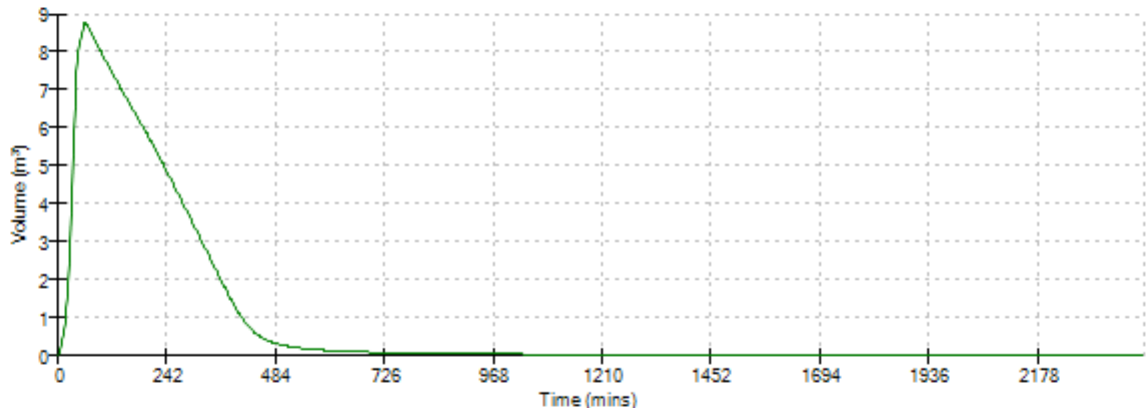
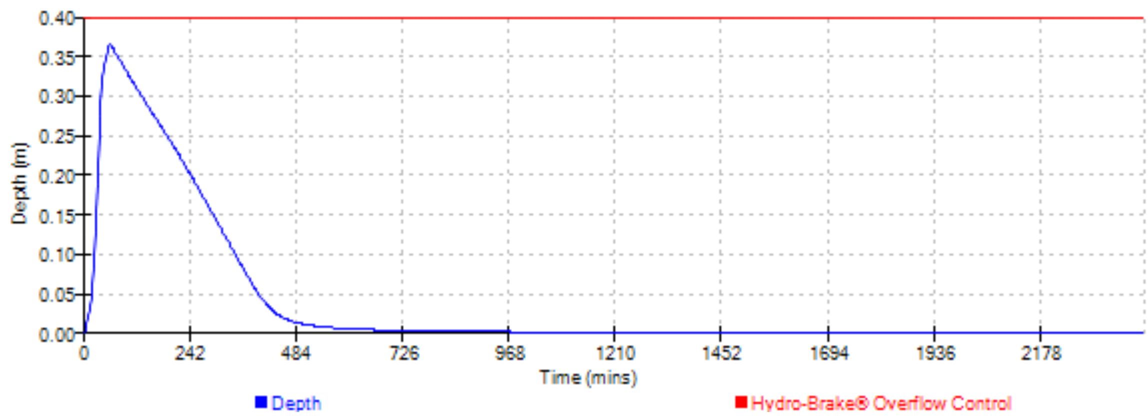


Event: 60 min Winter







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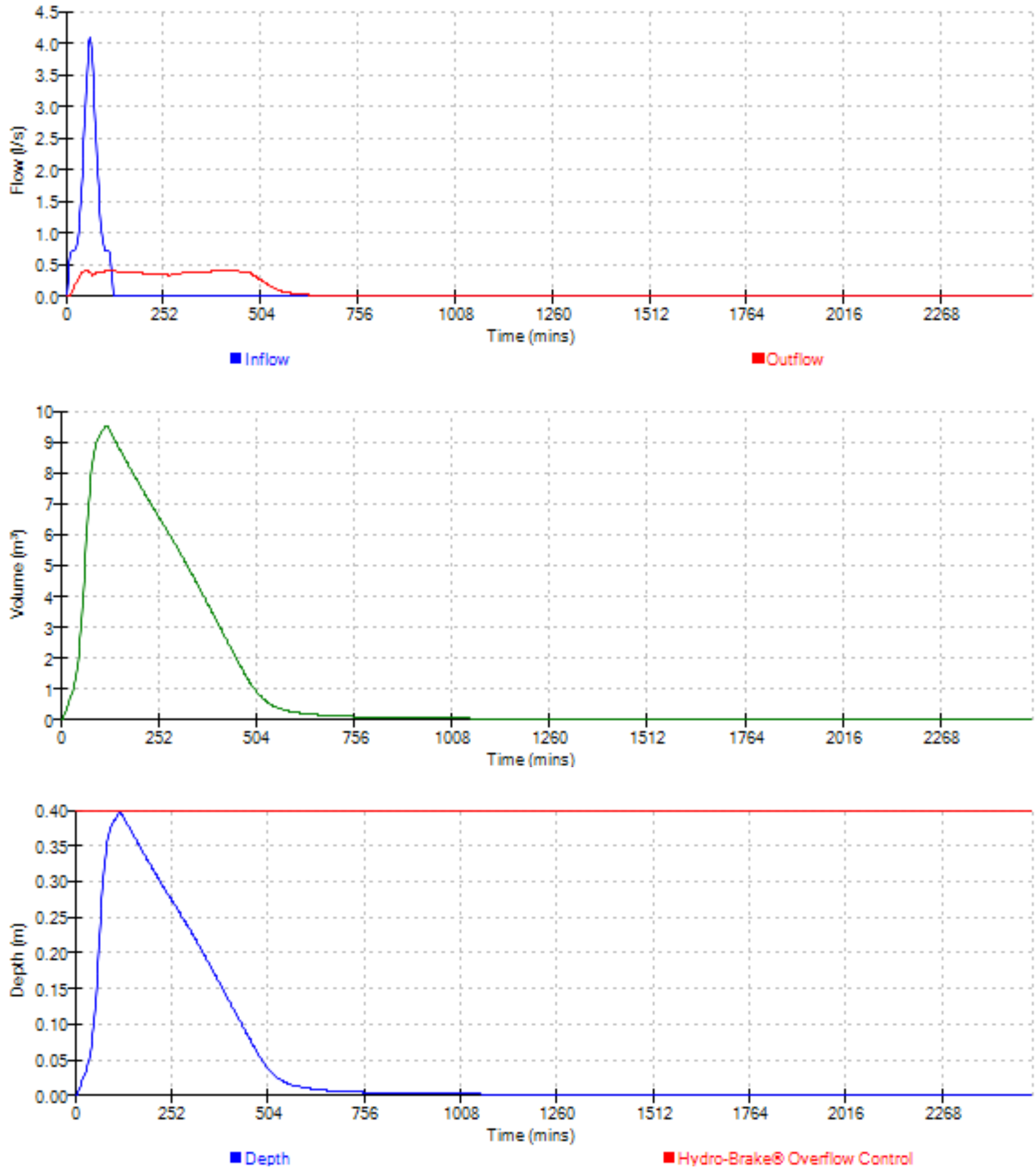
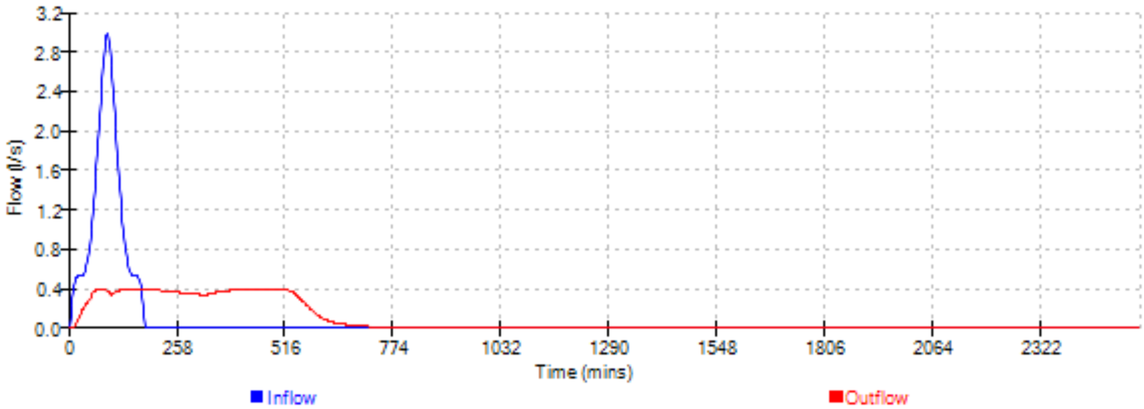
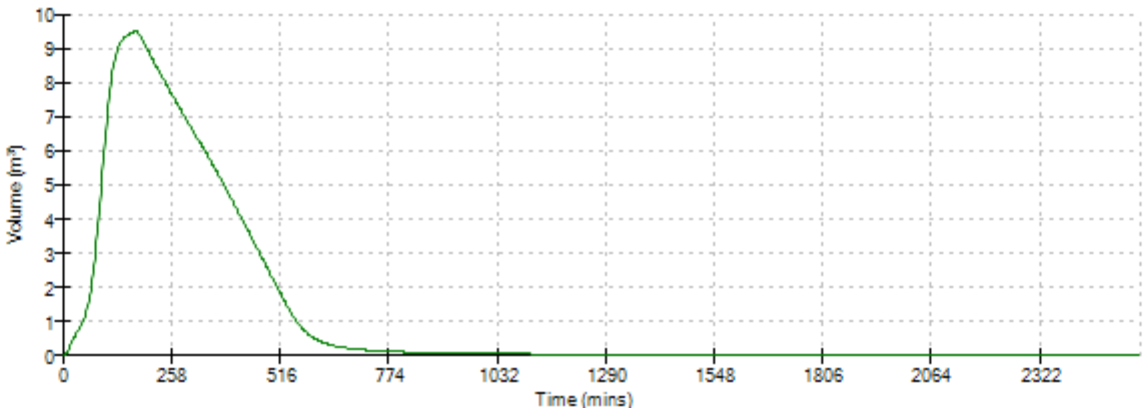
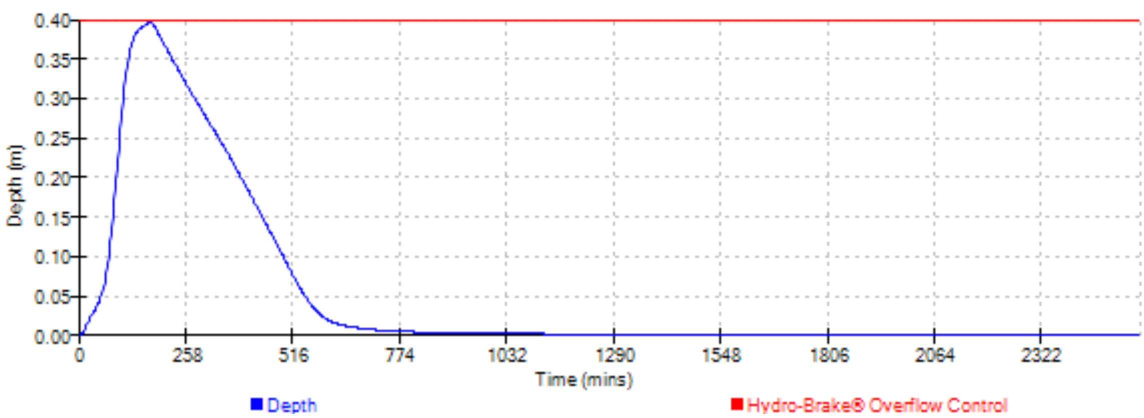


