



Project Title

Drainage Strategy Report

At

Land North of 57 Bradley Fold Road

Ainsworth

Bolton

BL2 5QR

For

Mr Chris Halliwell

PG Consulting
108 Ack Lane West
Cheadle Hulme
Cheshire
SK8 7ES

Tel: 07710 758971

Mail: Paul@pgcl.co.uk

Paul Graveney Consulting Ltd Trading as PG Consulting
Company Registration 11238546

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Executive Summary

Figure 1: Flood Risk and Drainage Strategy Summary

Item	Brief Description
Development Proposed	The construction of replacement detached property (following demolition of stables) with car parking and landscaping on land situated at Bradley Fold Road, Ainsworth, Bolton, BL2 5QR.
Flood Zone Classification	Flood Zone 1 – Low Risk
Geology	A review of the BGS online borehole data has indicated that the site is underlain by topsoil over Glaciofluvial Deposits – Sands, over Cannel Rock (South Lancashire) – Sandstone to depth.
Infiltration Rate	Based on the assessment of the BGS data set and information from the applicant, it is anticipated that infiltration has the potential to be suitable as a means of draining the site. As part of the future Phase 2 site investigation, infiltration tests in line with BRE 365 Guidance will be undertaken.
Nearest Watercourses	There is a small unnamed watercourse located approximately 150m to the southeast of the site, flowing generally in a southeasterly direction.
Nearest Adopted Sewers and onsite private drainage	The United Utilities (UU) sewer records have been reviewed. These have indicated no public sewers within 300m of the site boundary. The site is currently unmade with no positive drainage identified.
Existing Discharge Rate	For the purpose of this assessment and there being no confirmation of a live connection, the site will be classed as fully Greenfield with greenfield discharge rates defined below based on a site area of 0.1ha: 1yr – 0.7l/s Qbar – 0.8l/s 30yr – 1.4l/s 100yr – 1.7l/s
Proposed Discharge Rate	In lieu of formal testing, a conservative infiltration rate of 5×10^{-6} m/s has been used.
Surface Water Drainage Outfall and SuDS Hierarchal Approach	Based on current site information, the proposed strategy is to infiltrate to the underlying sands via a new infiltration tank.
Allowance for Climate Change	45% - based on a residential > 100-year design life to 'the 2100's' Upper end Allowance.
SuDS features	Water Butts, Permeable surfacing, Geocellular infiltration tank.
Maintenance Responsibility	Property Owner.
Foul Drainage Strategy	Foul drainage to outfall to the sands via a new sewage treatment plant and land drainage network.

1. Introduction

- 1.1 Paul Graveney Consulting Ltd (PGC) has been appointed by Mr Chris Halliwell to prepare this Drainage & Sustainable Drainage Systems (SuDS) Strategy to support a full planning submission for the construction of a detached property with car parking and landscaping on land situated off Bradley Fold Road, Ainsworth, Bolton, BL2 5QR. The Site Masterplan as indicated in Appendix A provides details of the proposed development intent.
- 1.2 The assessment has been undertaken in line with Section 14 of the 2021 'National Planning Policy Framework', plus the accompanying Technical Guidance on Flood Risk and any local policies.
- 1.3 This report has been commissioned by Mr Chris Halliwell and is specific to his interests in the development proposals as described by the Architectural plan in Appendix A.
- 1.4 The report has been commissioned to identify any drainage-related issues associated with the proposed development and any likely constraints that could be imposed. The following issues have been addressed within this report.
 - Determine the current surface water drainage regime and assess any potential increase in surface water runoff as a result of the proposed development.
 - Assess local and national policy in relation to the inclusion of SuDS.
 - Discuss Sustainable Drainage Systems (SUDS) as an option for reducing surface water flood risk and devise an outline Drainage layout.
 - Devise an appropriate outline surface water drainage strategy (including calculation where appropriate) to deal with any potential increase in surface water runoff and include for climate change.
 - Devise an appropriate outline foul water drainage strategy.

2. Development Description and Location

2.1 Site Location

The site is referenced in Figure 2, and a site location map is provided in Appendix A.

Item	Brief Description
Project name	Bradley Fold Road, Bolton.
Site address and location	Land north of 57 Bradley Fold Road, Ainsworth, Bolton, BL2 5QR.
Council Area	Bury Council
Approximate Grid Reference	OS: 376341, 409585
General Locality	The site is located approximately 4km east of Bolton Town centre.

Figure 2: Site Referencing Information

2.2 Existing Site Description

- 2.2.1 The development site (Red Line Boundary) is rectangular in plan shape and currently encompasses a small area of hardstanding (previously stables) with some grassed and shrubbed areas and limited hedging north and east. Access to the development is from Bradley Fold Road to the west of the site. There are other private dwellings situated adjacent the development to the north and the south.
- 2.2.2 The site is located within a predominantly rural led area. There are open fields in all directions.
- 2.2.3 Figure 3 identifies the overall site location details. Further details of the existing layout can be seen on the Red Line Plans in Appendix A.

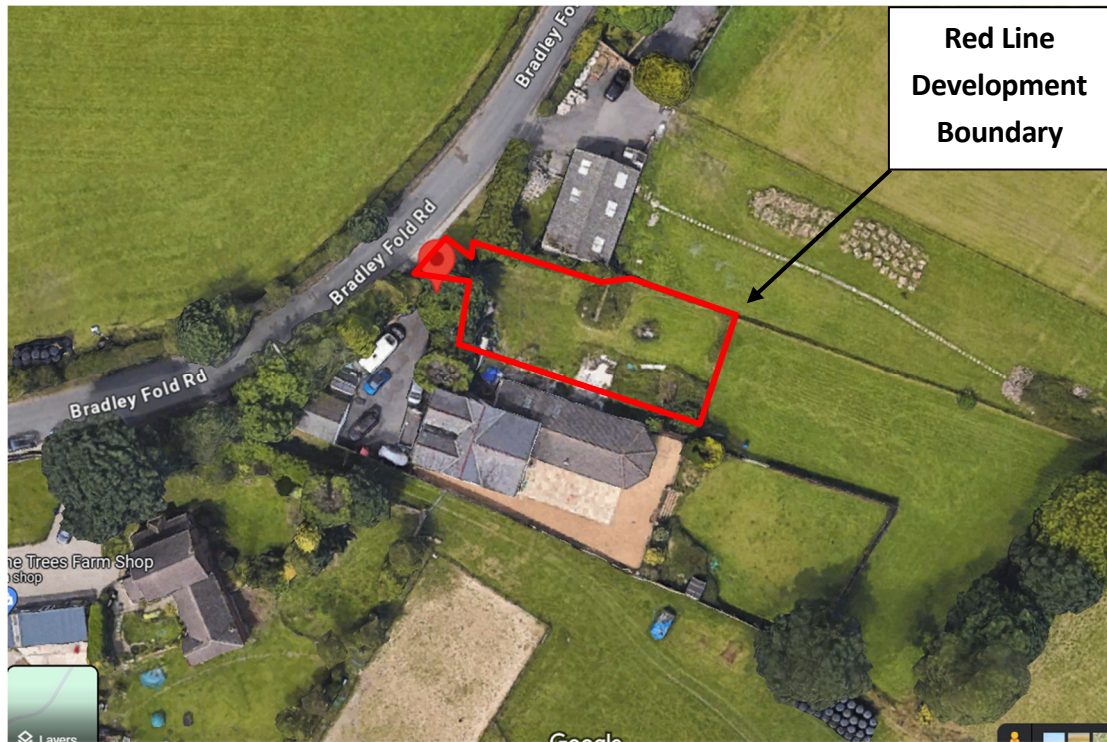


Figure 3: Location Plan as taken from Google Maps (2024)

2.3 Topography

- 2.3.1 A topographical survey has been completed at this time. This has identified the ground level on Bradley Fold Road to be circa 153.18m AOD. The site itself encompasses a moderate fall in a south easterly direction from 152.43m AOD at the entrance down to 151.66m AOD at the south eastern boundary. Refer to Appendix B for full details.

