



Drainage Strategy

Project:

Leisure Development, Bourne Road, Spalding

Client:

RDC

Document Ref: DR-REP-0435	Revision: 00	Original Issue Date: 24/11/2025	Author: B. Jackson
Reason for Issue: For Planning	Revision Note: 00 - Initial Issue 01 (08/03/2026) – Updated to address some initial comments. 02 (06/09/2026) – Updated to address some initial comments.		



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Introduction

Jackson consulting engineers have been appointed by RDC on behalf of their client, to undertake a drainage strategy forming part of the supporting evidence for the proposed leisure development, to land off Bourne Road, Spalding, Lincolnshire, PE11 3LJ. The following document is to assist the planners and Lead Local Flood Authority (LLFA) in demonstrating that the development is acceptable in terms of sustainable drainage strategy and flood risk as a result of the development.

Existing Site

The site lies to the north of Bourne Road of the outskirts of Spalding. An aerial location plan, with approximate site boundary is shown in figure 1, noting that the redline boundary does not constitute as the planning boundary. The site is greenfield with a total site area of approximately 1.4 hectares.

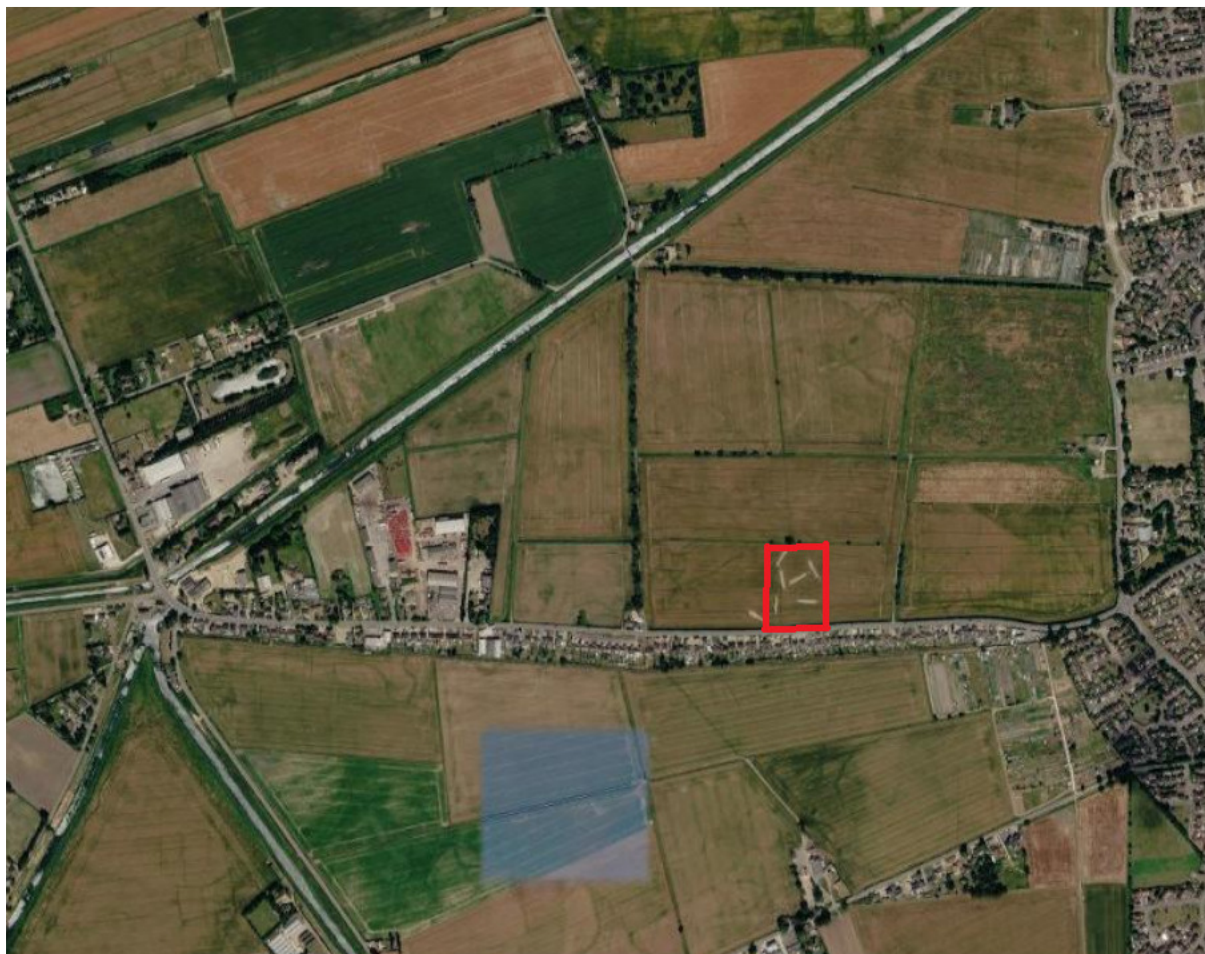


Figure 1 - Site Location

A full topographical survey is not available, but the LIDAR data has been assessed. The data shows that the main road has an approximate elevation of 3.9m AOD with the internal site having an average level of approximately 2.35m AOD – the level appears to fluctuates around 300mm over the sites area with the range between 2.50m and 2.20m AOD.

There is a roadside ditch to the north of Bourne road, and a presumably riparian ditch to the north of the development boundary. The entirety of the site is greenfield.



A site walkover has been carried out. It was identified that there was a ditch to the northern boundary of the site. This ditch was dry, even after a period of rain, but it did not appear to have an outfall. There was an additional ditch beyond the northern boundary (north and then west) – this appeared to have a significant outlet into the IDB drain located to the west of the site. Both ditches would be accessible to the client, but the levels would need confirming.

Flood Risk

The FRA is being addressed by another consultant and will be provided as part of the overall planning application.



Development Proposals

The development consists of leisure development, consisting of a single large building, with access road, gravel parking and amenity areas.

Proposed Drainage Strategy

The following section provides narrative on the principles behind the drainage strategy and has been carried out in general accordance with “CIRIA’s C753 – the SUDS Manual”, where appropriate.

Surface Water Drainage

For new developments there is a requirement to apply sustainable drainage principles (SuDS) to the disposal of surface water from the site where practicable. As required by Building Regulations and PPG, surface water must discharge to the following, listed in priority.

1. To ground – in an adequate soakaway or some other adequate infiltration system.
2. To a watercourse.
3. To a surface water sewer, highway drain or other drainage system.
4. To a combined sewer.

Infiltration

At this stage of the project a phase 2 ground investigation report has not been undertaken, and therefore a desktop study is being undertaken to understand the prospect of infiltration.

BGS mapping shows that the bedrock of the area is unrecorded, and no assessment can be made of this.

The superficial deposits, as shown in the figure below, is shown as ‘Tidal Flat Deposits – Clay and Silt’. It is very likely that the silt content will block any pores available through the clay and the clay would be generally seen as impermeable.