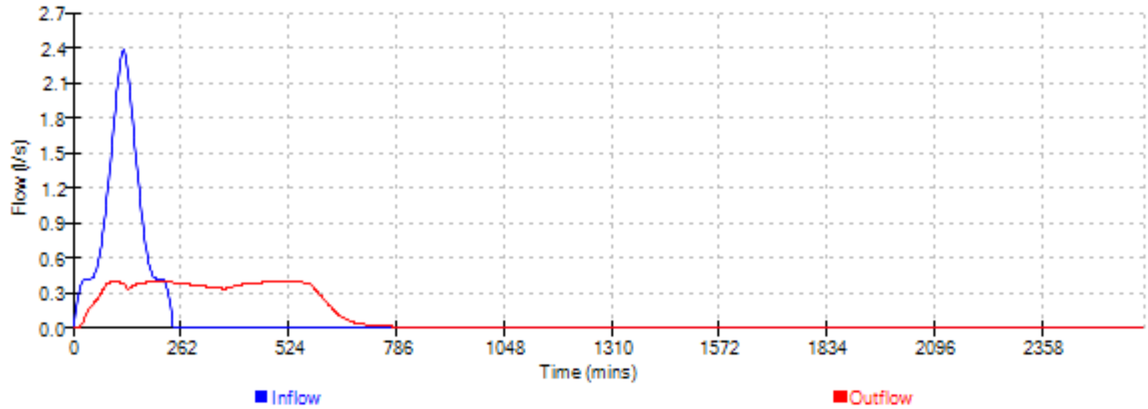
Event: 180 min Winter

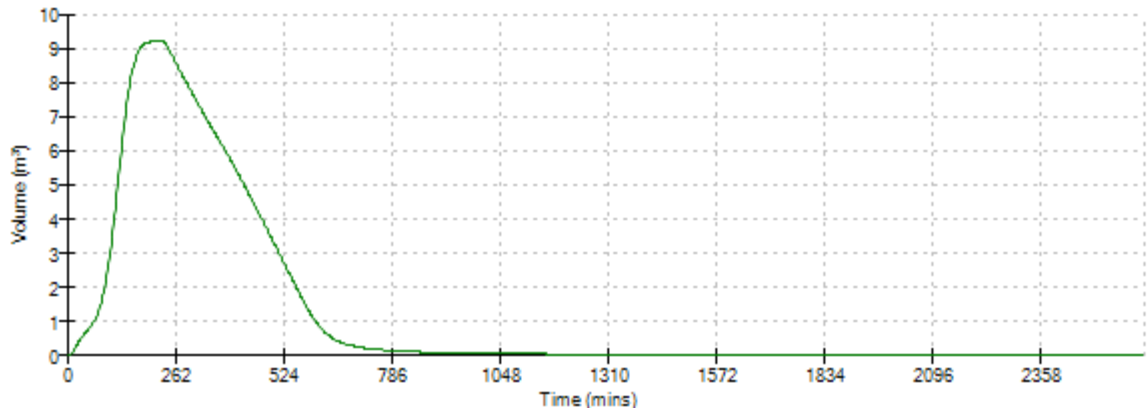


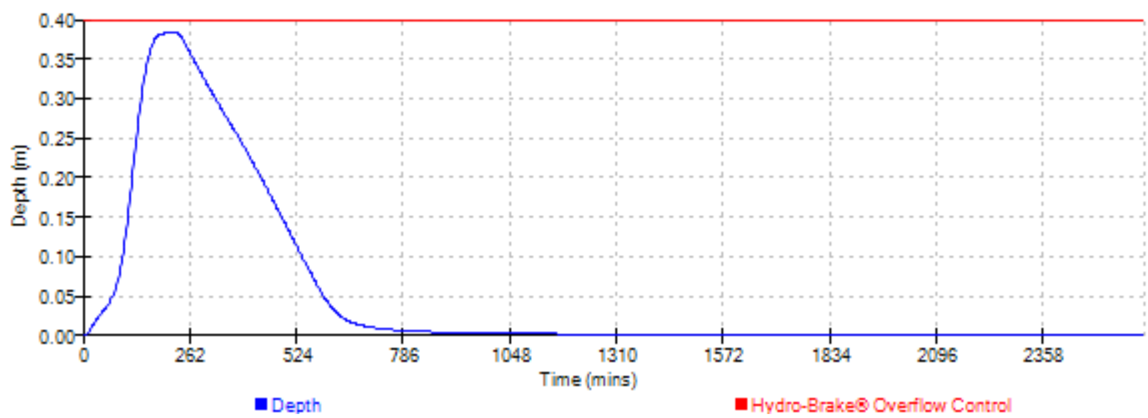




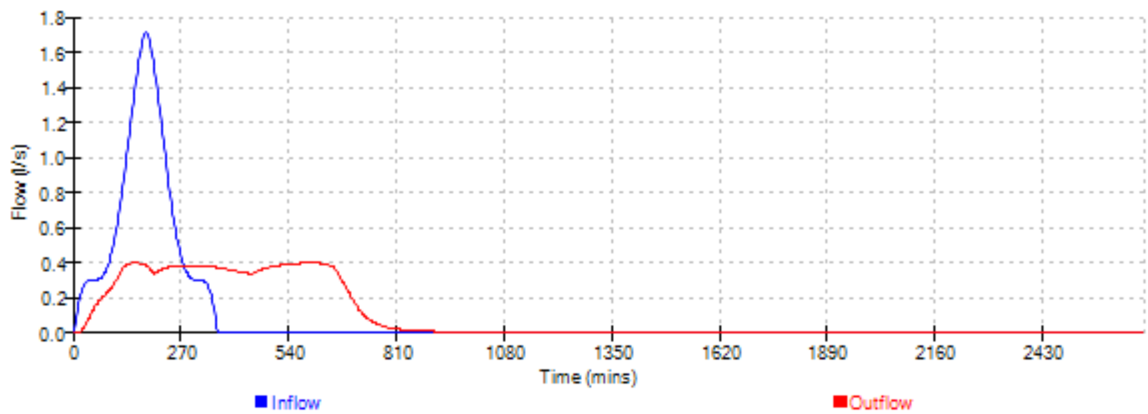
Event: 240 min Winter

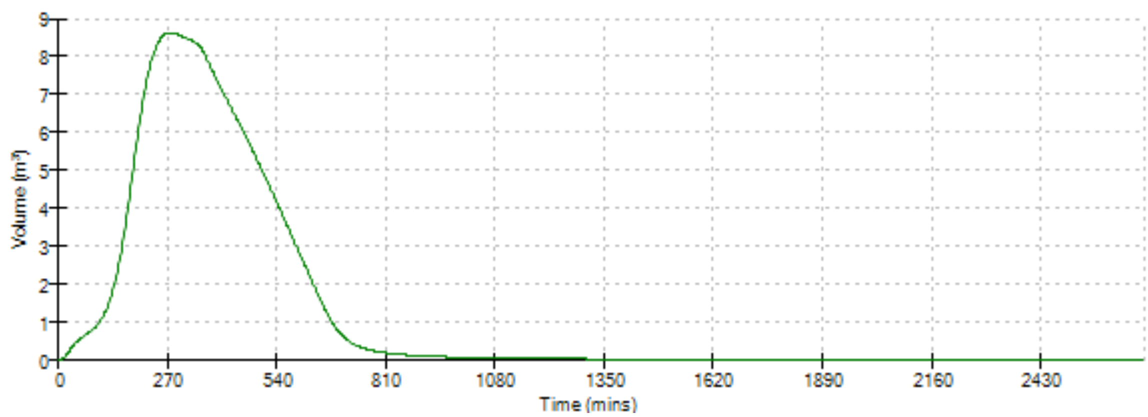


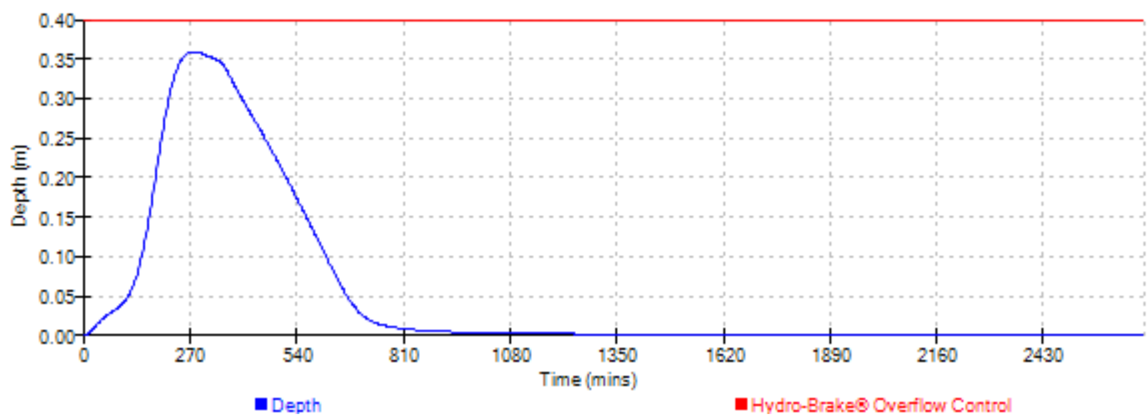




