LANMOR Consulting

Civil Engineers & Transport Planners

Parker Collins House

Flood Risk Assessment & Drainage Strategy

January 2024

231743/FRA/OR/RS/01

Rev A

LANMOR Consulting

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1 INTRODUCTION

1.1 Scope

1.1.1 Lanmor Consulting Ltd has been appointed to complete a Flood Risk Assessment & Drainage Strategy report for the proposed development at Parker Collins House, Portsmouth Road, Ripley, Woking, GU23 6JA.

1.1.2 This report describes the existing and proposed development, the implications of flooding and the impact the proposed development will have on the flood plain in accordance with the government's guidance document: The National Planning Policy Framework (NPPF), with specific reference to its Planning Practice Guidance.

1.1.3 This report will consider the following:

- Location of the site;
- Development proposals;
- Existing information on extents and depths of flood events or on flood predictions;
- Sources of flooding;
- The impact of flooding on site.

1.1.4 This flood risk assessment has been prepared in accordance with the requirements of the National Planning Policy Framework and will demonstrate that the proposed development will be safe and will not increase the risk of flooding in the surrounding areas.

1.1.5 This report will also consider the proposed drainage regime for the site. It will assess the site's current Greenfield runoff rate, suitable methods of discharging the runoff from the development and set the drainage strategy for the proposed development, including discharge rates and any requirements for attenuation.

2 SITE CONDITIONS

2.1 Site Location

2.1.1 The site is located at the intersection of Send Marsh Road and Portsmouth Road and is in close proximity to a residential area to the north. The site is in Ripley, Woking, which is southwest of London. The site is positioned directly to the southeast of a watercourse that runs parallel to Portsmouth Road for the length of the site.

2.2 Site Geology

2.2.1 British Geological Survey records indicate the site sits upon a bedrock of London Clay Formation, which consists of clay, silt and sand. The sedimentary bedrock was formed between 56 and 47.8 million years ago during the Palaeogene period. There are no superficial deposits recorded over laying the London Clay formation.

2.2.2 Due to the nature of clay, it is unlikely ground infiltration would be viable.

2.3 Proposed Development

2.3.1 The proposals seek approval for the construction of 6 x 3 bed semi-detached houses, a detached 3 bed house and 2x detached 4 bed houses together with associated parking and new access off Send Marsh Road, following demolition of existing house and outbuildings.

3 SOURCES OF FLOODING

3.1 Fluvial / Tidal Flooding

3.1.1 Flood mapping for planning has been provided by the Environment Agency (EA) for the site and surrounding area. The mapping indicates the site to be within Flood Zone 2, with a small area of Flood Zone 3 on the route of the watercourse along the northwest boundary.

3.1.2 The NPPF and PPG define the Flood Zones as follows:

- Zone 1: 'Low Probability' This zone comprises land assessed as having a less than a 1 in 1000 annual probability of river or sea flooding (<0.1%) in any year.

- Zone 2: 'Medium Probability' – This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% - 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5%-0.1%) in any year.

- Zone 3a: 'High Probability' – This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.

- Zone 3b: 'The Functional Floodplain' – This zone comprises land where water has to flow or be stored in times of flood. SFRAs should identify this Flood Zone (land which would flood with an annual probability of 1 in 20 (5%) or greater in any year or is designed to flood in an extreme (0.1%) flood, or at another probability to be agreed between the LPA and the Environment Agency, including water conveyance routes).

3.1.3 The EA mapping shows the site to be within Flood Zone 2 with a probability of fluvial flooding between 1% and 0.1% in any given year. Figure 3.1 below shows an extract from the Flood Maps for Planning, the site is located in Flood Zone 2 with only a small area of Flood Zone 3 associated with the watercourse that passes along the northwest boundary.

Figure 3.1 – EA Flood Zone Mapping

3.1.4 The areas shaded in light blue represents the extent of Flood Zone 2 areas, while regions shaded in dark blue represent Flood Zone 3 areas.

3.2 Surface Water Flooding

3.2.1 The surface water flood mapping provided by the EA is considered to be the best available source of national information for surface water flooding. The EA accept that the mapping has limitations and state that: '*these maps cannot definitively show that an area of land or property is, or is not, at risk of flooding, and the maps are not suitable for use at an individual property level*.'

3.2.2 The EA mapping indicates the application site to have a very low risk of surface water flooding, although there is a higher risk of flooding along the northwest boundary along the route of the watercourse as you would expect.

3.2.3 This map can be found below as Figure 3.2.

Figure 3.2 – Extent of flooding from surface water

3.2.4 Figure 3.2 shows the site is at very low risk of surface water flooding with the exception of the northwest boundary where there is a risk of surface water flooding associated with the watercourse bounding the site.

3.3 Groundwater Flooding

3.3.1 Guildford Borough Council (GBC) as part of their planning policy published their Strategic Flood Risk Assessment (SFRA) this demonstrates that the site is not in an area of major groundwater flood risk. The groundwater flood mapping from the SFRA is included in Figure 3.3 below.

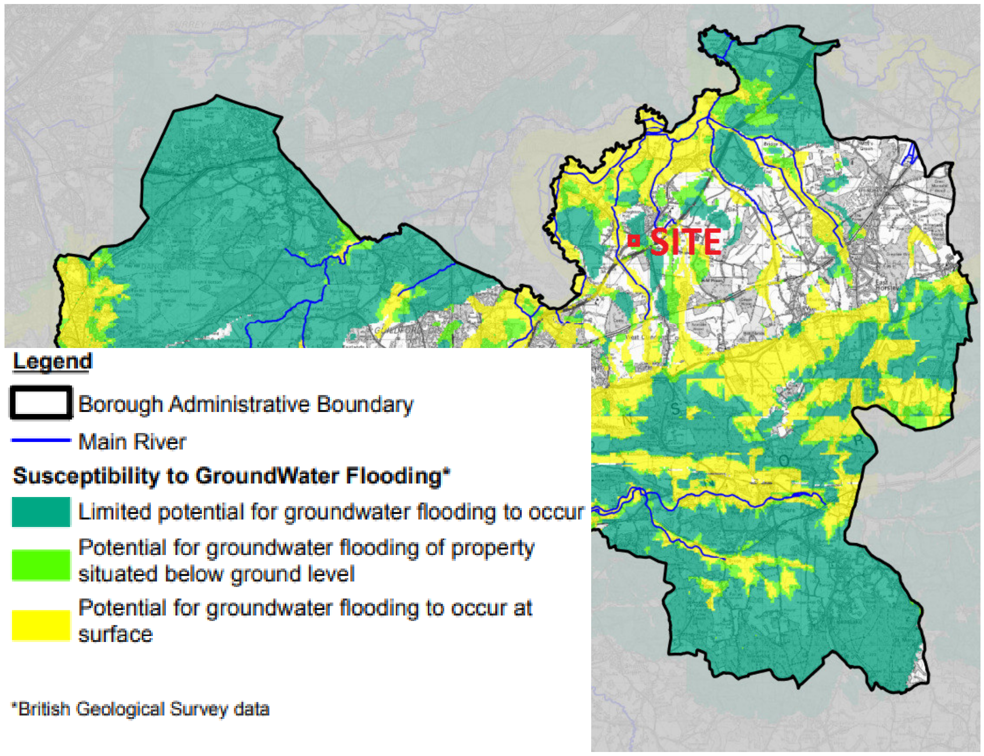

Figure 3.3 – Flood Risk from Groundwater

3.4 Reservoir Flooding

3.4.1 The EA's flood risk mapping indicates that there is no risk of flooding to the site in the event of a dam or reservoir failure.

4 MODELLED FLOOD EVENTS AND CLIMATE CHANGE

4.1 Flood Probability

4.1.1 The principal source of flooding to the site comes from the watercourse, known as the East Clandon Stream, which directly abuts the site along its northwest boundary. According to the Environment Agency's "Flood Maps for Planning", the site is mostly within Flood Zone 2, but with Flood Zone 3 contained along the route of the watercourse.

4.1.2 Detailed flood modelling was requested from the EA and they have provided Products 5, 6 and 7 with the raw flood modelling data. The hydraulic modelling for the East Clandon Stream was undertaken by JBA Consulting. In their draft report dated June 2020 (Product 5) they have identified flood defences along the northern riverbank of the stream in the vicinity of the site (opposite the site). These defences provide protection to the properties on Maple Road that back onto the stream. However, the report has found the defences are in poor condition and would not currently provide full protection. Two scenarios have been modelled for the defended and undefended scenarios and the data has been extracted for both. Figure 4.1 below shows the worst-case scenario for the undefended event.

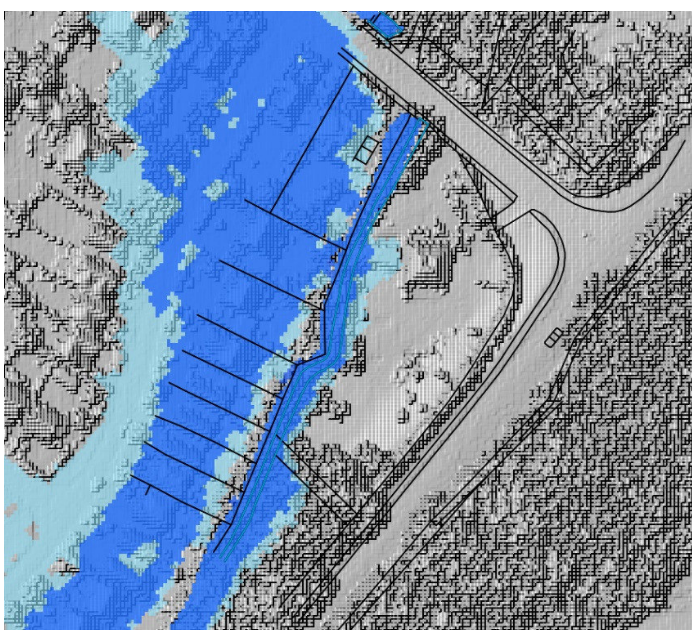

Figure 4.1 – Existing Flood Zone 2 & 3 Extents

4.1.3 The flood data (flood outlines extents) provided by the EA for the different return periods have been overlaid on the existing site. Figure 4.1 below shows the flood extents from a 1 in 100 year event or 1.0% probability (Flood Zone 3) in dark blue and the 1 in 1000 year event or 0.1% probability (Flood Zone 2) in light blue.

4.1.4 Figure 4.2 below shows the extent of flooding on the development proposals, the proposed buildings will be located outside of flood zone 3.

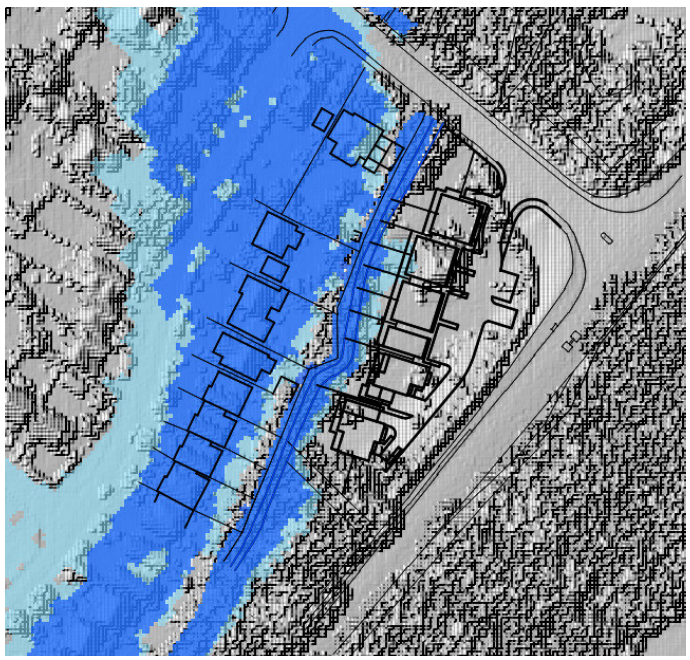

Figure 4.2 – Proposed Development Flood Zone 2 & 3 Extents

4.1.5 Flood level data for the 2 scenarios were extracted from the product 6 model data Plan 1 in Appendix C shows the location of the flood data extracted which are tabulated below in tables 4.1 and 4.2.

4.1.6 In the defended scenario the Flood Zone 3 extent is contained within the river channel, whist Flood Zone 2 affects the properties to the west, but only a small part of the application site. For the undefended scenario the Flood Zone 3 extent now impacts the properties on Maple Road as indicated in Figure 4.2 above, with little change to the Flood Zone 2 extent.

4.1.7 The EA's latest flood modelling of the East Clandon Stream has shown that the majority of the application site is in Flood Zone 1, at low risk of fluvial flooding. The extent of Flood Zone 2 on the 'Flood map for planning' is taken from historical records of flooding in January 1968 and not the modelled extents, which is why the GIS mapping of the flood outlines substantially smaller than that indicted on the EA flood maps for planning.

	Eastings	Northings	1 in 10	1 in 20	1 in 30	1 in 75	1 in 100	1 in 1000	1 in 100 +25%
Point 1	504251	155242	29.66	29.79	29.86	30.02	30.07	30.42	30.26
Point 2	504259	155259	29.58	29.71	29.78	29.95	30.00	30.38	30.21
Point 3	504269	155270	29.56	29.70	29.76	29.93	29.99	30.37	30.20
Point 4	504271	155285	29.51	29.65	29.72	29.89	29.95	30.35	30.17
Point 5	504274	155297	29.44	29.59	29.65	29.84	29.90	30.34	30.15
Point 6	504283	155316	29.28	29.45	29.49	29.69	29.76	30.24	30.03
Point 7	504291	155333	29.16	29.36	29.37	29.59	29.66	30.19	29.97

Table 4.1 – Flood Data for Defended Scenario

	Eastings	Northings	1 in 10	1 in 20	1 in 30	1 in 75	1 in 100	1 in 1000	1 in 100 +25%
Point 1	504251	155242	29.66	29.79	29.86	29.99	30.01	30.23	30.13
Point 2	504259	155259	29.58	29.71	29.78	29.91	29.94	30.17	30.07
Point 3	504269	155270	29.56	29.70	29.76	29.90	29.93	30.16	30.06
Point 4	504271	155285	29.51	29.65	29.72	29.86	29.89	30.13	30.03
Point 5	504274	155297	29.44	29.59	29.65	29.80	29.83	30.12	30.00
Point 6	504283	155316	29.28	29.45	29.49	29.66	29.69	30.02	29.89
Point 7	504291	155333	29.16	29.36	29.37	29.55	29.60	29.98	29.82

Table 4.2 – Flood Data for Undefended Scenario

4.1.8 A topographical survey of the site shows there is a significant fall in levels from east to west, with the highest level in the southeast corner of 34.62m AOD and a lowest level on the banks of the stream of 29.28m AOD. At this point the stream channel level is 28.17m AOD. The flood data points have been plotted against the surveyed levels to provide a more accurate plot of the extent of flood waters into the site. This is shown on drawing 231743/FRA/01 in Appendix D.

4.2 Climate Change Allowances

4.2.1 The Environment Agency have published climate change allowances to be used in the preparation of Flood Risk Assessments. The allowance to be implemented for fluvial flooding it is based on the management catchment area, flood zone and site vulnerability. The site is located within the Wey and tributaries Management Catchment, as identified on the Department for Environment Food & Rural Affairs (DEFRA) climate change allowances website.

4.2.2 The site lies within all of Flood Zones 1, 2 and 3. Under Annex 3 of the NPPF the proposed development would be classed as: "Buildings used for residential uses" to be a "More Vulnerable" use.

4.2.3 The Flood Risk Assessments: Climate Change Allowances guidance, recommends that the Central Allowance for More Vulnerable uses in Floods Zones 2 and 3 should be used. The DEFRA website provides the Central Allowance to be applied to peak river flows for developments with a 100-year lifetime as 24%. The flood modelling provided by the EA included a scenario with a 25% increase in river flows, and this model will be used in our assessment.

4.2.4 Figure 4.3 show the results of the EA's flood modelling for the worst-case undefended scenario for the 1% AEP event plus 25% climate change allowance.

4.2.5 This report has therefore taken into account the future impacts of climate change when assessing the impact of flood waters on the development, in accordance with the NPPF and its Planning Practice Guidance. The above flood mapping indicates the proposed building will not be affected by a 1.0%AEP (1 in 100 year) + 25% allowance for climate change, however a detailed assessment of flooding on site was undertaken using the topographical survey information for the site.

4.2.6 Drawing 231743/FRA/01 shows the potential flood extent for the 1.0%+25% CC scenario, this has been used to assessment compensation requirements due to raising of ground levels and is discussed further in the next chapter.

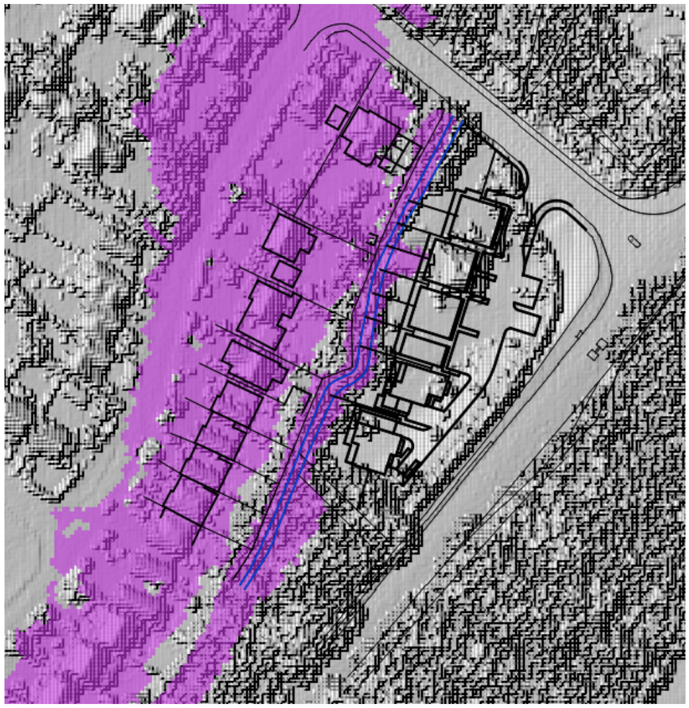

Figure 4.3 – Flood Zone 3 Plus CC Extent

5 IMPACT OF FLOODING

5.1 Impact on Flow of Flood Waters

5.1.1 As demonstrated above, the application site lies within Flood Zones 1, 2 and 3. The higher risk area, Flood Zone 3, is confined to the western side of the site. The proposed buildings, as indicated on drawing 231743/FRA/01 in Appendix D, will not affect the free flow of flood waters for an event with a probability of 1.0% plus 25% climate change allowance.

5.2 Impact on Flood Storage Volumes

5.2.1 The survey information that once the climate change allowance is factored in overtopping of the riverbank might occur to the rear of Plots 3-5 and Plots 6-9. In the case of Plots 6-9 gardens the flood waters will not reach the proposed dwellings, and therefore maintaining the existing ground levels to the rear of the properties will not impact on flood storage volumes.

5.2.2 For Plots 3-5, there is an existing building but flood waters could extent around it which will cover the area of the proposed patios of Plots 3-4. The patios will be slightly raised therefore, existing and proposed flood storage volumes have been calculated for this area, to ensure there is no loss. The results are shown on drawing 2317413/FRA/02 in Appendix D which found that there will be an increase of 3.23m^3 as a result of the proposed works.

	Existing Band	Total Vol.	Proposed Band	Proposed Total	Band Change	Total Change
Band 1	4.07	7.20	5.24	10.43	+1.17	+3.23
Band 2	2.08	3.13	3.35	5.19	+1.27	+2.06
Band 3	0.83	1.05	1.62	1.84	+0.79	+0.79
Band 4	0.22	0.22	0.22	0.22	0.00	0.00

Table 5.1 – Existing and Proposed Flood Storage Volumes

5.2.3 This report has shown that the proposed buildings will be outside of the 1% AEP +25% CC flooding extent so they will not reduce the volume of flood storage on site. The raised patios to the rear of Plots 3 and 4 could impact existing flood storage so comparison has been made on a level for level basis to ensure there is no loss in storage. It is therefore concluded that the proposals will not result in the loss of any flood storage volume across the application site for an event with a probability of 1.0% +25% CC allowance.

5.3 Flood Impact on Development

5.3.1 The floor level of the proposed buildings varies from 31.0 to 30.6m AOD. The buildings will be located above the estimated flood level for a 1.0% +25% CC event. The lowest ground floor level is Plot 7 at +30.6m AOD. The design flood level in this area (Point 3) is +30.200m AOD so a freeboard of 400mm will be provided to the finished floor level of the proposed building at this point and up to 800mm for the other properties.

5.3.2 The flood modelling demonstrates the proposed properties will the not be subject to flooding from a 1.0% +25%CC event, so they should suffer damage from flooding and minimum of 400mm clearance is provided between the highest estimated flood level and lowest floor level.

5.4 Safe Access & Egress

5.4.1 The proposed building will be located above the highest estimated flood level for an event with a probability of 1.0% +25% CC allowance, the internal road and Send Marsh Road will be free from flooding with a probability of 1.0% +25% CC so a safe dry access can be provided at all times during a flood event.

5.5 Development Vulnerability Classification

5.5.1 The proposed development will comprise of the construction of 9 residential properties. Under Annex 3 of the NPPF and Planning Practical Guidance, the development would be classified as a building used for dwelling houses and therefore considered to have a "More Vulnerable" proposed use. This use class has been used when assessing the future impacts of climate change, and when undertaking the Sequential Test.

6 SEQUENTIAL TEST

6.1.1 The aim of the Sequential Test is to ensure that a sequential approach is used to steer new developments to areas with the lowest probability of flooding as set out in the NPPF and PPG.

6.1.2 Strategic Flood Risk Assessments (SFRA) refine information on the probability of flooding, taking other sources of flooding and the impacts of climate change into account. They provide the basis for applying the Sequential Test.