3. Fluvial Flood Risk Review

- 3.1 Figure 4 below locates the site on the Environment Agency's indicative floodplain map. It is clear from this that the red line boundary sits outside of a fluvial generator of flood water from any identified water body or river. It is considered therefore that the site lays outside of the active 100-year and extreme event floodplains, thus lying within 'Flood Zone 1 Classification' in accordance with the 2023 National Planning Policy Framework (NPPF) Flood Risk Guidance Notes, i.e., probability of annual fluvial flooding significantly less than 1 in 1000 in any one year (<0.1%). The risk from fluvial flood water is diminished to acceptable levels, removing the requirement for further investigation and assessment of the fluvial flood regime.

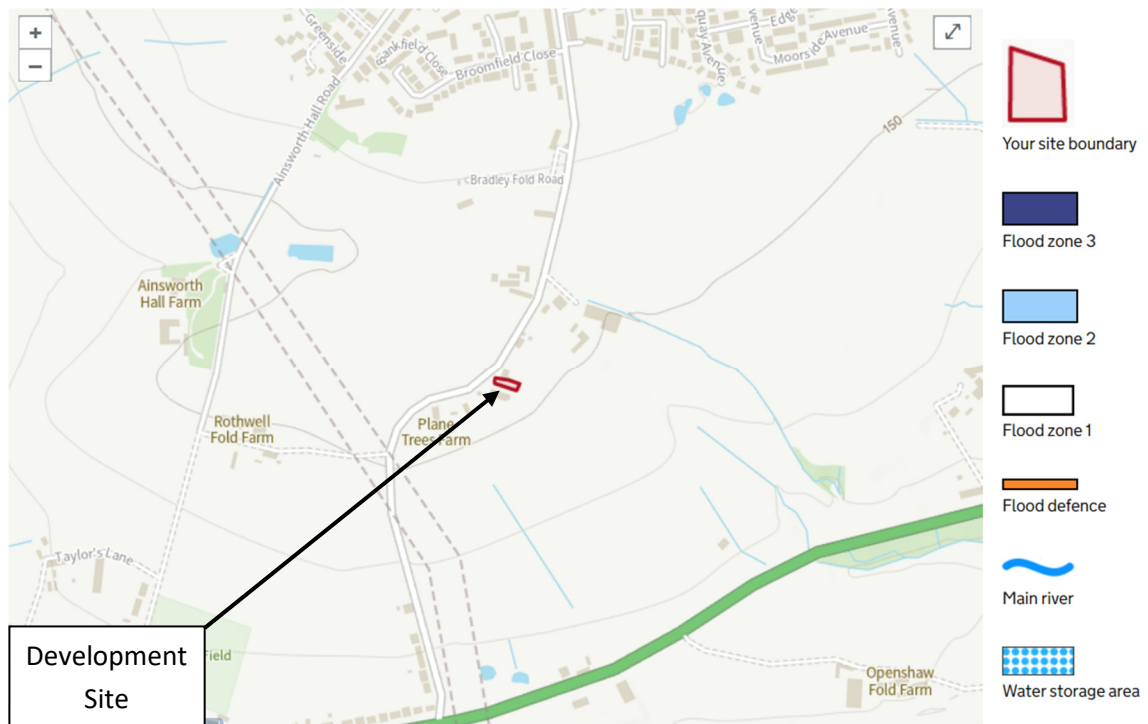


Figure 4: EA Indicative Flood Maps

- 3.2 In addition, the development application boundary is less than 1ha in plan area. In line with criteria set within the NPPF a Flood Risk Assessment is not required to support a planning application if the development is less than 1ha and in Flood Zone 1.

4. Local Policy

4.1 Bury Metropolitan Borough Council Sustainable Drainage

4.1.1 Although Bury Council do not have a formal Policy document for the Management of Surface Water, there is information on their website defining how SuDS can be integrated into the fabric of development starting at the planning stage and leading through the concept, outline and detailed design stages.

4.1.2 The main principles of the integration of SuDS for Major developments are summarised below and as taken from the CIRIA SuDS Manual:

- Sustainable surface water management is a material consideration for all planning applications. This means all development proposals must include a site-specific surface water drainage strategy following sustainable urban drainage guidelines (SuDS).
- On greenfield sites, surface water run off must be managed to achieve at least no increase in run off rates. Where possible, there should be a reduction in rates.
- On previously developed sites, run off proposals should demonstrate a reduction in rates in line with the non-Statutory Technical Standards for Sustainable Drainage Systems (2015) (or any later replacement standards).
- In line with Part H of the building regulations, surface water drainage options must be considered in the following order. An option higher in the hierarchy can only be agreed if it can be demonstrated that earlier options are not feasible.
 - i. Into the ground (infiltration)
 - ii. To a surface water body
 - iii. To a surface water sewer
 - iv. To a combined sewer
- Development in a critical drainage area should not result in the loss of open watercourses. Culverts should be opened where possible. We will only permit the culverting of existing watercourses if there is an overriding need.
- Proposals must show how watercourses and riverside habitats will be conserved and enhanced.
- The Council as Lead Local Flood Authority are a statutory consultee for surface water drainage on all major planning applications. To approve an application, we need to be satisfied that:
 - i. The proposals are appropriate in relation to flood risk and pollution control.
 - ii. There are clear arrangements in place for ongoing maintenance

5. Outline Drainage Strategy

5.1 Existing Drainage

- 5.1.1 The United Utilities (UU) sewer records have been reviewed. These have indicated no public sewers within 300m of the site boundary.
- 5.1.2 The site area is unmade with no positive drainage identified.

5.2 Existing Runoff

- 5.2.1 For the purpose of this assessment the site will be classed as fully greenfield with greenfield discharge rates defined below.
- 5.2.2 Greenfield discharge calculations have been undertaken for the site in accordance with Rainfall Runoff Management for Developments (Report SC030219, October 2013, Defra/EA). In accordance with the Non-statutory Technical Standards for Sustainable Drainage Systems (March 2015, Defra) greenfield rates have been calculated for the 1 in 1 year, Q_{bar} , 1 in 30 and 1 in 100-year rainfall events. Figure 5 below provides a summary of the existing greenfield runoff rates based on an area of 0.10ha.

Area	Greenfield Runoff Rates (l/s)			
	1 yr	Q_{bar}	30yr	100yr
0.10	0.7	0.8	1.4	1.7

Figure 5: Existing Greenfield Runoff Rates

5.3 Hydrological Assessment

- 5.3.1 There is a small unnamed watercourse located approximately 150m to the southeast of the site, flowing generally in a southeasterly direction.

5.4 Geology

- 5.4.1 No site-specific intrusive Phase 2 Site Investigation has been carried out at the site at this time. A review of the BGS online borehole data has indicated that the site is underlain by topsoil over Glaciofluvial Deposits (Sands), over Cannel Rosk (South Lancashire) - Sandstone to depth.
- 5.4.2 In light of these findings, it is considered that infiltration has the potential to be suitable for draining the site. At this time an infiltration rate of $5 \times 10^{-6} \text{m/s}$ will be used for outline sizing of the soakaway tank, with formal BRE 365 testing to be completed as part of the Phase 2 intrusive investigations.

5.5 Sustainable Drainage Systems (SuDS) Assessment

5.5.1 SuDS Objectives

5.5.1.1 Sustainable drainage developed in line with the ideals of sustainable development is collectively referred to as Sustainable Drainage Systems (SuDS). At a particular site, these systems are designed both to manage the environmental risks resulting from urban runoff and to contribute wherever possible to environmental enhancement. SuDS objectives are therefore to minimise the impacts from the development on the quantity and quality of the runoff and maximise amenity and biodiversity opportunities (CIRIA C753, 2015).