Event: 360 min Winter







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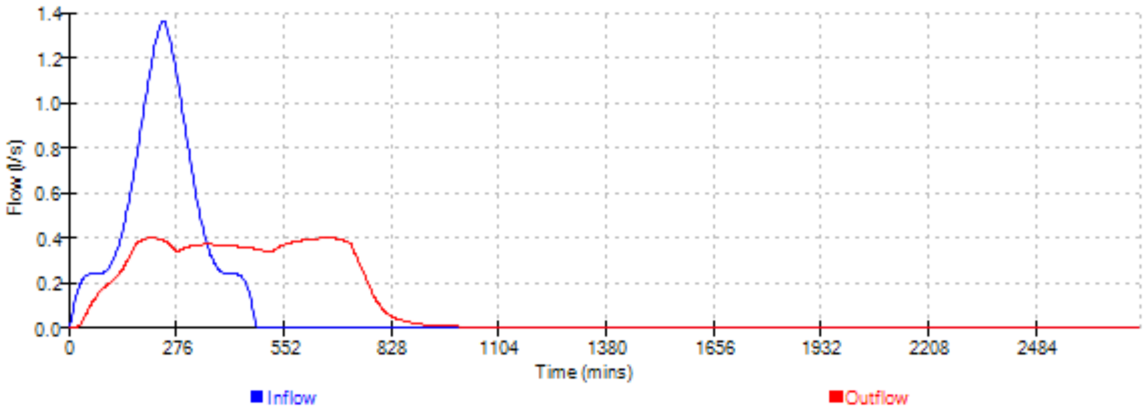
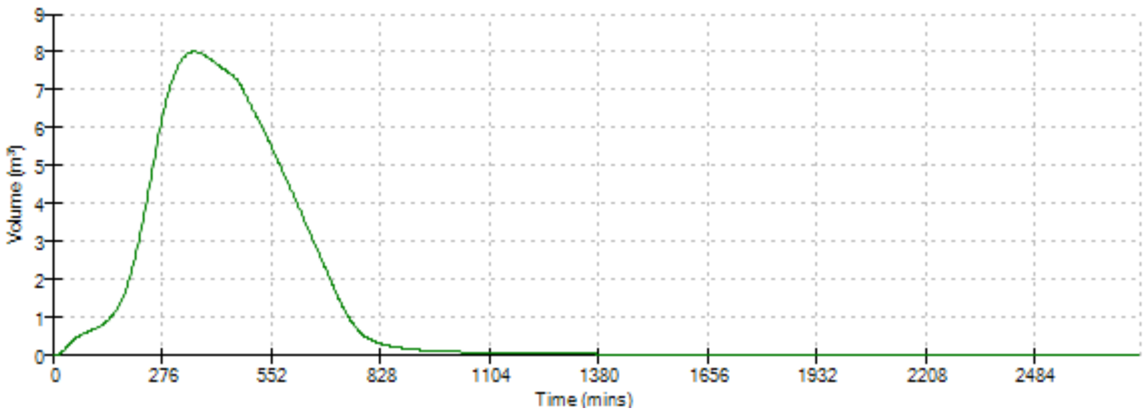
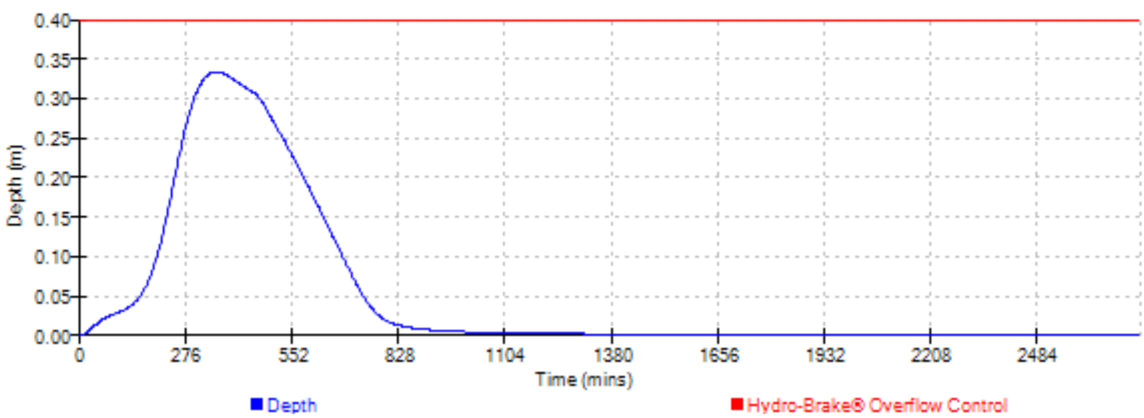
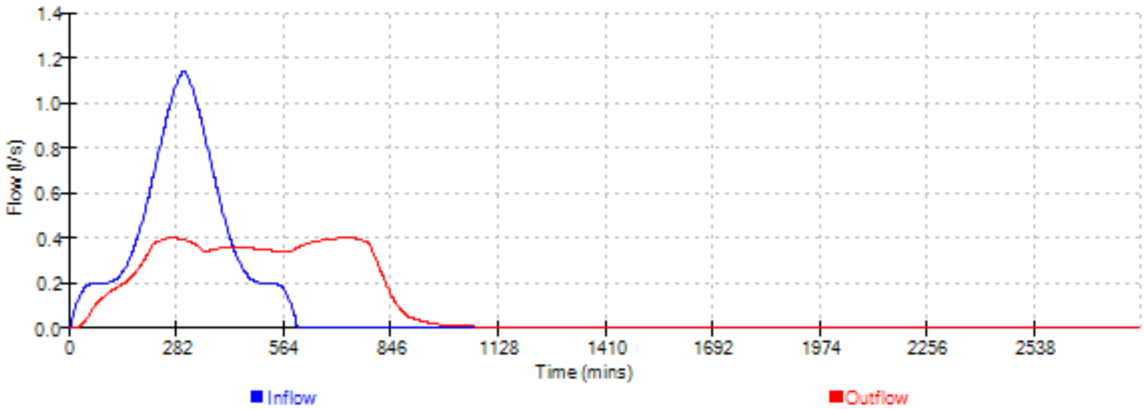
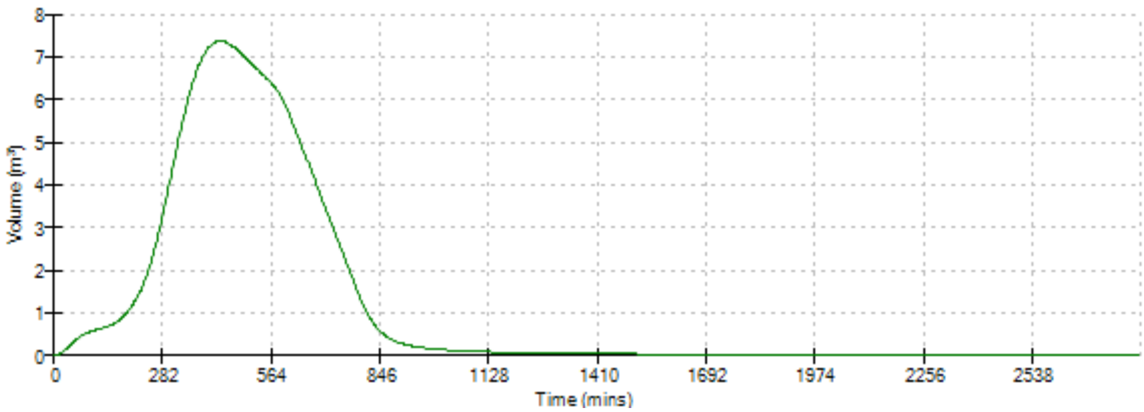