6.1.3 The proposed development is for residential use and therefore considered a 'More Vulnerable' use. An assessment of the EA's flood modelling has shown that the site falls within Flood Zones 1, 2 and 3 but with the extent of Flood Zones 2 and 3 limited to the western boundary along the route of the stream. A sequential approach has been used when designing the layout of the development and the dwellings have been located in an area at less risk of flooding. As the proposed dwellings will be located above the estimated flood level for a 1 in 1000 year 0.1% (Flood Zone 1) the Sequential Test is satisfied.

6.1.4 Table 2 of the PGG reproduced as Table 6.1 below sets out the compatibility of proposed development in relation to the Flood Zones. The proposed dwellings are considered a More Vulnerable use and are located in Flood Zone 1 which is considered a suitable use, and the exception test is not required.

Flood Zones	**Flood Risk Vulnerability Classification**				
	Essential infrastructure	Highly vulnerable	More vulnerable	Less vulnerable	Water compatible
Zone 1	✔	✔	✔	✔	✔
Zone 2	✔	Exception Test required	✔	✔	✔
Zone 3a †	Exception Test required †	X	Exception Test required	✔	✔
Zone 3b *	Exception Test required *	X	X	X	✔ *

Key:

✔ Exception test is not required

X Development should not be permitted

Table 6.1 – Flood Risk vulnerability Classification

7 EXISTING DRAINAGE

7.1 Existing Foul Water Drainage

7.1.1 Thames Water sewer records have been obtained for the local area; these show there are no public sewers directly adjacent to the site. The nearest foul public sewer is to the north of the site in Send Marsh Road.

7.1.2 A topographical survey of the site has identified a few manholes to the rear of the property. It is assumed that the foul water drainage from the existing building is discharged to a septic tank to the rear, or via a private connection though the properties on Maple Road. A CCTV survey will be required to confirm how the site currently drains and if the is an existing connection suitable for reuse.

7.2 Existing Surface Water Drainage

7.2.1 No soakaways etc have been identified on site, it is assumed that there are currently no surface water drains directly to the ditch to the west. There are no adopted surface water sewers in the area of the site.

8 PROPOSED DRAINAGE

8.1 Proposed Foul Water Drainage

8.1.1 The foul water from the proposed dwellings will be collected on site with a new network. If it is found that there is no existing connection to the public sewer then a new connection will be constructed along Send Marsh Road. The new sewer will have to cross either under or over the existing culvert of the East Clandon Stream and so a pumping station may be required on site to facilitate the connection. The drainage network on site will be designed to meet the requirements of the building regulations, with 24 hour back up storage provided in the pump chamber.

8.2 Proposed Surface Water Drainage

8.2.1 The Sustainable Drainage Systems (SuDS) hierarchy has been used to set the drainage strategy for the development. The SuDS considered as part of this assessment for the disposal of surface water runoff include rainwater harvesting, ground infiltration and discharging to watercourse.

8.2.2 Green or blue roofs were considered, but the proposed dwellings will all have pitched roofs, so these are not practical and have been discounted.

8.2.3 Rainwater harvesting was also considered, as a means of reusing surface water runoff within the dwellings. However, these systems require a separate network of pipes within the property, as well as tanks and pumps to store the rainwater and distribute it throughout. It was considered impractical to implement rainwater harvesting systems on the site due to site constraints and excessive cost for the development.

8.2.4 In addition, for these systems to be successfully implemented there must be sufficient demand for water reuse otherwise this may lead to water quality issues. Furthermore, rainwater harvesting tanks should not be included in the assessment of attenuation required to store runoff from a development as there is no guarantee that the tank will be sufficiently empty to receive another storm.

8.2.5 Should the rainwater harvesting tank be full at the start of the storm, it will not be able to receive any more runoff, therefore additional storage of a similar size would be required to cater for all storm events and the rainwater harvesting tank will provide no benefit in terms of attenuation. For those reasons, and the excessive cost of providing the system, this method has been discounted.

8.2.6 Next on the SuDS Hierarchy is use of infiltration techniques. Soil infiltration involves the surface runoff water being drained into the ground and absorbed by the soil. Due to the nature of the geology of the site being clay, infiltration is not viable therefore this has also been discounted.

8.2.7 Next on the list is discharging surface water to a river or watercourse. There is a watercourse which runs along the western boundary of the site. It is therefore proposed to attenuate runoff on site and discharge to the watercourse at a restricted rate.

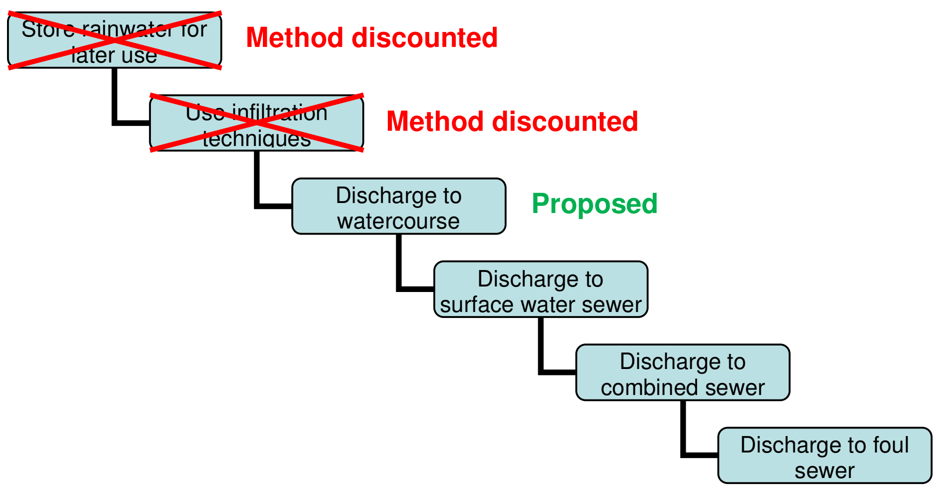

Figure 8.1 – SuDS Hierarchy

8.2.8 The development proposals involve the construction of new houses, access road and parking areas. There is the opportunity to use permeable paving on the access road and parking areas as a form of SuDS. This will provide water quality benefits along with attenuation storage but cannot discharge to ground due to the presents of clay. In addition, a below ground tank will be used in the rear gardens of the properties to attenuation the runoff from the roofs before the final discharge to the stream.

8.2.9 Calculations have been completed to estimate the existing Greenfield and Brownfield runoff rates from the existing site to set the proposed discharge rates. The results are tabulated below and are also included in Appendix F.

Return Period	Greenfield Rate (l/s)	Brownfield Rate (l/s)	Proposed Discharge		% Reduction
			Depth of Water in Tank (m)	Proposed Flow Rate (l/s)	
Q_{BAR}	1.8	-	-	-	-
1 in 1	1.5	1.5	0.172	1.3	13%
1 in 30	4.1	3.7	0.445	3.0	27%
1 in 100	5.8	4.8	0.545	4.9	16%
1 in 100 +45% CC	8.4	6.9	0.926	6.0	29%

Table 8.1 – Existing and Proposed Discharge Rates

8.2.10 Attenuation storage will be provided in the sub-base of the permeable paving which will be formed from **300mm of gravel and 150mm permavoid** units to provide extra storage. The discharge from the paving will be restricted by a 20mm diameter orifice plate which will connect into the drainage network.

8.2.11 Surface water runoff from the roofs will be collected in an attenuation tank in the rear gardens along with the discharge from the permeable paving. The final discharge will be restricted by a combination of a 40mm diameter orifice plate at the base of the tank, and a HydroBrake set at 2.5 l/s at a higher level to act as an overflow during extreme events. The tank has been sized at 3.0m wide by 10.0m long by 0.8m deep to accommodate the 1 in 100 year storm event (1% AEP) plus 45% allowance for future climate change.

8.2.12 The final discharge rate for the 1% AEP event plus CC has been calculated at 6.0 l/s which is a 29% reduction on the Greenfield rate for the same event. Overall, there will be a 13-29% reduction in flow rates from the Greenfields rates as a result of the development.

8.2.13 Drawing 231743/DS/01 shows the drainage strategy for the development and is included in Appendix E. The supporting drainage calculations for the different return periods are also included in Appendix F.

9 SURFACE WATER/ SUDS MAINTENANCE AND TREATMENT

9.1 SuDS Maintenance

9.1.1 Regularly inspecting the surface water drainage network for blockages and clearing unwanted debris / silt from the system should improve the performance of the surface water network and decrease the need for future repairs.

9.1.2 The level and frequency of maintenance required on site is dependent on the type of facility. The type of maintenance will fall into one of three categories "regular maintenance", "occasional maintenance" and "remedial maintenance".

9.1.3 Regular maintenance of the drainage and SuDS features will include, inspections, removal of litter / debris and sweeping of the surfaces. Occasional maintenance will include removal of sediment etc. and remedial maintenance may include structural repairs if required.

9.1.4 The drainage and SuDS elements after an initial inspection following construction should be inspected on a monthly basis for the first 12 months and after large storms, thereafter the following maintenance regime should be applied and adjusted if the 12-month monitoring process has identified any issues.

9.1.5 A management company will be set up to manage the development which will include the access roads and landscaped areas. The developer will be responsible for the drainage and SuDS until the management company is set up when the responsibility for the maintenance of SuDS will be transferred and they will ensure the system is funded adequately.

9.1.6 The appropriate health and safety equipment must be used when accessing manholes. Confined space certificates must be held by any personnel entering a manhole and the appropriate permits should be obtained.

Pipes and Manholes

9.1.7 For drainage pipes and manhole, the following maintenance is recommended.

Manhole / Pipe Maintenance Schedule		
	Required Action	**Typical Frequency**
Regular maintenance	Inspect for evidence of poor operation via water level in chambers. If required, take remedial action.	3-monthly, 48 hours after large storms.
	Check and remove large vegetation growth near pipe runs.	Monthly or as required
	Remove sediment from structures.	Annually or as required
Remedial Actions	Rod through poorly performing runs as initial remediation.	As required
	If continued poor performance jet and CCTV survey poorly performing runs.	As required
Monitoring	Inspect/check all inlets, outlets, to ensure that they are in good condition and operating as designed.	Annually
	Survey inside of pipe manholes for sediment build-up and remove if necessary	Every 5 years or as required

Table 9.1 – Manhole / Pipe Maintenance Schedule

Permeable Paving

9.1.8 For permeable paving areas, the following maintenance is recommended.

Permeable Paving Maintenance Schedule		
	Required Action	**Typical Frequency**
Regular maintenance	Remove debris and leaves etc.	Once a year, after autumn leaf fall, or reduced frequency as required, based on site-specific observations of clogging or manufacturer's recommendations – pay particular attention to areas where water runs onto pervious surfaces from adjacent impermeable areas as this area is most likely to collect the most sediment.
Occasional maintenance	Stabilise and mow contributing and adjacent areas	As required
	Removal of weeds	As required- once per year on less frequently used pavements
Remedial Actions	Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50 mm of the level of the paving	As required
	Remedial work to any depressions, rutting etc	As required
	Rehabilitation of surface and upper substructure	Every 10 to 15 years or as required (if infiltration performance is reduced due to significant clogging)
Monitoring	Inspect for evidence of poor operation and/or weed growth - if required, take remedial action.	Three-monthly, 48 hours after large storms in the first six months
	Inspect silt accumulation rates and establish appropriate frequencies for rehabilitation	Annually
	Monitor inspection chambers	Annually

Table 9.2 – Permeable Paving Maintenance Schedule

Attenuation Tanks

9.1.9 For the attenuation tanks, the following maintenance will be required.

Attenuation Tank Maintenance Schedule		
	Required Action	**Typical Frequency**
Regular maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action	Annually
	Remove debris from the catchment surface (where it may cause risk to performance).	Monthly
	For systems where rainfall infiltrates in the tank from above, check surface of filter for blockage by sediment, algae or other matter, remove and replace surface infiltration medium as necessary	Annually
	Remove sediment from pre-treatment structures.	Annually or as required
Remedial Actions	Repair/rehabilitate inlets/outlets, overflows and vents.	As required
Monitoring	Inspect/check all inlets, outlets, vents and overflows to ensure that they are in good condition and operating as designed.	Annually
	Survey inside of tanks for sediment build-up and remove if necessary	Every 5 years or as required

Table 9.3 – Attenuation Tank Maintenance

9.2 SuDS Treatment

9.2.1 As part of the CIRIA SuDS Manual C753, Section 26 provides guidance regarding methods for managing pollution risks from surface water runoff.

9.2.2 Part of the assessment is to determine which land use classification the proposed development falls under, Table 26.1 of the CIRIA Report C753 sets the approaches to water quality risk management. For this site the Simple Index Approach will be used.

9.2.3 Table 26.2 in C753 reproduced as Table 9.3, shows the potential hazard associated with different land uses the hazard indices. The development will consist of residential properties, it is concluded that the site should be classed within the sections shown in Table 9.3 below.

9.2.4 The roofs of the dwellings are considered to have a "very low" pollution hazard, generating 0.2 total suspended solids, 0.2 metals and 0.05 hydro-carbons. The access and parking area is considered to have a "low" pollution hazard, generating 0.5 total suspended solids, 0.4 metals and 0.4 hydro-carbons.

TABLE 26.2 Pollution hazard indices for different land use classifications

Land use	Pollution hazard level	Total suspended solids (TSS)	Metals	Hydro-carbons
Residential roofs	Very low	0.2	0.2	0.05
Other roofs (typically commercial/ industrial roofs)	Low	0.3	0.2 (up to 0.8 where there is potential for metals to leach from the roof)	0.05
Individual property driveways, residential car parks, low traffic roads (eg cul de sacs, homezones and general access roads) and non-residential car parking with infrequent change (eg schools, offices) ie < 300 traffic movements/day	Low	0.5	0.4	0.4
Commercial yard and delivery areas, non-residential car parking with frequent change (eg hospitals, retail), all roads except low traffic roads and trunk roads/motorways[1]	Medium	0.7	0.6	0.7
Sites with heavy pollution (eg haulage yards, lorry parks, highly frequented lorry approaches to industrial estates, waste sites), sites where chemicals and fuels (other than domestic fuel oil) are to be delivered, handled, stored, used or manufactured; industrial sites; trunk roads and motorways[1]	High	0.8[2]	0.8[2]	0.9[2]

Table 9.3 – CIRIA SuDS Manual C753 (Land use classifications)

9.2.5 The proposed development will incorporate permeable paving for storage and disposal of runoff from the site. Suitable treatment measures offered by SuDS features are set out in CIRA report.

9.2.6 Table 26.3 of C753 reproduced below as Table 9.4 sets out the mitigation indices provided by SuDS features for discharge to surface waters.

TABLE 26.3 Indicative SuDS mitigation indices for discharges to surface waters

	Mitigation indices[1]		
Type of SuDS component	**TSS**	**Metals**	**Hydrocarbons**
Filter strip	0.4	0.4	0.5
Filter drain	0.4[2]	0.4	0.4
Swale	0.5	0.6	0.6
Bioretention system	0.8	0.8	0.8
Permeable pavement	0.7	0.6	0.7
Detention basin	0.5	0.5	0.6
Pond[4]	0.7[3]	0.7	0.5
Wetland	0.8[3]	0.8	0.8
Proprietary treatment systems[5,6]	These must demonstrate that they can address each of the contaminant types to acceptable levels for frequent events up to approximately the 1 in 1 year return period event, for inflow concentrations relevant to the contributing drainage area.		

Table 9.4 – CIRIA SuDS Manual C753 (Mitigation Indices to Surface Water)

9.2.7 The permeable paving will provide mitigation of 0.7 for total suspended solids, 0.6 for metals and 0.7 for hydrocarbons. These are all greater than the pollution hazard indices identified in Table 9.3 above.

10 SUMMARY AND CONCLUSION

10.1.1 This report describes the existing and proposed development, the implications of flooding and the impact the proposed development will have on the flood plain in accordance with the government's guidance document: The National Planning Policy Framework (NPPF), with specific reference to its Planning Practice Guidance.

10.1.2 The site is located at the intersection of Send Marsh Road and Portsmouth Road and is in close proximity to a residential area to the north. The proposals involve the erection of 6 x 3 bed semi-detached houses, a detached 3 bed house and 2x detached 4 bed houses with parking. A new access off Send Marsh Road will be provided for the development.

10.1.3 The EA Flood Map for Planning shows the site is within Flood Zones 2 and 3. The mapping shows the extent of Flood Zone 3 is confined to the corridor of the watercourse with the majority of the site falling within Flood Zone 2. However, an assessment of the EA's latest hydraulic modelling has shown that the majority of the site actually falls within Flood Zone 1. When climate change allowances have been factored into the flood model the proposed properties will still be free from flooding with a probability of 1.0% +25% CC.

10.1.4 This assessment has demonstrated that the proposed development will not restrict the free flow of flood waters or result in the loss of flood storage. The proposed buildings will be free of flooding and a safe access can be provided to and from the site during flood conditions.

10.1.5 The drainage strategy for the site will restrict the runoff from the site to less than the current greenfield rate, the runoff will be attenuated in the permeable paving and below ground tank on site ensuring there is no increased risk of flooding to the proposed development or neighbouring area.

10.1.6 This FRA has demonstrated that the proposals will not have any impact on the current flooding in the area and that a suitable drainage strategy can be provided without increasing the risk of flooding, and we therefore see no reason why these proposals should be refused on the grounds of flooding or drainage.

APPENDIX A

1348-03 Proposed Site Plan

PRIOR TO THE COMMENCEMENT OF ANY WORKS, THE BUILDER IS TO CHECK AND/OR DETERMINE ALL CONSTRUCTION DETAILS, INCLUDING CHECKING EXISTING SITE LEVELS AND DIMENSIONS.THE DRAWING IS TO BE READ IN CONJUNCTION WITH ALL OTHER PROJECT DRAWINGS, CONSTRUCTION NOTES AND/OR PROJECT SPECIFICATION. ALL DISCREPANCIES SHOULD BE REPORTED IMMEDIATELY.

Rev	Date	Details	Drawn

Client:

RUSHMON HOMES

Site Address:
PARKER COLLINS HOUSE, PORTSMOUTH RD, RIPLEY, WOKING, SURREY, GU23 6JA

Description:
PROPOSED SITE PLAN

Status: PLANNING

Date:	DEC '23	Scale:	1:200@A1
Drawn:	JC	Checked:	TCA
Job Number: 1348		Drawing Number: 03	Revision: –

TCA ARCHITECTURAL DESIGN
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KT22 7PL
Tel: 01372 466443
Email: info@tcalimited.com
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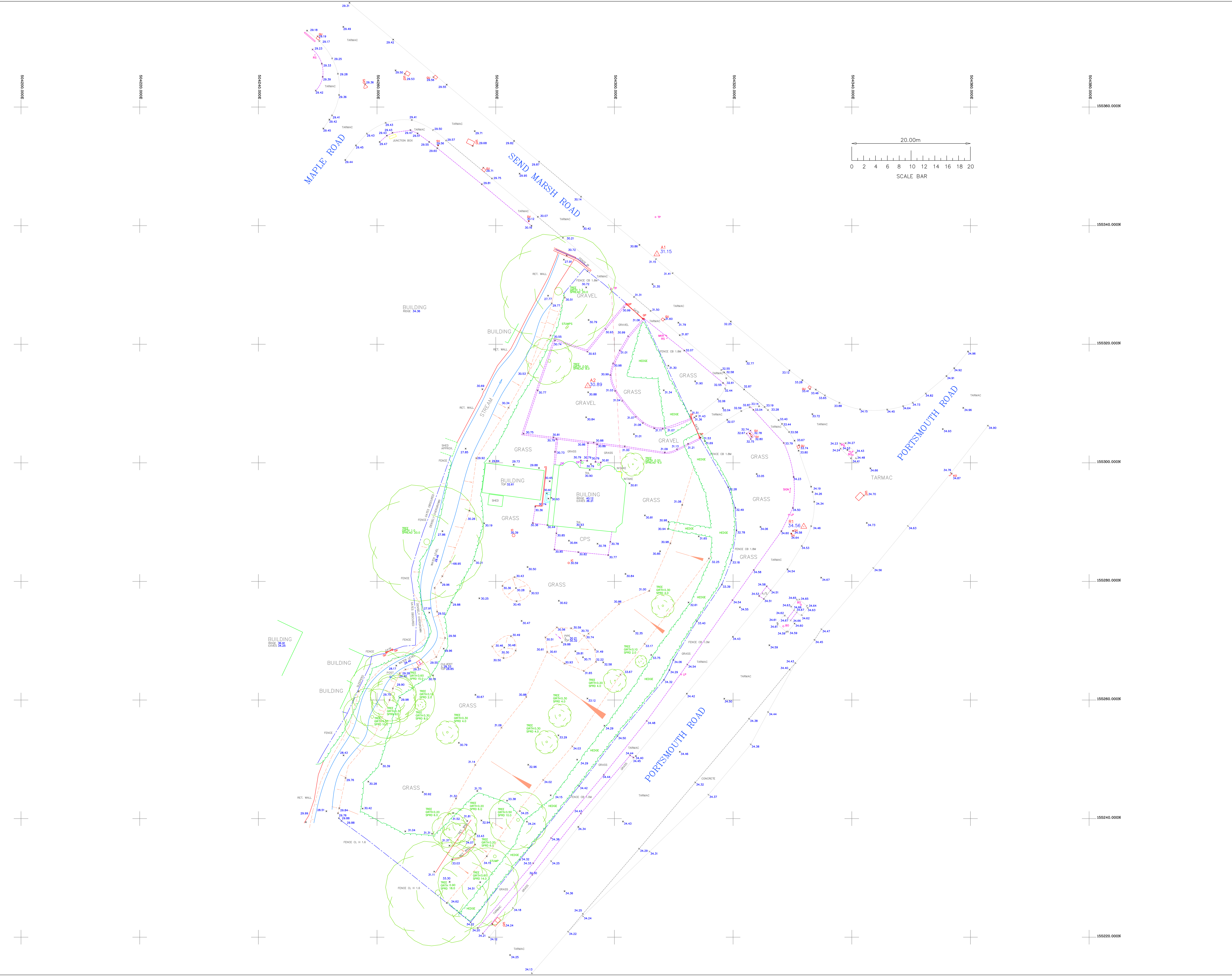
APPENDIX B