5.5.2 SuDS Design Themes

5.5.2.1 The 'Management Train Approach' should be central to the surface water drainage strategy of the proposed site. The main objective is treatment and control of runoff as near to the source as possible protecting downstream habitats and further enhancing the amenity value of the site. This concept uses a hierarchy of drainage techniques to incrementally reduce pollution, flow rates and volumes of storm water discharge from the site, and is as follows:

- i. **Prevention** – The use of good site design and housekeeping measures to prevent runoff and pollution and includes the use of rainwater reuse / harvesting.
- ii. **Source Controls** – Control of runoff at source or as close to source as possible (e.g. soakaways, green roofs, pervious pavements).
- iii. **Site Control** – Management of water in a local area and can include below ground storage / attenuation, detention basins, large infiltration devices.
- iv. **Regional Control** – Management of water from a site or various sites and can include wetlands and balancing ponds.

5.5.3 SuDS Site Constraints

5.5.3.1 SuDS techniques are suitable for all sites; therefore an assessment of the existing site is required so that SuDS limitations can be determined.

- *Land Use Characteristics:* The size and type of development allows a range of prevention, source control and site control SuDS devices to be considered.
- *Site Characteristics:* Based on the BGS mapping, infiltration has the potential to be suitable subject to the results of infiltration testing.
- *Catchment Characteristics:* The site is currently classed for drainage purposes as 'Greenfield'.
- *Environmental and Amenity Performance:* The inclusion of SuDS within the overall development is a key driver in providing both amenity and habitat creation. All types of SuDS will be considered and blended into the project where feasible. Maintenance plans will be prepared for all SuDS devices that are included.

5.5.4 SuDS Methods

5.5.4.1 Figure 6 and 7 on the following pages provide an assessment of various above and below ground SuDS methods that can provide water quality treatment and management of flows to reduce runoff rates & volumes, and whether they can be suitably incorporated at this development site. The purpose of this assessment is to set out options to be considered at the planning stage with consideration to time constraints, viability and lifetime maintenance of the residential development.

Method	Comment	Suitability for Development
Green Roofs	Can be used on suitable low-rise buildings to provide retention, attenuation and treatment of rainwater. Promotes evaporation and local biodiversity.	<u>Not suitable:</u> Architectural proposals for the development and maintenance issues deem this unsuitable.
Water Butts	Plastic tanks placed at the base of rainwater down pipes to collect rainwater runoff from the roof areas for reuse by the property owners.	<u>Suitable:</u> To be included to the rear downpipes where possible and agreed with client.
Rainwater Harvesting	Rainwater harvesting reduces the total runoff volume from the developed site by reusing as 'Grey' water. Also reduces treated water consumption.	<u>Not suitable:</u> - Additional costs of installation would have a severe effect on the viability of the development. - Running and maintenance costs would not be acceptable to our client and future occupiers. - The ability to restrict peak flow rates and short-term peak volumes is non-existent where a critical storm event occurs.
Infiltration Options	Reduces total run off volume from the development by allowing water to infiltrate to suitable sub strata.	<u>May be Suitable:</u> Potential underlying sands would indicate ground should be suitable for infiltration. Further investigations to be undertaken.
Permeable Surfacing (Infiltration)	- Reduces total run off volume from the development by allowing water to infiltrate to suitable sub strata. - Can be used to enhance water quality.	<u>May be Suitable:</u> Potential underlying sands would indicate ground should be suitable for infiltration. Further investigations to be undertaken (subject to confirmation of surface finishes).

Method	Comment	Suitability for Development
Permeable Surfacing (Standard)	- Can be used to enhance quality of runoff water. - Sub-base provides 'source' storage and reduces the volume of storage downstream with selection of stone fill or use of plastic box stems. - Impermeable membrane at base of construction to prevent impact on pavement stability.	<u>Suitable:</u> Driveway has the potential to attenuate and filter surface water flows through the use of permeable surfacing
Bio-Retention	Collect and retain run-off within tree pits or above ground planers to help improve water quality, prior to discharge in piped system or infiltration.	<u>Not Suitable:</u> The size and type of the development restricts the use of above ground surface runoff storage.
Swales, basins and ponds	- Provide areas for above ground surface runoff storage. - Swales also improve water quality through filtration.	<u>Not Suitable:</u> No available area for attenuation pond to be allocated.

Figure 6: Surface SuDS Methods

Method	Comment	Suitability for Development
Geocellular Storage	- Suitable for sites with insufficient space for basins etc. - Suitable for sites where topography prevents the use of open basins etc.	<u>Suitable:</u> To be incorporated as part of the infiltration attenuation measures beneath the garden area.
Large Diameter Pipes, Culverts or Tanks	- Suitable for sites with insufficient space for basins etc. - Provide a volume of below ground storage with a high void ratio and good man entry provision to allow for future maintenance and cleaning. - Generally, be suitable for adoption by the statutory water company (e.g., United Utilities).	<u>Not Suitable:</u> The use of oversized pipes is more suited to large residential schemes.

Figure 7: Sub-Surface SuDS Methods

5.5.5 SuDS Hierarchal Approach

Based on the SuDS assessment in Tables 6 & 7, plus an assessment of the local site conditions, the SuDS hierarchal approach for discharge of surface water at the development site is considered in greater detail below:

Method	Suitability	Suitability for Development
Infiltration to Ground	Yes	Initial assessment has determined that the underlying ground has the potential to be suitable for infiltration-based options. Further investigation and testing required.
Connection to Watercourse	Yes*	Should infiltration be found not to be suitable, take new connection across fields to the south east to local watercourse at restricted rates.
Connection to Surface Water Sewer	No	No surface water sewer in close proximity.
Connection to a Combined Sewer	No	Higher options available.

Figure 8: SuDS Hierarchal Approach

5.5.6 SuDS Design Philosophy

5.5.6.1 SuDS assessment and hierarchal approach discussed in Figure 6, 7 and 8 above has defined the overall SuDS strategy. Thus, the SuDS philosophy for the development site is the promotion of prevention, source control and site control techniques with discharge to the adjacent watercourse at a restricted rate.

The following design philosophy is proposed:

- Surface water treatment using the 'Management Train' approach to remove and isolate contamination at all SuDS facilities prior to conveyance to the existing drainage infrastructure.
- Prevention measures in the form of Water butts at the base of rear rainwater pipes.
- Source Control via the inclusion of permeable surfacing to the parking bays.
- Site control in the form of a Geocellular infiltration tanks to enable infiltration to the underlying sands and gravels, and to retain the peak storm events.
- Aim to limit where possible the impermeable fraction of development.

5.6 The Non-Statutory Technical Standards for SuDS

5.6.1 It is best practice to develop drainage strategies to the DEFRA document 'The Non-Statutory Technical Standards for SuDS'. The Bury Council SuDS document also follows the principles of this document.

5.6.2 The DEFRA document advises the following with respect to 'Peak Flow Control' (S2) and 'Volume Control' (S4) for Greenfield sites such as this:

- **S2** *For greenfield developments, the peak runoff rate from the development to any highway drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100-year rainfall event should never exceed the peak greenfield runoff rate for the same event.*
- **S4** *Where reasonably practicable, for greenfield development, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100-year, 6-hour rainfall event should never exceed the greenfield runoff volume for the same event.*
- **S6** *Where it is not reasonably practicable to constrain the volume of runoff to any drain, sewer or surface water body in accordance with S4 above, the runoff volume must be discharged at a rate that does not adversely affect flood risk.*

5.6.3 As noted above, and in line with policy, it is intended that surface water discharge rates will be restricted below the respective greenfield runoff rates for all rainfall events in accordance with standard **S2** and to comply with the peak volume requirements as per **S4** and **S6**. This is due to the proposed infiltration tank allowing the runoff to permeate to the underlying sands.

5.7 Climate Change

5.7.1 In May 2022, the Environment Agency released updated climate change allowances for peak rainfall intensities which should be applied to new developments. Rather than nation wide allowances, each area will have its own peak rainfall allowances. In the case of the Ainsworth area, this is the Irwell Management Catchment peak rainfall allowances.

5.7.2 Based on the nature of the development, a lifespan of circa 100 years is anticipated. Therefore, the potential climate change allowance for the 2070's Upper End Allowance for residential developments is 45%, which will be included in the hydraulic calculations.