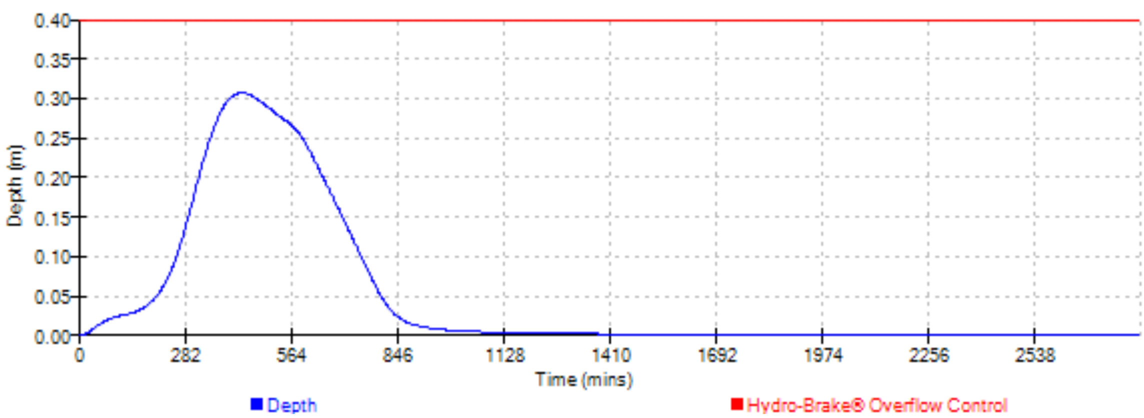




Event: 600 min Winter







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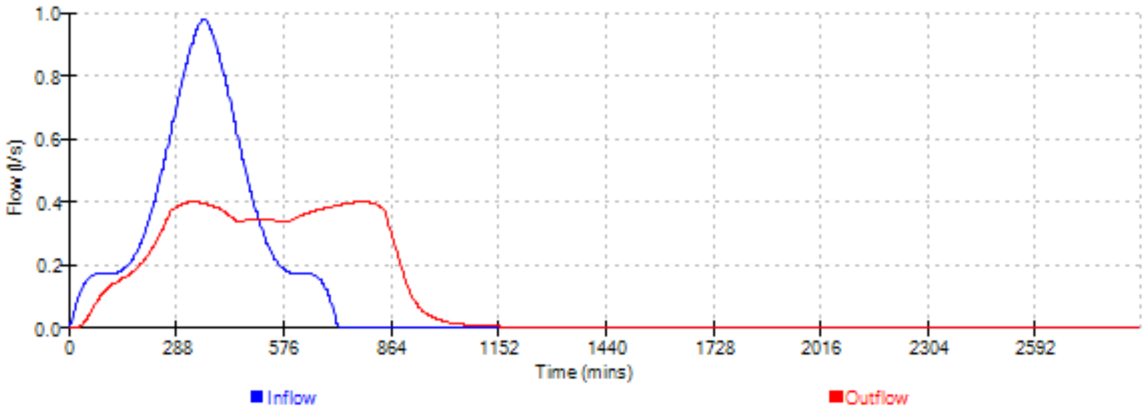

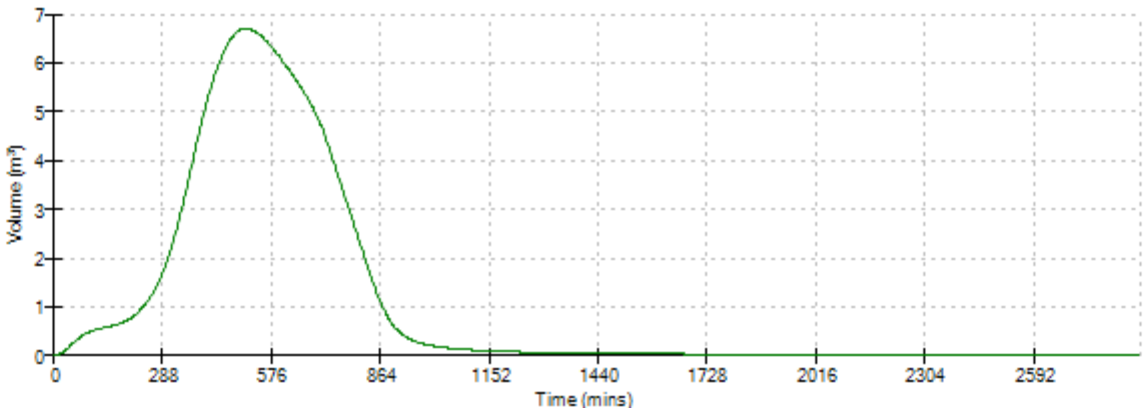

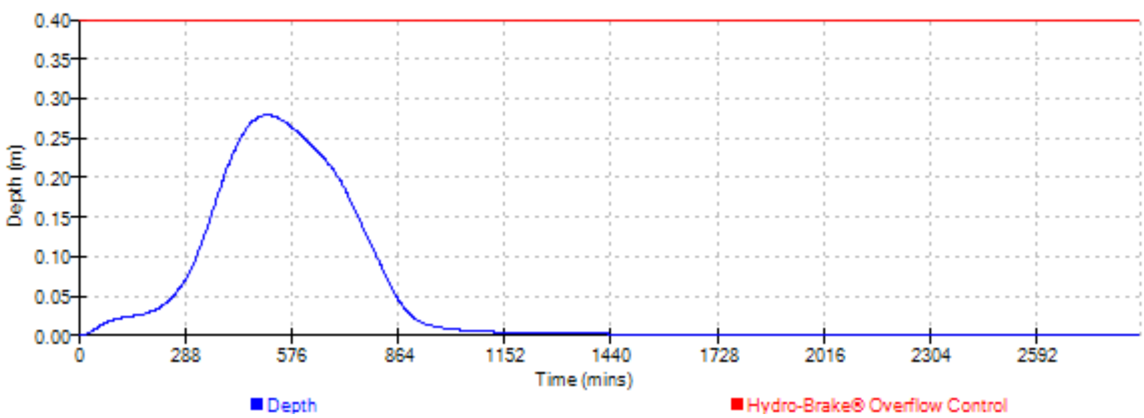

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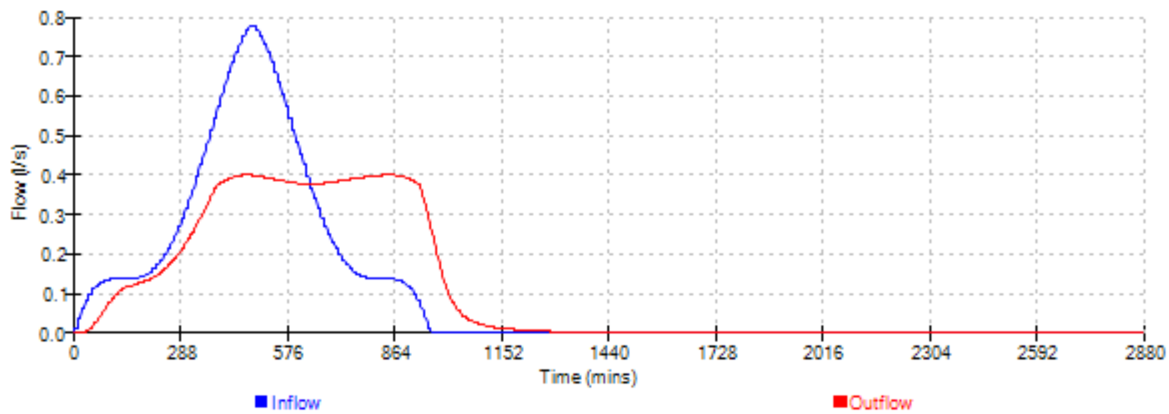