Topographical Survey



Building Abbreviations

BL	Basement Level	HD	Heating Duct
BH	Beam Soffit Height	H	Height
BSL	Beam Soffit Level	RWP	Rain Water Pipe
C	Cill Height from FFL	SL	Soffit Level
DP	Down Pipe	SVP	Soil and Vent Pipe
DPC	Damp Proof Course	VP	Vent Pipe
DH	Door Height	W	Window Height from cill
DHL	Door Head level		Direction of Floor Joist Span
FFL	Finished Floor Level	C Level	Cill Level
(2100)	Floor to Ceiling Height	H Level	Window Head Level
(25.26)	or Ceiling Level	------	Detail Approx.
		CSU	Ceiling slopes up
CH	Ceiling Height	F-H	Floor - Window head Ht

Topographical Abbreviations

A/R	Assumed Route	MKR	Marker
BH	Borehole	MT	Mercury Telecom Cover
BOL	Bollard	OHC	Overhead Cable
BT	British Telecom Cover	OHP	Overhead Pipe
BW	Barbed Wire Fence	OSBM	Ordnance Survey Bench Mark
BWK	Brickwork	PB	Post Box
CATV	Cable TV Cover	PGM	Permanent Ground Marker
CB	Close Boarded Fence	PR	Post & Rail Fence
CCTV	Closed Circuit TV	PW	Post & Wire Fence
CHLK	Chainlink Fence	PWM	Post & Wire Mesh Fence
CHPL	Chestnut Paling Fence	RE	Rodding Eye
CL	Cover Level	RG	Road Gully
CM	Cable Marker	RN	Road Name
CP	Catch Pit	RS	Road Sign
CPL	Catch Pit Base Level	RW	Retaining Wall
DIA	Diameter	RWP	Rain Water Pipe
DK	Drop Kerb	SAP	Sapling
DP	Down Pipe	SC	Stop Cock
EJB	Electricity Junction Box	SPR	Spread
EC	Electricity Cover	STA	Traverse Station
EP	Electricity Pole	SV	Stop Valve
ER	Earthing Rod	SVP	Soil Vent Pipe
FH	Fire Hydrant	SW	Storm Water
FIG	Feed Into Ground	TB	Telephone Box
FW	Foul Water	TBM	Temporary Bench Mark
GU	Gully	TFR	Taken From Records
GV	Gas Valve	THL	Threshold Level
H	Height	TJB	Telephone Junction Box
IC	Inspection Cover	TPT	Trial Pit
IL	Invert Level	TL	Traffic Light
IR	Iron Railing Fence	TP	Telephone Pole
KO	Kerb Outlet	UTL	Unable To Lift
LB	Litter Bin	UTT	Unable To Trace
LC	Lamp Column	VP	Vent Pipe
LP	Lamp Post	WKH	Water Key Hole
MH	Manhole	WM	Water Meter
		WV	Water Valve
		- - -	Approximate

THIS SURVEY DATA HAS BEEN PREPARED FOR THE CLIENT DETAILED BELOW TO AN AGREED SPECIFICATION. UNLESS OTHERWISE AGREED IN WRITING THE LIABILITY OF REED GEOMATICS LTD IS LIMITED TO THE CLIENT OR HIS APPOINTED AGENT AND DOES NOT EXTEND TO USE BEYOND THE LIMITATIONS OF THE SPECIFICATION.

Survey Station Information

STA No.	Easting	Northing	Level	Type
STN A1	504307.154	155335.187	31.15	Nail
STN A2	504295.514	155312.954	30.89	Nail
STN R1	504331.914	155289.243	34.56	Nail

Notes

Grid: Survey is based on a modified Ordnance Survey National Grid (OSGB36), site centered (or centered on STN A1 where present) with a scale factor of 1 applied.

Values have been derived via GPS using the OS active network using the OSGM15 transformation and OSGM15 geoid model.

Level datum: Ordnance Datum Newlyn (ODN).

Rev	QA Check	Description	Date
5	-	-	-
4	-	-	-
3	-	-	-
2	-	-	-
1	SR	Stream and boundaries survey	19-10-2023
0	GR	First Complete Issue	20-07-2023
Prelim	-	Preliminary - Not Complete	-

REEDgeomatics
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SURVEYED	SR	CLIENT: RUSHMON HOMES
DRAWN	SR	
SCALE	1:200	

TOPOGRAPHICAL SURVEY

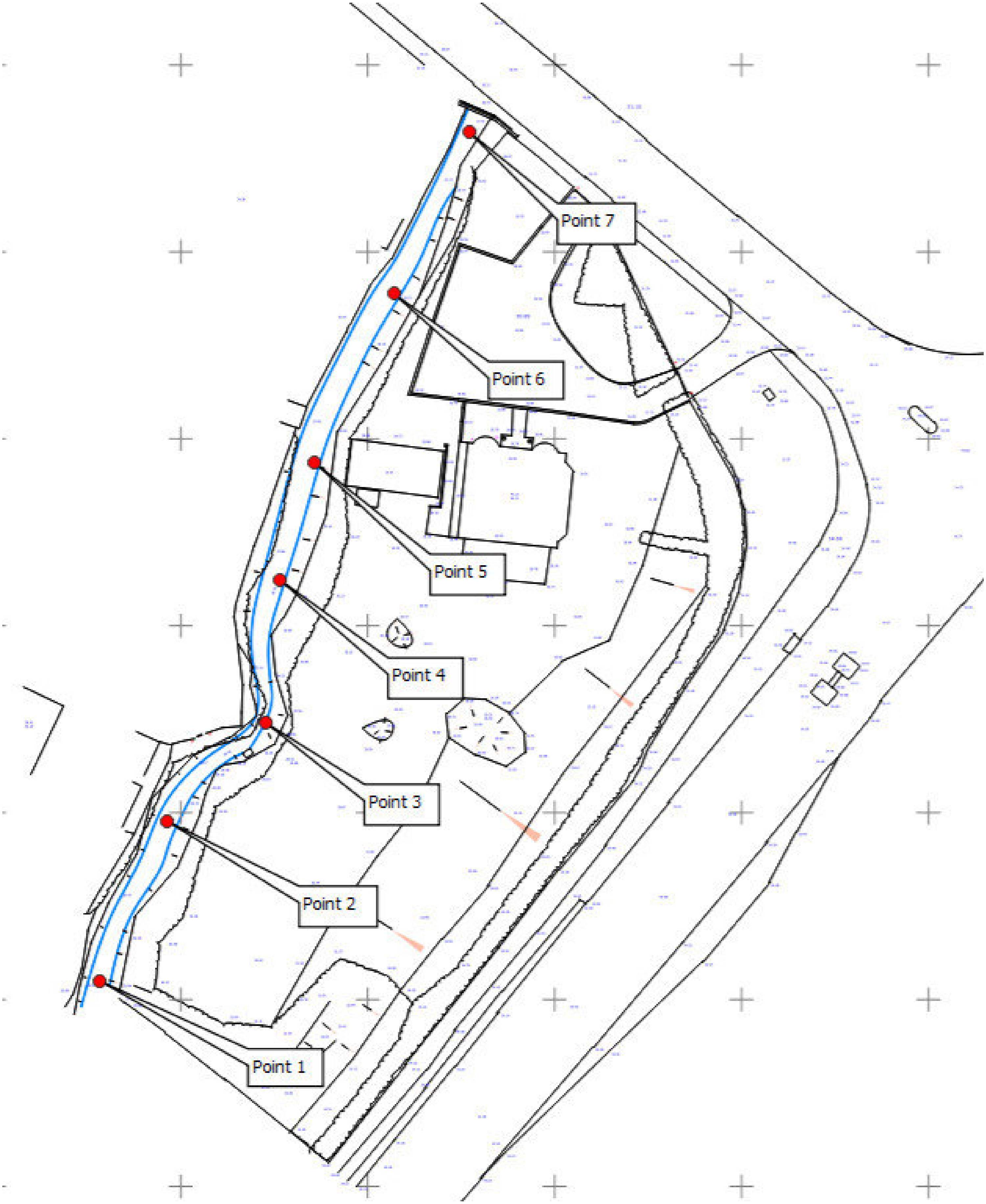
ADDRESS: PARKER COLLINS HOUSE
PORTSMOUTH ROAD
RIPLEY
GU23 6JA

JOB No	DRAWING NUMBER
RG23 2606	01

A0 Sheet

APPENDIX C

Plan 1



PLAN 1

Flood Node Locations

APPENDIX D

231743/FRA/01 – Depths of Flooding for 1% AEP +25% CC

DWG No. 231743/FRA/01

NOTES

KEY:

- Ground level to be raised
- Ground level to be lowered

KEY:

- 0.0m to 0.2m
- 0.2m to 0.4m
- 0.4m to 0.6m
- 0.6m to 0.8m
- 0.8m to 1.0m
- 1.0m to 1.2m
- 1.2m to 1.4m
- 1.4m to 1.6m
- 1.6m to 1.8m
- 1.8m to 2.0m
- 2.0m to 2.2m
- 2.2m to 2.4m

Rev	Amendment	Drawn	Checked	Approved	Date

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Rushmon Homes Ltd

Parker Collins House
Portsmouth Road, Ripley

Depth of Flooding for
1% AEP event +25% Climate Change
Defended Scenario

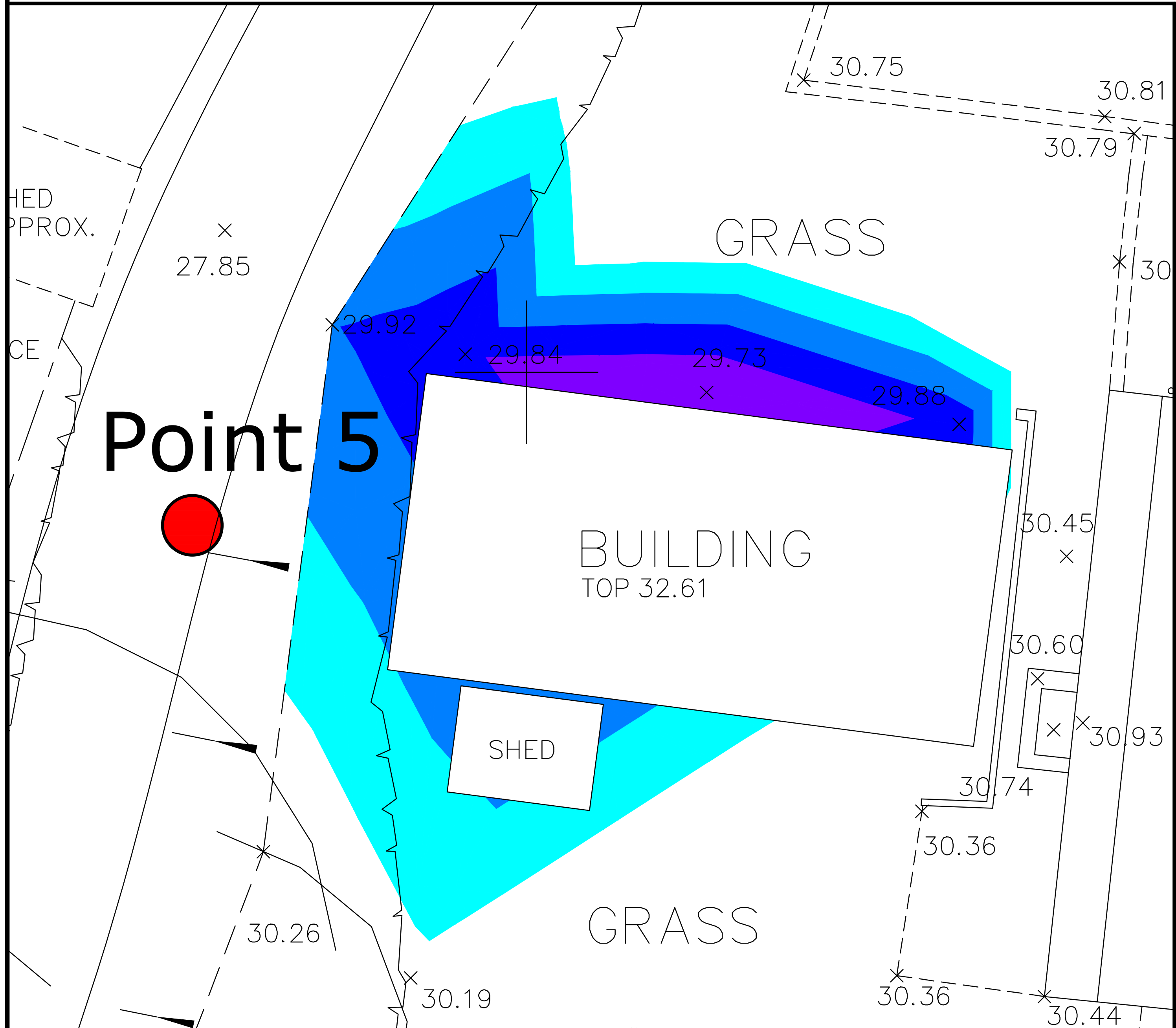
DRAWN	CHECKED	APPROVED
RS	KBL	KBL
DATE Jan-24	DATE Jan-24	DATE Jan-24

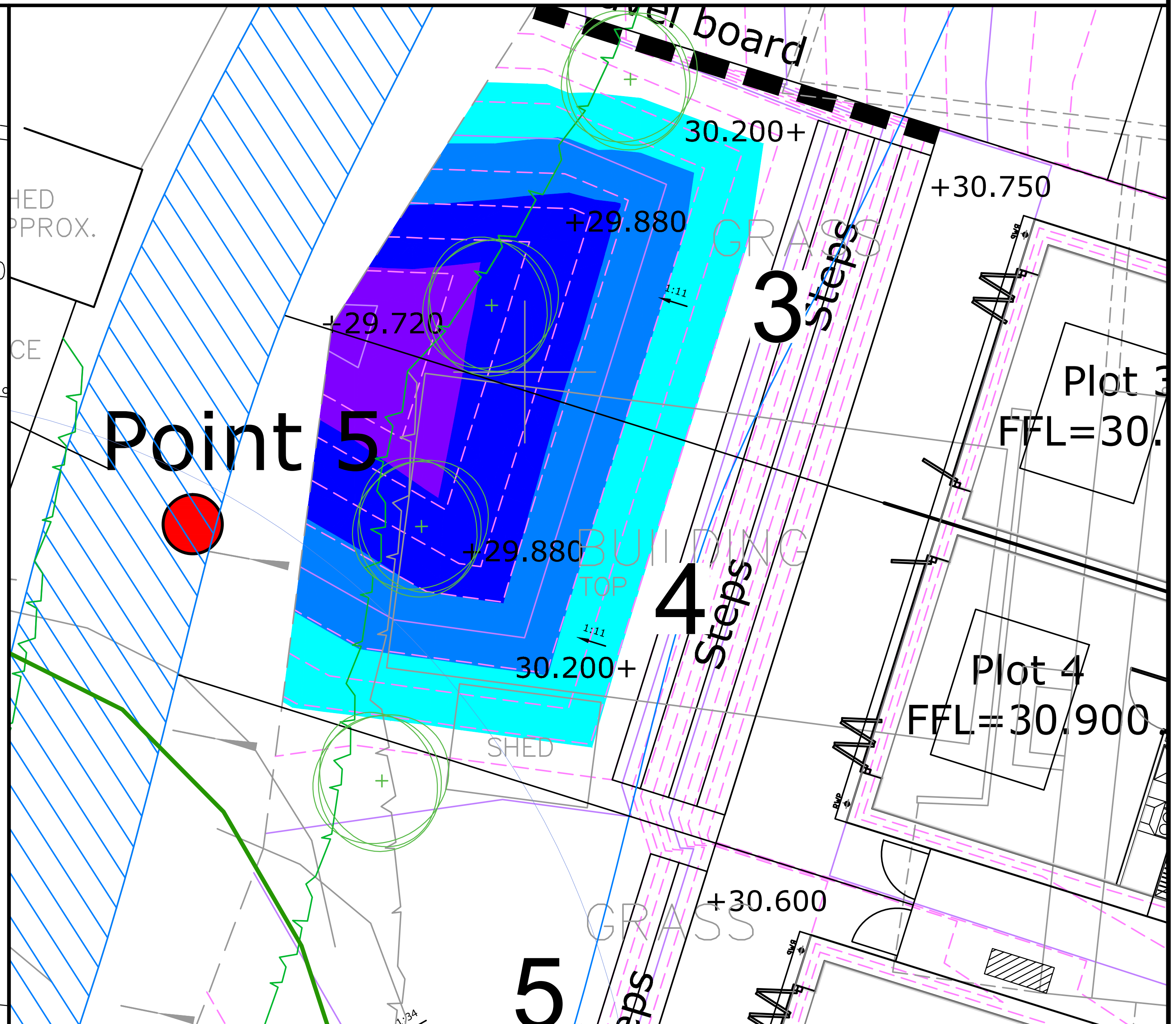
SCALE	PRJ No.	SIZE	REV
1:200	231743	A1	-

DWG No. 231743/FRA/01

231743/FRA/02 – Existing & Proposed Flood Storage Volumes

Existing and Proposed Flood Storage Volumes									
Band	Color	Minimum Depth	Maximum Depth	Existing Volume	Existing Cum.	Proposed Volume	Proposed Cum.	Change Volume	Change Cum.
1		0.00	0.10	4.07	7.20	5.24	10.43	+1.17	+3.23
2		0.10	0.20	2.08	3.13	3.35	5.19	+1.27	+2.06
3		0.20	0.30	0.83	1.05	1.62	1.84	+0.79	+0.79
4		0.30	0.40	0.22	0.22	0.22	0.22	0	0





Rushmon Homes Ltd

Parker Collins House
Portsmouth Road, Ripley

Existing & Proposed Flood Storage Volumes

SCALE	DRAWN BY	PRJ No.	DWG No.
1:100	RS	231743	231743/FRA/02

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231743/SK/02 – Proposed Levels

DWG No. 231743/SK/02

NOTES

Rev	Amendment	Drawn	Checked	Approved	Date

LANMOR Consulting

Civil Engineers & Transport Planning

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Rushmon Homes Ltd

Parker Collins House
Portsmouth Road, Ripley

Proposed Levels

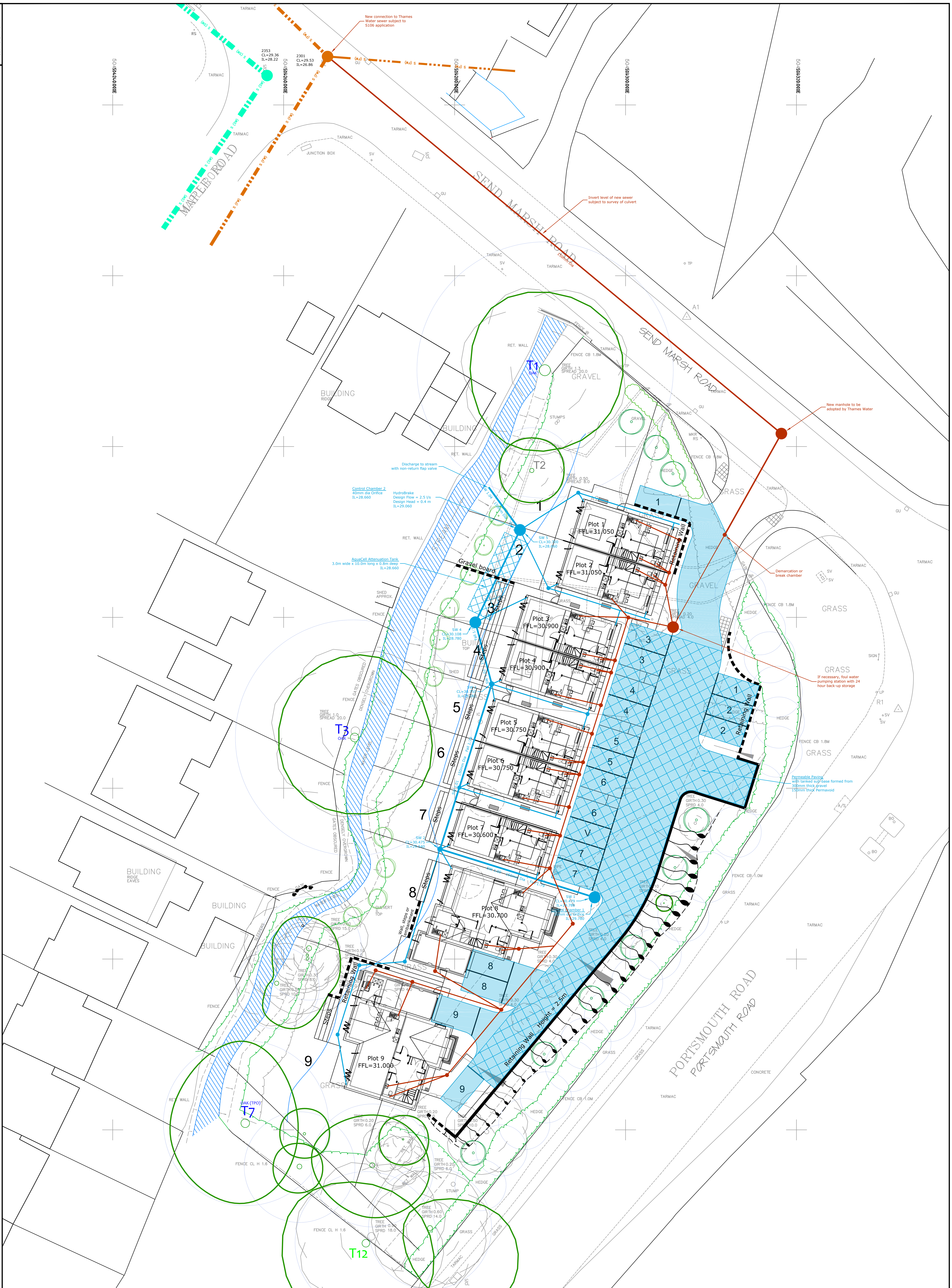
DRAWN	CHECKED	APPROVED
RS	KBL	KBL
DATE Jan-24	DATE Jan-24	DATE Jan-24