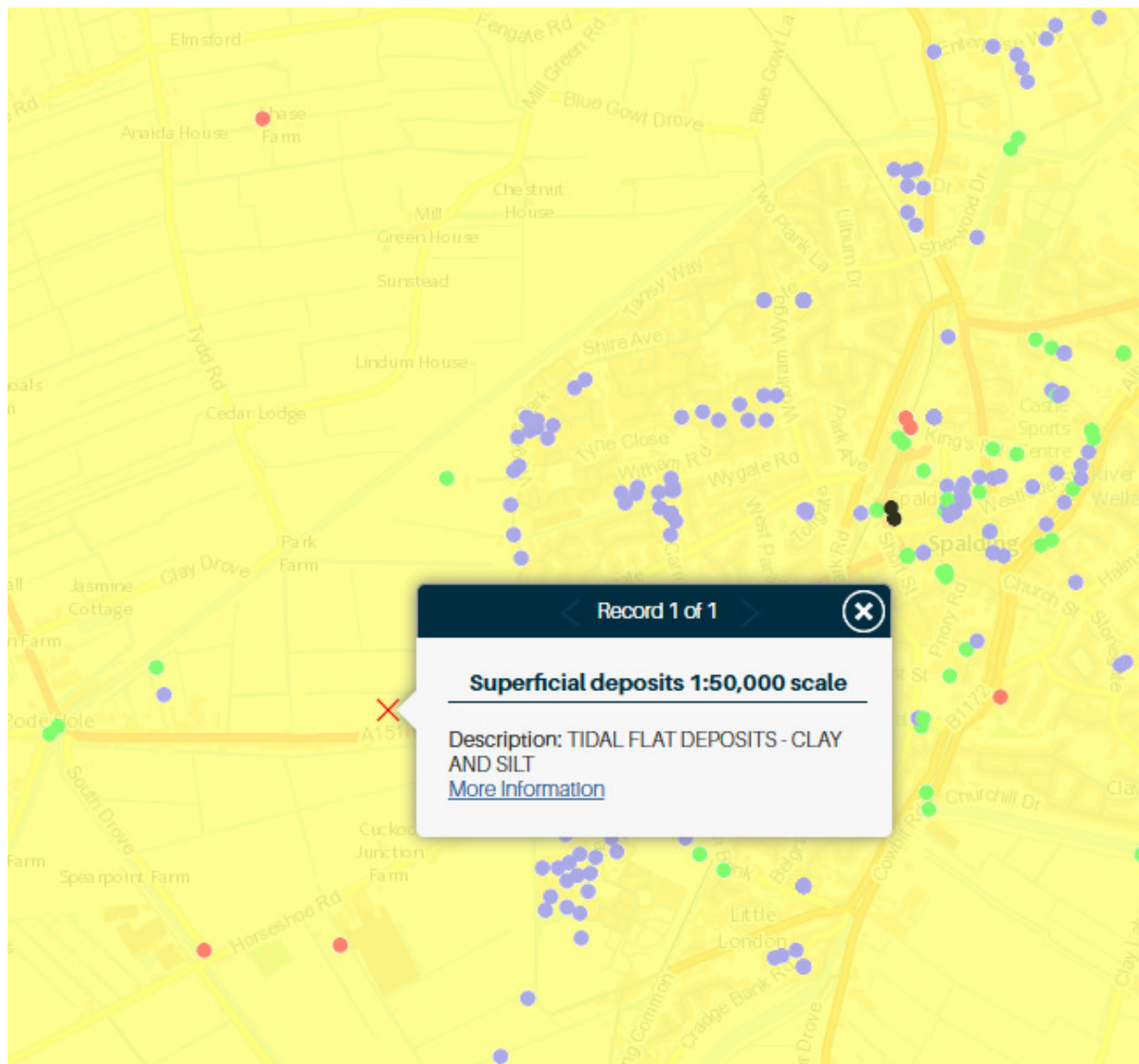


Figure 2 - Superficial Deposits

From the mapping there is limited local borehole information.

Local knowledge also understands that the water table would be relatively high owing to the low elevation of the site and infiltration had been ruled out for the development – although this will be checked for at detailed design.

Although a ground investigation report will be available at a later date, it is safe to assume infiltration will not be viable for the scheme.

Watercourse

As previously identified – there is an open watercourse to the north of the site. This flows to the west, towards an IDB drain – the ‘Pennygate Drain’. The open watercourse will be riparian.

Bylaw consent will still be required from the IDB.

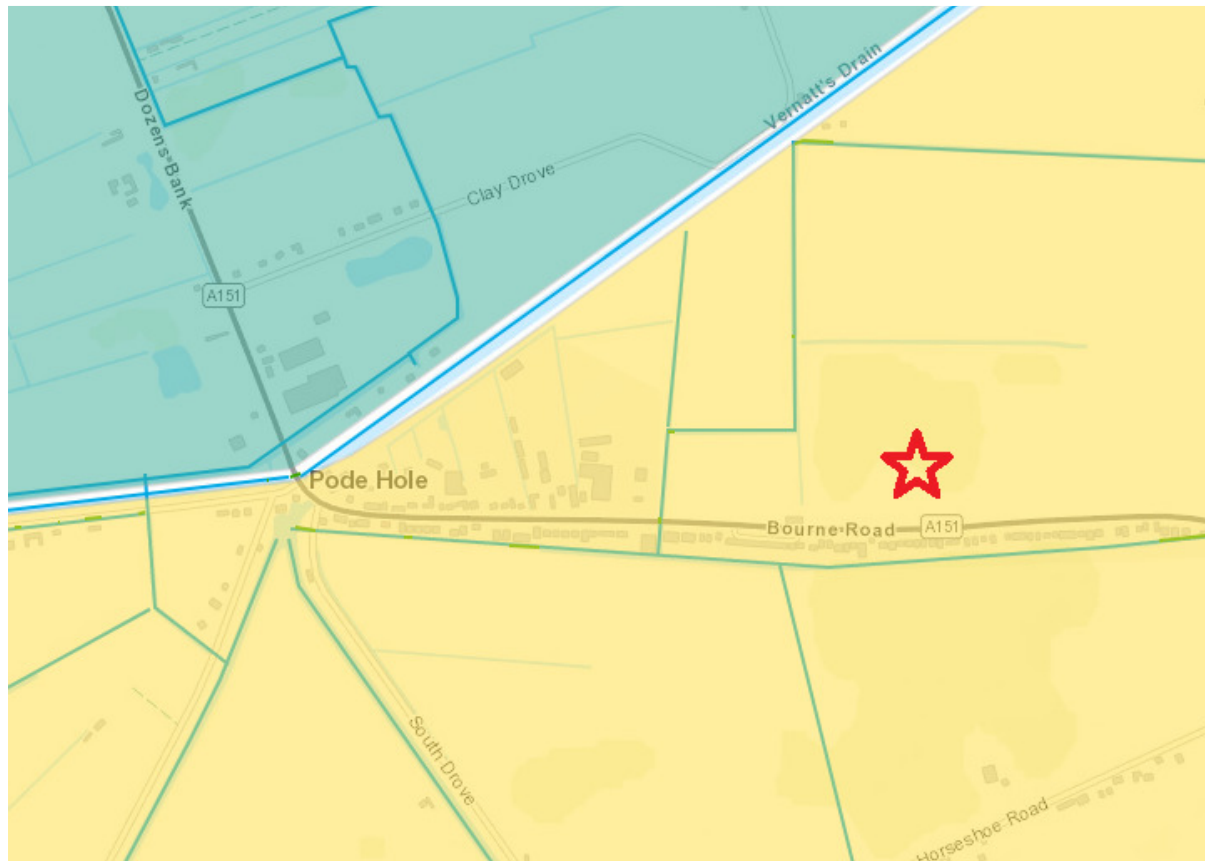


Figure 3 - Local IDB Features

As this is an adequate point of discharge, this is being considered as the discharge for the site.

Surface Water Sewer

There are no identified surface water sewers within close proximity of the site, and as a watercourse has been identified as a sufficient point of discharge then this is not being further explored.

Run-off Rates

Existing greenfield run-off

The existing run-off rates for the site for the 1 in 1 year, Q_{BAR} , 1 in 30 year, 1 in 100 year and 1 in 200 year events are summarised in the figure below. This is in accordance with the methodology in CIRIA C753 and the HR Wallingford Methods.



Results

Method 	IH124
Flow rate 1 year (l/s) 	0.5 l/s
Flow rate 2 year (l/s) 	0.5 l/s
Flow rate 10 years (l/s) 	1.0 l/s
Flow rate 30 years (l/s) 	1.5 l/s
Flow rate 100 years (l/s) 	2.1 l/s
Flow rate 200 years (l/s) 	2.5 l/s

Figure 4 - Existing Greenfield Runoff Rates

Proposed Run-off

To comply with the LLFA, the site should be returned to greenfield runoff as far as practical. There are two options to achieve this, to match the runoff to a maximum of Q_{Bar} , or to have a variable outflow, matching to the like for like predevelopment greenfield runoff. To keep the design straight forward at the planning stage, it is proposed that the sites discharge rate will be restricted to Q_{Bar} , although at detailed design, and through consultation with the IDB, the approach may be modified to suit the like-for-like storms. This is noting that the discharge is fairly low and we wish to mitigate the risk of blockage as much as possible.

The current approach means that the discharge is comparable to the pumpable catchment rate for the Q_{BAR} return (this would equate to around 1.4l/s), so would be fully accounted for in the current IDB system, although it is noted the greenfield discharge for the undeveloped site would be higher.