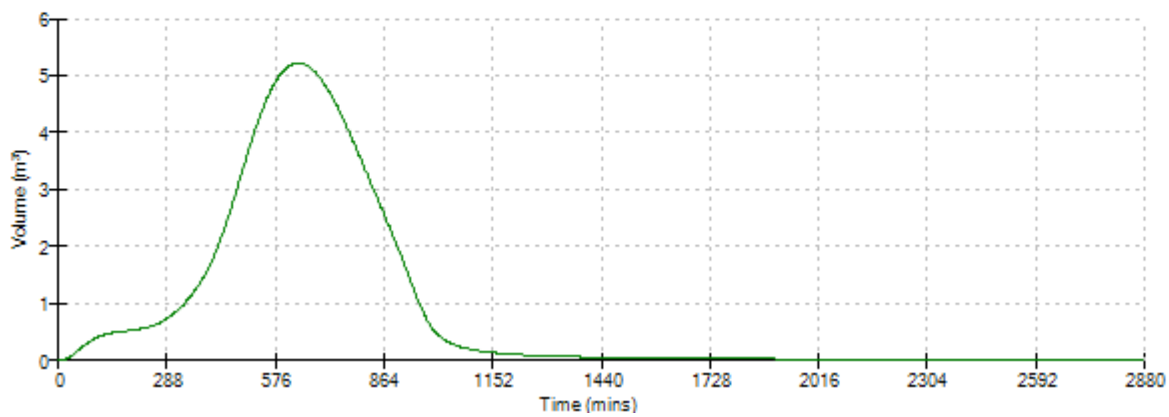

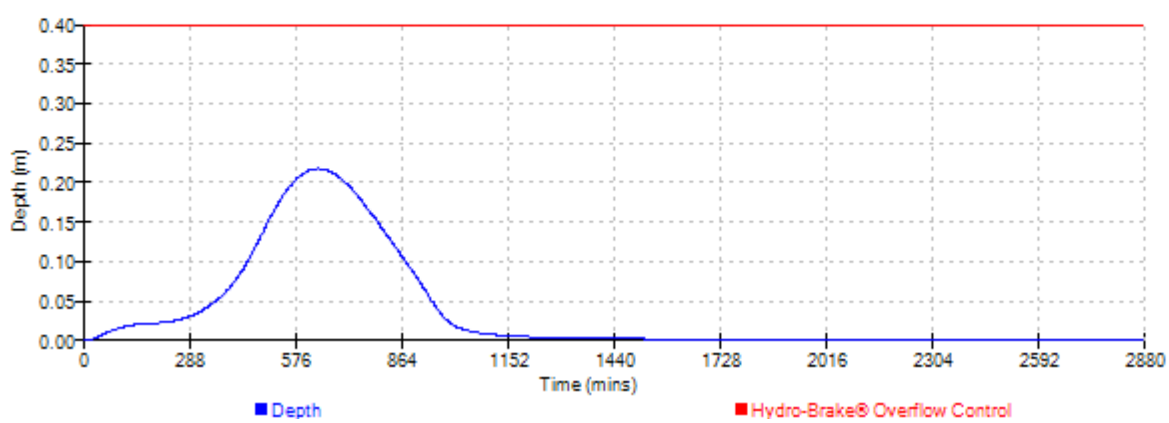

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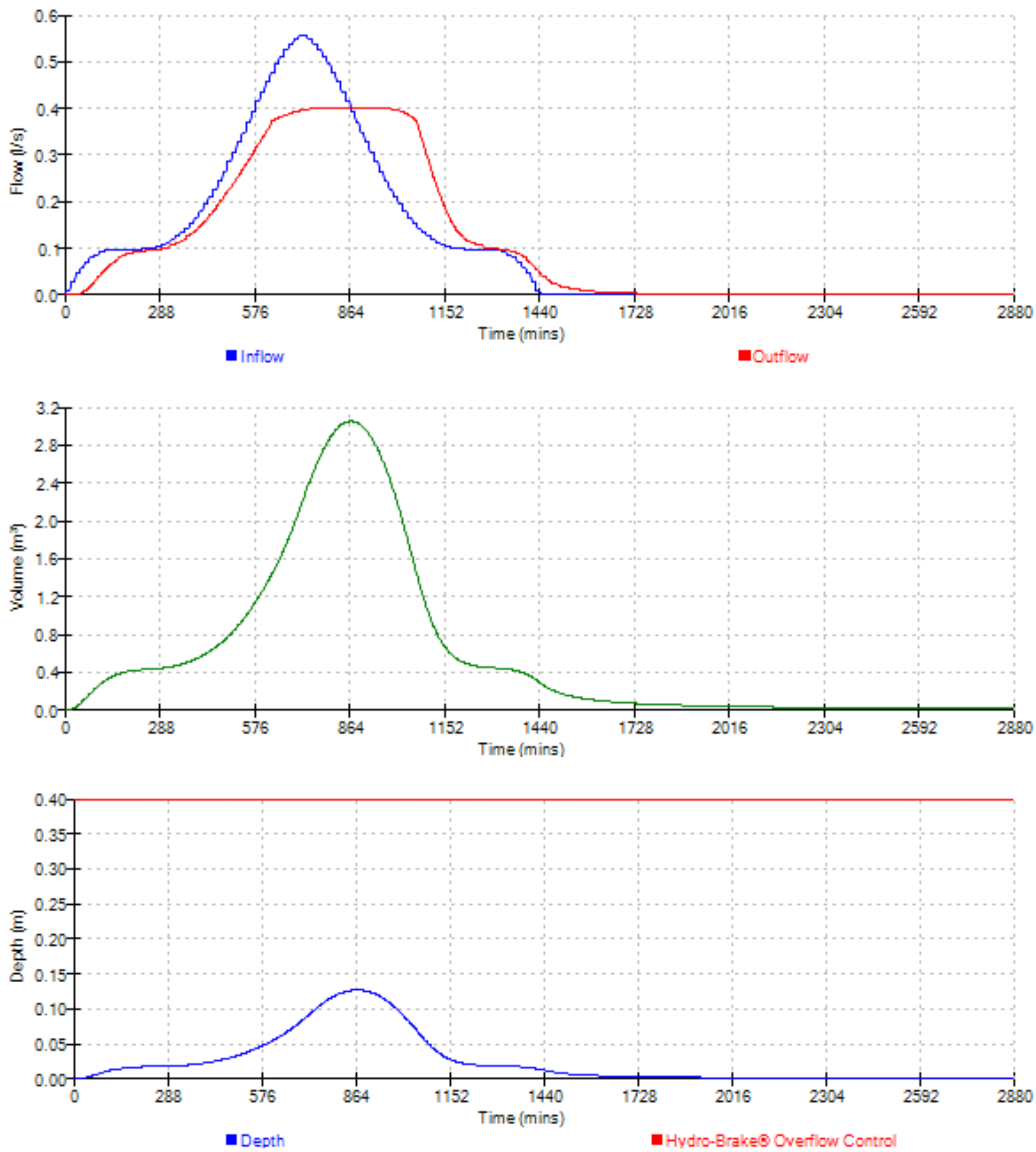

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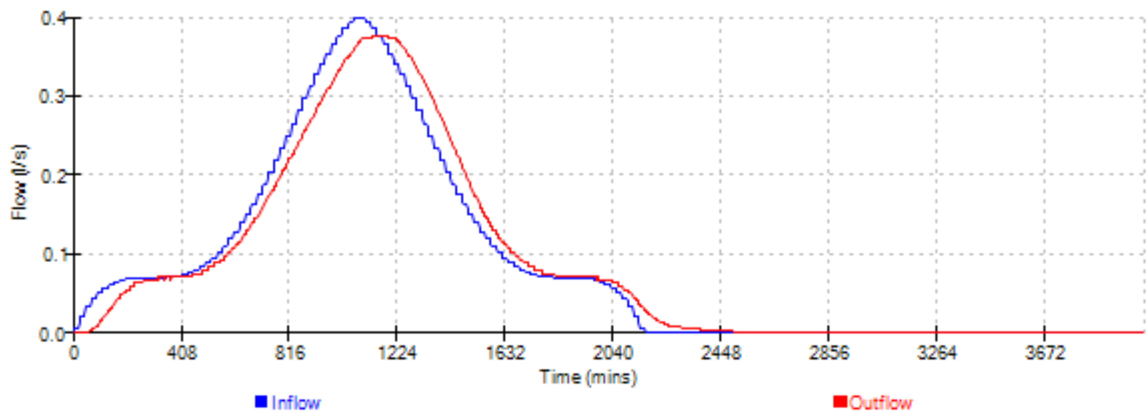