SCALE	PRJ No.	SIZE	REV
1:200	231743	A1	-
DWG No. 231743/SK/02			

APPENDIX E

231743/DS/01 – Proposed Drainage Strategy

DWG No. 231743/DS/01

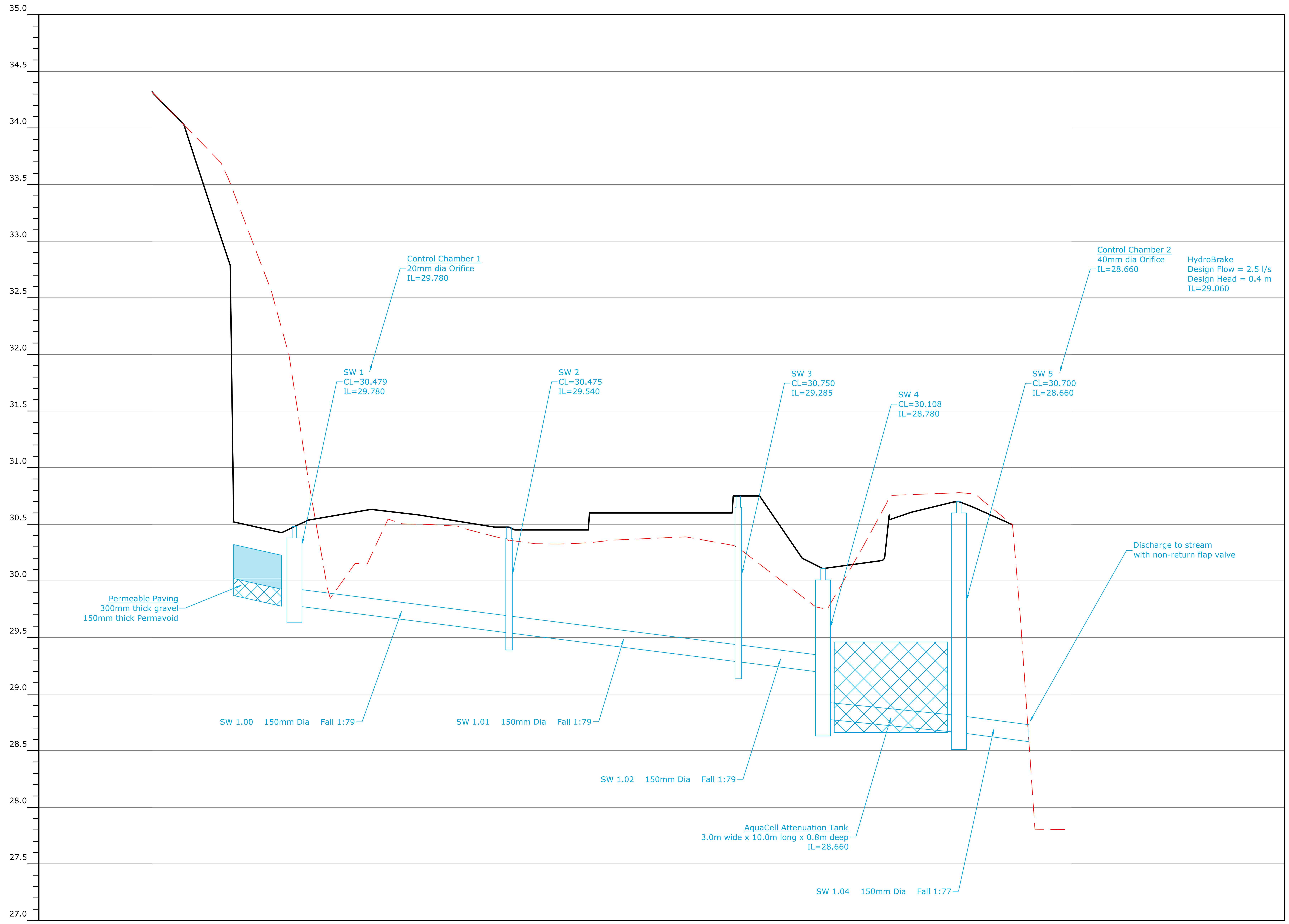


Rushmon Homes Ltd	Parker Collins House Portsmouth Road, Ripley			Drainage Strategy				LANMOR Consulting Civil Engineers & Transport Planning
	DRAWN RS	CHECKED KBL	APPROVED KBL	SCALE 1:200	JOB No. 231743	SIZE A1	REV -	158 Tolworth Rise South, Surbiton, Surrey, KT5 9NJ Telephone: 020 8241 0580 Fax: 020 8241 7290 e-mail: info@lanmor.co.uk www.lanmor.co.uk
	DATE Jan-24	DATE Jan-24	DATE Jan-24	DWG No. 231743/DS/01				

231743/DS/02 – Surface Water Sewer Long Section

DWG No. 231743/DS/02

Surface Water Drainage



NOTES

Rev	Amendment	Drawn	Checked	Approved	Date

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Rushmon Homes Ltd

Parker Collins House
Portsmouth Road, Ripley

Drainage Strategy
Surface Water Sewer Long Section

DRAWN	RS	CHECKED	KBL	APPROVED	KBL
DATE	Jan-24	DATE	Jan-24	DATE	Jan-24
SCALE	H 1:200 V 1:20	PRJ No.	231743	SIZE	REV
DWG No.	231743/DS/02			A1	-

APPENDIX F

Greenfield Calculations

ICP SUDS Mean Annual Flood

Input

Return Period (years)	100	SAAR (mm)	700	Urban	0.000
Area (ha)	0.414	Soil	0.450	Region Number	Region 6

Results	**l/s**
QBAR Rural	1.8
QBAR Urban	1.8
Q100 years	5.8
Q1 year	1.5
Q30 years	4.1
Q100 years	5.8

Permeable Paving & Tank Calculations

Cascade Summary of Results for PAVING.srcx

Upstream Structures	Outflow To	Overflow To
(None)	TANK.srcx	(None)

Half Drain Time : 202 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	29.780	0.000	0.0	0.0	0.0	0.0	O K
30 min Summer	29.819	0.039	0.0	0.1	0.1	0.6	O K
60 min Summer	29.851	0.071	0.0	0.2	0.2	1.9	O K
120 min Summer	29.872	0.092	0.0	0.2	0.2	3.2	O K
180 min Summer	29.881	0.101	0.0	0.3	0.3	3.8	O K
240 min Summer	29.886	0.106	0.0	0.3	0.3	4.1	O K
360 min Summer	29.891	0.111	0.0	0.3	0.3	4.5	O K
480 min Summer	29.894	0.114	0.0	0.3	0.3	4.8	O K
600 min Summer	29.895	0.115	0.0	0.3	0.3	4.9	O K
720 min Summer	29.896	0.116	0.0	0.3	0.3	5.0	O K
960 min Summer	29.896	0.116	0.0	0.3	0.3	5.0	O K
1440 min Summer	29.894	0.114	0.0	0.3	0.3	4.8	O K
2160 min Summer	29.886	0.106	0.0	0.3	0.3	4.2	O K
2880 min Summer	29.878	0.098	0.0	0.2	0.2	3.6	O K
4320 min Summer	29.862	0.082	0.0	0.2	0.2	2.5	O K
5760 min Summer	29.850	0.070	0.0	0.2	0.2	1.8	O K
7200 min Summer	29.840	0.060	0.0	0.2	0.2	1.3	O K
8640 min Summer	29.832	0.052	0.0	0.2	0.2	1.0	O K
10080 min Summer	29.825	0.045	0.0	0.2	0.2	0.8	O K
15 min Winter	29.780	0.000	0.0	0.0	0.0	0.0	O K
30 min Winter	29.838	0.058	0.0	0.2	0.2	1.3	O K
60 min Winter	29.867	0.087	0.0	0.2	0.2	2.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	30.991	0.0	0.0	0
30 min Summer	20.215	0.0	0.6	33
60 min Summer	12.800	0.0	2.2	62
120 min Summer	7.942	0.0	3.9	122
180 min Summer	5.979	0.0	5.0	180
240 min Summer	4.882	0.0	5.9	224
360 min Summer	3.646	0.0	7.0	280
480 min Summer	2.956	0.0	7.8	344
600 min Summer	2.511	0.0	8.5	412
720 min Summer	2.199	0.0	8.9	482
960 min Summer	1.782	0.0	9.7	616
1440 min Summer	1.326	0.0	10.6	882
2160 min Summer	0.988	0.0	11.3	1276
2880 min Summer	0.800	0.0	11.4	1648
4320 min Summer	0.595	0.0	11.0	2380
5760 min Summer	0.483	0.0	10.6	3112
7200 min Summer	0.410	0.0	10.4	3816
8640 min Summer	0.359	0.0	10.1	4496
10080 min Summer	0.322	0.0	9.8	5152
15 min Winter	30.991	0.0	0.0	0
30 min Winter	20.215	0.0	1.4	33
60 min Winter	12.800	0.0	3.1	62

Cascade Summary of Results for PAVING.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
120 min Winter	29.887	0.107	0.0	0.3	0.3	4.3	O K
180 min Winter	29.897	0.117	0.0	0.3	0.3	5.0	O K
240 min Winter	29.902	0.122	0.0	0.3	0.3	5.5	O K
360 min Winter	29.906	0.126	0.0	0.3	0.3	5.8	O K
480 min Winter	29.908	0.128	0.0	0.3	0.3	6.0	O K
600 min Winter	29.909	0.129	0.0	0.3	0.3	6.1	O K
720 min Winter	29.908	0.128	0.0	0.3	0.3	6.1	O K
960 min Winter	29.907	0.127	0.0	0.3	0.3	5.9	O K
1440 min Winter	29.900	0.120	0.0	0.3	0.3	5.3	O K
2160 min Winter	29.887	0.107	0.0	0.3	0.3	4.3	O K
2880 min Winter	29.874	0.094	0.0	0.2	0.2	3.3	O K
4320 min Winter	29.852	0.072	0.0	0.2	0.2	1.9	O K
5760 min Winter	29.835	0.055	0.0	0.2	0.2	1.1	O K
7200 min Winter	29.823	0.043	0.0	0.2	0.2	0.7	O K
8640 min Winter	29.815	0.035	0.0	0.1	0.1	0.5	O K
10080 min Winter	29.809	0.029	0.0	0.1	0.1	0.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
120 min Winter	7.942	0.0	5.1	118
180 min Winter	5.979	0.0	6.4	176
240 min Winter	4.882	0.0	7.3	230
360 min Winter	3.646	0.0	8.6	294
480 min Winter	2.956	0.0	9.6	368
600 min Winter	2.511	0.0	10.3	444
720 min Winter	2.199	0.0	10.9	520
960 min Winter	1.782	0.0	11.8	666
1440 min Winter	1.326	0.0	13.0	952
2160 min Winter	0.988	0.0	14.0	1344
2880 min Winter	0.800	0.0	14.4	1728
4320 min Winter	0.595	0.0	14.3	2424
5760 min Winter	0.483	0.0	13.8	3112
7200 min Winter	0.410	0.0	13.3	3752
8640 min Winter	0.359	0.0	12.8	4488
10080 min Winter	0.322	0.0	12.4	5136

Cascade Rainfall Details for PAVING.srcx

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	1	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.081

Time (mins) From:	To:	Area (ha)
0	4	0.081

Cascade Model Details for PAVING.srcx

Storage is Online Cover Level (m) 30.430

Complex Structure

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	4.1
Membrane Percolation (mm/hr)	1000	Length (m)	26.7
Max Percolation (l/s)	30.4	Slope (1:X)	50.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.95	Evaporation (mm/day)	3
Invert Level (m)	29.780	Cap Volume Depth (m)	0.150

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	11.5
Membrane Percolation (mm/hr)	1000	Length (m)	31.3
Max Percolation (l/s)	100.0	Slope (1:X)	50.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.95	Evaporation (mm/day)	3
Invert Level (m)	29.780	Cap Volume Depth (m)	0.150

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1000	Length (m)	7.5
Max Percolation (l/s)	10.4	Slope (1:X)	40.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.95	Evaporation (mm/day)	3
Invert Level (m)	29.920	Cap Volume Depth (m)	0.150

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	4.1
Membrane Percolation (mm/hr)	1000	Length (m)	26.7
Max Percolation (l/s)	30.4	Slope (1:X)	50.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	29.930	Cap Volume Depth (m)	0.300

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	11.5
Membrane Percolation (mm/hr)	1000	Length (m)	31.3
Max Percolation (l/s)	100.0	Slope (1:X)	50.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	29.930	Cap Volume Depth (m)	0.300

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1000	Length (m)	7.5
Max Percolation (l/s)	10.4	Slope (1:X)	36.3
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.95	Evaporation (mm/day)	3
Invert Level (m)	30.010	Cap Volume Depth (m)	0.150

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1000	Length (m)	7.5
Max Percolation (l/s)	10.4	Slope (1:X)	40.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	30.070	Cap Volume Depth (m)	0.300

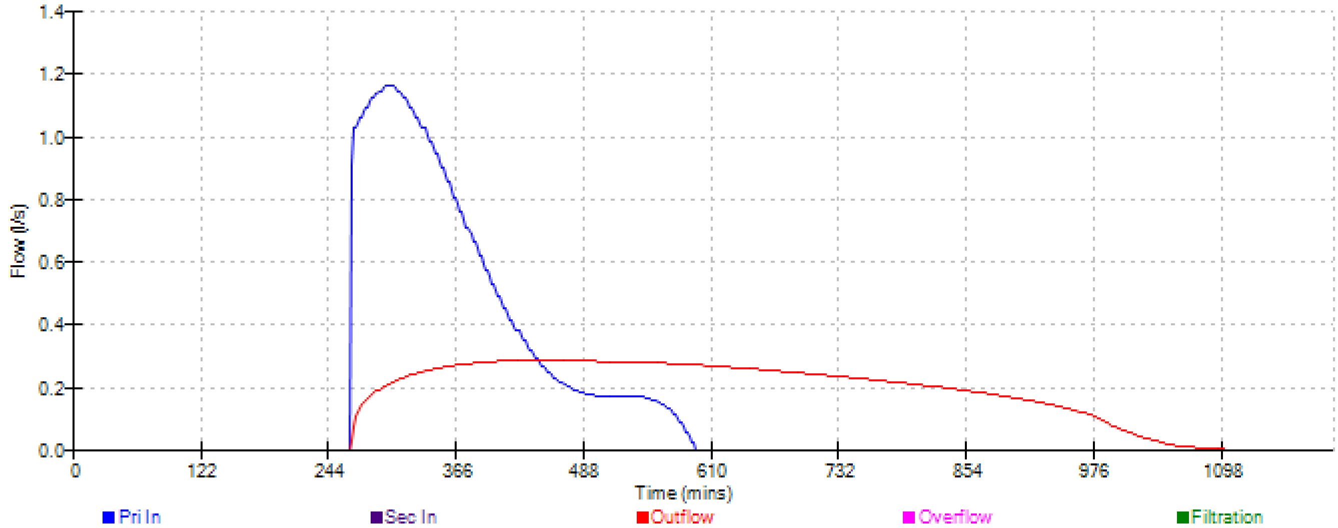
Porous Car Park

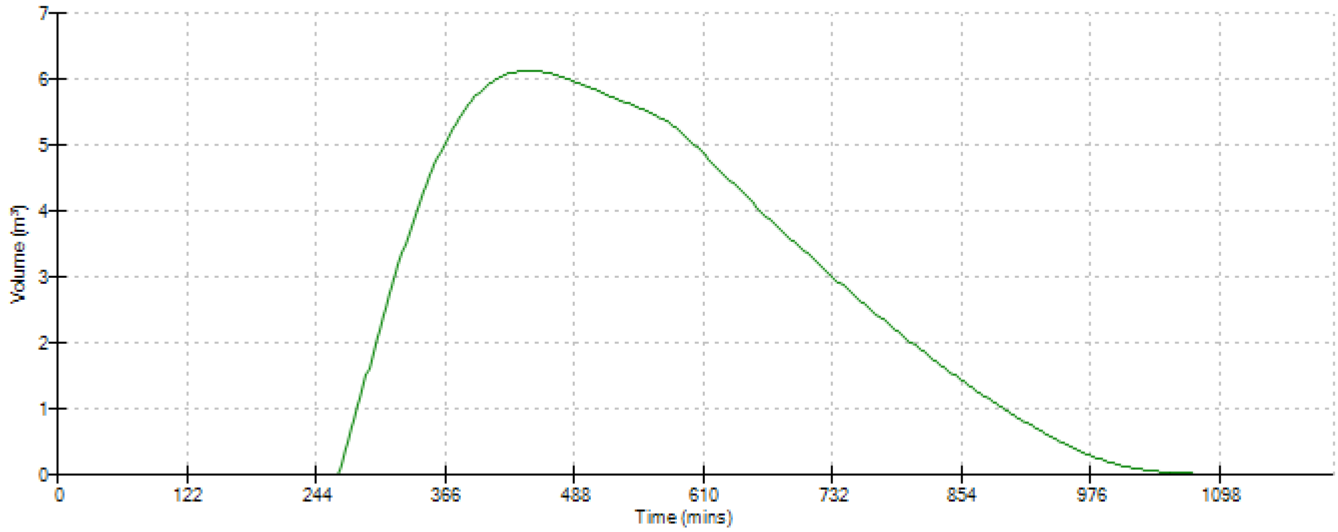
Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1000	Length (m)	7.5
Max Percolation (l/s)	10.4	Slope (1:X)	36.3
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	30.160	Cap Volume Depth (m)	0.300

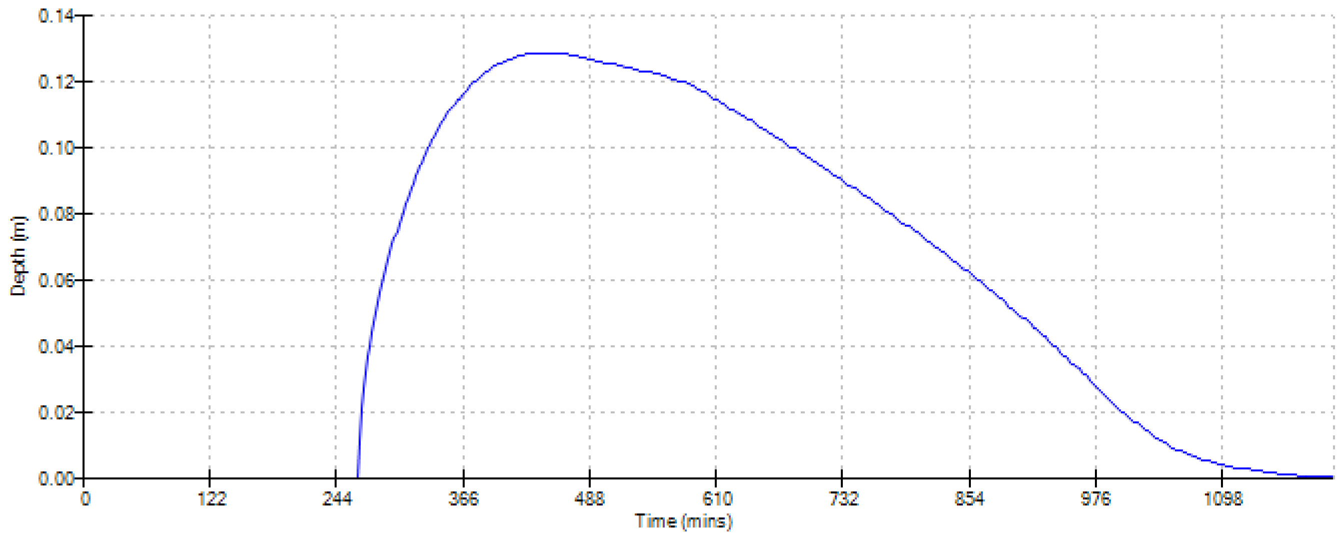
Orifice Outflow Control

Diameter (m) 0.020 Discharge Coefficient 0.600 Invert Level (m) 29.780

<u>Cascade Event: 600 min Winter for PAVING.srcx</u>







Cascade Summary of Results for TANK.srcx

Upstream Structures	Outflow To	Overflow To
PAVING.srcx	(None)	(None)