With consent of the IDB and LLFA, during the detailed design process and application of byelaw consent, it would be requested that a minimum practical discharge rate of 2l/s is achieved, or a rate in-between. The current design would allow for a very limited discharge and would increase a risk of blockage. The IDB drain seems to have good capacity so the risk of flooding will be limited.

Proposed Surface Water Drainage Design

The proposed drainage layout is shown on JCE drawing 0435-JCE-00-SI-SK-C-3000 & 3001, which has been provided as part of the overall planning submission.

All drainage models has been simulated for the 1 in 1, 30, 100 and 100 + 40% climate change events using FEH data, with a CV value set to 1. No urban creep is included in this instance as it would be expected that any alterations in the future would be subject to planning permission.

A full copy of the preliminary drainage calculations can be found in appendix A of this document, and a graphical representation of the model is shown in the figure below. Please note, that some of the



drainage model has been simplified for this stage of the design. The final model will be fully represented and fine-tuned.

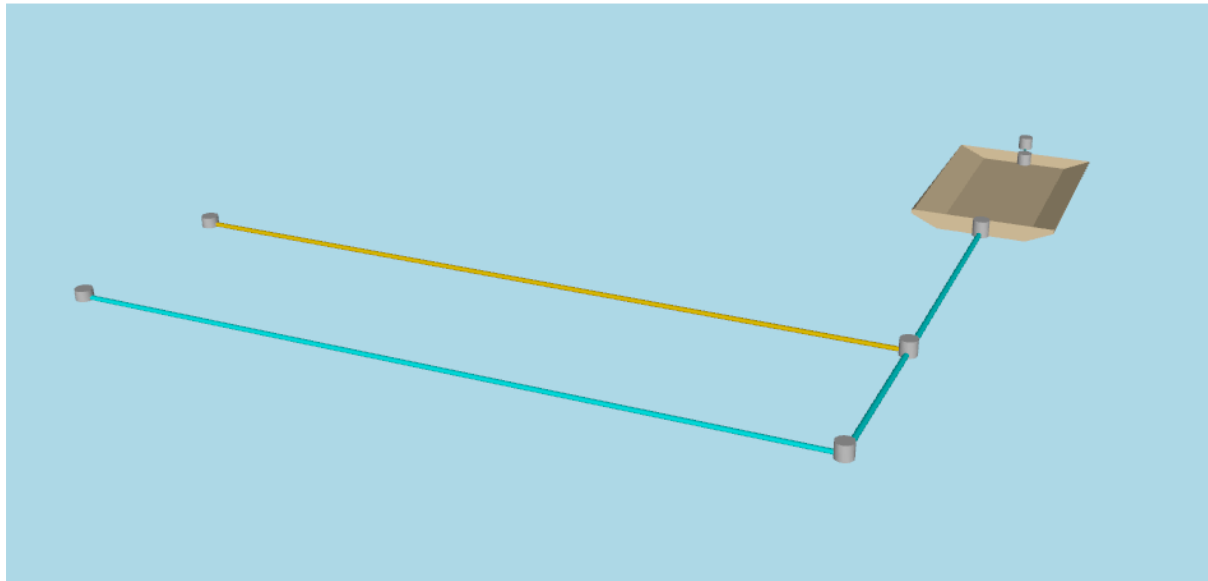


Figure 5 – Drainage Model

As outlined previously, it is assumed that infiltration is not feasible for this site, therefore the SuDS strategy for the surface water drainage will be achieved using the provision of surface water conveyance, cleansing and attenuation.

It is proposed the accessway will be collected through surface drainage such as an ACO channel, before discharging into below ground pipework and into the basin. The access road will be above the existing ground levels to ensure a gravity solution is feasible, and to provide acceptable gradients off the main road.

The car parking will be laid to gravel and be self-draining.

The roof water will discharging via. RWP's and into the below ground pipework, before discharging into the basin.

The basin will then pass through a Hydrobrake to limit the flows to the agreed rates.

Once a full phase 2 ground investigation has been undertaken, more will be known regarding the water table for the site. If the site has a high-water table, or at least if this is within or close to the base of the basin, it will be proposed it will be lined with an impermeable membrane to stop below ground lateral flow of the ground water – in essence to prevent it acting as a land drain.

Given the use of the attenuation basin, it is proposed that sufficient suds features are being used, and as a result the drainage from the development are to discharge into traditional pipework before entering the SUDs features as mentioned above.

The final discharge into the drain – subject to byelaw consent (as the catchment is into the Welland and Deepings IDB), will be via. a new insitu headwall.

The attenuation basin has been designed to store all storms, up to and including the 1 in 100 year + 40% climate change storm events. All storms up to and including the 1 in 100 year + 40% climate



change event will be stored within the site. Some limited flooding is present for the 1 in 100 year + 40% event, but this will flow towards the gravel parking and remain on site. This design ethos is in accordance with DEFRA guidance and LCC's requirements.

Given the elevation of the ditch and natural falls, it is not expected that surcharging will be an issue and therefore has not been included in the calculations.

One of the reasons a higher discharge rate will be applied for is due to the half drain times. The current arrangement means that the half drain times is quite extensive. By increasing them, the half drain times will be in line with technical standards (half drain within 24 hours). For safety, it is common to model consecutive storms of the 1 in 30 straight with a 1 in 10 year event. As a sense check on the current design, the peak storm for the 1 in 30 + CC is the 2880 minute and the 1440 for the 1 in 10 year. These storms have been modelled back to back and are still viable – this is shown in appendix B. It is still proposed that a higher allowance will be requested from the IDB.

Surface Water Drainage Summary

In summary, the surface water drainage will be to the following.

- Roofwater will discharge into a piped system before discharging into the attenuation basin.
- The access road will discharge into a piped system before discharging into the attenuation basin.
- The basin will discharge into the riparian drain to the north of the site, which in turn discharges into an IDB drain to the west.

Flood Routing

The scheme has been designed so that no above ground flooding is created in the 1 in 30 year event (other than to the basin) and manageable flooding in the 1 in 100 year + 40% climate change event. The design compliments the natural ground levels, and any flood water will flow towards the abundant land drainage.

Finished Floor Levels + Finished Levels

The FRA has requested that the FFL is set 500mm above the existing ground levels, this is something which is achievable.

The FFL is preliminary and subject to detailed design – in particular that gravity drainage is still viable.

Water Quality

The methods of surface water disposal mentioned above have included provisions for water quality. In accordance with CIRIA C753, the pollution hazard features for the drainage areas are:

- Other roofs - Low
- Low traffic roads, assumed less than 300 movements a day - Medium

To remove the pollution risks, CIRIA have developed 'Pollution hazard indices' and the 'mitigation indices' that the SuDS components provide, further details of these are found in the figures below.



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 6 - Pollution hazard indices for different land use classifications

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.		

Figure 7 - Indicative SuDS mitigation indices for discharging to a surface water

To deliver adequate treatment, the selected SuDS components should have a total pollution mitigation index (for each contaminant type) that equals or exceeds the pollution hazard index (for each contaminant type):

$$\text{Total SuDS mitigation index} \geq \text{pollution hazard index} \\ (\text{for each contaminant type}) (\text{for each contaminant type})$$

Where the mitigation index of an individual component is insufficient, two components (or more) in series will be required where:

$$\text{Total SuDS mitigation index} = \text{mitigation index}_1 + 0.5 (\text{mitigation index}_2)$$



Where:

Mitigation index_n = mitigation index for component n

Provided the total SuDS mitigation index exceeds the pollution hazard indices, then sufficient water quality will be provided.

For the calculations below the hazards are represented by;

Total suspended solids = Red

Metals = Blue

Hydrocarbons = Green

The figures are presented to show the actual achieved in the right-hand side column. The right-hand side's total must be higher than the left-hand side.

Other Roofs - attenuation basin

0.3 0.5 0.05 = Attenuation Basin 0.5 0.5 0.6

The mitigation provided by the SUDs features exceeds all the pollution indices, therefore sufficient treatment has been provided.

Low traffic roads - attenuation basin

0.5 0.4 0.4 = Attenuation Basin 0.5 0.5 0.6

The mitigation provided by the SUDs features exceeds all the pollution indices, therefore sufficient treatment has been provided.