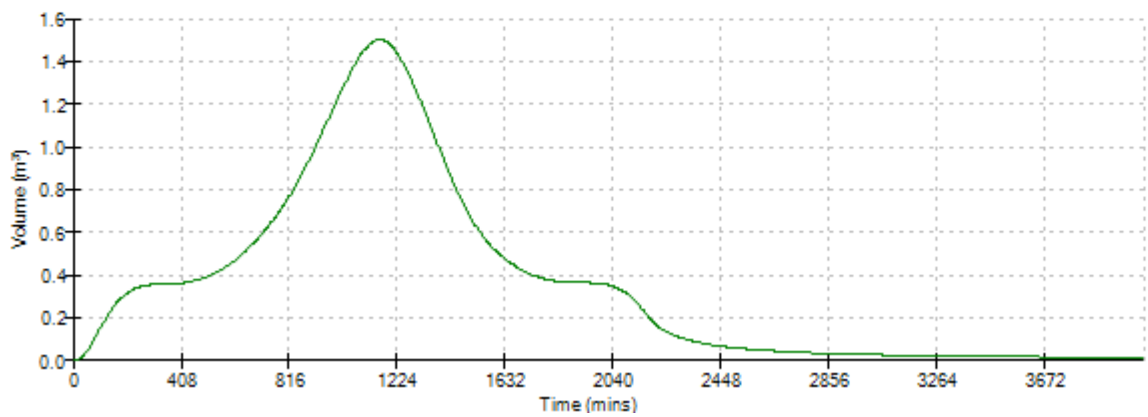

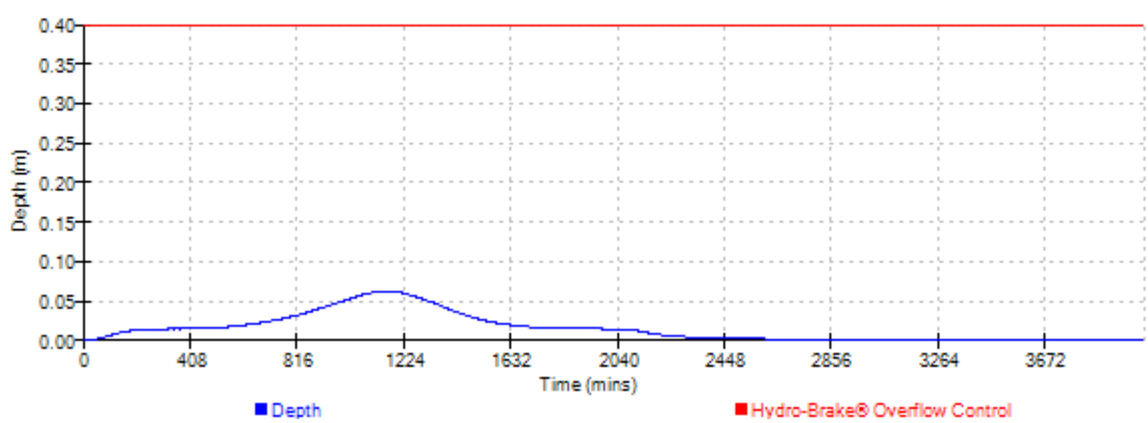

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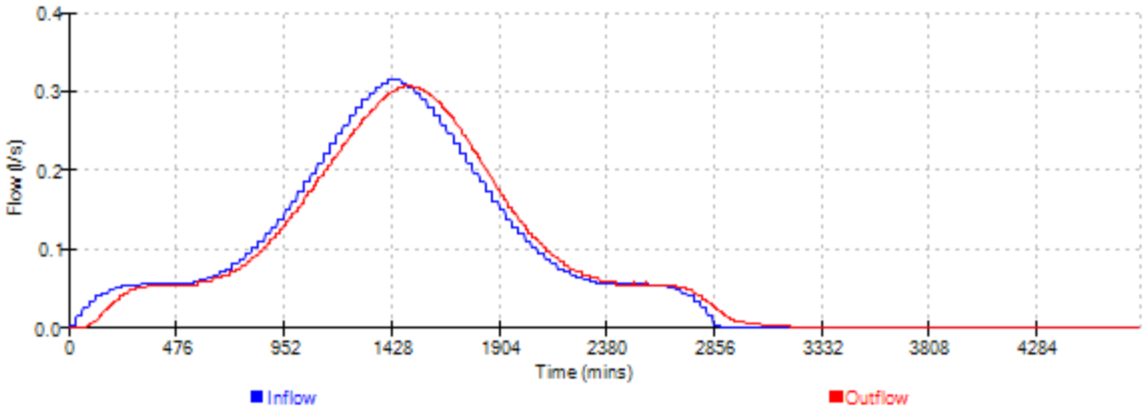
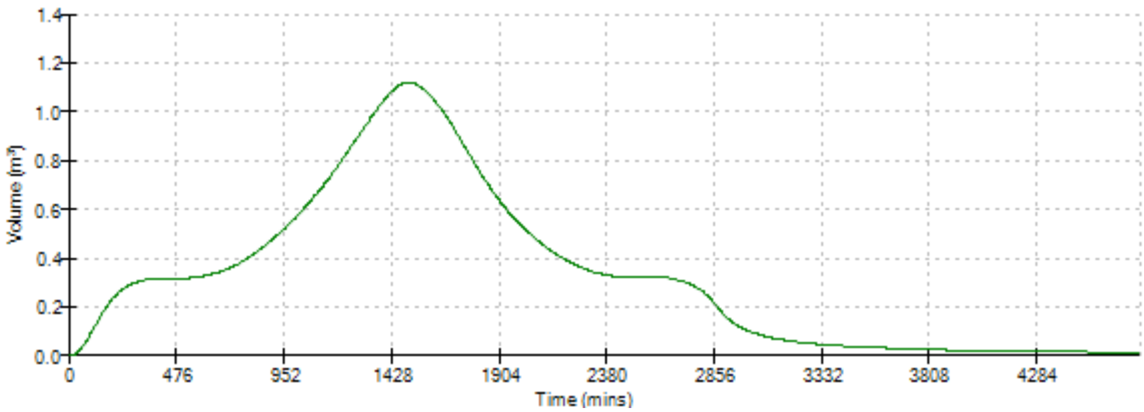
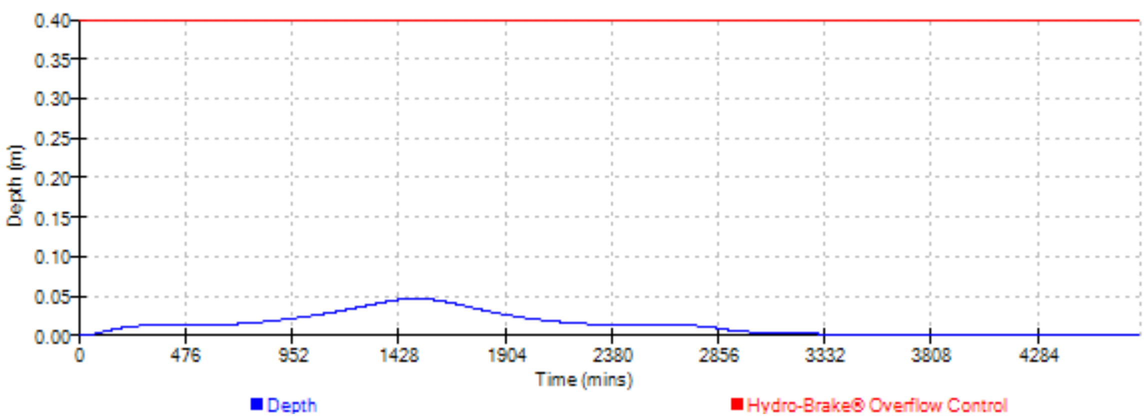
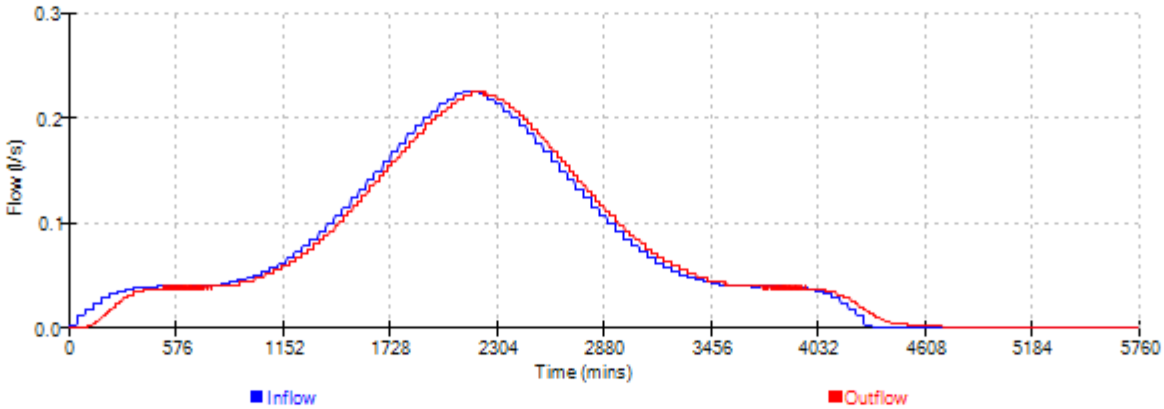
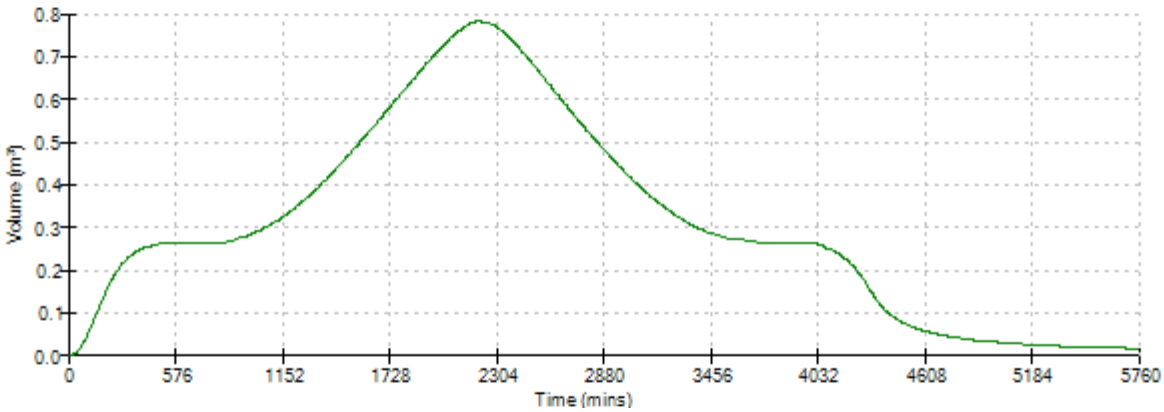