Half Drain Time : 42 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	28.775	0.115	0.0	1.0	0.0	1.0	3.3	O K
30 min Summer	28.797	0.137	0.0	1.1	0.0	1.1	3.9	O K
60 min Summer	28.812	0.152	0.0	1.2	0.0	1.2	4.3	O K
120 min Summer	28.817	0.157	0.0	1.2	0.0	1.2	4.5	O K
180 min Summer	28.813	0.153	0.0	1.2	0.0	1.2	4.4	O K
240 min Summer	28.808	0.148	0.0	1.2	0.0	1.2	4.2	O K
360 min Summer	28.794	0.134	0.0	1.1	0.0	1.1	3.8	O K
480 min Summer	28.782	0.122	0.0	1.1	0.0	1.1	3.5	O K
600 min Summer	28.773	0.113	0.0	1.0	0.0	1.0	3.2	O K
720 min Summer	28.765	0.105	0.0	1.0	0.0	1.0	3.0	O K
960 min Summer	28.753	0.093	0.0	0.9	0.0	0.9	2.7	O K
1440 min Summer	28.737	0.077	0.0	0.8	0.0	0.8	2.2	O K
2160 min Summer	28.723	0.063	0.0	0.7	0.0	0.7	1.8	O K
2880 min Summer	28.716	0.056	0.0	0.6	0.0	0.6	1.6	O K
4320 min Summer	28.709	0.049	0.0	0.5	0.0	0.5	1.4	O K
5760 min Summer	28.704	0.044	0.0	0.4	0.0	0.4	1.3	O K
7200 min Summer	28.701	0.041	0.0	0.4	0.0	0.4	1.2	O K
8640 min Summer	28.699	0.039	0.0	0.4	0.0	0.4	1.1	O K
10080 min Summer	28.697	0.037	0.0	0.3	0.0	0.3	1.0	O K
15 min Winter	28.790	0.130	0.0	1.1	0.0	1.1	3.7	O K
30 min Winter	28.816	0.156	0.0	1.2	0.0	1.2	4.4	O K
60 min Winter	28.831	0.171	0.0	1.3	0.0	1.3	4.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	30.991	0.0	3.8	0.0	16
30 min Summer	20.215	0.0	5.6	0.0	29
60 min Summer	12.800	0.0	8.5	0.0	46
120 min Summer	7.942	0.0	11.8	0.0	80
180 min Summer	5.979	0.0	13.9	0.0	114
240 min Summer	4.882	0.0	15.5	0.0	148
360 min Summer	3.646	0.0	17.8	0.0	216
480 min Summer	2.956	0.0	19.5	0.0	280
600 min Summer	2.511	0.0	20.9	0.0	344
720 min Summer	2.199	0.0	22.0	0.0	406
960 min Summer	1.782	0.0	23.8	0.0	530
1440 min Summer	1.326	0.0	26.4	0.0	768
2160 min Summer	0.988	0.0	28.8	0.0	1128
2880 min Summer	0.800	0.0	30.4	0.0	1472
4320 min Summer	0.595	0.0	32.2	0.0	2204
5760 min Summer	0.483	0.0	33.6	0.0	2944
7200 min Summer	0.410	0.0	34.7	0.0	3672
8640 min Summer	0.359	0.0	35.7	0.0	4408
10080 min Summer	0.322	0.0	36.5	0.0	5136
15 min Winter	30.991	0.0	4.3	0.0	16
30 min Winter	20.215	0.0	6.9	0.0	30
60 min Winter	12.800	0.0	10.2	0.0	48

Cascade Summary of Results for TANK.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
120 min Winter	28.832	0.172	0.0	1.3	0.0	1.3	4.9	O K
180 min Winter	28.824	0.164	0.0	1.3	0.0	1.3	4.7	O K
240 min Winter	28.814	0.154	0.0	1.2	0.0	1.2	4.4	O K
360 min Winter	28.794	0.134	0.0	1.1	0.0	1.1	3.8	O K
480 min Winter	28.779	0.119	0.0	1.0	0.0	1.0	3.4	O K
600 min Winter	28.767	0.107	0.0	1.0	0.0	1.0	3.0	O K
720 min Winter	28.757	0.097	0.0	0.9	0.0	0.9	2.8	O K
960 min Winter	28.744	0.084	0.0	0.8	0.0	0.8	2.4	O K
1440 min Winter	28.727	0.067	0.0	0.7	0.0	0.7	1.9	O K
2160 min Winter	28.715	0.055	0.0	0.6	0.0	0.6	1.6	O K
2880 min Winter	28.710	0.050	0.0	0.5	0.0	0.5	1.4	O K
4320 min Winter	28.703	0.043	0.0	0.4	0.0	0.4	1.2	O K
5760 min Winter	28.699	0.039	0.0	0.4	0.0	0.4	1.1	O K
7200 min Winter	28.695	0.035	0.0	0.3	0.0	0.3	1.0	O K
8640 min Winter	28.693	0.033	0.0	0.3	0.0	0.3	0.9	O K
10080 min Winter	28.690	0.030	0.0	0.2	0.0	0.2	0.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
120 min Winter	7.942	0.0	13.9	0.0	86
180 min Winter	5.979	0.0	16.3	0.0	124
240 min Winter	4.882	0.0	18.1	0.0	160
360 min Winter	3.646	0.0	20.7	0.0	228
480 min Winter	2.956	0.0	22.7	0.0	296
600 min Winter	2.511	0.0	24.2	0.0	362
720 min Winter	2.199	0.0	25.5	0.0	426
960 min Winter	1.782	0.0	27.6	0.0	550
1440 min Winter	1.326	0.0	30.6	0.0	794
2160 min Winter	0.988	0.0	33.7	0.0	1148
2880 min Winter	0.800	0.0	35.7	0.0	1500
4320 min Winter	0.595	0.0	38.1	0.0	2236
5760 min Winter	0.483	0.0	39.4	0.0	2992
7200 min Winter	0.410	0.0	40.5	0.0	3752
8640 min Winter	0.359	0.0	41.5	0.0	4456
10080 min Winter	0.322	0.0	42.3	0.0	5144

Cascade Rainfall Details for TANK.srcx

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	1	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.066

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.066

Cascade Model Details for TANK.srcx

Storage is Online Cover Level (m) 30.500

Cellular Storage Structure

Invert Level (m) 28.660 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	30.0	30.0	0.800	30.0	50.8	0.801	0.0	50.8

Orifice Outflow Control

Diameter (m) 0.040 Discharge Coefficient 0.600 Invert Level (m) 28.660

Hydro-Brake Optimum® Overflow Control

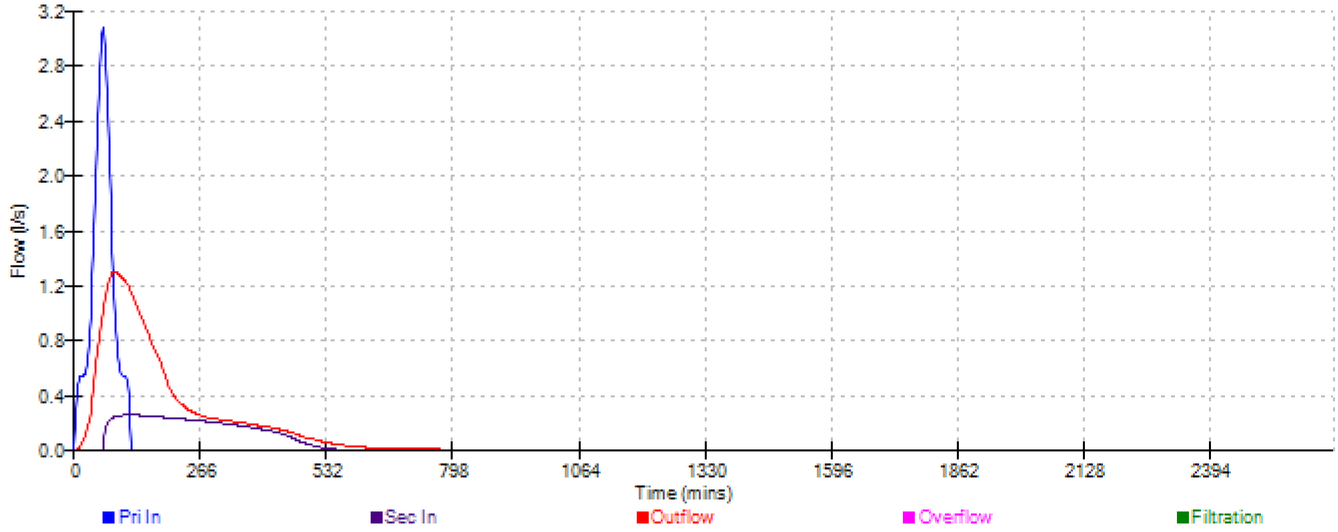
Unit Reference	MD-SHE-0083-2500-0400-2500
Design Head (m)	0.400
Design Flow (l/s)	2.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	83
Invert Level (m)	29.060
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

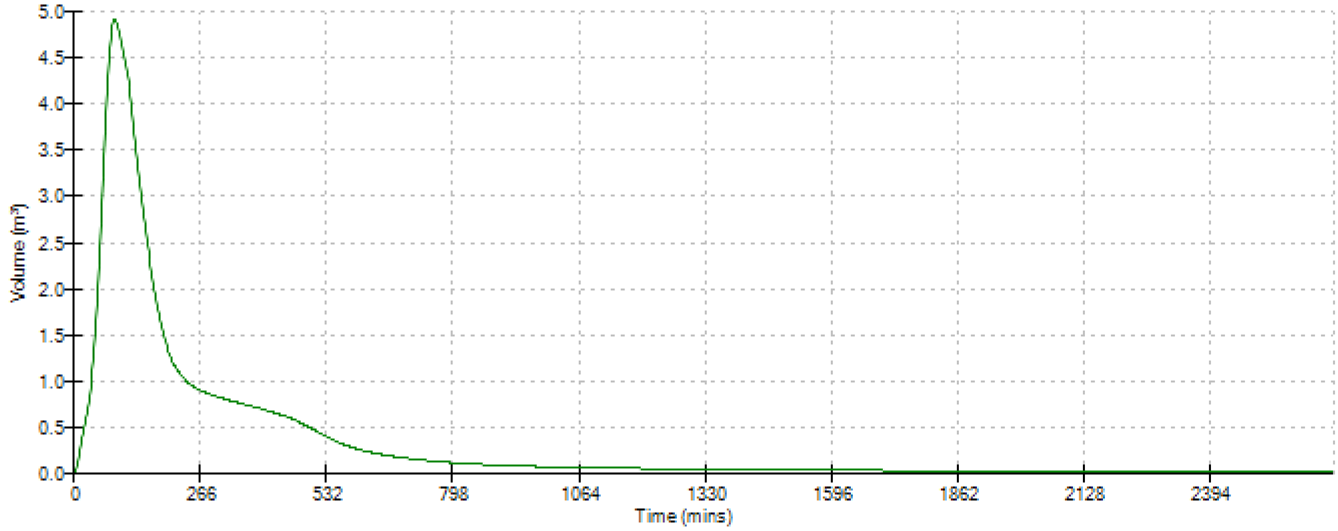
Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.400	2.5	Kick-Flo®	0.290	2.1
Flush-Flo™	0.131	2.4	Mean Flow over Head Range	-	2.0

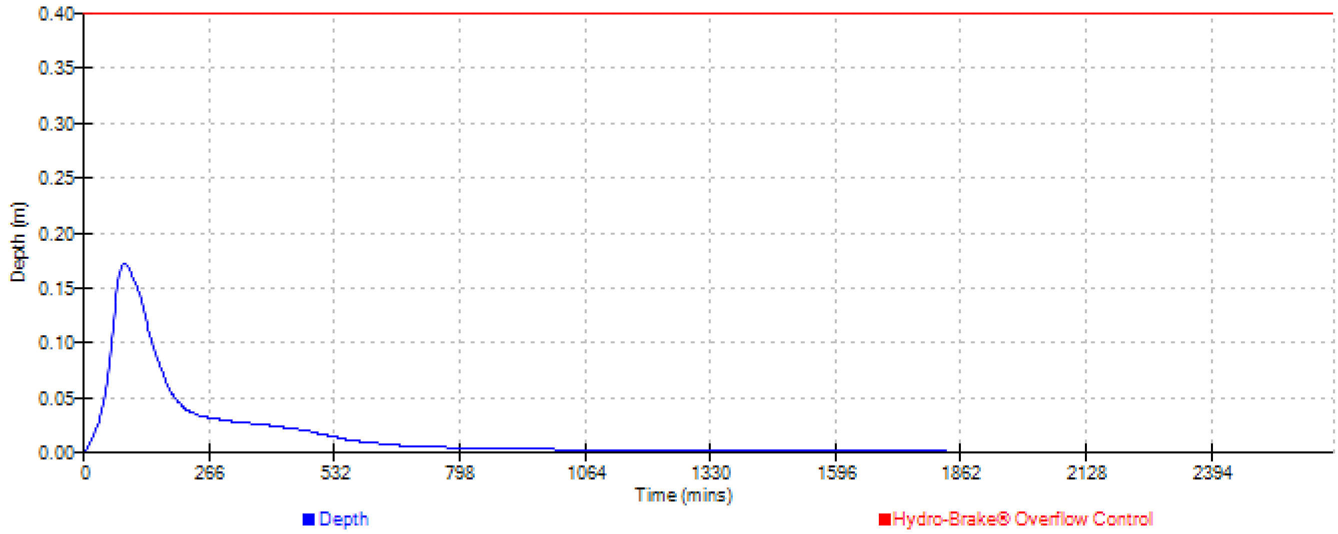
The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.4	0.800	3.4	2.000	5.2	4.000	7.1	7.000	9.4
0.200	2.4	1.000	3.7	2.200	5.4	4.500	7.5	7.500	9.8
0.300	2.2	1.200	4.1	2.400	5.6	5.000	8.0	8.000	10.1
0.400	2.5	1.400	4.4	2.600	5.8	5.500	8.3	8.500	10.4
0.500	2.7	1.600	4.6	3.000	6.2	6.000	8.7	9.000	10.7
0.600	3.0	1.800	4.9	3.500	6.7	6.500	9.1	9.500	11.0

Cascade Event: 120 min Winter for TANK.srcx







Cascade Summary of Results for PAVING.srcx

Upstream Structures	Outflow To	Overflow To
(None)	TANK.srcx	(None)

Half Drain Time : 505 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	29.906	0.126	0.0	0.3	0.3	5.9	O K
30 min Summer	29.937	0.157	0.0	0.3	0.3	9.2	O K
60 min Summer	29.964	0.184	0.0	0.3	0.3	12.5	O K
120 min Summer	29.987	0.207	0.0	0.4	0.4	15.5	O K
180 min Summer	29.997	0.217	0.0	0.4	0.4	16.9	O K
240 min Summer	30.003	0.223	0.0	0.4	0.4	17.7	O K
360 min Summer	30.007	0.227	0.0	0.4	0.4	18.4	O K
480 min Summer	30.009	0.229	0.0	0.4	0.4	18.5	O K
600 min Summer	30.009	0.229	0.0	0.4	0.4	18.6	O K
720 min Summer	30.009	0.229	0.0	0.4	0.4	18.6	O K
960 min Summer	30.008	0.228	0.0	0.4	0.4	18.5	O K
1440 min Summer	30.003	0.223	0.0	0.4	0.4	17.7	O K
2160 min Summer	29.992	0.212	0.0	0.4	0.4	16.1	O K
2880 min Summer	29.979	0.199	0.0	0.4	0.4	14.4	O K
4320 min Summer	29.956	0.176	0.0	0.3	0.3	11.4	O K
5760 min Summer	29.935	0.155	0.0	0.3	0.3	9.0	O K
7200 min Summer	29.918	0.138	0.0	0.3	0.3	7.1	O K
8640 min Summer	29.903	0.123	0.0	0.3	0.3	5.6	O K
10080 min Summer	29.890	0.110	0.0	0.3	0.3	4.5	O K
15 min Winter	29.920	0.140	0.0	0.3	0.3	7.3	O K
30 min Winter	29.952	0.172	0.0	0.3	0.3	11.0	O K
60 min Winter	29.981	0.201	0.0	0.4	0.4	14.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	76.035	0.0	6.1	19
30 min Summer	49.499	0.0	9.5	34
60 min Summer	30.811	0.0	13.1	64
120 min Summer	18.615	0.0	16.9	122
180 min Summer	13.715	0.0	19.1	182
240 min Summer	10.995	0.0	20.7	242
360 min Summer	8.034	0.0	23.0	360
480 min Summer	6.428	0.0	24.7	414
600 min Summer	5.404	0.0	26.0	476
720 min Summer	4.687	0.0	27.1	536
960 min Summer	3.743	0.0	28.8	672
1440 min Summer	2.723	0.0	31.0	940
2160 min Summer	1.979	0.0	32.9	1344
2880 min Summer	1.577	0.0	34.0	1756
4320 min Summer	1.143	0.0	34.8	2508
5760 min Summer	0.910	0.0	34.6	3232
7200 min Summer	0.762	0.0	33.8	3968
8640 min Summer	0.659	0.0	32.7	4672
10080 min Summer	0.583	0.0	31.7	5352
15 min Winter	76.035	0.0	7.5	19
30 min Winter	49.499	0.0	11.3	33
60 min Winter	30.811	0.0	15.4	62

Cascade Summary of Results for PAVING.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
120 min Winter	30.005	0.225	0.0	0.4	0.4	18.1	O K
180 min Winter	30.017	0.237	0.0	0.4	0.4	19.8	O K
240 min Winter	30.023	0.243	0.0	0.4	0.4	20.7	O K
360 min Winter	30.029	0.249	0.0	0.4	0.4	21.6	O K
480 min Winter	30.030	0.250	0.0	0.4	0.4	21.9	O K
600 min Winter	30.030	0.250	0.0	0.4	0.4	21.7	O K
720 min Winter	30.029	0.249	0.0	0.4	0.4	21.7	O K
960 min Winter	30.027	0.247	0.0	0.4	0.4	21.3	O K
1440 min Winter	30.018	0.238	0.0	0.4	0.4	19.9	O K
2160 min Winter	30.000	0.220	0.0	0.4	0.4	17.3	O K
2880 min Winter	29.982	0.202	0.0	0.4	0.4	14.8	O K
4320 min Winter	29.948	0.168	0.0	0.3	0.3	10.5	O K
5760 min Winter	29.920	0.140	0.0	0.3	0.3	7.3	O K
7200 min Winter	29.897	0.117	0.0	0.3	0.3	5.1	O K
8640 min Winter	29.878	0.098	0.0	0.2	0.2	3.5	O K
10080 min Winter	29.862	0.082	0.0	0.2	0.2	2.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
120 min Winter	18.615	0.0	19.6	120
180 min Winter	13.715	0.0	22.1	178
240 min Winter	10.995	0.0	23.9	236
360 min Winter	8.034	0.0	26.5	348
480 min Winter	6.428	0.0	28.5	454
600 min Winter	5.404	0.0	30.0	546
720 min Winter	4.687	0.0	31.2	570
960 min Winter	3.743	0.0	33.1	722
1440 min Winter	2.723	0.0	35.8	1024
2160 min Winter	1.979	0.0	38.2	1452
2880 min Winter	1.577	0.0	39.6	1872
4320 min Winter	1.143	0.0	41.0	2640
5760 min Winter	0.910	0.0	41.3	3392
7200 min Winter	0.762	0.0	41.0	4104
8640 min Winter	0.659	0.0	40.3	4752
10080 min Winter	0.583	0.0	39.3	5440

Cascade Rainfall Details for PAVING.srcx

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.081

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.081

Cascade Model Details for PAVING.srcx

Storage is Online Cover Level (m) 30.430

Complex Structure

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	4.1
Membrane Percolation (mm/hr)	1000	Length (m)	26.7
Max Percolation (l/s)	30.4	Slope (1:X)	50.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.95	Evaporation (mm/day)	3
Invert Level (m)	29.780	Cap Volume Depth (m)	0.150

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	11.5
Membrane Percolation (mm/hr)	1000	Length (m)	31.3
Max Percolation (l/s)	100.0	Slope (1:X)	50.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.95	Evaporation (mm/day)	3
Invert Level (m)	29.780	Cap Volume Depth (m)	0.150

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1000	Length (m)	7.5
Max Percolation (l/s)	10.4	Slope (1:X)	40.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.95	Evaporation (mm/day)	3
Invert Level (m)	29.920	Cap Volume Depth (m)	0.150

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	4.1
Membrane Percolation (mm/hr)	1000	Length (m)	26.7
Max Percolation (l/s)	30.4	Slope (1:X)	50.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	29.930	Cap Volume Depth (m)	0.300

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	11.5
Membrane Percolation (mm/hr)	1000	Length (m)	31.3
Max Percolation (l/s)	100.0	Slope (1:X)	50.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	29.930	Cap Volume Depth (m)	0.300

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1000	Length (m)	7.5
Max Percolation (l/s)	10.4	Slope (1:X)	36.3
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.95	Evaporation (mm/day)	3
Invert Level (m)	30.010	Cap Volume Depth (m)	0.150

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1000	Length (m)	7.5
Max Percolation (l/s)	10.4	Slope (1:X)	40.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	30.070	Cap Volume Depth (m)	0.300