All the methods above provide enough water quality in accordance with CIRIA's C753 mitigation indices.

Maintenance

It is crucial that the elements mentioned in the drainage elements and water quality are maintained to a sufficient standard to ensure that the devices can still function as designed. Generally, the maintenance requirements are either from CIRIA 753, or manufacturer guidance.

It is not possible to give full details of the proposed maintenance responsibilities as the project has not been developed enough, but it is expected that a full maintenance/management strategy will be put forward at detailed design and that this can be conditioned.

The maintenance for the devices outlined below are preliminary only and subject to detailed design. The final design will be subject to a full maintenance plan. At present, it will be intended that the drainage for the scheme will remain private.



Attenuation Basin Maintenance

Operation and maintenance requirements for detention basins		
Maintenance schedule	Required action	Typical frequency
Regular maintenance	Remove litter and debris	Monthly
	Cut grass – for spillways and access routes	Monthly (during growing season), or as required
	Cut grass – meadow grass in and around basin	Half yearly (spring – before nesting season, and autumn)
	Manage other vegetation and remove nuisance plants	Monthly (at start, then as required)
	Inspect inlets, outlets and overflows for blockages, and clear if required.	Monthly
	Inspect banksides, structures, pipework etc for evidence of physical damage	Monthly
	Inspect inlets and facility surface for silt accumulation. Establish appropriate silt removal frequencies.	Monthly (for first year), then annually or as required
	Check any penstocks and other mechanical devices	Annually
	Tidy all dead growth before start of growing season	Annually
	Remove sediment from inlets, outlet and forebay	Annually (or as required)
	Manage wetland plants in outlet pool – where provided	Annually (as set out in Chapter 23)
Occasional maintenance	Reseed areas of poor vegetation growth	As required
	Prune and trim any trees and remove cuttings	Every 2 years, or as required
	Remove sediment from inlets, outlets, forebay and main basin when required	Every 5 years, or as required (likely to be minimal requirements where effective upstream source control is provided)
Remedial actions	Repair erosion or other damage by reseedling or re-turfing	As required
	Realignment of rip-rap	As required
	Repair/rehabilitation of inlets, outlets and overflows	As required
	Relevel uneven surfaces and reinstate design levels	As required



Foul Proposals

The preferred method of foul disposal is via a sewer. In this instance, the nearest foul sewer is located in Broadway, or Primrose Way – this is between 6-700m of the site. There is a further connection located in Monkshouse Court – this is approximately 600m away. The connection in Monkshouse Court would be more favourable as it would be easier to manage in terms of traffic and will be away from the 4-way traffic lights. It is expected that AW will be consulted on the planning application and under this they will be able to confirm if the proposed connection into Monkshouse Court has capacity issues.

The connection into the foul sewer will be expensive, this is due to the distance, requirement of a pump, connection within 3rd party land and the road crossing/associated works.

Therefore, it is proposed to connect into the local ditch, which in turn connects into the drain. As the drain is dry and as the capacity exceeds the general binding rules, an EA permit will need to be granted. The EA might require additional treatment, or outright refuse this. In the event that this is the case, then the only solution will be to the AW sewer.



Conclusion

- There is a natural site gradient to the north, where an existing ditch lies.
- The above drainage strategy demonstrates that the site can be drained through the use of a Sustainable Drainage System at an appropriate level for the development.
- The flow offsite will be restricted to ensure they do not exceed greenfield runoff rates for the Q_{BAR} event, although negotiations to return this to the like-for-like event or even a peak discharge rate of 2l/s are to be undertaken to offer some resilience to the flow control size.
- Discharge from the site will be restricted to 0.5/s, subject to IDB byelaw consent. As above this is looking to be increased.
- No above ground flooding is present for the 1 in 30 occurs and limited flooding for the 1 in 100 year + 40% climate change event climate change event occurs, but this is held within the site, and would not pose a risk to life.
- The proposed scheme does not increase the risk of flooding either on or off site as a result of the development, as storm water for all design storms are kept on site.
- The risk of flooding as a result of the development is not increased as a result of the development.
- The ditch where the scheme is connecting must be fully excavated and confirmed.
- A full maintenance strategy will be developed at the detailed design stage.
- A preliminary drainage layout can be found on JCE's Preliminary Drainage Strategy drawing: 0435-JCE-00-SI-DR-C-3000 & 3001.
- Finished floor levels will be set at a minimum of 500mm above general existing ground levels. This has been taken as a minimum of 2.80m AOD – to be confirmed through detailed design.
- Foul water has two viable solutions; into the AW system – subject to capacity , or through a waste water treatment plant into the watercourse network – this is subject to EA and IDB approval. At present a connection into the foul sewer is not viable due to cost.



Appendices

Appendix A – Drainage Calculations

Design Settings

Rainfall Methodology	FSR	Maximum Time of Concentration (mins)	30.00
Return Period (years)	1	Maximum Rainfall (mm/hr)	1.0
Additional Flow (%)	0	Minimum Velocity (m/s)	1.00
FSR Region	England and Wales	Connection Type	Level Soffits
M5-60 (mm)	20.000	Minimum Backdrop Height (m)	0.200
Ratio-R	0.400	Preferred Cover Depth (m)	1.200
CV	1.000	Include Intermediate Ground	✓
Time of Entry (mins)	5.00	Enforce best practice design rules	✓

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)	Invert Level (m)
S1	0.073	5.00	2.650	1500	522449.703	323929.906	0.650	2.000
S3a	0.008	5.00	2.650	450	522432.399	323960.263	0.450	2.200
S3	0.048	5.00	2.650	1500	522449.913	323970.836	0.736	1.914
S2	0.048	5.00	2.650	1500	522492.916	323929.906	0.944	1.706
S4	0.048	5.00	2.650	1500	522493.127	323970.836	1.035	1.615
S5			2.500	1500	522493.126	324025.026	1.005	1.495
HW1			2.650	1350	522488.712	324030.766	1.171	1.479
S6	0.106	5.00	2.500	1200	522461.843	323996.134	0.600	1.900
S7	0.106	5.00	2.500	1200	522461.843	324026.089	0.800	1.700
HW2			2.500	1200	522464.579	324031.563	0.940	1.560
HW3		5.00	2.500	1200	522462.934	324044.033	1.100	1.400
Hydrobrake			2.500	1200	522456.609	324044.033	1.142	1.358
Outlet			2.500	1200	522456.609	324053.793	1.207	1.293

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	S1	S2	43.213	0.600	2.000	1.856	0.144	300.0	300	5.80	1.0
1.001	S2	S4	40.931	0.600	1.706	1.615	0.091	450.0	450	6.52	1.0
1.002	S4	S5	54.190	0.600	1.615	1.495	0.120	450.0	450	7.46	1.0
1.003	S5	HW1	7.241	0.600	1.495	1.479	0.016	450.0	450	7.59	1.0
2.000	S3a	S3	20.458	0.600	2.200	2.064	0.136	150.0	150	5.42	1.0
2.001	S3	S4	43.214	0.600	1.914	1.770	0.144	300.0	300	6.22	1.0
3.000	S6	S7	29.955	0.600	1.900	1.700	0.200	150.0	150	5.61	1.0
3.001	S7	HW2	6.120	0.600	1.700	1.659	0.041	150.0	150	5.74	1.0
4.000	HW3	Hydrobrake	6.325	0.600	1.400	1.358	0.042	150.0	150	5.13	1.0

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	0.902	63.8	0.3	0.350	0.494	0.073	0.0	14	0.222
1.001	0.952	151.4	0.4	0.494	0.585	0.121	0.0	18	0.212
1.002	0.952	151.4	0.8	0.585	0.555	0.225	0.0	23	0.253
1.003	0.952	151.4	0.8	0.555	0.721	0.225	0.0	23	0.253
2.000	0.818	14.5	0.0	0.300	0.436	0.008	0.0	5	0.146
2.001	0.902	63.8	0.2	0.436	0.580	0.056	0.0	13	0.203
3.000	0.818	14.5	0.4	0.450	0.650	0.106	0.0	17	0.347
3.001	0.818	14.5	0.8	0.650	0.691	0.212	0.0	24	0.435
4.000	0.818	14.5	0.0	0.950	0.992	0.000	0.0	0	0.000