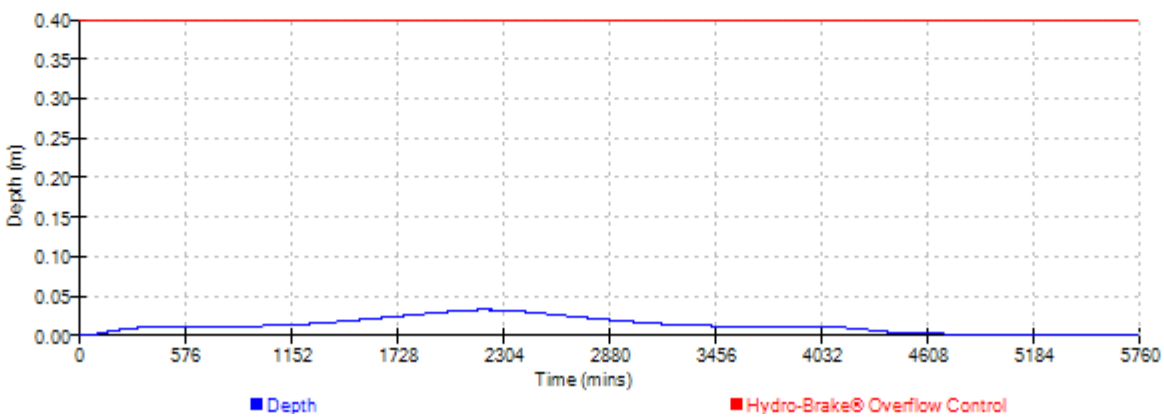




Event: 4320 min Winter







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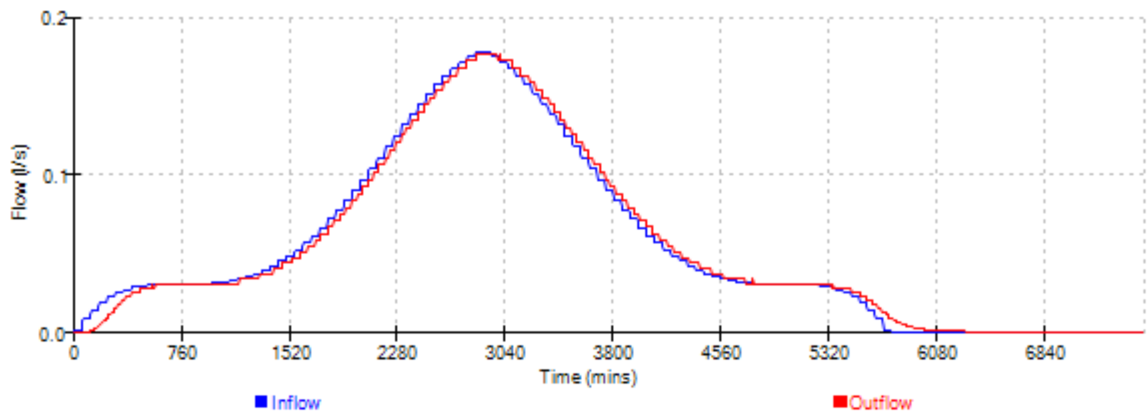
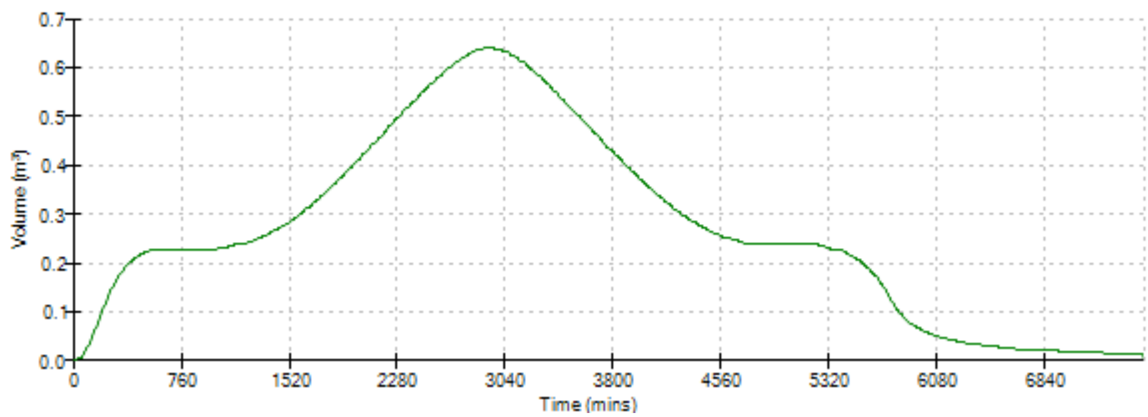
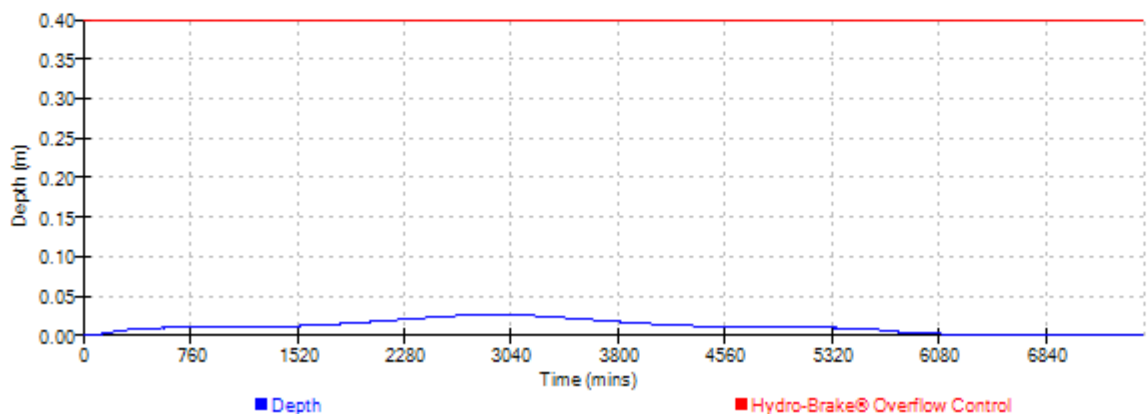
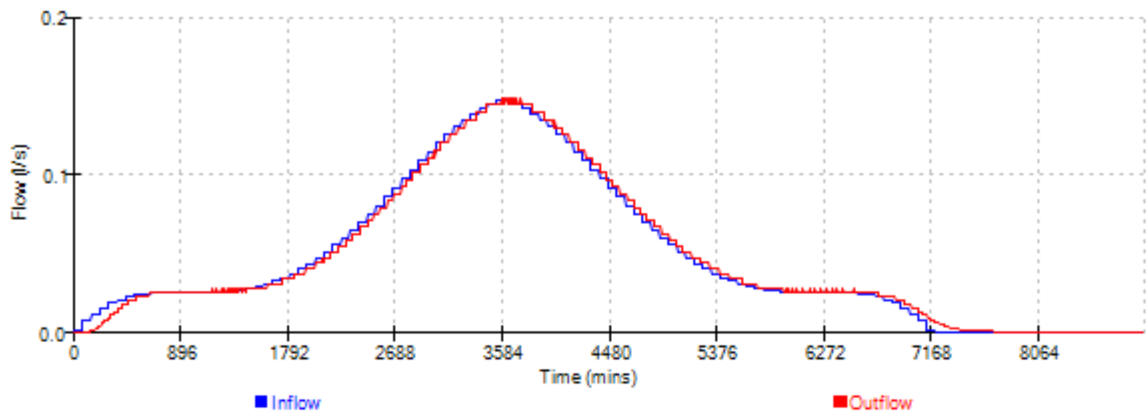


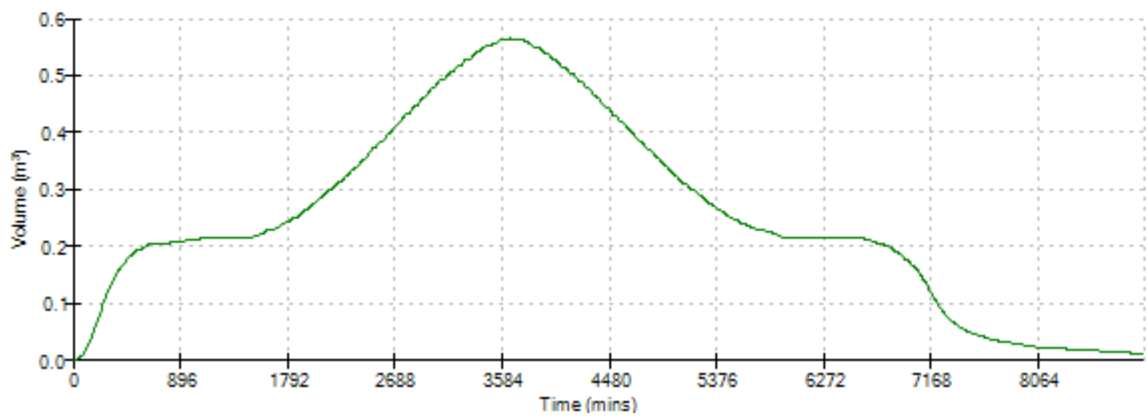


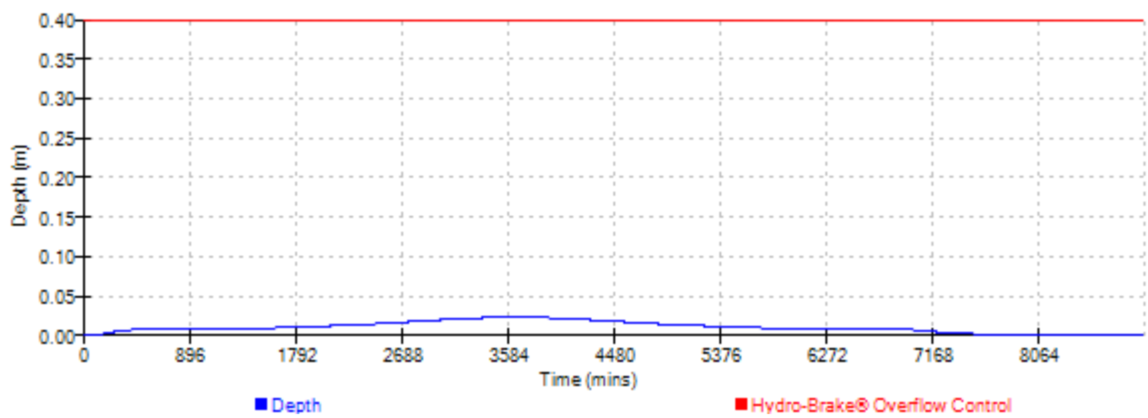


Easy Flood Risk		Page 41
55 Shepherds Lane Dartford DA1 2NL		
Date 14/02/2025 08:23 File Blackhorseyard.SRCX	Designed by sheph Checked by	
Innovyze	Source Control 2020.1	