5.8 Outline Surface Water Drainage Strategy

5.8.1 At this time, the general principal of the surface water drainage strategy is to collect the runoff from the roof of the new residential property and outfall into a geocellular infiltration tank located in the rear garden that will enable the water to infiltrate to the underlying sands. The rainwater pipes will outfall via a waterbutt. * Note that should the formal BRE 365 infiltration testing indicate that the ground is not suitable then connection will be made to the nearest local watercourse at a peak rate not exceeding 3l/s.

5.8.2 Permeable paving will be constructed to the parking area.

5.8.3 The proposed drainage layout for the new development site will be designed in accordance with BS EN 752: 2008 and Building Regulations Part H guidance, i.e. up to the 30-year storm return period criterion and tested for the 1 in 100-year return period including a 45% increase to account for climate change to confirm that there is no flood risk to the units.

- 5.8.4 Flooding can occur on a local scale beyond the 30yr criterion due to runoff exceeding the capacity of the minor system during extreme events and it can only be addressed on a site-specific basis. Guidance states that development should be protected against flooding from extreme events (1 in 30 year) and that flood pathways are identified when the drainage system is exceeded.
- 5.8.5 In the case of this development, exceedance flows will be all those over and above the 30-year design criterion set by guidance. Using storage within the external areas would be achievable and would direct flood water away from the proposed residential unit, with flows directed back into the surface water drainage network as water levels in the drainage network receded. The exceedance flows and volumes can be calculated for the new development drainage layout. In the case of this development and due to the fall across the site, consideration has been given to ensure all water is controlled so that it does not impact on the new residential property.
- 5.8.6 Although it is envisaged that Prevention measures could be included in the final scheme, this strategy will assume for outline calculations purposes that only Site Control methods are incorporated. A fully detailed hydraulic surface water network has been simulated in the Causeway 'Flow' Design Software. This takes into account a conservative infiltration rate of 5×10^{-6} m/s and factor of safety of 2. It is noted that these rates and volumes are preliminary for this outline assessment and are likely to alter at detailed design stage when more site-specific information is made available.
- 5.8.7 Drawing PGC1020-DR-C-001 in Appendix C indicates the Drainage Strategy based on the Architects masterplan intent, with the outline hydraulic calculations in Appendix D.

5.9 Volume Control

- 5.9.1 The impermeable area of the application site will be increased as a result of the development and therefore the volume of run-off in the 100-year 6-hour storm event will be increased above the pre-development greenfield level. The management of the additional volume will be managed through a new infiltration tank for all storm events in order to prevent an adverse effect on flood risk.

5.10 Pollution Control

- 5.10.1 Runoff from roofs is generally considered to be clean and will be discharged directly into the new drainage network. Surface water run-off from hard paved areas at risk of contamination should receive water quality treatment. Driveways are considered as a low hazard in terms of contamination and also constructed in permeable surfacing. Figure 9 illustrates the pollution hazard indices for different land use classifications from The CIRIA SuDS Manual C753 (2015).

Land use	Pollution hazard level	Total suspended solids (TSS)	Metals	Hydrocarbons
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

Figure 9: Pollution Hazard indices for land use classification (Table 26.2 the CIRIA SuDS manual 2015)

- 5.10.2 Figure 10 then illustrates the SuDS Component mitigation indices from the CIRIA SuDS Manual C753 (2015)
- 5.10.3 The selection of treatment should ensure that the SuDS mitigation component index (Figure 10) exceeds the pollution hazard index (Figure 9).

Type of SuDS component	Mitigation indices ¹		
	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.		

Notes

- 1 SuDS components only deliver these indices if they follow design guidance with respect to hydraulics and treatment set out in the relevant technical component chapters.
- 2 Filter drains can remove coarse sediments, but their use for this purpose will have significant implications with respect to maintenance requirements, and this should be taken into account in the design and Maintenance Plan.
- 3 Ponds and wetlands can remove coarse sediments, but their use for this purpose will have significant implications with respect to the maintenance requirements and amenity value of the system. Sediment should normally be removed upstream, unless they are specifically designed to retain sediment in a separate part of the component, where it cannot easily migrate to the main body of water.
- 4 Where a wetland is not specifically designed to provide significantly enhanced treatment, it should be considered as having the same mitigation indices as a pond.
- 5 See Chapter 14 for approaches to demonstrate product performance. A British Water/Environment Agency assessment code of practice is currently under development that will allow manufacturers to complete an agreed test protocol for systems intended to treat contaminated surface water runoff. Full details can be found at: <http://tinyurl.com/qf7yuj7>
- 6 SEPA only considers proprietary treatment systems as appropriate in exceptional circumstances where other types of SuDS component are not practicable. Proprietary treatment systems may also be considered appropriate for existing sites that are causing pollution where there is a requirement to retrofit treatment. SEPA (2014) also provides a flowchart with a summary of checks on suitability of a proprietary system.

Figure 10: Indicative SuDS mitigation indices (Table 26.3 the CIRIA SuDS manual 2015)

5.10.4 The roof areas have a have low pollution hazard level and thus no further treatment is required.

5.10.5 Permeable paving is proposed to the car parking areas which will provide the necessary treatment, to reduce contamination risk to the downstream catchments.

5.11 Maintenance

5.11.1 This section is intended to give an overview of the operation and maintenance for the drainage features included with the drainage strategy and in relation to typical details. Where proprietary products are specified, the manufacturer's instructions and recommendations should be followed in priority to this document unless specifically noted otherwise due to project constraints. The recommended operations and frequencies are typical only and should be more frequent initially to ensure that there are no unforeseen issues with the operation and then adjusted to suit the site requirements.

5.11.2 There are three types of maintenance activities associated with surface water drainage systems. The SuDS Manual, CIRIA C753, defines these as:

- Regular Maintenance – *'basic tasks undertaken on a frequent and predictable schedule' including vegetation management, litter and debris removal, and inspections.'*
- Occasional Maintenance – *'tasks that are likely to be required periodically, but on a much less frequent and predictable basis than the routine tasks (sediment removal is an example).'*
- Remedial Maintenance – *'intermittent tasks that may be required to rectify faults associated with the system, although the likelihood of faults can be minimised by good design. Where remedial work is found to be necessary, it is likely to be due to site-specific characteristics or unforeseen events, and as such timings are difficult to predict.'*

- 5.11.3 Specific maintenance needs should be monitored, and maintenance schedules adjusted to suit the location and condition of the drainage feature in question.

Operation and Maintenance Activity	SuDS Component		
	Piped Network / Inspection Chambers	Permeable Paving	Attenuation Storage Pond
Regular Maintenance			
Inspection	■	■	■
Litter and debris removal	■	■	
Vacuuming		■	
Weed and invasive plant control		■	■
Shrub management (including pruning)		□	■
Occasional Maintenance			
Sediment management ¹	■	■	■
Remedial Maintenance			
Structure rehabilitation / repair	□	□	□
Infiltration surface reconditioning		□	
■ Will be required □ May be required. ¹ Sediment should be collected and managed in pre-treatment systems, upstream of the main device.			

Figure 11: Extract from The SuDS Manual Table 32.1: Typical key SuDS components operation and maintenance activities.

5.11.4 Piped Networks, Inspection, Manhole and Catchpit Chambers

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 where required.

Pipes are proprietary products, and the materials can vary across the site and as such where used the manufacture's recommendations should be followed.

Pipes are intended to be the main conveyance across the development and where oversized they form the attenuation volume required by the limitation of the discharge rate. They are intended to be dry except for during rainfall events. These have been designed to be self-cleaning where possible for smaller diameter pipes, and for larger diameters the risk is reduced due to the overall pipe size.

Access for maintenance is provided through access chambers and manholes.

Regular inspection and maintenance are important to identify areas which may have been obstructed / clogged and may not be drainage correctly thus exposing the development to a greater level of flood risk.