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)
4.001	Hydrobrake	Outlet	9.760	0.600	1.358	1.293	0.065	150.0	150	5.33	1.0

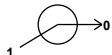
Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
4.001	0.818	14.5	0.0	0.992	1.057	0.000	0.0	0	0.000

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	43.213	300.0	300	Circular	2.650	2.000	0.350	2.650	1.856	0.494
1.001	40.931	450.0	450	Circular	2.650	1.706	0.494	2.650	1.615	0.585
1.002	54.190	450.0	450	Circular	2.650	1.615	0.585	2.500	1.495	0.555
1.003	7.241	450.0	450	Circular	2.500	1.495	0.555	2.650	1.479	0.721
2.000	20.458	150.0	150	Circular	2.650	2.200	0.300	2.650	2.064	0.436
2.001	43.214	300.0	300	Circular	2.650	1.914	0.436	2.650	1.770	0.580
3.000	29.955	150.0	150	Circular	2.500	1.900	0.450	2.500	1.700	0.650
3.001	6.120	150.0	150	Circular	2.500	1.700	0.650	2.500	1.659	0.691
4.000	6.325	150.0	150	Circular	2.500	1.400	0.950	2.500	1.358	0.992
4.001	9.760	150.0	150	Circular	2.500	1.358	0.992	2.500	1.293	1.057

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.000	S1	1500	Manhole	1 Adoptable	S2	1500	Manhole	1 Adoptable
1.001	S2	1500	Manhole	1 Adoptable	S4	1500	Manhole	1 Adoptable
1.002	S4	1500	Manhole	1 Adoptable	S5	1500	Manhole	1 Adoptable
1.003	S5	1500	Manhole	1 Adoptable	HW1	1350	Manhole	1 Adoptable
2.000	S3a	450	Manhole	1 Adoptable	S3	1500	Manhole	1 Adoptable
2.001	S3	1500	Manhole	1 Adoptable	S4	1500	Manhole	1 Adoptable
3.000	S6	1200	Manhole	1 Adoptable	S7	1200	Manhole	1 Adoptable
3.001	S7	1200	Manhole	1 Adoptable	HW2	1200	Manhole	1 Adoptable
4.000	HW3	1200	Manhole	1 Adoptable	Hydrobrake	1200	Manhole	1 Adoptable
4.001	Hydrobrake	1200	Manhole	1 Adoptable	Outlet	1200	Manhole	1 Adoptable

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
S1	522449.703	323929.906	2.650	0.650	1500				
						0	1.000	2.000	300
S3a	522432.399	323960.263	2.650	0.450	450				
						0	2.000	2.200	150
S3	522449.913	323970.836	2.650	0.736	1500				
						1	2.000	2.064	150
						0	2.001	1.914	300

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)	
S2	522492.916	323929.906	2.650	0.944	1500		1	1.000	1.856	300
						0	1.001	1.706	450	
S4	522493.127	323970.836	2.650	1.035	1500		1	2.001	1.770	300
							2	1.001	1.615	450
S5	522493.126	324025.026	2.500	1.005	1500		0	1.002	1.615	450
							1	1.002	1.495	450
HW1	522488.712	324030.766	2.650	1.171	1350		1	1.003	1.479	450
S6	522461.843	323996.134	2.500	0.600	1200		0	3.000	1.900	150
S7	522461.843	324026.089	2.500	0.800	1200		1	3.000	1.700	150
							0	3.001	1.700	150
HW2	522464.579	324031.563	2.500	0.940	1200		1	3.001	1.659	150
HW3	522462.934	324044.033	2.500	1.100	1200		0	4.000	1.400	150
Hydrobrake	522456.609	324044.033	2.500	1.142	1200		1	4.000	1.358	150
							0	4.001	1.358	150
Outlet	522456.609	324053.793	2.500	1.207	1200		1	4.001	1.293	150

Simulation Settings

Rainfall Methodology	FEH-22	Analysis Speed	Normal	Starting Level (m)	
Rainfall Events	Singular	Skip Steady State	x	Check Discharge Rate(s)	x
Summer CV	1.000	Drain Down Time (mins)	4320	Check Discharge Volume	x
Winter CV	1.000	Additional Storage (m³/ha)	0.0		

Storm Durations

15	60	180	360	600	960	2160	4320	7200	10080
30	120	240	480	720	1440	2880	5760	8640	

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
1	0	0	0
2	0	0	0
10	0	0	0
30	0	0	0
100	0	0	0
100	40	0	0

Node Hydrobrake Online Hydro-Brake® Control

Flap Valve	x	Objective	(CL) Minimise blockage risk
Replaces Downstream Link	x	Sump Available	✓
Invert Level (m)	1.358	Product Number	CTL-SCL-0031-5000-0900-5000
Design Depth (m)	0.900	Min Outlet Diameter (m)	0.075
Design Flow (l/s)	0.5	Min Node Diameter (mm)	1200

Node S7 Online Orifice Control

Flap Valve	x	Invert Level (m)	1.700	Discharge Coefficient	0.600
Replaces Downstream Link	x	Diameter (m)	0.045		

Node HW3 Flow through Pond Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Main Channel Length (m)	32.000
Side Inf Coefficient (m/hr)	0.00000	Invert Level (m)	1.400	Main Channel Slope (1:X)	200.0
Safety Factor	2.0	Time to half empty (mins)		Main Channel n	0.035

Inlets

HW1 | HW2

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	349.0	349.0	1.000	637.0	647.3

Node S7 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	2.050
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.30	Time to half empty (mins)	4304

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	1056.0	1056.0	0.300	1056.0	1090.6	0.301	0.0	1090.6

Node S6 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	2.050
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.30	Time to half empty (mins)	4304

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	1056.0	1056.0	0.300	1056.0	1090.6	0.301	0.0	1090.6

Other (defaults)

Entry Loss (manhole)	0.250	Entry Loss (junction)	0.000	Apply Recommended Losses	x
Exit Loss (manhole)	0.250	Exit Loss (junction)	0.000	Flood Risk (m)	0.300

Results for 1 year Critical Storm Duration. Lowest mass balance: 96.56%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	S1	11	2.070	0.070	7.8	0.1242	0.0000	OK
15 minute summer	S3a	11	2.224	0.024	0.8	0.0038	0.0000	OK
15 minute summer	S3	11	1.975	0.061	5.9	0.1077	0.0000	OK
15 minute summer	S2	11	1.791	0.085	12.3	0.1495	0.0000	OK
15 minute summer	S4	12	1.728	0.113	22.6	0.1994	0.0000	OK
1440 minute summer	S5	1350	1.690	0.195	2.4	0.3437	0.0000	OK
1440 minute summer	HW1	1350	1.690	0.211	2.3	0.3026	0.0000	OK
240 minute summer	S6	160	2.068	0.168	4.3	6.2014	0.0000	SURCHARGED
240 minute summer	S7	160	2.067	0.367	5.5	5.9212	0.0000	SURCHARGED
960 minute winter	HW2	930	1.690	0.130	2.1	0.1469	0.0000	OK
1440 minute summer	HW3	1350	1.689	0.289	3.8	0.3263	0.0000	SURCHARGED
1440 minute summer	Hydrobrake	1350	1.688	0.330	0.4	0.3738	0.0000	SURCHARGED
15 minute summer	Outlet	77	1.309	0.016	0.4	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	S1	1.000	S2	7.4	0.628	0.116	0.5108	
15 minute summer	S3a	2.000	S3	0.8	0.439	0.055	0.0372	
15 minute summer	S3	2.001	S4	5.6	0.579	0.087	0.4151	
15 minute summer	S2	1.001	S4	12.1	0.479	0.080	1.0467	
15 minute summer	S4	1.002	S5	21.6	0.565	0.143	2.3389	
1440 minute summer	S5	1.003	HW1	2.3	0.085	0.015	0.5021	
1440 minute summer	HW1	Flow through Pond	HW3	3.8	0.009	0.000	80.0678	
240 minute summer	S6	3.000	S7	2.2	0.181	0.154	0.5274	
240 minute summer	S7	3.001	HW2	2.4	0.591	0.166	0.0249	
960 minute winter	HW2	Flow through Pond	HW3	4.0	0.018	0.000	79.9652	
1440 minute summer	HW3	4.000	Hydrobrake	0.4	0.093	0.026	0.1114	
1440 minute summer	Hydrobrake	4.001	Outlet	0.4	0.347	0.025	0.0103	107.7