Event: 7200 min Winter







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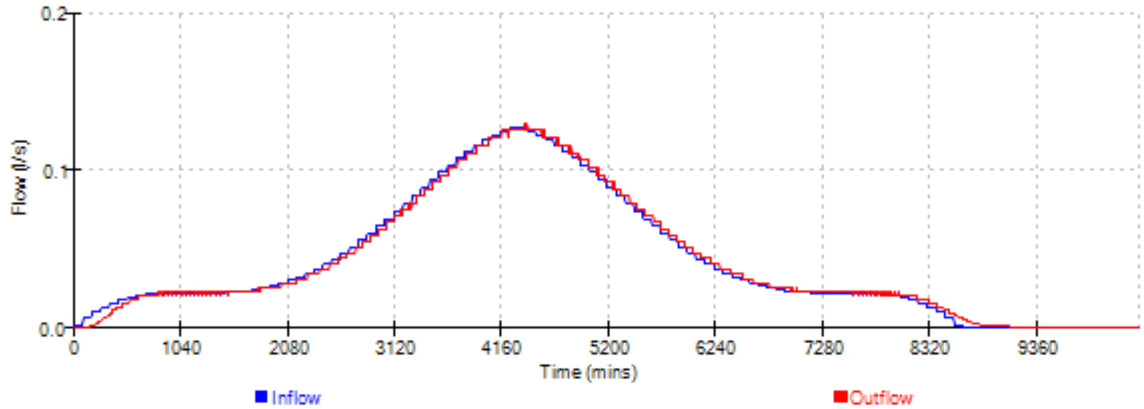

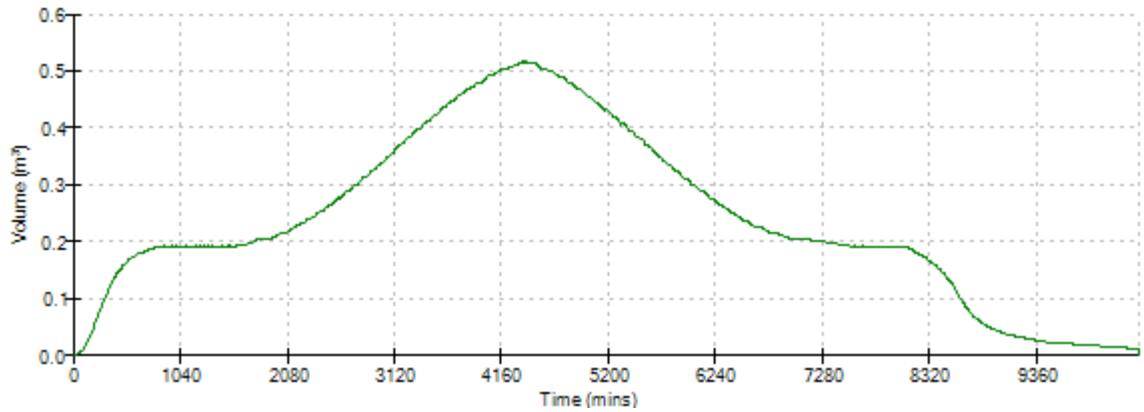

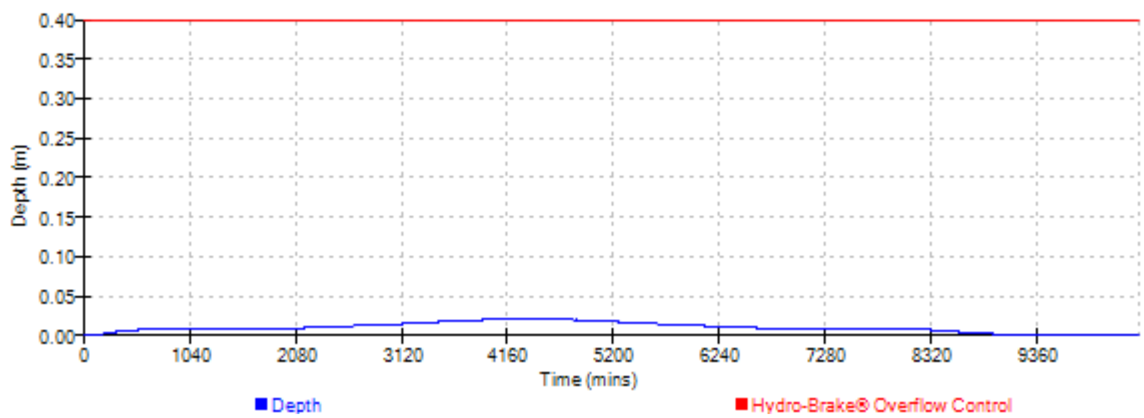

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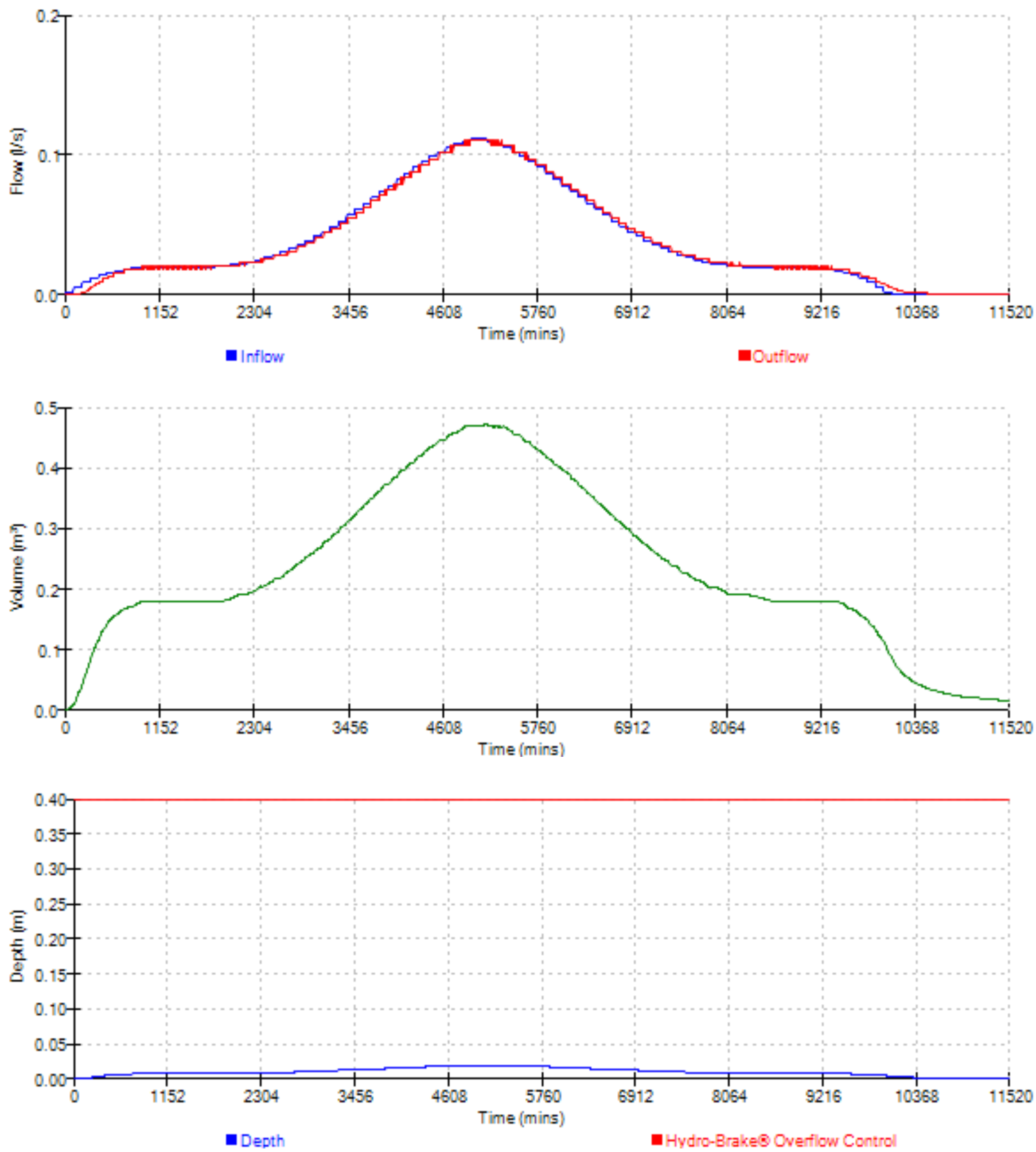

Appendix L Exceedance Flow Routes

Appendix L Exceedance Flow Routes