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Inspect and identify any features that are not operating correctly. If required, take remedial action	Monthly for three months, then six monthly
	Debris removal from catchment surface / gratings (where may cause risks to performance)	Monthly (and after large storms)
	Remove sediment from trapped sumps, manholes and catchpits.	Annually or as required
Remedial Maintenance	Repair / rehabilitation of gratings, inlets and outlets	As required
Monitoring	Inspect / check all gratings, trapped sumps, manholes and catchpits to ensure that they are in good condition and operating as designed	Annually and after large storm events
Structure Rehabilitation / Repair	Regular Maintenance and Monitoring to identify if repair and / or replacement of features or pipework is required.	As required

Figure 12: Operation and Maintenance Requirements of Piped Networks and Inspection Chambers

5.11.5 Attenuation Storage Tanks

Geocellular tanks are modular storage systems made with plastic units. These units can be assembled to achieved re required volume and usually on multiple layers. Generally, the units have 95% of voids content and are used to create an efficient below ground structure to store surface water.

The geocellular units and geotextile are proprietary products and therefore manufacturer's recommendations should also be taken into consideration.

Access for maintenance should be provided by an access shaft located on the tank and from the manhole chambers downstream of the tank.

Regular inspection and maintenance are important for the effective operation of attenuation tanks as designed. As the feature is buried, a regular inspection regime is very important to ensure the correction functionality of the surface water drainage network.

Maintenance Schedule	Required Action	Frequency
Regular Maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action.	Monthly for 3 months, then annually.
	Remove debris from the catchment surface (where it may cause risks to performance).	Monthly.
	For systems where rainfall infiltrates into the tank from above, check surface of filter for blockages by sediment, algae or other matter; remove and replace surface infiltration medium as required.	Annually.
	Remove sediments from pre-treatment structures and/or internal forebays.	Annually, or as required.
Occasional Maintenance	Remove sediment from pre-treatment structures and/or internal forebays	Annually, or as required
	Inspect/check all inlets, outlets, vents and overflows to ensure that they are in good condition and operating as designed.	Annually
Remedial Actions	Survey inside of tank for sediment build-up and remove if necessary.	Every 5 years or as required.

Figure 13: Operation and Maintenance Requirements for Attenuation Crates

5.11.6 Permeable Paving

Permeable paving provides a surface suitable for vehicular traffic, while allowing rainwater to infiltrate through the surface and into the underlying structural layers. The surface itself is impervious to water, but the blocks are laid to provide void space through the surface to the sub-base. The water is temporarily stored within this sub-base before controlled discharge downstream.

Permeable surfaces, together with their associated substructures, are an efficient means of managing surface water runoff close to its source – intercepting runoff, reducing the volume and frequency of runoff, and providing a treatment medium. Treatment processes that occur within the surface structure, sub-base and geotextile layers include filtration, absorption, biodegradation and sedimentation.

Permeable paving should be inspected regularly, preferably during and after heavy rainfall to check effective operation and identify areas of ponding. Permeable paving needs to be regularly cleaned of silt and other sediments to preserve their infiltration capacity. Evidence suggests that sweeping once per year should be sufficient to maintain an acceptable infiltration rate on most developments.

Maintenance Schedule	Required Action	Frequency
Regular Maintenance	Brushing and vacuuming (standard cosmetic sweep over whole surface)	Once a year, or when required during autumn leaf fall
	Inspect infiltration surfaces for ponding, compaction, silt accumulation, record areas where water is ponding for > 48hours	Every 3 months, 48 hours after large storms.
Occasional Maintenance	Stabilise and mow contributing and adjacent areas	As required
	Manage other weeds and vegetation and remove nuisance plants	Once a year, or when required
Remedial Actions	Repair erosion of any adjacent soft landscaping adjacent to the paving	As required
	Remedial work to any depressions, rutting and cracked or broken blocks.	As required
	Rehabilitation of surface and upper substructure by remedial sweeping	As required
	Remove and dispose of oils or petrol residues using safe standard practices	As required

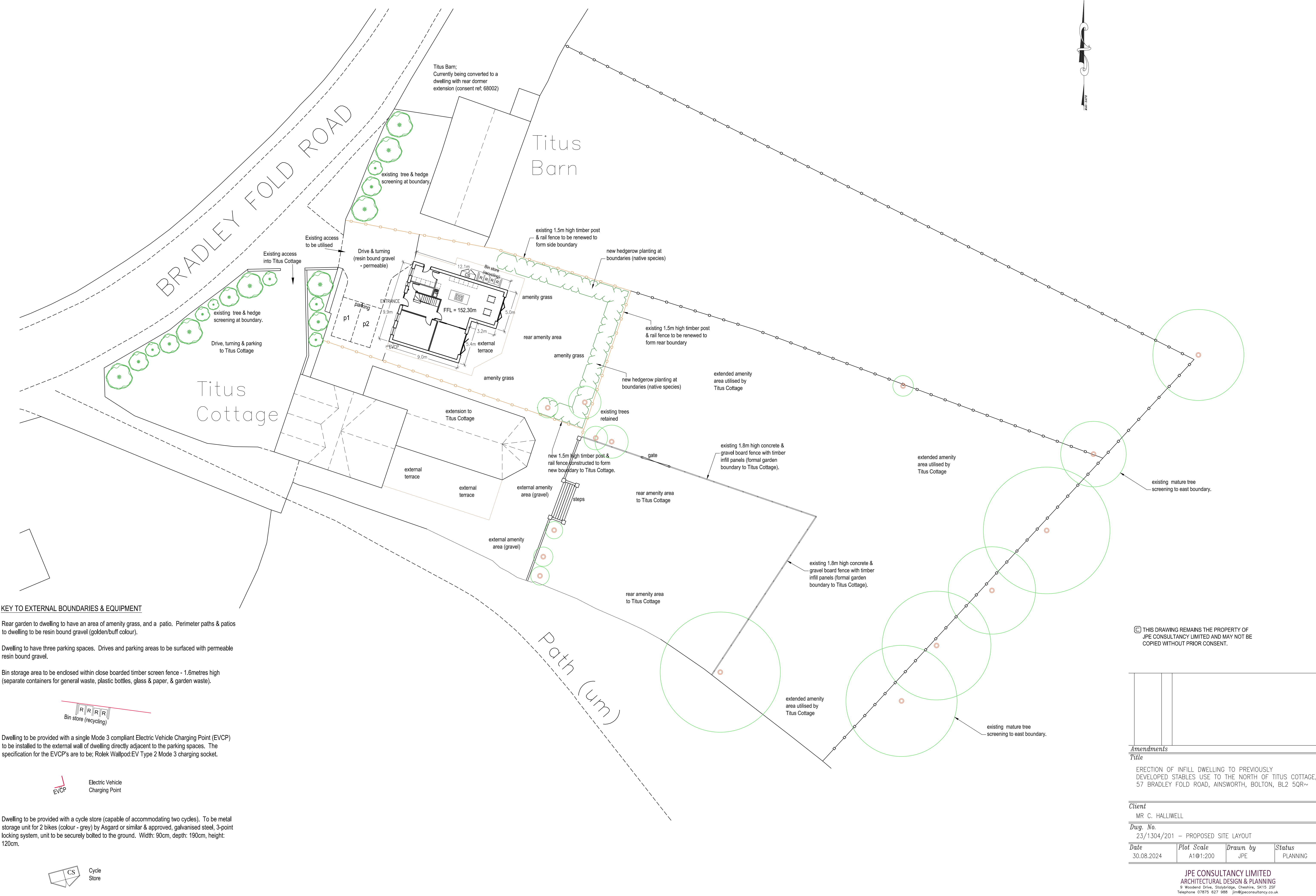
Figure 14: Operation and Maintenance Requirements for Permeable Paving

5.12 Foul Water Drainage

- 5.12.1 As discussed in earlier sections, there are no public sewers in close proximity.
- 5.12.2 The outline foul drainage strategy will be to direct all new foul drainage to a new sewage treatment plant, sized for the proposed population usage, which will then outfall to the underlying sands via a new land drainage network.
- 5.12.3 The proposed foul drainage for the new development site will be designed in accordance with BS EN 752: 2008 and Building Regulations Part H guidance.
- 5.12.4 Drawing PGC1020-DR-C-001 in Appendix B indicates the Drainage Strategy.