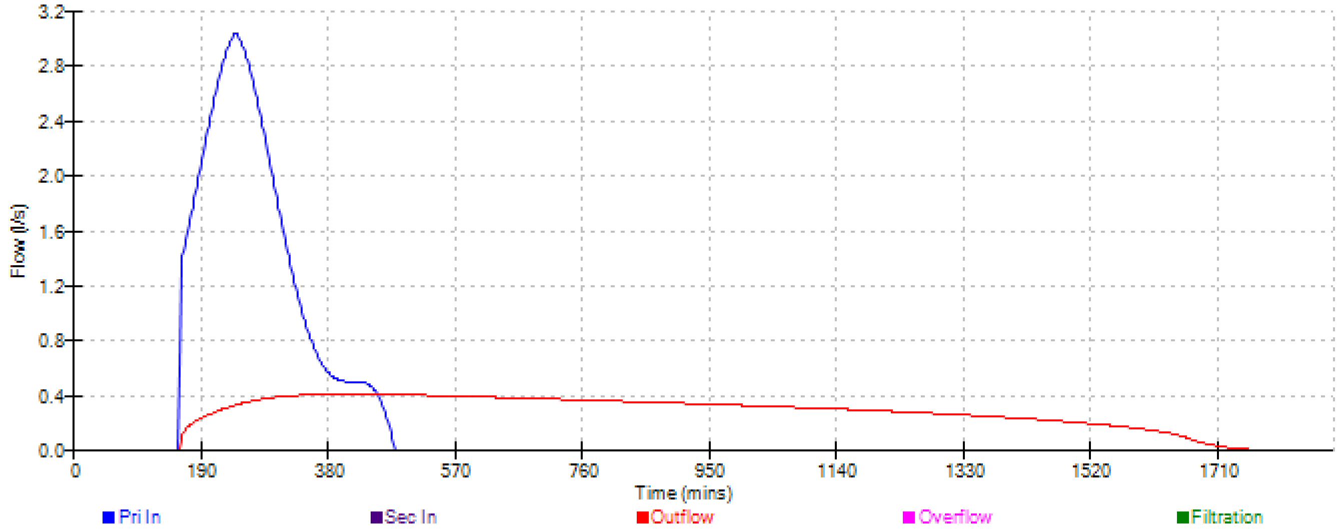
Porous Car Park

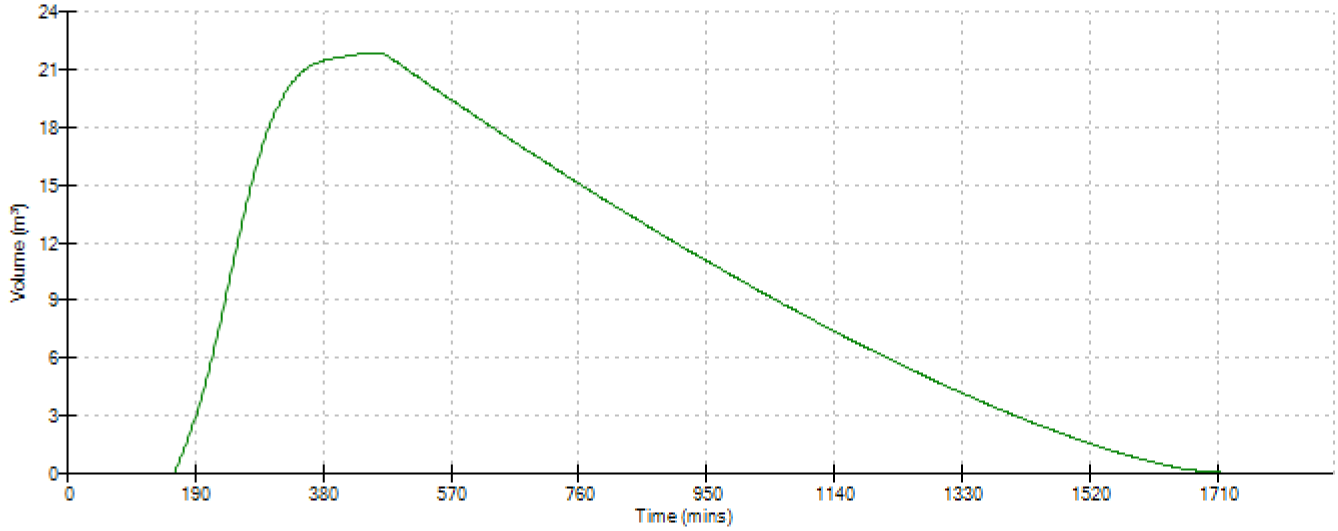
Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1000	Length (m)	7.5
Max Percolation (l/s)	10.4	Slope (1:X)	36.3
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	30.160	Cap Volume Depth (m)	0.300

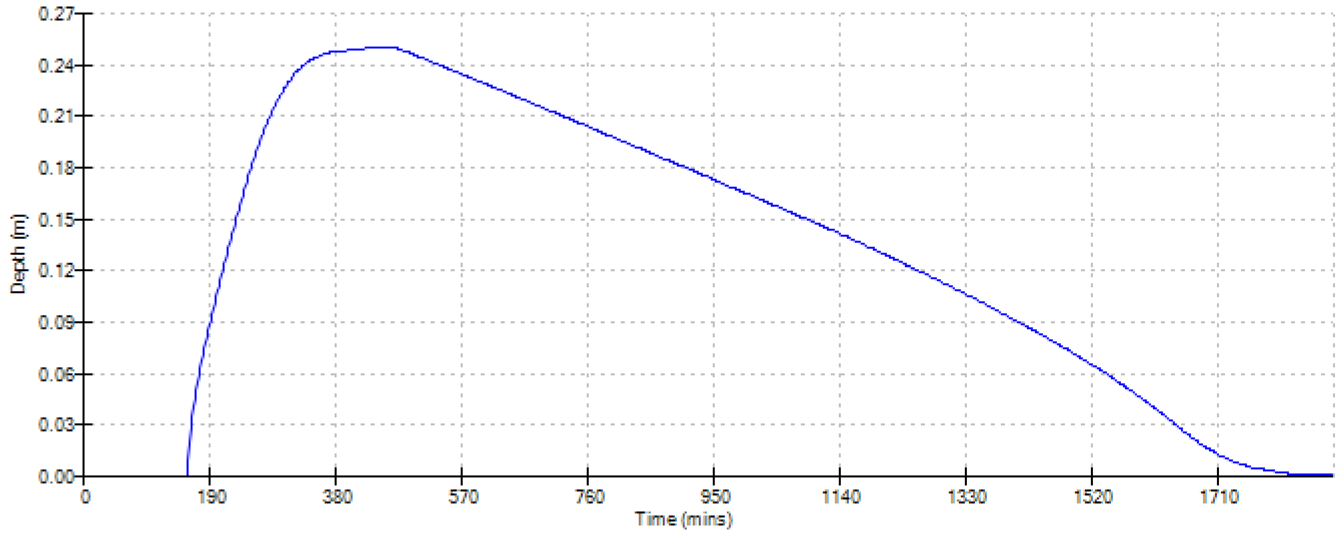
Orifice Outflow Control

Diameter (m) 0.020 Discharge Coefficient 0.600 Invert Level (m) 29.780

Cascade Event: 480 min Winter for PAVING.srcx







Cascade Summary of Results for TANK.srcx

Upstream Structures	Outflow To	Overflow To
PAVING.srcx	(None)	(None)

Half Drain Time : 61 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	28.958	0.298	0.0	1.8	0.0	1.8	8.5	O K
30 min Summer	29.024	0.364	0.0	2.0	0.0	2.0	10.4	O K
60 min Summer	29.060	0.400	0.0	2.1	0.0	2.1	11.4	O K
120 min Summer	29.070	0.410	0.0	2.1	0.1	2.1	11.7	O K
180 min Summer	29.061	0.401	0.0	2.1	0.0	2.1	11.4	O K
240 min Summer	29.046	0.386	0.0	2.0	0.0	2.0	11.0	O K
360 min Summer	29.016	0.356	0.0	1.9	0.0	1.9	10.1	O K
480 min Summer	28.988	0.328	0.0	1.9	0.0	1.9	9.3	O K
600 min Summer	28.964	0.304	0.0	1.8	0.0	1.8	8.7	O K
720 min Summer	28.942	0.282	0.0	1.7	0.0	1.7	8.0	O K
960 min Summer	28.907	0.247	0.0	1.6	0.0	1.6	7.0	O K
1440 min Summer	28.857	0.197	0.0	1.4	0.0	1.4	5.6	O K
2160 min Summer	28.810	0.150	0.0	1.2	0.0	1.2	4.3	O K
2880 min Summer	28.782	0.122	0.0	1.1	0.0	1.1	3.5	O K
4320 min Summer	28.750	0.090	0.0	0.9	0.0	0.9	2.6	O K
5760 min Summer	28.732	0.072	0.0	0.8	0.0	0.8	2.1	O K
7200 min Summer	28.722	0.062	0.0	0.7	0.0	0.7	1.8	O K
8640 min Summer	28.716	0.056	0.0	0.6	0.0	0.6	1.6	O K
10080 min Summer	28.712	0.052	0.0	0.6	0.0	0.6	1.5	O K
15 min Winter	28.995	0.335	0.0	1.9	0.0	1.9	9.6	O K
30 min Winter	29.071	0.411	0.0	2.1	0.1	2.2	11.7	O K
60 min Winter	29.101	0.441	0.0	2.2	0.7	2.9	12.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	76.035	0.0	15.4	0.0	17
30 min Summer	49.499	0.0	21.7	0.0	31
60 min Summer	30.811	0.0	28.4	0.0	54
120 min Summer	18.615	0.0	35.3	0.0	86
180 min Summer	13.715	0.0	39.5	0.0	120
240 min Summer	10.995	0.0	42.5	0.0	154
360 min Summer	8.034	0.0	46.9	0.0	222
480 min Summer	6.428	0.0	50.1	0.0	288
600 min Summer	5.404	0.0	52.7	0.0	352
720 min Summer	4.687	0.0	54.9	0.0	416
960 min Summer	3.743	0.0	58.4	0.0	540
1440 min Summer	2.723	0.0	63.3	0.0	782
2160 min Summer	1.979	0.0	68.2	0.0	1148
2880 min Summer	1.577	0.0	71.4	0.0	1500
4320 min Summer	1.143	0.0	75.5	0.0	2208
5760 min Summer	0.910	0.0	77.8	0.0	2944
7200 min Summer	0.762	0.0	79.0	0.0	3672
8640 min Summer	0.659	0.0	79.6	0.0	4400
10080 min Summer	0.583	0.0	80.1	0.0	5136
15 min Winter	76.035	0.0	17.9	0.0	17
30 min Winter	49.499	0.0	25.0	0.0	31
60 min Winter	30.811	0.0	32.4	0.8	48

Cascade Summary of Results for TANK.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
120 min Winter	29.105	0.445	0.0	2.2	0.9	3.0	12.7	O K
180 min Winter	29.093	0.433	0.0	2.1	0.5	2.7	12.3	O K
240 min Winter	29.078	0.418	0.0	2.1	0.2	2.3	11.9	O K
360 min Winter	29.033	0.373	0.0	2.0	0.0	2.0	10.6	O K
480 min Winter	28.993	0.333	0.0	1.9	0.0	1.9	9.5	O K
600 min Winter	28.959	0.299	0.0	1.8	0.0	1.8	8.5	O K
720 min Winter	28.931	0.271	0.0	1.7	0.0	1.7	7.7	O K
960 min Winter	28.886	0.226	0.0	1.5	0.0	1.5	6.4	O K
1440 min Winter	28.828	0.168	0.0	1.3	0.0	1.3	4.8	O K
2160 min Winter	28.781	0.121	0.0	1.1	0.0	1.1	3.5	O K
2880 min Winter	28.756	0.096	0.0	0.9	0.0	0.9	2.7	O K
4320 min Winter	28.730	0.070	0.0	0.7	0.0	0.7	2.0	O K
5760 min Winter	28.717	0.057	0.0	0.6	0.0	0.6	1.6	O K
7200 min Winter	28.712	0.052	0.0	0.6	0.0	0.6	1.5	O K
8640 min Winter	28.708	0.048	0.0	0.5	0.0	0.5	1.4	O K
10080 min Winter	28.704	0.044	0.0	0.4	0.0	0.4	1.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
120 min Winter	18.615	0.0	40.2	1.1	86
180 min Winter	13.715	0.0	44.9	0.6	124
240 min Winter	10.995	0.0	48.3	0.2	164
360 min Winter	8.034	0.0	53.2	0.0	238
480 min Winter	6.428	0.0	56.9	0.0	306
600 min Winter	5.404	0.0	59.9	0.0	374
720 min Winter	4.687	0.0	62.3	0.0	436
960 min Winter	3.743	0.0	66.3	0.0	566
1440 min Winter	2.723	0.0	72.0	0.0	810
2160 min Winter	1.979	0.0	77.7	0.0	1172
2880 min Winter	1.577	0.0	81.6	0.0	1556
4320 min Winter	1.143	0.0	86.6	0.0	2288
5760 min Winter	0.910	0.0	89.7	0.0	3000
7200 min Winter	0.762	0.0	91.6	0.0	3744
8640 min Winter	0.659	0.0	92.8	0.0	4464
10080 min Winter	0.583	0.0	93.5	0.0	5240

Cascade Rainfall Details for TANK.srcx

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.066

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.066

Cascade Model Details for TANK.srcx

Storage is Online Cover Level (m) 30.500

Cellular Storage Structure

Invert Level (m) 28.660 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	30.0	30.0	0.800	30.0	50.8	0.801	0.0	50.8

Orifice Outflow Control

Diameter (m) 0.040 Discharge Coefficient 0.600 Invert Level (m) 28.660

Hydro-Brake Optimum® Overflow Control

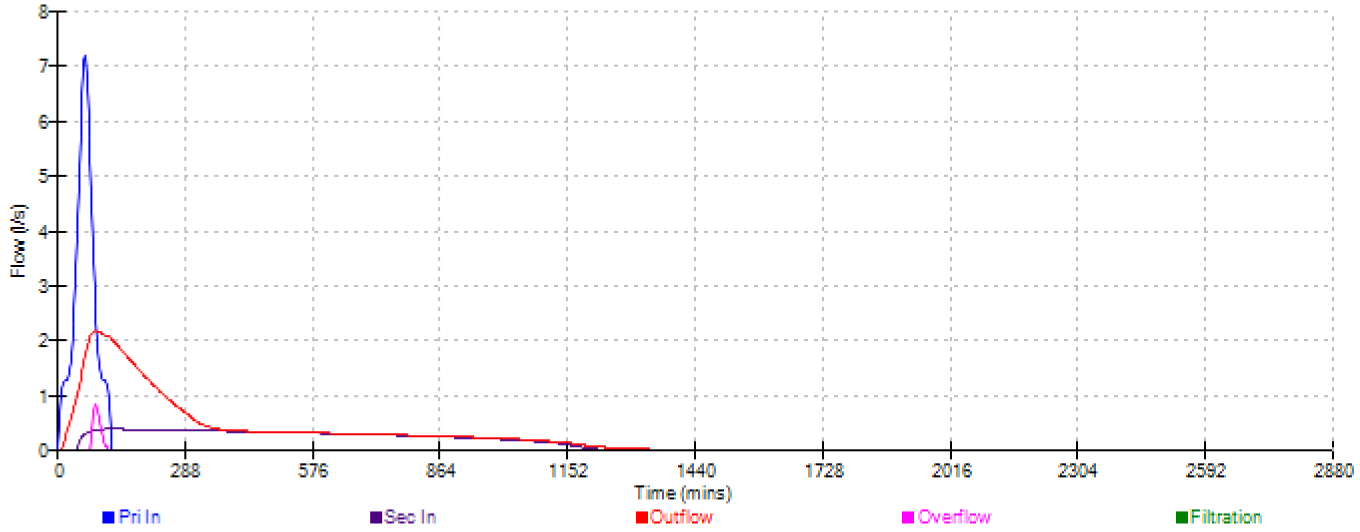
Unit Reference	MD-SHE-0083-2500-0400-2500
Design Head (m)	0.400
Design Flow (l/s)	2.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	83
Invert Level (m)	29.060
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

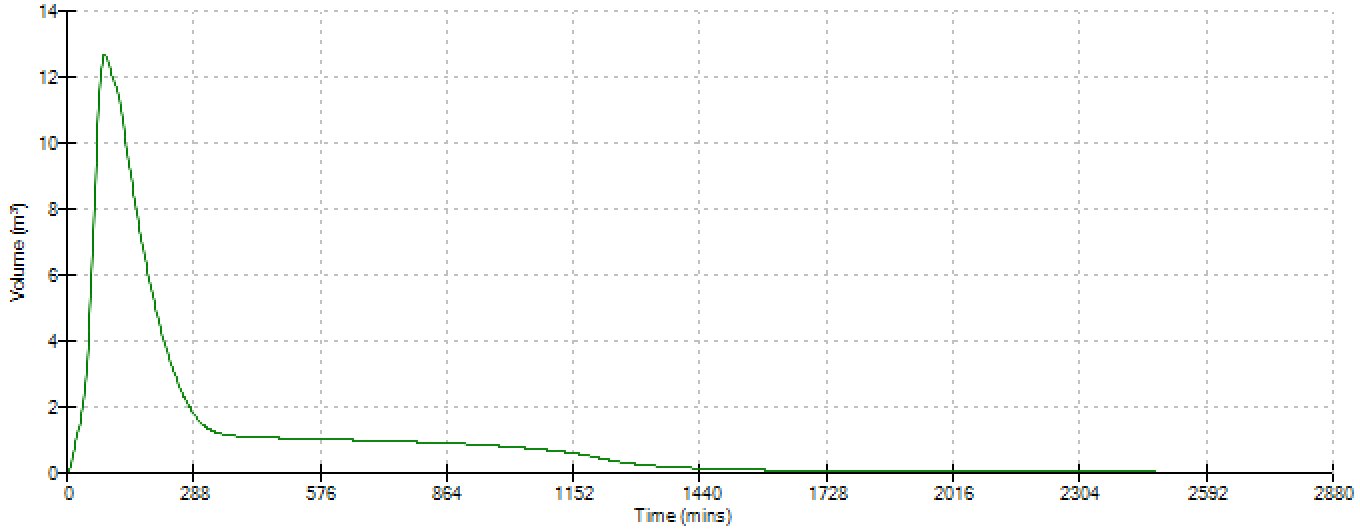
Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.400	2.5	Kick-Flo®	0.290	2.1
Flush-Flo™	0.131	2.4	Mean Flow over Head Range	-	2.0

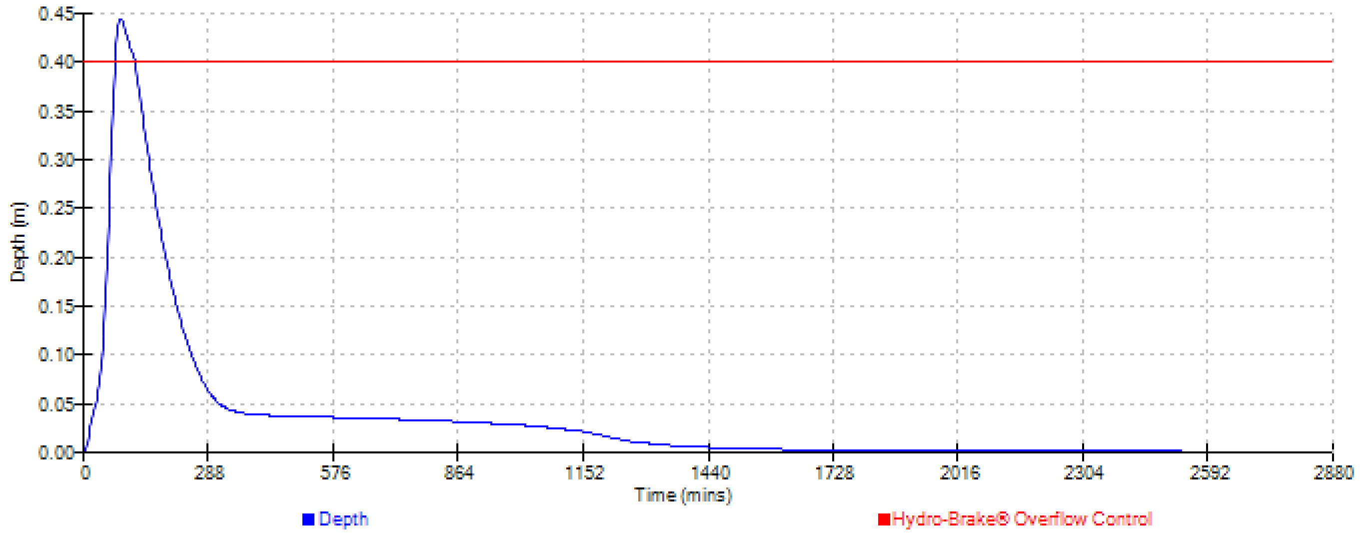
The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.4	0.800	3.4	2.000	5.2	4.000	7.1	7.000	9.4
0.200	2.4	1.000	3.7	2.200	5.4	4.500	7.5	7.500	9.8
0.300	2.2	1.200	4.1	2.400	5.6	5.000	8.0	8.000	10.1
0.400	2.5	1.400	4.4	2.600	5.8	5.500	8.3	8.500	10.4
0.500	2.7	1.600	4.6	3.000	6.2	6.000	8.7	9.000	10.7
0.600	3.0	1.800	4.9	3.500	6.7	6.500	9.1	9.500	11.0

Cascade Event: 120 min Winter for TANK.srcx







Cascade Summary of Results for PAVING.srcx

Upstream Structures	Outflow To	Overflow To
(None)	TANK.srcx	(None)