Results for 2 year Critical Storm Duration. Lowest mass balance: 91.41%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	S1	11	2.092	0.092	13.1	0.1633	0.0000	OK
15 minute summer	S3a	11	2.232	0.032	1.4	0.0051	0.0000	OK
15 minute summer	S3	11	1.994	0.080	10.0	0.1416	0.0000	OK
15 minute summer	S2	11	1.817	0.111	20.9	0.1954	0.0000	OK
1440 minute summer	S4	1440	1.771	0.156	3.3	0.2760	0.0000	OK
1440 minute summer	S5	1440	1.771	0.276	3.3	0.4877	0.0000	OK
1440 minute summer	HW1	1440	1.774	0.295	3.1	0.4217	0.0000	OK
180 minute summer	S6	132	2.084	0.184	7.2	11.0658	0.0000	SURCHARGED
180 minute summer	S7	132	2.082	0.382	8.4	10.7628	0.0000	SURCHARGED
1440 minute summer	HW2	1440	1.770	0.210	2.4	0.2377	0.0000	OK
1440 minute summer	HW3	1470	1.768	0.368	3.4	0.4167	0.0000	SURCHARGED
1440 minute summer	Hydrobrake	1470	1.768	0.410	0.4	0.4642	0.0000	SURCHARGED
15 minute summer	Outlet	29	1.309	0.016	0.4	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	S1	1.000	S2	12.7	0.730	0.199	0.7512	
15 minute summer	S3a	2.000	S3	1.4	0.517	0.097	0.0553	
15 minute summer	S3	2.001	S4	9.6	0.675	0.151	0.6145	
15 minute summer	S2	1.001	S4	20.8	0.557	0.137	1.5434	
1440 minute summer	S4	1.002	S5	3.3	0.162	0.022	4.0891	
1440 minute summer	S5	1.003	HW1	3.1	0.083	0.021	0.7665	
1440 minute summer	HW1	Flow through Pond	HW3	3.4	0.010	0.000	113.6589	
180 minute summer	S6	3.000	S7	1.2	0.192	0.085	0.5274	
180 minute summer	S7	3.001	HW2	2.5	0.594	0.170	0.0253	
1440 minute summer	HW2	Flow through Pond	HW3	3.4	0.010	0.000	113.6589	
1440 minute summer	HW3	4.000	Hydrobrake	0.4	0.151	0.026	0.1114	
1440 minute summer	Hydrobrake	4.001	Outlet	0.4	0.347	0.025	0.0103	113.7

Results for 10 year Critical Storm Duration. Lowest mass balance: 85.34%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	S1	11	2.144	0.144	29.1	0.2547	0.0000	OK
15 minute summer	S3a	10	2.248	0.048	3.2	0.0077	0.0000	OK
15 minute summer	S3	11	2.038	0.124	22.3	0.2187	0.0000	OK
960 minute summer	S2	1125	1.914	0.208	4.3	0.3683	0.0000	OK
960 minute summer	S4	1125	1.914	0.299	8.0	0.5284	0.0000	OK
960 minute summer	S5	1110	1.915	0.420	7.6	0.7414	0.0000	OK
1440 minute summer	HW1	1320	1.929	0.450	5.1	0.6439	0.0000	OK
180 minute winter	S6	176	2.138	0.238	9.4	28.1587	0.0000	SURCHARGED
180 minute winter	S7	176	2.136	0.436	10.6	27.7716	0.0000	SURCHARGED
1440 minute summer	HW2	1320	1.917	0.357	2.4	0.4040	0.0000	OK
1440 minute summer	HW3	1320	1.915	0.515	5.9	0.5825	0.0000	SURCHARGED
1440 minute summer	Hydrobrake	1320	1.915	0.557	0.4	0.6299	0.0000	SURCHARGED
1440 minute summer	Outlet	1320	1.310	0.017	0.4	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	S1	1.000	S2	28.5	0.913	0.447	1.3506	
15 minute summer	S3a	2.000	S3	3.1	0.647	0.215	0.0984	
15 minute summer	S3	2.001	S4	21.8	0.847	0.342	1.1122	
960 minute summer	S2	1.001	S4	4.3	0.325	0.028	3.7586	
960 minute summer	S4	1.002	S5	7.6	0.225	0.050	7.1981	
960 minute summer	S5	1.003	HW1	7.3	0.107	0.048	1.1259	
1440 minute summer	HW1	Flow through Pond	HW3	5.9	0.015	0.000	180.1726	
180 minute winter	S6	3.000	S7	1.5	0.200	0.100	0.5274	
180 minute winter	S7	3.001	HW2	2.6	0.605	0.183	0.1056	
1440 minute summer	HW2	Flow through Pond	HW3	5.9	0.015	0.000	180.1726	
1440 minute summer	HW3	4.000	Hydrobrake	0.4	0.102	0.031	0.1114	
1440 minute summer	Hydrobrake	4.001	Outlet	0.4	0.357	0.028	0.0110	123.2

Results for 30 year Critical Storm Duration. Lowest mass balance: 68.78%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	S1	11	2.174	0.174	39.4	0.3067	0.0000	OK
15 minute summer	S3a	10	2.257	0.057	4.3	0.0091	0.0000	OK
4320 minute winter	S3	4140	2.063	0.149	1.2	0.2640	0.0000	OK
4320 minute winter	S2	4140	2.063	0.357	2.5	0.6315	0.0000	OK
4320 minute winter	S4	4140	2.063	0.448	3.6	0.7922	0.0000	OK
4320 minute winter	S5	4140	2.065	0.570	3.8	1.0072	0.0000	SURCHARGED
2880 minute summer	HW1	2940	2.070	0.591	26.6	0.8458	0.0000	OK
180 minute winter	S6	176	2.176	0.276	12.3	40.3908	0.0000	SURCHARGED
180 minute winter	S7	176	2.174	0.474	13.6	40.0193	0.0000	SURCHARGED
4320 minute winter	HW2	4140	2.064	0.504	1.8	0.5702	0.0000	OK
4320 minute winter	HW3	4200	2.059	0.659	8.9	0.7454	0.0000	SURCHARGED
4320 minute winter	Hydrobrake	4200	2.059	0.701	0.6	0.7929	0.0000	SURCHARGED
4320 minute winter	Outlet	4200	1.311	0.018	0.4	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	S1	1.000	S2	38.7	0.992	0.606	1.6832	
15 minute summer	S3a	2.000	S3	4.2	0.702	0.291	0.1229	
4320 minute winter	S3	2.001	S4	-1.0	0.295	-0.015	2.2700	
4320 minute winter	S2	1.001	S4	2.7	0.196	0.018	6.0026	
4320 minute winter	S4	1.002	S5	3.8	0.074	0.025	8.5819	
4320 minute winter	S5	1.003	HW1	6.2	0.066	0.041	1.1473	
2880 minute summer	HW1	Flow through Pond	HW3	-15.1	0.015	-0.001	249.1951	
180 minute winter	S6	3.000	S7	2.0	0.208	0.137	0.5274	
180 minute winter	S7	3.001	HW2	2.7	0.606	0.188	0.1077	
4320 minute winter	HW2	Flow through Pond	HW3	8.9	0.008	0.000	251.4171	
4320 minute winter	HW3	4.000	Hydrobrake	0.6	0.081	0.038	0.1114	
4320 minute winter	Hydrobrake	4.001	Outlet	0.4	0.368	0.031	0.0118	202.9