Appendix A – Architects Drawings

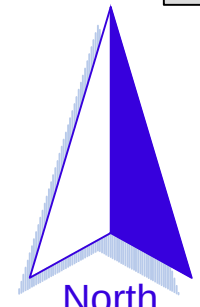
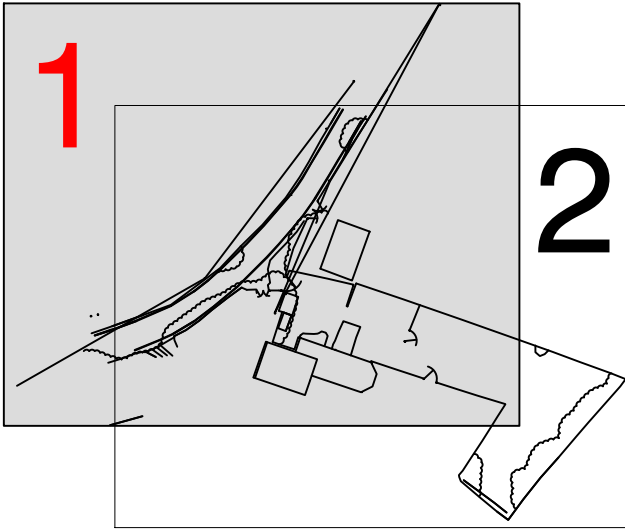
ERECTION OF INFILL DWELLING TO PREVIOUSLY DEVELOPED STABLE USE TO THE NORTH OF TITUS COTTAGE, 57 BRADLEY FOLD ROAD, AINSWORTH~



Appendix B – Topographical Survey

Notes

All Dimensions to be checked on site. Walls shown on plans are not to be assumed to be solid & should be checked for thickness, construction, load bearing capacity & stability.



0 2 4 6 8 10 12 14 16 18 20
Metres

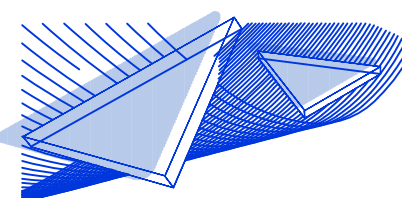
ABBREVIATIONS

CH Cable Height
DK Drop Kerb
EH Eaves Height
EP Electric Pole
GU Gully
LP Lamp Post
RH Ridge/Roof Height
RWP Rain Water Pipe
SP Sign Post
TF Top of Fence
TP Telegraph Pole
TS Traffic Signal
TW Top of Wall

NOTE

All levels and coordinates relate to OSGB36(13) using CHSS data.
Levels defining edge of carriageway are observed at channel (bottom of kerb).

Rev.0 Description. Issued



TriCAD
Solutions Ltd.
BUILDING & LAND SURVEYORS

2 Berkshire Close | Wilpshire | Blackburn | Lancashire | BB1 9NG
tel 01254 614055 fax 01254 209754 e-mail sales@tricadsolutions.co.uk

Site Address

Titus Cottage
Ainsworth
BL2 5QR
Project Description
Site Survey

Drawing Title

Existing
Site Layout

Scale

1:200@A1

Date

05/06/2024

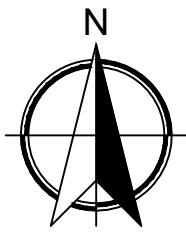
Drawn By

JB

Drawing Number

TRI-4483-01

Appendix C – PGC Drawings



FOUL WATER DRAINAGE

FOUL WATER GENERATED BY THE NEW DEVELOPMENT WILL DISCHARGE TO THE UNDERLYING SANDS VIA A NEW SEWAGE TREATMENT PLANT.

SURFACE WATER DRAINAGE

CONSIDERATION HAS BEEN GIVEN TO THE HIERARCHY OF DRAINAGE OPTIONS FOR THE SITE AS FOLLOWS:

- DISCHARGE INTO GROUND - UNDERLYING SAND HAVE THE POTENTIAL TO ENABLE INFILTRATION OPTIONS TO BE CONSIDERED SUBJECT TO FORMAL BRE 365 INFILTRATION TESTING.
- DISCHARGE TO SURFACE WATER BODY - NO WATERCOURSE IN CLOSE PROXIMITY.
- DISCHARGE TO SURFACE WATER SEWER, HIGHWAY DRAIN OR OTHER DRAINAGE SYSTEM - NO SURFACE WATER SEWER IN CLOSE PROXIMITY.
- DISCHARGE TO COMBINED WATER SEWER - NO COMBINED WATER SEWER IN CLOSE PROXIMITY.

SUMMARY

GEOCELLULAR SOAKAWAY TO THE REAR GARDEN, AND PERMEABLE SURFACING TO THE DRIVEWAY TO ENABLE INFILTRATION TO THE UNDERLYING SANDS. DESIGN AT THIS TIME BASED ON INFILTRATION RATE OF 5x10-6 M/S AND FACTOR OF SAFETY OF 2, THOUGH SUBJECT TO FORMAL BRE 365 TESTING.

SUDS TO ENCOMPASS:

- WATER BUTTS
- PERMEABLE SURFACING
- GEOCELLULAR INFILTRATION CRATES.

GENERAL NOTES

- DRAWINGS ARE TO BE READ IN CONJUNCTION WITH ALL RELEVANT SPECIFICATIONS, ENGINEERS, ARCHITECTS & SERVICES DRAWINGS, INCLUDING APPROVED BUILDERS WORK DRAWINGS. CONTRACTOR TO NOTIFY ENGINEER OF DISCREPANCIES BETWEEN STRUCTURAL DRAWINGS AND SPECIFICATIONS OR OTHER DRAWINGS.
- ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.
- DETAILS OF EXISTING SEWERS SHALL BE CONFIRMED BY THE CONTRACTOR ON SITE PRIOR TO THE COMMENCEMENT OF WORKS. ANY DISCREPANCIES ARE TO BE REPORTED TO THE ENGINEER IMMEDIATELY. THE CONTRACTOR SHOULD CHECK THE LEVELS OF ALL NEW OUT FALLS IN RELATION TO EXISTING SEWERS PRIOR TO ANY CONSTRUCTION TO ENSURE THE PROPOSED DESIGN CAN BE ACHIEVED.
- DO NOT SCALE FROM THIS DRAWN, WORK TO DIMENSIONS OR COORDINATES PROVIDED. ALL LEVELS ARE IN MILLIMETRES, UNLESS OTHERWISE NOTED. ANY AMBIGUITIES, OMISSIONS AND ERRORS ON DRAWINGS SHALL BE BROUGHT TO THE ATTENTION OF THE ENGINEER IMMEDIATELY.

KEY

- PROPOSED FOUL WATER DRAINAGE
- PROPOSED SURFACE WATER DRAINAGE
- SITE BOUNDARY
- PROPOSED PERMEABLE SURFACING
- RWP RAINWATER PIPE
- WPC WASTE POINT CONNECTION (FOUL)
- RE RODDING EYE

NOTE ALL RWP AND SVP LOCATIONS TO BE CONFIRMED BY OTHERS

ALL PIPEWORK TO BE 100Ø UNLESS NOTED OTHERWISE

FFL: 152.30

KLARGESTER BIODISC BA (6 POPULATION) OR SIMILAR, SEWAGE TREATMENT PLANT WITH POWER SUPPLY AND VENTED. FINAL POSITION TO BE AGREED ON SITE.