Half Drain Time : 630 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	29.939	0.159	0.0	0.3	0.3	9.3	O K
30 min Summer	29.974	0.194	0.0	0.4	0.4	13.8	O K
60 min Summer	30.006	0.226	0.0	0.4	0.4	18.2	O K
120 min Summer	30.033	0.253	0.0	0.4	0.4	22.3	O K
180 min Summer	30.045	0.265	0.0	0.4	0.4	24.3	O K
240 min Summer	30.051	0.271	0.0	0.4	0.4	25.4	O K
360 min Summer	30.057	0.277	0.0	0.4	0.4	26.3	O K
480 min Summer	30.058	0.278	0.0	0.4	0.4	26.5	O K
600 min Summer	30.058	0.278	0.0	0.4	0.4	26.5	O K
720 min Summer	30.058	0.278	0.0	0.4	0.4	26.4	O K
960 min Summer	30.056	0.276	0.0	0.4	0.4	26.1	O K
1440 min Summer	30.050	0.270	0.0	0.4	0.4	25.0	O K
2160 min Summer	30.037	0.257	0.0	0.4	0.4	22.9	O K
2880 min Summer	30.023	0.243	0.0	0.4	0.4	20.8	O K
4320 min Summer	29.997	0.217	0.0	0.4	0.4	16.8	O K
5760 min Summer	29.973	0.193	0.0	0.4	0.4	13.6	O K
7200 min Summer	29.953	0.173	0.0	0.3	0.3	11.0	O K
8640 min Summer	29.935	0.155	0.0	0.3	0.3	9.0	O K
10080 min Summer	29.920	0.140	0.0	0.3	0.3	7.3	O K
15 min Winter	29.953	0.173	0.0	0.3	0.3	11.1	O K
30 min Winter	29.992	0.212	0.0	0.4	0.4	16.1	O K
60 min Winter	30.026	0.246	0.0	0.4	0.4	21.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	98.681	0.0	9.5	19
30 min Summer	64.789	0.0	14.2	34
60 min Summer	40.510	0.0	19.0	64
120 min Summer	24.461	0.0	24.0	122
180 min Summer	17.964	0.0	26.9	182
240 min Summer	14.342	0.0	28.9	242
360 min Summer	10.418	0.0	31.7	360
480 min Summer	8.302	0.0	33.8	468
600 min Summer	6.956	0.0	35.5	514
720 min Summer	6.017	0.0	36.8	572
960 min Summer	4.784	0.0	38.9	696
1440 min Summer	3.456	0.0	41.7	968
2160 min Summer	2.493	0.0	44.2	1384
2880 min Summer	1.975	0.0	45.6	1784
4320 min Summer	1.421	0.0	46.9	2552
5760 min Summer	1.124	0.0	47.0	3296
7200 min Summer	0.936	0.0	46.5	4040
8640 min Summer	0.806	0.0	45.5	4760
10080 min Summer	0.710	0.0	44.2	5448
15 min Winter	98.681	0.0	11.3	19
30 min Winter	64.789	0.0	16.5	33
60 min Winter	40.510	0.0	22.0	62

Cascade Summary of Results for PAVING.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
120 min Winter	30.054	0.274	0.0	0.4	0.4	25.8	O K
180 min Winter	30.067	0.287	0.0	0.4	0.4	28.1	O K
240 min Winter	30.074	0.294	0.0	0.4	0.4	29.3	O K
360 min Winter	30.081	0.301	0.0	0.5	0.5	30.6	O K
480 min Winter	30.083	0.303	0.0	0.5	0.5	31.0	O K
600 min Winter	30.083	0.303	0.0	0.5	0.5	31.0	O K
720 min Winter	30.081	0.301	0.0	0.5	0.5	30.7	O K
960 min Winter	30.078	0.298	0.0	0.4	0.4	30.1	O K
1440 min Winter	30.069	0.289	0.0	0.4	0.4	28.4	O K
2160 min Winter	30.051	0.271	0.0	0.4	0.4	25.2	O K
2880 min Winter	30.031	0.251	0.0	0.4	0.4	22.0	O K
4320 min Winter	29.994	0.214	0.0	0.4	0.4	16.5	O K
5760 min Winter	29.961	0.181	0.0	0.3	0.3	12.1	O K
7200 min Winter	29.934	0.154	0.0	0.3	0.3	8.8	O K
8640 min Winter	29.912	0.132	0.0	0.3	0.3	6.4	O K
10080 min Winter	29.892	0.112	0.0	0.3	0.3	4.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
120 min Winter	24.461	0.0	27.6	120
180 min Winter	17.964	0.0	30.8	178
240 min Winter	14.342	0.0	33.0	236
360 min Winter	10.418	0.0	36.3	350
480 min Winter	8.302	0.0	38.7	462
600 min Winter	6.956	0.0	40.5	566
720 min Winter	6.017	0.0	42.1	660
960 min Winter	4.784	0.0	44.5	744
1440 min Winter	3.456	0.0	47.8	1052
2160 min Winter	2.493	0.0	50.8	1492
2880 min Winter	1.975	0.0	52.6	1928
4320 min Winter	1.421	0.0	54.5	2724
5760 min Winter	1.124	0.0	55.2	3464
7200 min Winter	0.936	0.0	55.1	4184
8640 min Winter	0.806	0.0	54.5	4848
10080 min Winter	0.710	0.0	53.7	5552

Cascade Rainfall Details for PAVING.srcx

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)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.081

Time (mins) From:	To:	Area (ha)
0	4	0.081

Cascade Model Details for PAVING.srcx

Storage is Online Cover Level (m) 30.430

Complex Structure

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	4.1
Membrane Percolation (mm/hr)	1000	Length (m)	26.7
Max Percolation (l/s)	30.4	Slope (1:X)	50.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.95	Evaporation (mm/day)	3
Invert Level (m)	29.780	Cap Volume Depth (m)	0.150

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	11.5
Membrane Percolation (mm/hr)	1000	Length (m)	31.3
Max Percolation (l/s)	100.0	Slope (1:X)	50.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.95	Evaporation (mm/day)	3
Invert Level (m)	29.780	Cap Volume Depth (m)	0.150

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1000	Length (m)	7.5
Max Percolation (l/s)	10.4	Slope (1:X)	40.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.95	Evaporation (mm/day)	3
Invert Level (m)	29.920	Cap Volume Depth (m)	0.150

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	4.1
Membrane Percolation (mm/hr)	1000	Length (m)	26.7
Max Percolation (l/s)	30.4	Slope (1:X)	50.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	29.930	Cap Volume Depth (m)	0.300

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	11.5
Membrane Percolation (mm/hr)	1000	Length (m)	31.3
Max Percolation (l/s)	100.0	Slope (1:X)	50.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	29.930	Cap Volume Depth (m)	0.300

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1000	Length (m)	7.5
Max Percolation (l/s)	10.4	Slope (1:X)	36.3
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.95	Evaporation (mm/day)	3
Invert Level (m)	30.010	Cap Volume Depth (m)	0.150

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1000	Length (m)	7.5
Max Percolation (l/s)	10.4	Slope (1:X)	40.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	30.070	Cap Volume Depth (m)	0.300

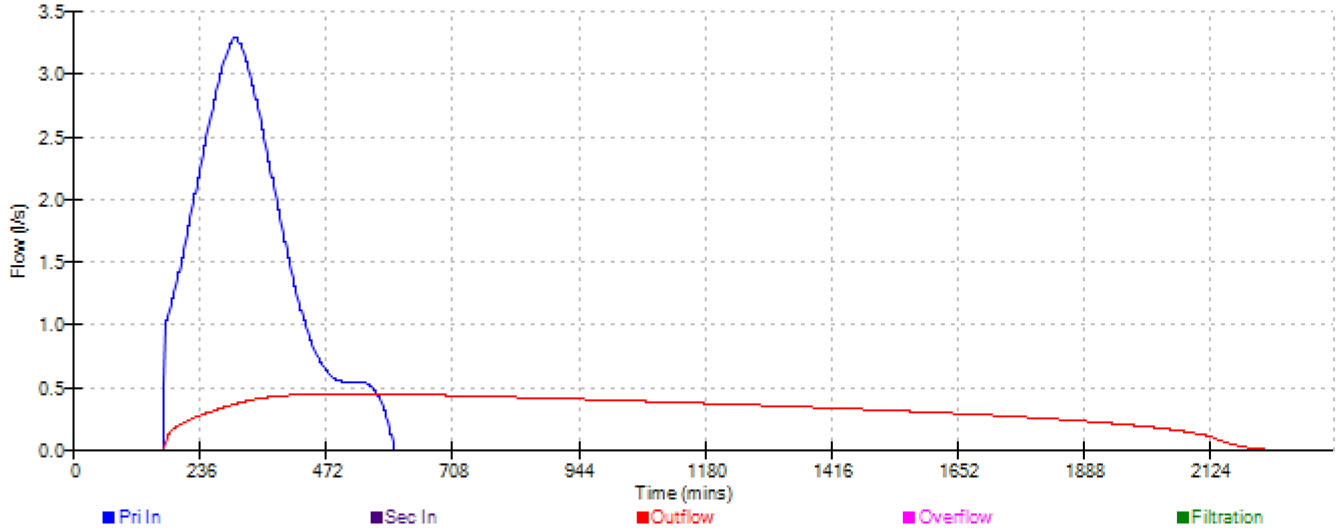
Porous Car Park

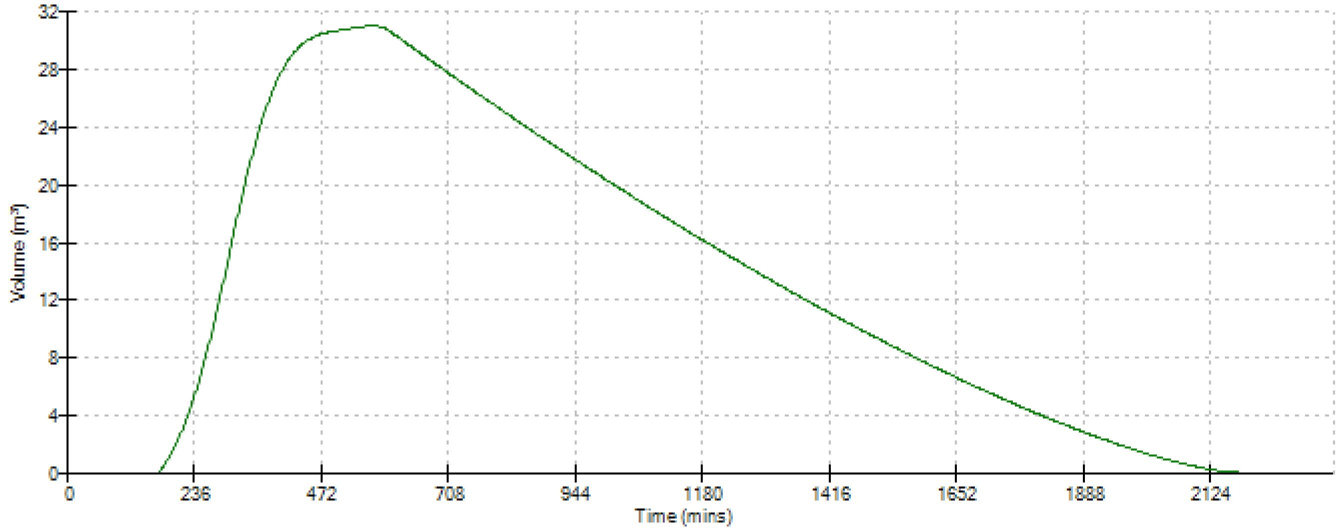
Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1000	Length (m)	7.5
Max Percolation (l/s)	10.4	Slope (1:X)	36.3
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	30.160	Cap Volume Depth (m)	0.300

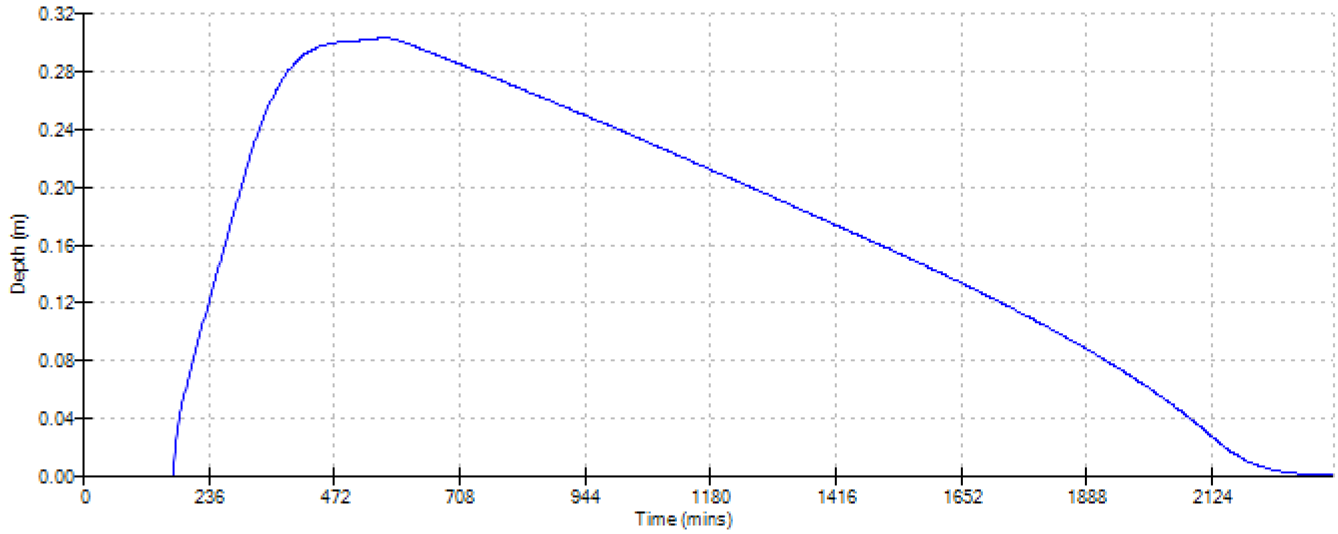
Orifice Outflow Control

Diameter (m) 0.020 Discharge Coefficient 0.600 Invert Level (m) 29.780

Cascade Event: 600 min Winter for PAVING.srcx







Cascade Summary of Results for TANK.srcx

Upstream Structures	Outflow To	Overflow To
PAVING.srcx	(None)	(None)

Half Drain Time : 74 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	29.050	0.390	0.0	2.0	0.0	2.0	11.1	O K
30 min Summer	29.121	0.461	0.0	2.2	1.4	3.6	13.1	O K
60 min Summer	29.152	0.492	0.0	2.3	2.3	4.6	14.0	O K
120 min Summer	29.158	0.498	0.0	2.3	2.4	4.7	14.2	O K
180 min Summer	29.145	0.485	0.0	2.3	2.1	4.4	13.8	O K
240 min Summer	29.131	0.471	0.0	2.2	1.7	4.0	13.4	O K
360 min Summer	29.110	0.450	0.0	2.2	1.0	3.2	12.8	O K
480 min Summer	29.093	0.433	0.0	2.1	0.5	2.7	12.4	O K
600 min Summer	29.075	0.415	0.0	2.1	0.1	2.2	11.8	O K
720 min Summer	29.050	0.390	0.0	2.0	0.0	2.0	11.1	O K
960 min Summer	29.001	0.341	0.0	1.9	0.0	1.9	9.7	O K
1440 min Summer	28.930	0.270	0.0	1.7	0.0	1.7	7.7	O K
2160 min Summer	28.864	0.204	0.0	1.4	0.0	1.4	5.8	O K
2880 min Summer	28.823	0.163	0.0	1.3	0.0	1.3	4.7	O K
4320 min Summer	28.778	0.118	0.0	1.0	0.0	1.0	3.4	O K
5760 min Summer	28.753	0.093	0.0	0.9	0.0	0.9	2.6	O K
7200 min Summer	28.738	0.078	0.0	0.8	0.0	0.8	2.2	O K
8640 min Summer	28.727	0.067	0.0	0.7	0.0	0.7	1.9	O K
10080 min Summer	28.720	0.060	0.0	0.7	0.0	0.7	1.7	O K
15 min Winter	29.097	0.437	0.0	2.2	0.6	2.8	12.4	O K
30 min Winter	29.165	0.505	0.0	2.3	2.4	4.7	14.4	O K
60 min Winter	29.205	0.545	0.0	2.4	2.4	4.9	15.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	98.681	0.0	21.7	0.0	18
30 min Summer	64.789	0.0	30.1	1.1	29
60 min Summer	40.510	0.0	39.1	3.0	44
120 min Summer	24.461	0.0	48.2	3.8	76
180 min Summer	17.964	0.0	53.5	3.5	110
240 min Summer	14.342	0.0	57.2	3.0	144
360 min Summer	10.418	0.0	62.6	1.9	210
480 min Summer	8.302	0.0	66.6	0.9	280
600 min Summer	6.956	0.0	69.8	0.2	352
720 min Summer	6.017	0.0	72.5	0.0	420
960 min Summer	4.784	0.0	76.7	0.0	548
1440 min Summer	3.456	0.0	82.6	0.0	794
2160 min Summer	2.493	0.0	88.6	0.0	1148
2880 min Summer	1.975	0.0	92.6	0.0	1524
4320 min Summer	1.421	0.0	97.5	0.0	2244
5760 min Summer	1.124	0.0	100.4	0.0	2944
7200 min Summer	0.936	0.0	102.1	0.0	3672
8640 min Summer	0.806	0.0	102.9	0.0	4408
10080 min Summer	0.710	0.0	103.2	0.0	5144
15 min Winter	98.681	0.0	24.9	0.2	17
30 min Winter	64.789	0.0	34.4	2.4	28
60 min Winter	40.510	0.0	44.4	4.5	46

Cascade Summary of Results for TANK.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
120 min Winter	29.194	0.534	0.0	2.4	2.4	4.8	15.2	O K
180 min Winter	29.162	0.502	0.0	2.3	2.4	4.7	14.3	O K
240 min Winter	29.141	0.481	0.0	2.3	2.0	4.3	13.7	O K
360 min Winter	29.115	0.455	0.0	2.2	1.2	3.4	13.0	O K
480 min Winter	29.096	0.436	0.0	2.2	0.6	2.7	12.4	O K
600 min Winter	29.075	0.415	0.0	2.1	0.1	2.2	11.8	O K
720 min Winter	29.040	0.380	0.0	2.0	0.0	2.0	10.8	O K
960 min Winter	28.977	0.317	0.0	1.8	0.0	1.8	9.0	O K
1440 min Winter	28.894	0.234	0.0	1.5	0.0	1.5	6.7	O K
2160 min Winter	28.826	0.166	0.0	1.3	0.0	1.3	4.7	O K
2880 min Winter	28.789	0.129	0.0	1.1	0.0	1.1	3.7	O K
4320 min Winter	28.750	0.090	0.0	0.9	0.0	0.9	2.6	O K
5760 min Winter	28.731	0.071	0.0	0.8	0.0	0.8	2.0	O K
7200 min Winter	28.719	0.059	0.0	0.7	0.0	0.7	1.7	O K
8640 min Winter	28.714	0.054	0.0	0.6	0.0	0.6	1.5	O K
10080 min Winter	28.710	0.050	0.0	0.5	0.0	0.5	1.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
120 min Winter	24.461	0.0	54.7	5.9	82
180 min Winter	17.964	0.0	60.7	5.6	114
240 min Winter	14.342	0.0	64.8	4.8	148
360 min Winter	10.418	0.0	70.9	3.1	216
480 min Winter	8.302	0.0	75.4	1.5	290
600 min Winter	6.956	0.0	79.0	0.2	372
720 min Winter	6.017	0.0	82.0	0.0	442
960 min Winter	4.784	0.0	86.8	0.0	570
1440 min Winter	3.456	0.0	93.5	0.0	822
2160 min Winter	2.493	0.0	100.5	0.0	1188
2880 min Winter	1.975	0.0	105.2	0.0	1556
4320 min Winter	1.421	0.0	111.2	0.0	2288
5760 min Winter	1.124	0.0	115.0	0.0	3000
7200 min Winter	0.936	0.0	117.4	0.0	3744
8640 min Winter	0.806	0.0	118.9	0.0	4448
10080 min Winter	0.710	0.0	119.8	0.0	5328

Cascade Rainfall Details for TANK.srcx

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)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.066

Time (mins) From:	**To:**	**Area (ha)**
0	4	0.066

Cascade Model Details for TANK.srcx

Storage is Online Cover Level (m) 30.500

Cellular Storage Structure

Invert Level (m) 28.660 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	30.0	30.0	0.800	30.0	50.8	0.801	0.0	50.8

Orifice Outflow Control

Diameter (m) 0.040 Discharge Coefficient 0.600 Invert Level (m) 28.660

Hydro-Brake Optimum® Overflow Control

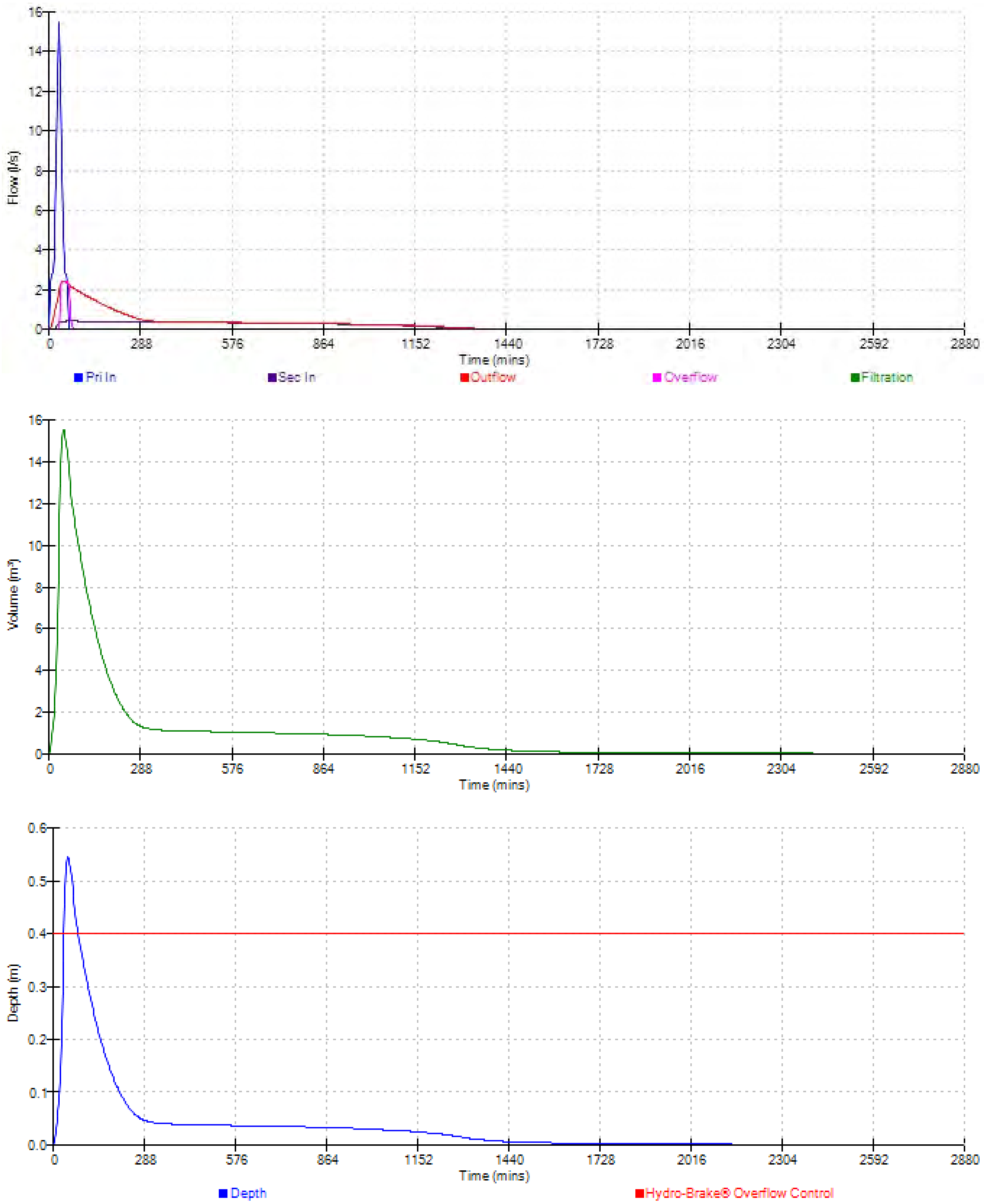
Unit Reference	MD-SHE-0083-2500-0400-2500
Design Head (m)	0.400
Design Flow (l/s)	2.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	83
Invert Level (m)	29.060
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.400	2.5	Kick-Flo®	0.290	2.1
Flush-Flo™	0.131	2.4	Mean Flow over Head Range	-	2.0