Results for 100 year Critical Storm Duration. Lowest mass balance: 57.47%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	S1	10	2.207	0.207	51.4	0.3654	0.0000	OK
15 minute summer	S3a	10	2.266	0.066	5.6	0.0105	0.0000	OK
2160 minute winter	S3	2100	2.162	0.248	1.9	0.4385	0.0000	OK
2160 minute winter	S2	2100	2.161	0.455	2.5	0.8043	0.0000	SURCHARGED
2160 minute winter	S4	2100	2.161	0.546	6.7	0.9655	0.0000	SURCHARGED
2160 minute winter	S5	2100	2.163	0.668	7.4	1.1806	0.0000	SURCHARGED
2160 minute winter	HW1	1920	2.156	0.677	14.9	0.9690	0.0000	OK
240 minute winter	S6	236	2.227	0.327	12.9	56.4486	0.0000	FLOOD RISK
240 minute winter	S7	236	2.225	0.525	14.2	56.1512	0.0000	FLOOD RISK
2160 minute winter	HW2	2220	2.157	0.597	2.6	0.6751	0.0000	OK
2160 minute winter	HW3	2160	2.156	0.756	13.2	0.8551	0.0000	SURCHARGED
2160 minute winter	Hydrobrake	2160	2.156	0.798	0.6	0.9025	0.0000	SURCHARGED
2160 minute winter	Outlet	2160	1.312	0.019	0.5	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	S1	1.000	S2	50.5	1.049	0.791	2.2092	
15 minute summer	S3a	2.000	S3	5.5	0.753	0.382	0.1500	
2160 minute winter	S3	2.001	S4	2.1	0.350	0.033	2.8681	
2160 minute winter	S2	1.001	S4	4.5	0.219	0.030	6.4851	
2160 minute winter	S4	1.002	S5	7.4	0.098	0.049	8.5861	
2160 minute winter	S5	1.003	HW1	14.8	0.094	0.098	1.1473	
2160 minute winter	HW1	Flow through Pond	HW3	13.2	0.017	0.001	302.8047	
240 minute winter	S6	3.000	S7	1.3	0.200	0.093	0.5274	
240 minute winter	S7	3.001	HW2	2.7	0.606	0.187	0.1077	
2160 minute winter	HW2	Flow through Pond	HW3	13.2	0.017	0.001	302.8047	
2160 minute winter	HW3	4.000	Hydrobrake	0.6	0.117	0.043	0.1114	
2160 minute winter	Hydrobrake	4.001	Outlet	0.5	0.374	0.033	0.0123	167.7

Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 46.80%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	S1	11	2.650	0.650	71.9	1.1486	0.2212	FLOOD
15 minute summer	S3a	11	2.579	0.379	7.9	0.0603	0.0000	FLOOD RISK
15 minute summer	S3	11	2.562	0.648	54.9	1.1447	0.0000	FLOOD RISK
15 minute summer	S2	11	2.483	0.777	110.6	1.3721	0.0000	FLOOD RISK
15 minute summer	S4	11	2.432	0.817	201.2	1.4428	0.0000	FLOOD RISK
2880 minute summer	S5	2880	2.312	0.817	5.7	1.4431	0.0000	FLOOD RISK
2880 minute winter	HW1	2700	2.312	0.833	42.1	1.1919	0.0000	OK
480 minute winter	S6	472	2.325	0.425	10.5	87.7108	0.0000	FLOOD RISK
480 minute winter	S7	472	2.324	0.624	11.8	87.6035	0.0000	FLOOD RISK
2880 minute summer	HW2	2880	2.308	0.748	2.3	0.8462	0.0000	OK
2880 minute summer	HW3	2940	2.304	0.904	16.1	1.0225	0.0000	FLOOD RISK
2880 minute summer	Hydrobrake	2940	2.304	0.946	0.9	1.0700	0.0000	FLOOD RISK
2880 minute summer	Outlet	2940	1.312	0.019	0.5	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	S1	1.000	S2	65.3	1.087	1.024	3.0430	
15 minute summer	S3a	2.000	S3	9.9	0.793	0.687	0.3602	
15 minute summer	S3	2.001	S4	49.6	0.894	0.777	3.0431	
15 minute summer	S2	1.001	S4	106.4	0.675	0.703	6.4852	
15 minute summer	S4	1.002	S5	198.7	1.254	1.313	8.5861	
2880 minute summer	S5	1.003	HW1	14.5	0.091	0.096	1.1473	
2880 minute winter	HW1	Flow through Pond	HW3	-16.6	0.009	-0.001	385.6099	
480 minute winter	S6	3.000	S7	1.3	0.138	0.090	0.5274	
480 minute winter	S7	3.001	HW2	2.6	0.599	0.181	0.1077	
2880 minute summer	HW2	Flow through Pond	HW3	16.1	0.014	0.001	386.4008	
2880 minute summer	HW3	4.000	Hydrobrake	0.9	0.104	0.062	0.1114	
2880 minute summer	Hydrobrake	4.001	Outlet	0.5	0.383	0.035	0.0130	198.8



Appendix B – Consecutive Storms

Design Settings

Rainfall Methodology	FSR	Maximum Time of Concentration (mins)	30.00
Return Period (years)	1	Maximum Rainfall (mm/hr)	1.0
Additional Flow (%)	0	Minimum Velocity (m/s)	1.00
FSR Region	England and Wales	Connection Type	Level Soffits
M5-60 (mm)	20.000	Minimum Backdrop Height (m)	0.200
Ratio-R	0.400	Preferred Cover Depth (m)	1.200
CV	1.000	Include Intermediate Ground	✓
Time of Entry (mins)	5.00	Enforce best practice design rules	✓

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)	Invert Level (m)
S1	0.073	5.00	2.650	1500	522449.703	323929.906	0.650	2.000
S3a	0.008	5.00	2.650	450	522432.399	323960.263	0.450	2.200
S3	0.048	5.00	2.650	1500	522449.913	323970.836	0.736	1.914
S2	0.048	5.00	2.650	1500	522492.916	323929.906	0.944	1.706
S4	0.048	5.00	2.650	1500	522493.127	323970.836	1.035	1.615
S5			2.500	1500	522493.126	324025.026	1.005	1.495
HW1			2.650	1350	522488.712	324030.766	1.171	1.479
S6	0.106	5.00	2.500	1200	522461.843	323996.134	0.600	1.900
S7	0.106	5.00	2.500	1200	522461.843	324026.089	0.800	1.700
HW2			2.500	1200	522464.579	324031.563	0.940	1.560
HW3		5.00	2.500	1200	522462.934	324044.033	1.100	1.400
Hydrobrake			2.500	1200	522456.609	324044.033	1.142	1.358
Outlet			2.500	1200	522456.609	324053.793	1.207	1.293

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	S1	S2	43.213	0.600	2.000	1.856	0.144	300.0	300	5.80	1.0
1.001	S2	S4	40.931	0.600	1.706	1.615	0.091	450.0	450	6.52	1.0
1.002	S4	S5	54.190	0.600	1.615	1.495	0.120	450.0	450	7.46	1.0
1.003	S5	HW1	7.241	0.600	1.495	1.479	0.016	450.0	450	7.59	1.0
2.000	S3a	S3	20.458	0.600	2.200	2.064	0.136	150.0	150	5.42	1.0
2.001	S3	S4	43.214	0.600	1.914	1.770	0.144	300.0	300	6.22	1.0
3.000	S6	S7	29.955	0.600	1.900	1.700	0.200	150.0	150	5.61	1.0
3.001	S7	HW2	6.120	0.600	1.700	1.659	0.041	150.0	150	5.74	1.0
4.000	HW3	Hydrobrake	6.325	0.600	1.400	1.358	0.042	150.0	150	5.13	1.0

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	0.902	63.8	0.3	0.350	0.494	0.073	0.0	14	0.222
1.001	0.952	151.4	0.4	0.494	0.585	0.121	0.0	18	0.212
1.002	0.952	151.4	0.8	0.585	0.555	0.225	0.0	23	0.253
1.003	0.952	151.4	0.8	0.555	0.721	0.225	0.0	23	0.253
2.000	0.818	14.5	0.0	0.300	0.436	0.008	0.0	5	0.146
2.001	0.902	63.8	0.2	0.436	0.580	0.056	0.0	13	0.203
3.000	0.818	14.5	0.4	0.450	0.650	0.106	0.0	17	0.347
3.001	0.818	14.5	0.8	0.650	0.691	0.212	0.0	24	0.435
4.000	0.818	14.5	0.0	0.950	0.992	0.000	0.0	0	0.000

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)
4.001	Hydrobrake	Outlet	9.760	0.600	1.358	1.293	0.065	150.0	150	5.33	1.0

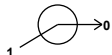
Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
4.001	0.818	14.5	0.0	0.992	1.057	0.000	0.0	0	0.000

