

11 Appendices

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Gravesham Borough Council

Ms Kirsty Thomas
Herrington Consulting Ltd.
Barham Business Park (Unit 6)
Elham Valley Road
Barham
Canterbury
CT4 6DQ

Our ref: KT/2020/127776/01-L01
Your ref: 2813/KT
Date: 13 January 2021

Dear Ms Thomas

ENVPAC/1/KSL/00360

Custom House, The Terrace, Gravesend, DA12 2DE

Thank you for consulting us on the above pre-application. We have reviewed the submitted pre-application letter, dated 4 December 2020. We would like to offer the following advice.

The application site lies partially within Flood Zone 3, which is considered to be 'High Risk'. Under the National Planning Policy Framework (NPPF) the development is classified as 'more vulnerable'.

As stated within your letter, a Flood Risk Assessment (FRA) will be required to be submitted alongside any planning application.

The Thames Estuary 2100 (TE2100) defence level at this location is 6.90 metres Above Ordnance Datum (AOD) for the epoch from 2040 to 2070 and 8.00m AOD for the epoch from 2070 to 2170. Please be aware that we are currently re-modelling the flood levels for the Thames Estuary as part of the 10 year review of the Thames Estuary 2100 Plan. However, the results from this study will not be available for a number of months.

The applicant will need to demonstrate how the site will be protected for the lifetime of the development. This should include demonstration that the existing defence crest level meets the requirement for 2040, as well as how the defences will be upgraded to achieve the defence level of 6.90m AOD by 2040 (if required) and 8.0m AOD by 2070. We are happy to discuss this further if you have any questions.

Page 17 of the submitted letter states that "the open space to the north of the outbuildings are constrained by the flood wall anchors which project back into the property." We note that an extension is proposed towards the north of the site and we would like to understand how close this would be to the anchors as it is currently unclear from the information provided at present.

We note from our records that there is a flood gate within this site. Please confirm if this is the case so we can provide further advice.

We would advise that finished floor levels should be situated to a minimum of 300mm above the 1 in 200 year plus climate change breach flood level for residential non-sleeping accommodation and a minimum of 600mm above the 1 in 200 year plus climate change breach flood level for sleeping accommodation. Due to the proximity of the site to the river we would also advise the applicant to consider the in-channel level as well as the breach level. The finished floor levels proposed on page 2 of the submitted letter follow the principles of the above guidance. However, the letter also states that “as the proposals comprise the conversion of existing buildings, which lie within a listed curtilage and are constrained by the existing ceiling height and need for accessible access, the opportunity to raise floors to the levels stated is severely limited.”

Firstly, we would ask the applicant to include the finished floor levels on any floor plans they submit so we can be clear what the finished floor levels will be across the site, on the ground and first floor. Secondly, if the current ground floor finished floor levels are already below the breach level then the applicant should look at options such as having accommodation split over two storeys. If the first floor was 600mm above the 1 in 200 year plus climate change breach flood level this would allow internal safe refuge for the occupants of the dwelling and could be considered. Please be aware that if a future planning application included any self-contained flats with finished floor levels entirely below the breach level we would raise an objection to this.

We are pleased with the recommendation to incorporate flood resilience into the design where possible. Information on flood resilience can be found on the following link http://www.planningportal.gov.uk/uploads/br/flood_performance.pdf.

We are pleased with the recommendation that occupants register with the Environment Agency's flood warning service, 'FloodLine', so that they may prepare themselves in case of a flood event. This can be done by calling 0345 988 1188 to register.

The FRA should also consider safe dry access and egress. Please be aware that we do not normally comment on or approve the adequacy of flood emergency response procedures, as we do not carry out these roles during a flood. Our involvement with this development during an emergency will be limited to delivering flood warnings to occupants/users covered by our flood warning network. Any evacuation plan should provide suitable access and egress from the site and would need to be approved by the Local Planning Authority's Emergency Planning Department.

Landscaping close to the Thames should aim for a biodiversity net gain by providing ecologically beneficial landscaping such as native species, and flowering plants for pollinators.

If any flood defences require alteration or raising, we would need to see an improved interface between the river and the terrestrial environment. So where it is feasible to provide estuary edge habitats or other beneficial features we do require these for the benefit of the Thames.