20m² DRAINAGE FIELD, SIZED AND DESIGNED IN LINE WITH BUILDING REGULATIONS PART H TO SUIT GROUND CONDITIONS AND FLOW RATES FROM 4 BEDROOM PROPERTY

- 9.6m³ GEOCELLULAR SOAKAWAY STORAGE TANK (4m X 3m X 0.8m HIGH) WITH MIN 600mm COVER DEPTH.
- IMPERMEABLE AREA - 120m².
- DESIGNED FOR THE 100YR + 45% CC PEAK STORM EVENT.
- INFILTRATION RATE - 0.018mm/hr (TBC)
- TANK AND VENT LOCATION TO BE AGREED ON SITE WITH CLIENT.
- CL: 151.80
- IL: 150.00

NOTE THIS DRAWING IS ISSUED TO SUPPORT THE OUTLINE PLANNING APPLICATION ONLY. FINAL DRAINAGE LAYOUT AND SUDS CONFIGURATION SUBJECT TO FINAL SITE LAYOUT AND DETAILED DESIGN

P2	05.12.24	PG	PG	SITE LAYOUT UPDATED
P1	10.09.24	PG	PG	PRELIMINARY ISSUE
REV	DATE	DRAWN	REV'D	NOTES

CLIENT	MR C HALLIWELL
PROJECT	NEW RESIDENTIAL DWELLING 57 BRADLEY FOLD ROAD
DRAWING TITLE	DRAINAGE STRATEGY PLAN

DRAWING STATUS					INFORMATION			
SCALE	1:100	DRAWN BY	PG	ENGINEER	PG	SHEET	A1	
DRAWING No						PGC1020-RP-C-001	REVISION	P2

PG Consulting
Civil & Infrastructure Engineers

106 Ack Lane West,
Cheadle Hulme,
Cheshire,
SK9 7ES
Tel: 07710 758971
Email: paul@pgcd.co.uk

Appendix D – Outline Hydraulic Calculations

PG Consulting

Civil & Infrastructure Engineers

PGC

File: Bradley Fold Road SW Net

Network: Storm Network

Paul Graveney

10.09.24

Page 1

Bradley Fold Road

Surface Water Network

Design Settings

Rainfall MethodologyFSR

Return Period (years)10

Additional Flow (%)0

FSR RegionEngland and Wales

M5-60 (mm)20.000

Ratio-R0.400

CV0.750

Time of Entry (mins)4.00

Maximum Time of Concentration (mins)30.00

Maximum Rainfall (mm/hr)50.0

Minimum Velocity (m/s)1.00

Connection TypeLevel Soffits

Minimum Backdrop Height (m)0.200

Preferred Cover Depth (m)1.200

Include Intermediate Ground✓

Enforce best practice design rules✓

Adoptable Manhole Type

Max Width (mm)374

Diameter (mm)1200

Max Width (mm)749

Diameter (mm)1500

Max Width (mm)499

Diameter (mm)1350

Max Width (mm)900

Diameter (mm)1800

>900 Link+900 mm

Max Depth (m)1.500

Diameter (mm)1050

Max Depth (m)99.999

Diameter (mm)1200

Circular Link Type

ShapeCircular

Barrels1

Auto Increment (mm)75

Follow Groundx

Available Diameters (mm)

100

150

Nodes

Name

Area (ha)

T of E (mins)

Cover Level (m)

Diameter (mm)

Depth (m)

RE01

0.006

4.00

152.350

100

0.600

SW01

152.350

450

0.750

RE02

0.006

4.00

152.350

100

0.600

SW02

152.350

450

0.750

SW03

151.900

450

0.800

TANK

151.800

100

1.800

DUMMY

151.500

100

1.600

Flow+ v12.0 Copyright © 1988-2024 Causeway Technologies Ltd

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	RE01	SW01	10.000	0.600	151.750	151.600	0.150	66.7	100	4.18	50.0
1.001	SW01	SW03	14.000	0.600	151.600	151.100	0.500	28.0	100	4.34	50.0
2.000	RE02	SW02	10.000	0.600	151.750	151.600	0.150	66.7	100	4.18	50.0
2.001	SW02	SW03	11.000	0.600	151.600	151.100	0.500	22.0	100	4.29	50.0
1.002	SW03	TANK	2.000	0.600	151.100	151.000	0.100	20.0	100	4.36	50.0
1.003	TANK	DUMMY	5.000	0.600	150.000	149.900	0.100	50.0	100	4.43	50.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
1.000	0.944	7.4	0.8	0.500	0.650	0.006	0.0	22	0.616
1.001	1.464	11.5	0.8	0.650	0.700	0.006	0.0	18	0.850
2.000	0.944	7.4	0.8	0.500	0.650	0.006	0.0	22	0.616
2.001	1.653	13.0	0.8	0.650	0.700	0.006	0.0	17	0.909
1.002	1.734	13.6	1.6	0.700	0.700	0.012	0.0	23	1.157
1.003	1.092	8.6	1.6	1.700	1.500	0.012	0.0	29	0.836

Pipeline Schedule

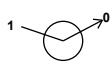
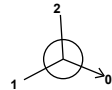
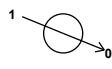
Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.000	10.000	66.7	100	Circular	152.350	151.750	0.500	152.350	151.600	0.650
1.001	14.000	28.0	100	Circular	152.350	151.600	0.650	151.900	151.100	0.700
2.000	10.000	66.7	100	Circular	152.350	151.750	0.500	152.350	151.600	0.650
2.001	11.000	22.0	100	Circular	152.350	151.600	0.650	151.900	151.100	0.700
1.002	2.000	20.0	100	Circular	151.900	151.100	0.700	151.800	151.000	0.700
1.003	5.000	50.0	100	Circular	151.800	150.000	1.700	151.500	149.900	1.500

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.000	RE01	100	Manhole	Adoptable	SW01	450	Manhole	Adoptable
1.001	SW01	450	Manhole	Adoptable	SW03	450	Manhole	Adoptable
2.000	RE02	100	Manhole	Adoptable	SW02	450	Manhole	Adoptable
2.001	SW02	450	Manhole	Adoptable	SW03	450	Manhole	Adoptable
1.002	SW03	450	Manhole	Adoptable	TANK	100	Manhole	Adoptable
1.003	TANK	100	Manhole	Adoptable	DUMMY	100	Manhole	Adoptable

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
RE01	-1.345	87.627	152.350	0.600	100				
						0	1.000	151.750	100
SW01	30.181	75.932	152.350	0.750	450		1	1.000	151.600
						0	1.001	151.600	100
RE02	-22.870	48.136	152.350	0.600	100				
						0	2.000	151.750	100

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
SW02	9.672	37.119	152.350	0.750	450		1 2.000	151.600	100
							0 2.001	151.600	100
SW03	31.876	48.814	151.900	0.800	450		1 2.001	151.100	100
							2 1.001	151.100	100
							0 1.002	151.100	100
TANK	40.181	45.424	151.800	1.800	100		1 1.002	151.000	100
							0 1.003	150.000	100
DUMMY	60.350	37.288	151.500	1.600	100		1 1.003	149.900	100

Simulation Settings

Rainfall Methodology	FSR	Analysis Speed	Normal
Rainfall Events	Singular	Skip Steady State	x
FSR Region	England and Wales	Drain Down Time (mins)	240
M5-60 (mm)	20.000	Additional Storage (m³/ha)	20.0
Ratio-R	0.400	Starting Level (m)	
Summer CV	0.750	Check Discharge Rate(s)	x
Winter CV	0.840	Check Discharge Volume	x

Storm Durations

15 | 30 | 60 | 120 | 180 | 240 | 360 | 480 | 600 | 720 | 960 | 1440

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
1	0	0	0
30	0	0	0
100	45	0	0

Node TANK Online Pump Control

Flap Valve	x	Design Depth (m)	1.400	Switch off depth (m)	0.100				
Replaces Downstream Link	✓	Design Flow (l/s)	0.1						
Invert Level (m)	150.000	Switch on depth (m)	1.400						
<table><tr><th>Depth (m)</th><th>Flow (l/s)</th></tr><tr><td>1.400</td><td>0.100</td></tr></table>						Depth (m)	Flow (l/s)	1.400	0.100
Depth (m)	Flow (l/s)								
1.400	0.100								

Node TANK Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.01800	Safety Factor	2.0	Invert Level (m)	150.000
Side Inf Coefficient (m/hr)	0.01800	Porosity	0.95	Time to half empty (mins)	