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)	Depth (m)	Flow (l/s)
0.100	2.4	0.800	3.4	2.000	5.2	4.000	7.1	7.000	9.4
0.200	2.4	1.000	3.7	2.200	5.4	4.500	7.5	7.500	9.8
0.300	2.2	1.200	4.1	2.400	5.6	5.000	8.0	8.000	10.1
0.400	2.5	1.400	4.4	2.600	5.8	5.500	8.3	8.500	10.4
0.500	2.7	1.600	4.6	3.000	6.2	6.000	8.7	9.000	10.7
0.600	3.0	1.800	4.9	3.500	6.7	6.500	9.1	9.500	11.0

Cascade Event: 60 min Winter for TANK.srcx



Cascade Summary of Results for PAVING.srcx

Upstream Structures	Outflow To	Overflow To
(None)	TANK.srcx	(None)

Half Drain Time : 897 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	29.991	0.211	0.0	0.4	0.4	16.0	O K
30 min Summer	30.035	0.255	0.0	0.4	0.4	22.6	O K
60 min Summer	30.073	0.293	0.0	0.4	0.4	29.1	O K
120 min Summer	30.105	0.325	0.0	0.5	0.5	35.3	O K
180 min Summer	30.121	0.341	0.0	0.5	0.5	38.5	O K
240 min Summer	30.129	0.349	0.0	0.5	0.5	40.3	O K
360 min Summer	30.139	0.359	0.0	0.5	0.5	42.3	Flood Risk
480 min Summer	30.143	0.363	0.0	0.5	0.5	43.1	Flood Risk
600 min Summer	30.144	0.364	0.0	0.5	0.5	43.3	Flood Risk
720 min Summer	30.143	0.363	0.0	0.5	0.5	43.1	Flood Risk
960 min Summer	30.141	0.361	0.0	0.5	0.5	42.7	Flood Risk
1440 min Summer	30.135	0.355	0.0	0.5	0.5	41.5	Flood Risk
2160 min Summer	30.123	0.343	0.0	0.5	0.5	38.9	O K
2880 min Summer	30.109	0.329	0.0	0.5	0.5	36.2	O K
4320 min Summer	30.083	0.303	0.0	0.5	0.5	31.0	O K
5760 min Summer	30.058	0.278	0.0	0.4	0.4	26.5	O K
7200 min Summer	30.035	0.255	0.0	0.4	0.4	22.7	O K
8640 min Summer	30.015	0.235	0.0	0.4	0.4	19.5	O K
10080 min Summer	29.996	0.216	0.0	0.4	0.4	16.7	O K
15 min Winter	30.009	0.229	0.0	0.4	0.4	18.6	O K
30 min Winter	30.055	0.275	0.0	0.4	0.4	26.0	O K
60 min Winter	30.095	0.315	0.0	0.5	0.5	33.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	143.087	0.0	16.2	19
30 min Summer	93.944	0.0	23.0	34
60 min Summer	58.739	0.0	30.1	64
120 min Summer	35.469	0.0	37.4	122
180 min Summer	26.047	0.0	41.6	182
240 min Summer	20.795	0.0	44.5	242
360 min Summer	15.106	0.0	48.8	362
480 min Summer	12.038	0.0	52.0	480
600 min Summer	10.086	0.0	54.5	600
720 min Summer	8.725	0.0	56.5	658
960 min Summer	6.936	0.0	59.5	770
1440 min Summer	5.012	0.0	60.1	1024
2160 min Summer	3.615	0.0	68.7	1432
2880 min Summer	2.864	0.0	71.6	1844
4320 min Summer	2.060	0.0	74.9	2640
5760 min Summer	1.629	0.0	76.5	3408
7200 min Summer	1.357	0.0	77.2	4184
8640 min Summer	1.169	0.0	77.2	4928
10080 min Summer	1.030	0.0	76.8	5648
15 min Winter	143.087	0.0	18.9	19
30 min Winter	93.944	0.0	26.4	33
60 min Winter	58.739	0.0	34.4	62

Cascade Summary of Results for PAVING.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
120 min Winter	30.130	0.350	0.0	0.5	0.5	40.4	Flood Risk
180 min Winter	30.147	0.367	0.0	0.5	0.5	44.0	Flood Risk
240 min Winter	30.157	0.377	0.0	0.5	0.5	46.1	Flood Risk
360 min Winter	30.169	0.389	0.0	0.5	0.5	48.6	Flood Risk
480 min Winter	30.174	0.394	0.0	0.5	0.5	49.8	Flood Risk
600 min Winter	30.176	0.396	0.0	0.5	0.5	50.2	Flood Risk
720 min Winter	30.176	0.396	0.0	0.5	0.5	50.2	Flood Risk
960 min Winter	30.173	0.393	0.0	0.5	0.5	49.5	Flood Risk
1440 min Winter	30.164	0.384	0.0	0.5	0.5	47.6	Flood Risk
2160 min Winter	30.147	0.367	0.0	0.5	0.5	44.0	Flood Risk
2880 min Winter	30.128	0.348	0.0	0.5	0.5	40.0	O K
4320 min Winter	30.091	0.311	0.0	0.5	0.5	32.5	O K
5760 min Winter	30.056	0.276	0.0	0.4	0.4	26.1	O K
7200 min Winter	30.024	0.244	0.0	0.4	0.4	20.9	O K
8640 min Winter	29.996	0.216	0.0	0.4	0.4	16.7	O K
10080 min Winter	29.971	0.191	0.0	0.4	0.4	13.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
120 min Winter	35.469	0.0	42.5	122
180 min Winter	26.047	0.0	47.3	180
240 min Winter	20.795	0.0	50.6	238
360 min Winter	15.106	0.0	55.4	354
480 min Winter	12.038	0.0	59.0	468
600 min Winter	10.086	0.0	61.8	578
720 min Winter	8.725	0.0	63.7	686
960 min Winter	6.936	0.0	65.2	884
1440 min Winter	5.012	0.0	64.9	1098
2160 min Winter	3.615	0.0	78.3	1556
2880 min Winter	2.864	0.0	81.6	1992
4320 min Winter	2.060	0.0	85.8	2852
5760 min Winter	1.629	0.0	88.1	3632
7200 min Winter	1.357	0.0	89.4	4400
8640 min Winter	1.169	0.0	89.9	5112
10080 min Winter	1.030	0.0	89.9	5848

Cascade Rainfall Details for PAVING.srcx

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)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+45

Time Area Diagram

Total Area (ha) 0.081

Time From:	(mins) To:	Area (ha)
0	4	0.081

Cascade Model Details for PAVING.srcx

Storage is Online Cover Level (m) 30.430

Complex Structure

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	4.1
Membrane Percolation (mm/hr)	1000	Length (m)	26.7
Max Percolation (l/s)	30.4	Slope (1:X)	50.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.95	Evaporation (mm/day)	3
Invert Level (m)	29.780	Cap Volume Depth (m)	0.150

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	11.5
Membrane Percolation (mm/hr)	1000	Length (m)	31.3
Max Percolation (l/s)	100.0	Slope (1:X)	50.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.95	Evaporation (mm/day)	3
Invert Level (m)	29.780	Cap Volume Depth (m)	0.150

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1000	Length (m)	7.5
Max Percolation (l/s)	10.4	Slope (1:X)	40.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.95	Evaporation (mm/day)	3
Invert Level (m)	29.920	Cap Volume Depth (m)	0.150

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	4.1
Membrane Percolation (mm/hr)	1000	Length (m)	26.7
Max Percolation (l/s)	30.4	Slope (1:X)	50.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	29.930	Cap Volume Depth (m)	0.300

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	11.5
Membrane Percolation (mm/hr)	1000	Length (m)	31.3
Max Percolation (l/s)	100.0	Slope (1:X)	50.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	29.930	Cap Volume Depth (m)	0.300

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1000	Length (m)	7.5
Max Percolation (l/s)	10.4	Slope (1:X)	36.3
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.95	Evaporation (mm/day)	3
Invert Level (m)	30.010	Cap Volume Depth (m)	0.150

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1000	Length (m)	7.5
Max Percolation (l/s)	10.4	Slope (1:X)	40.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	30.070	Cap Volume Depth (m)	0.300

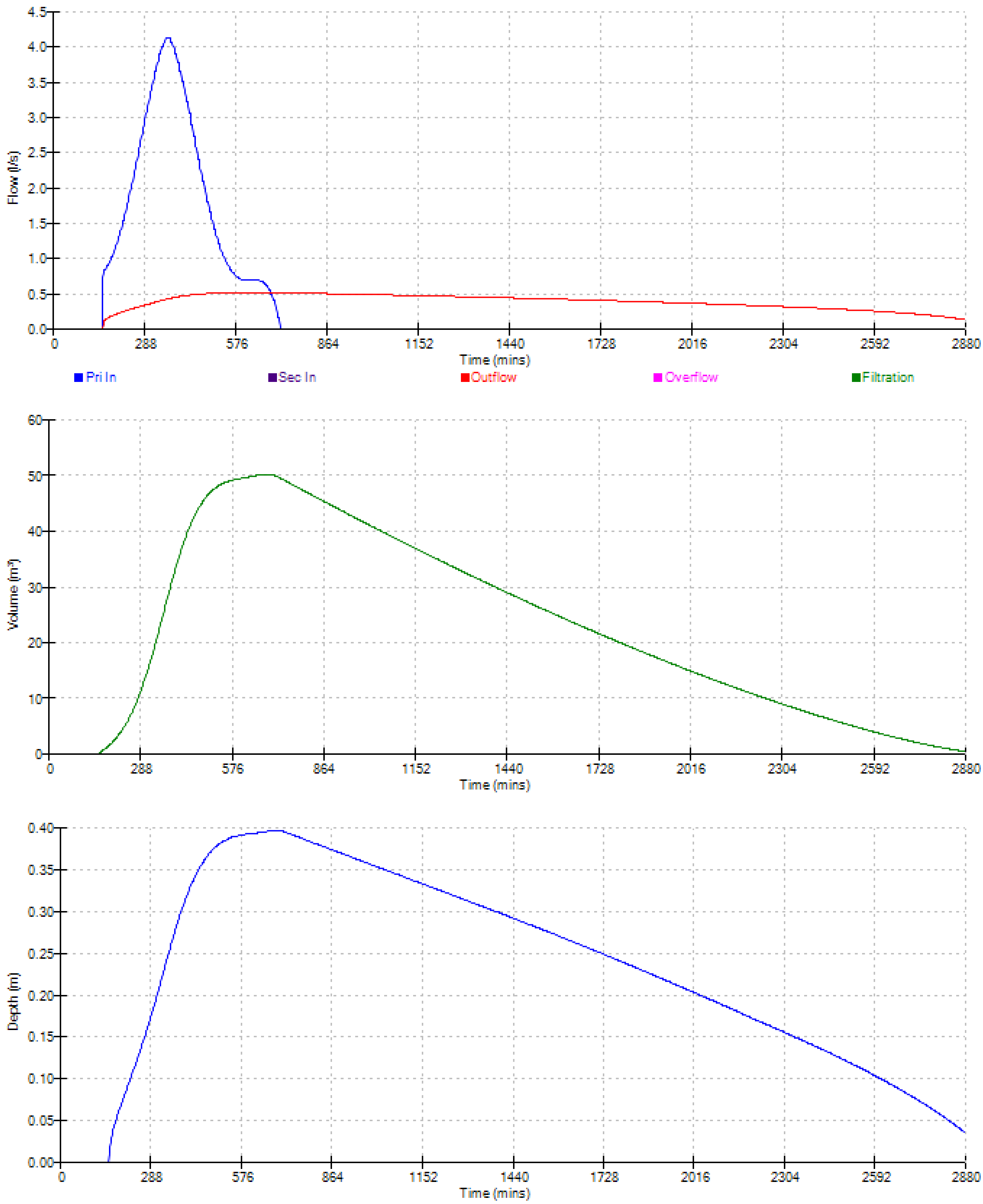
Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1000	Length (m)	7.5
Max Percolation (l/s)	10.4	Slope (1:X)	36.3
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	30.160	Cap Volume Depth (m)	0.300

Orifice Outflow Control

Diameter (m) 0.020 Discharge Coefficient 0.600 Invert Level (m) 29.780

Cascade Event: 720 min Winter for PAVING.srcx



Cascade Summary of Results for TANK.srcx

Upstream Structures	Outflow To	Overflow To
PAVING.srcx	(None)	(None)

Half Drain Time : 86 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	29.205	0.545	0.0	2.4	2.4	4.9	15.5	O K
30 min Summer	29.315	0.655	0.0	2.7	2.4	4.9	18.7	O K
60 min Summer	29.383	0.723	0.0	2.8	2.4	5.0	20.6	O K
120 min Summer	29.396	0.736	0.0	2.8	2.4	5.1	21.0	O K
180 min Summer	29.368	0.708	0.0	2.8	2.4	4.9	20.2	O K
240 min Summer	29.324	0.664	0.0	2.7	2.4	4.9	18.9	O K
360 min Summer	29.246	0.586	0.0	2.5	2.4	4.9	16.7	O K
480 min Summer	29.190	0.530	0.0	2.4	2.4	4.8	15.1	O K
600 min Summer	29.156	0.496	0.0	2.3	2.4	4.7	14.1	O K
720 min Summer	29.139	0.479	0.0	2.3	2.0	4.2	13.7	O K
960 min Summer	29.117	0.457	0.0	2.2	1.3	3.5	13.0	O K
1440 min Summer	29.086	0.426	0.0	2.1	0.3	2.5	12.1	O K
2160 min Summer	29.000	0.340	0.0	1.9	0.0	1.9	9.7	O K
2880 min Summer	28.932	0.272	0.0	1.7	0.0	1.7	7.8	O K
4320 min Summer	28.854	0.194	0.0	1.4	0.0	1.4	5.5	O K
5760 min Summer	28.810	0.150	0.0	1.2	0.0	1.2	4.3	O K
7200 min Summer	28.783	0.123	0.0	1.1	0.0	1.1	3.5	O K
8640 min Summer	28.765	0.105	0.0	1.0	0.0	1.0	3.0	O K
10080 min Summer	28.752	0.092	0.0	0.9	0.0	0.9	2.6	O K
15 min Winter	29.274	0.614	0.0	2.6	2.4	4.9	17.5	O K
30 min Winter	29.408	0.748	0.0	2.8	2.4	5.2	21.3	O K
60 min Winter	29.586	0.926	0.0	3.2	2.8	6.0	23.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	143.087	0.0	33.9	2.5	17
30 min Summer	93.944	0.0	46.1	5.2	30
60 min Summer	58.739	0.0	59.1	7.7	46
120 min Summer	35.469	0.0	72.5	10.1	80
180 min Summer	26.047	0.0	80.3	11.1	114
240 min Summer	20.795	0.0	85.7	11.0	146
360 min Summer	15.106	0.0	93.6	10.4	208
480 min Summer	12.038	0.0	99.5	9.5	266
600 min Summer	10.086	0.0	104.3	8.3	322
720 min Summer	8.725	0.0	108.2	7.1	384
960 min Summer	6.936	0.0	113.9	4.7	510
1440 min Summer	5.012	0.0	118.8	1.0	780
2160 min Summer	3.615	0.0	133.1	0.0	1168
2880 min Summer	2.864	0.0	139.6	0.0	1528
4320 min Summer	2.060	0.0	148.3	0.0	2248
5760 min Summer	1.629	0.0	153.9	0.0	2952
7200 min Summer	1.357	0.0	157.8	0.0	3680
8640 min Summer	1.169	0.0	160.5	0.0	4408
10080 min Summer	1.030	0.0	162.4	0.0	5144
15 min Winter	143.087	0.0	38.6	3.7	17
30 min Winter	93.944	0.0	52.0	6.6	30
60 min Winter	58.739	0.0	66.9	9.5	48

Cascade Summary of Results for TANK.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
120 min Winter	29.511	0.851	0.0	3.0	2.6	5.6	22.9	O K
180 min Winter	29.411	0.751	0.0	2.9	2.4	5.2	21.4	O K
240 min Winter	29.344	0.684	0.0	2.7	2.4	4.9	19.5	O K
360 min Winter	29.224	0.564	0.0	2.5	2.4	4.9	16.1	O K
480 min Winter	29.158	0.498	0.0	2.3	2.4	4.7	14.2	O K
600 min Winter	29.136	0.476	0.0	2.3	1.9	4.1	13.6	O K
720 min Winter	29.122	0.462	0.0	2.2	1.4	3.7	13.2	O K
960 min Winter	29.103	0.443	0.0	2.2	0.8	3.0	12.6	O K
1440 min Winter	29.057	0.397	0.0	2.0	0.0	2.0	11.3	O K
2160 min Winter	28.941	0.281	0.0	1.7	0.0	1.7	8.0	O K
2880 min Winter	28.875	0.215	0.0	1.5	0.0	1.5	6.1	O K
4320 min Winter	28.807	0.147	0.0	1.2	0.0	1.2	4.2	O K
5760 min Winter	28.772	0.112	0.0	1.0	0.0	1.0	3.2	O K
7200 min Winter	28.752	0.092	0.0	0.9	0.0	0.9	2.6	O K
8640 min Winter	28.738	0.078	0.0	0.8	0.0	0.8	2.2	O K
10080 min Winter	28.728	0.068	0.0	0.7	0.0	0.7	1.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
120 min Winter	35.469	0.0	81.8	12.3	86
180 min Winter	26.047	0.0	90.6	13.8	122
240 min Winter	20.795	0.0	96.7	14.1	158
360 min Winter	15.106	0.0	105.5	13.4	216
480 min Winter	12.038	0.0	112.2	11.9	266
600 min Winter	10.086	0.0	117.4	9.9	326
720 min Winter	8.725	0.0	121.1	7.9	388
960 min Winter	6.936	0.0	125.8	4.3	520
1440 min Winter	5.012	0.0	130.5	0.0	836
2160 min Winter	3.615	0.0	150.4	0.0	1208
2880 min Winter	2.864	0.0	157.8	0.0	1560
4320 min Winter	2.060	0.0	168.0	0.0	2292
5760 min Winter	1.629	0.0	174.8	0.0	3048
7200 min Winter	1.357	0.0	179.7	0.0	3752
8640 min Winter	1.169	0.0	183.2	0.0	4496
10080 min Winter	1.030	0.0	185.8	0.0	5240

Cascade Rainfall Details for TANK.srcx

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)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+45

Time Area Diagram

Total Area (ha) 0.066

Time (mins) From:	To:	Area (ha)
0	4	0.066

Cascade Model Details for TANK.srcx

Storage is Online Cover Level (m) 30.500

Cellular Storage Structure

Invert Level (m) 28.660 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	**Area (m²)**	**Inf. Area (m²)**	**Depth (m)**	**Area (m²)**	**Inf. Area (m²)**	**Depth (m)**	**Area (m²)**	**Inf. Area (m²)**
0.000	30.0	30.0	0.800	30.0	50.8	0.801	2.3	50.8

Orifice Outflow Control

Diameter (m) 0.040 Discharge Coefficient 0.600 Invert Level (m) 28.660

Hydro-Brake Optimum® Overflow Control

Unit Reference	MD-SHE-0083-2500-0400-2500
Design Head (m)	0.400
Design Flow (l/s)	2.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	83
Invert Level (m)	29.060
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	**Head (m)**	**Flow (l/s)**	**Control Points**	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	0.400	2.5	Kick-Flo®	0.290	2.1
Flush-Flo™	0.131	2.4	Mean Flow over Head Range	-	2.0

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)**	**Depth (m)**	**Flow (l/s)**
0.100	2.4	0.800	3.4	2.000	5.2	4.000	7.1	7.000	9.4
0.200	2.4	1.000	3.7	2.200	5.4	4.500	7.5	7.500	9.8
0.300	2.2	1.200	4.1	2.400	5.6	5.000	8.0	8.000	10.1
0.400	2.5	1.400	4.4	2.600	5.8	5.500	8.3	8.500	10.4
0.500	2.7	1.600	4.6	3.000	6.2	6.000	8.7	9.000	10.7
0.600	3.0	1.800	4.9	3.500	6.7	6.500	9.1	9.500	11.0

Cascade Event: 60 min Winter for TANK.srcx