Pipeline Schedule

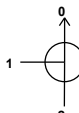
Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.000	43.213	300.0	300	Circular	2.650	2.000	0.350	2.650	1.856	0.494
1.001	40.931	450.0	450	Circular	2.650	1.706	0.494	2.650	1.615	0.585
1.002	54.190	450.0	450	Circular	2.650	1.615	0.585	2.500	1.495	0.555
1.003	7.241	450.0	450	Circular	2.500	1.495	0.555	2.650	1.479	0.721
2.000	20.458	150.0	150	Circular	2.650	2.200	0.300	2.650	2.064	0.436
2.001	43.214	300.0	300	Circular	2.650	1.914	0.436	2.650	1.770	0.580
3.000	29.955	150.0	150	Circular	2.500	1.900	0.450	2.500	1.700	0.650
3.001	6.120	150.0	150	Circular	2.500	1.700	0.650	2.500	1.659	0.691
4.000	6.325	150.0	150	Circular	2.500	1.400	0.950	2.500	1.358	0.992
4.001	9.760	150.0	150	Circular	2.500	1.358	0.992	2.500	1.293	1.057

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.000	S1	1500	Manhole	1 Adoptable	S2	1500	Manhole	1 Adoptable
1.001	S2	1500	Manhole	1 Adoptable	S4	1500	Manhole	1 Adoptable
1.002	S4	1500	Manhole	1 Adoptable	S5	1500	Manhole	1 Adoptable
1.003	S5	1500	Manhole	1 Adoptable	HW1	1350	Manhole	1 Adoptable
2.000	S3a	450	Manhole	1 Adoptable	S3	1500	Manhole	1 Adoptable
2.001	S3	1500	Manhole	1 Adoptable	S4	1500	Manhole	1 Adoptable
3.000	S6	1200	Manhole	1 Adoptable	S7	1200	Manhole	1 Adoptable
3.001	S7	1200	Manhole	1 Adoptable	HW2	1200	Manhole	1 Adoptable
4.000	HW3	1200	Manhole	1 Adoptable	Hydrobrake	1200	Manhole	1 Adoptable
4.001	Hydrobrake	1200	Manhole	1 Adoptable	Outlet	1200	Manhole	1 Adoptable

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
S1	522449.703	323929.906	2.650	0.650	1500				
						0	1.000	2.000	300
S3a	522432.399	323960.263	2.650	0.450	450				
						0	2.000	2.200	150
S3	522449.913	323970.836	2.650	0.736	1500				
						1	2.000	2.064	150
						0	2.001	1.914	300

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)	
S2	522492.916	323929.906	2.650	0.944	1500		1	1.000	1.856	300
S4	522493.127	323970.836	2.650	1.035	1500		0	1.001	1.706	450
							1	2.001	1.770	300
							2	1.001	1.615	450
S5	522493.126	324025.026	2.500	1.005	1500		0	1.002	1.615	450
							1	1.002	1.495	450
HW1	522488.712	324030.766	2.650	1.171	1350		1	1.003	1.479	450
S6	522461.843	323996.134	2.500	0.600	1200		0	3.000	1.900	150
S7	522461.843	324026.089	2.500	0.800	1200		1	3.000	1.700	150
							0	3.001	1.700	150
HW2	522464.579	324031.563	2.500	0.940	1200		1	3.001	1.659	150
HW3	522462.934	324044.033	2.500	1.100	1200		0	4.000	1.400	150
Hydrobrake	522456.609	324044.033	2.500	1.142	1200		1	4.000	1.358	150
Outlet	522456.609	324053.793	2.500	1.207	1200		0	4.001	1.358	150
							1	4.001	1.293	150

Simulation Settings

Rainfall Methodology	FEH-22	Skip Steady State	x
Rainfall Events	Consecutive	Drain Down Time (mins)	4320
Summer CV	1.000	Additional Storage (m³/ha)	0.0
Additional Area (A %)	0	Starting Level (m)	
Additional Flow (Q %)	0	Check Discharge Rate(s)	x
Analysis Speed	Normal	Check Discharge Volume	x

Time Offset (mins)	Duration (mins)	Return Period (years)	Climate Change (CC %)	Time Offset (mins)	Duration (mins)	Return Period (years)	Climate Change (CC %)
15	2880	30	40	1440	1440	10	0

Node Hydrobrake Online Hydro-Brake® Control

Flap Valve	x	Objective	(CL) Minimise blockage risk
Replaces Downstream Link	x	Sump Available	✓
Invert Level (m)	1.358	Product Number	CTL-SCL-0031-5000-0900-5000
Design Depth (m)	0.900	Min Outlet Diameter (m)	0.075
Design Flow (l/s)	0.5	Min Node Diameter (mm)	1200

Node S7 Online Orifice Control

Flap Valve	x	Invert Level (m)	1.700	Discharge Coefficient	0.600
Replaces Downstream Link	x	Diameter (m)	0.045		

Node HW3 Flow through Pond Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Main Channel Length (m)	32.000
Side Inf Coefficient (m/hr)	0.00000	Invert Level (m)	1.400	Main Channel Slope (1:X)	200.0
Safety Factor	2.0	Time to half empty (mins)		Main Channel n	0.035

Inlets

HW1 | HW2

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	349.0	349.0	1.000	637.0	647.3

Node S7 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	2.050
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.30	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	1056.0	1056.0	0.300	1056.0	1090.6	0.301	0.0	1090.6

Node S6 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	2.050
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.30	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	1056.0	1056.0	0.300	1056.0	1090.6	0.301	0.0	1090.6

Other (defaults)

Entry Loss (manhole)	0.250	Entry Loss (junction)	0.000	Apply Recommended Losses	x
Exit Loss (manhole)	0.250	Exit Loss (junction)	0.000	Flood Risk (m)	0.300

Results for Consecutive Rainfall Critical Storm Duration. Lowest mass balance: 99.86%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
2880-1440	S1	5760	2.306	0.306	1.8	0.5401	0.0000	SURCHARGED
2880-1440	S3a	5760	2.305	0.105	0.2	0.0167	0.0000	OK
2880-1440	S3	5760	2.305	0.391	1.4	0.6911	0.0000	SURCHARGED
2880-1440	S2	5760	2.305	0.599	3.0	1.0589	0.0000	SURCHARGED
2880-1440	S4	5760	2.306	0.691	5.7	1.2216	0.0000	SURCHARGED
2880-1440	S5	5760	2.308	0.813	6.1	1.4369	0.0000	FLOOD RISK
2880-1440	HW1	5280	2.285	0.806	17.6	1.1540	0.0000	OK
2880-1440	S6	5820	2.305	0.405	2.6	81.3500	0.0000	FLOOD RISK
2880-1440	S7	5820	2.305	0.605	3.5	81.5707	0.0000	FLOOD RISK
2880-1440	HW2	5760	2.302	0.742	2.3	0.8388	0.0000	OK
2880-1440	HW3	5820	2.300	0.900	11.9	1.0183	0.0000	FLOOD RISK
2880-1440	Hydrobrake	5820	2.300	0.942	0.7	1.0658	0.0000	FLOOD RISK
2880-1440	Outlet	5820	1.312	0.019	0.5	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)
2880-1440	S1	1.000	S2	1.8	0.417	0.028	3.0430	
2880-1440	S3a	2.000	S3	0.6	0.291	0.043	0.3151	
2880-1440	S3	2.001	S4	1.9	0.350	0.031	3.0431	
2880-1440	S2	1.001	S4	3.8	0.204	0.025	6.4852	
2880-1440	S4	1.002	S5	6.1	0.087	0.040	8.5861	
2880-1440	S5	1.003	HW1	9.7	0.061	0.064	1.1473	
2880-1440	HW1	Flow through Pond	HW3	-13.9	0.016	-0.001	384.2520	
2880-1440	S6	3.000	S7	1.1	0.120	0.078	0.5274	
2880-1440	S7	3.001	HW2	2.3	0.561	0.162	0.1077	
2880-1440	HW2	Flow through Pond	HW3	-13.9	0.016	-0.001	384.2520	
2880-1440	HW3	4.000	Hydrobrake	0.7	0.103	0.047	0.1114	
2880-1440	Hydrobrake	4.001	Outlet	0.5	0.383	0.035	0.0130	279.5