Depth (m)	Area (m ²)	Inf Area (m ²)	Depth (m)	Area (m ²)	Inf Area (m ²)	Depth (m)	Area (m ²)	Inf Area (m ²)
0.000	12.0	11.0	0.800	12.0	23.0	0.801	0.0	23.0

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)	Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
1 year 15 minute summer	109.521	30.991	30 year 360 minute summer	31.221	8.034
1 year 15 minute winter	76.857	30.991	30 year 360 minute winter	20.295	8.034
1 year 30 minute summer	71.439	20.215	30 year 480 minute summer	24.324	6.428
1 year 30 minute winter	50.133	20.215	30 year 480 minute winter	16.160	6.428
1 year 60 minute summer	48.435	12.800	30 year 600 minute summer	19.756	5.404
1 year 60 minute winter	32.179	12.800	30 year 600 minute winter	13.498	5.404
1 year 120 minute summer	30.053	7.942	30 year 720 minute summer	17.490	4.687
1 year 120 minute winter	19.966	7.942	30 year 720 minute winter	11.754	4.687
1 year 180 minute summer	23.233	5.979	30 year 960 minute summer	14.215	3.743
1 year 180 minute winter	15.102	5.979	30 year 960 minute winter	9.416	3.743
1 year 240 minute summer	18.475	4.882	30 year 1440 minute summer	10.161	2.723
1 year 240 minute winter	12.274	4.882	30 year 1440 minute winter	6.829	2.723
1 year 360 minute summer	14.169	3.646	100 year +45% CC 15 minute summer	505.670	143.087
1 year 360 minute winter	9.210	3.646	100 year +45% CC 15 minute winter	354.856	143.087
1 year 480 minute summer	11.185	2.956	100 year +45% CC 30 minute summer	332.000	93.944
1 year 480 minute winter	7.431	2.956	100 year +45% CC 30 minute winter	232.982	93.944
1 year 600 minute summer	9.182	2.511	100 year +45% CC 60 minute summer	222.268	58.739
1 year 600 minute winter	6.274	2.511	100 year +45% CC 60 minute winter	147.669	58.739
1 year 720 minute summer	8.203	2.199	100 year +45% CC 120 minute summer	134.215	35.469
1 year 720 minute winter	5.513	2.199	100 year +45% CC 120 minute winter	89.169	35.469
1 year 960 minute summer	6.768	1.782	100 year +45% CC 180 minute summer	101.219	26.047
1 year 960 minute winter	4.483	1.782	100 year +45% CC 180 minute winter	65.795	26.047
1 year 1440 minute summer	4.949	1.326	100 year +45% CC 240 minute summer	78.690	20.795
1 year 1440 minute winter	3.326	1.326	100 year +45% CC 240 minute winter	52.280	20.795
30 year 15 minute summer	268.706	76.035	100 year +45% CC 360 minute summer	58.701	15.106
30 year 15 minute winter	188.566	76.035	100 year +45% CC 360 minute winter	38.157	15.106
30 year 30 minute summer	174.929	49.499	100 year +45% CC 480 minute summer	45.550	12.038
30 year 30 minute winter	122.757	49.499	100 year +45% CC 480 minute winter	30.262	12.038
30 year 60 minute summer	116.589	30.811	100 year +45% CC 600 minute summer	36.875	10.086
30 year 60 minute winter	77.459	30.811	100 year +45% CC 600 minute winter	25.195	10.086
30 year 120 minute summer	70.438	18.615	100 year +45% CC 720 minute summer	32.556	8.725
30 year 120 minute winter	46.797	18.615	100 year +45% CC 720 minute winter	21.879	8.725
30 year 180 minute summer	53.298	13.715	100 year +45% CC 960 minute summer	26.340	6.936
30 year 180 minute winter	34.645	13.715	100 year +45% CC 960 minute winter	17.448	6.936
30 year 240 minute summer	41.604	10.995	100 year +45% CC 1440 minute summer	18.700	5.012
30 year 240 minute winter	27.641	10.995	100 year +45% CC 1440 minute winter	12.567	5.012

Results for 1 year Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	RE01	10	151.775	0.025	0.9	0.0052	0.0000	OK
15 minute winter	SW01	10	151.619	0.019	0.9	0.0030	0.0000	OK
15 minute summer	RE02	10	151.775	0.025	0.9	0.0052	0.0000	OK
15 minute winter	SW02	10	151.618	0.018	0.9	0.0028	0.0000	OK
15 minute winter	SW03	10	151.127	0.027	1.8	0.0043	0.0000	OK
600 minute winter	TANK	405	150.163	0.163	0.2	1.8544	0.0000	SURCHARGED
15 minute summer	DUMMY	1	149.900	0.000	0.0	0.0000	0.0000	OK
Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	RE01	1.000	SW01	0.9	0.713	0.121	0.0127	
15 minute winter	SW01	1.001	SW03	0.9	0.663	0.078	0.0190	
15 minute summer	RE02	2.000	SW02	0.9	0.732	0.121	0.0124	
15 minute winter	SW02	2.001	SW03	0.9	0.688	0.069	0.0145	
15 minute winter	SW03	1.002	TANK	1.8	1.113	0.129	0.0032	
600 minute winter	TANK	Pump	DUMMY	0.0				0.0
600 minute winter	TANK	Infiltration		0.0				

Results for 30 year Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m ³)	Flood (m ³)	Status
15 minute summer	RE01	10	151.790	0.040	2.2	0.0083	0.0000	OK
15 minute winter	SW01	10	151.630	0.030	2.2	0.0047	0.0000	OK
15 minute summer	RE02	10	151.790	0.040	2.2	0.0084	0.0000	OK
15 minute winter	SW02	10	151.628	0.028	2.2	0.0044	0.0000	OK
15 minute winter	SW03	10	151.146	0.046	4.4	0.0073	0.0000	OK
360 minute winter	TANK	328	150.397	0.397	0.6	4.5273	0.0000	SURCHARGED
15 minute summer	DUMMY	1	149.900	0.000	0.0	0.0000	0.0000	OK
Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m ³)	Discharge Vol (m ³)
15 minute summer	RE01	1.000	SW01	2.2	0.910	0.297	0.0243	
15 minute winter	SW01	1.001	SW03	2.2	0.814	0.191	0.0381	
15 minute summer	RE02	2.000	SW02	2.2	0.937	0.297	0.0236	
15 minute winter	SW02	2.001	SW03	2.2	0.845	0.169	0.0290	
15 minute winter	SW03	1.002	TANK	4.4	1.381	0.320	0.0063	
360 minute winter	TANK	Pump	DUMMY	0.0				0.0
360 minute winter	TANK	Infiltration		0.0				

Results for 100 year +45% CC Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m ³)	Flood (m ³)	Status
15 minute summer	RE01	10	151.807	0.057	4.1	0.0119	0.0000	OK
15 minute winter	SW01	10	151.641	0.041	4.1	0.0066	0.0000	OK
15 minute summer	RE02	10	151.808	0.058	4.1	0.0120	0.0000	OK
15 minute winter	SW02	10	151.639	0.039	4.1	0.0062	0.0000	OK
720 minute winter	SW03	675	151.279	0.179	0.6	0.0285	0.0000	SURCHARGED
720 minute winter	TANK	675	151.279	1.279	0.6	9.1359	0.0000	SURCHARGED
15 minute summer	DUMMY	1	149.900	0.000	0.0	0.0000	0.0000	OK
Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m ³)	Discharge Vol (m ³)
15 minute summer	RE01	1.000	SW01	4.1	1.066	0.553	0.0385	
15 minute winter	SW01	1.001	SW03	4.1	0.921	0.357	0.0626	
15 minute summer	RE02	2.000	SW02	4.1	1.097	0.553	0.0374	
15 minute winter	SW02	2.001	SW03	4.1	0.953	0.316	0.0477	
720 minute winter	SW03	1.002	TANK	0.6	0.837	0.044	0.0156	
720 minute winter	TANK	Pump	DUMMY	0.0				0.0
720 minute winter	TANK	Infiltration		0.1				