The Estuary Edges website is available with ideas for how to improve habitats, and provide enhancements: <https://www.estuaryedges.co.uk/>

Please do not hesitate to contact us should you require any further information.

Yours sincerely

Ms Laura Edwards
Planning Advisor

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Direct email KSLPLANNING@environment-agency.gov.uk

Ms Kirsty Thomas
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Our ref: KT/2020/127776/02-L01
Your ref: 2813/KT
Date: 17 February 2021

Dear Ms Thomas

Custom House, The Terrace, Gravesend, DA12 2DE

We have reviewed the Herrington Consulting Limited letter dated 20 January 2021, and offer the following advice.

The application site lies partially within Flood Zone 3, which is 'High Risk'. Under the National Planning Policy Framework (NPPF) residential development is generally classified as 'More Vulnerable' but self-contained basement dwellings are classified as 'Highly Vulnerable'.

Flood Defence

The proposal is for a change of use to residential. This would increase the flood risk vulnerability of the development and significantly increase the dependence on the flood defence wall and the flood gate. The extent of any extensions or external building alterations is currently unclear.

Whether proposals include elements within 16 metres of the flood defence walls or not we expect the applicant to demonstrate how the site and its residents will be safe in flood risk terms for the development lifetime. The lifetime of residential development is taken to be 100-years. This should include how the defences will remain structurally sound and how they will be upgraded for climate change induced sea level rise in line with the Thames Estuary 2100 Plan.

This requires the applicant to either construct replacement flood defences with a 100-year design life, or provide a suitable structural survey, including intrusive investigation, to demonstrate that the residual life of any elements of the flood defences that are to be retained is in line with the 100-year development lifetime, along with a suitable scheme of remedial works where that is not the case.

Given the age of the existing flood wall, it appears less likely that the structure can be shown to have a remaining life of 100-years.

If the applicant chooses to undertake a river wall survey, including intrusive investigation, we would suggest that we are first consulted over the scope of the

Environment Agency

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proposed survey to reduce the risk of abortive work.

The applicant also needs to demonstrate how the flood defence crest level will be raised to 8 metres Above Ordnance Datum in order to protect the site for its lifetime, taking account of sea level rise. That could be achieved by raising the defences now as part of the development, or proving how it can be raised, along with a robust funding strategy to undertake the needed defence raising.

The northern extent of the buildings abutting the eastern boundary are only about 4.5 metres from the visible part of the flood defence structure. That proximity may affect the ability to raise or renew the tidal defences.

We also expect applicants to show how a replacement flood defence could be formed with the development in place without needing to encroach towards the river, even when a new defence is formed as part of a development. This can be called a contingency or future proofing option. Again the extent of any northern building extension is currently uncertain.

Services in the northern part of the site could hinder future flood defence works. Please can you provide any details of existing and proposed services that are available.

It is important to prevent flood defence structures being compromised during construction work. Ground anchors running landward from their origin soon reach a depth where they are difficult to locate. This creates a legacy problem as the installation of deep foundations may risk damaging existing ground anchors. Where there is uncertainty over the location of ground anchors we need to take a precautionary approach. On page 13 of the letter dated 04 December 2020, it states that, *'The open space to the north of the outbuildings are constrained by the flood wall anchors which project back into the property.'* At present we have no information on the nature and depth of any foundations proposed for any building extensions. Please provide details of the location, nature and depth of any proposed new foundations and also the worst case location of all ground anchors, in terms of the potential for a clash.

Flood gates are weak points in the line of the flood defences. We therefore seek to have existing flood gates removed and replaced with a section of fixed flood defence wall wherever possible as part of re-developments. You have stated that the flood gate will be retained. Please provide information about what the flood gate will need to be opened for post development, and the ongoing arrangements for its management and operation.

Sleeping Accommodation

Although it may not be possible for each dwelling to have safe access and egress during the 1 in 200-year modelled breach flood levels factored for climate change, every dwelling must have all sleeping accommodation set no lower than 600mm above the 1 in 200 year plus climate change breach flood level. This is to provide its own temporary safe refuge and reduce the risk to people who are sleeping.

It is not clear how the above requirement can be met for the single story elements including the northern most part of the workshop building.

We would oppose any basement dwelling where there is any threshold or water entry level at or below the modelled breach flood level. We would also oppose the dwellings being dependent on flood doors or any other active / movable flood exclusion features. Please can you provide details and photos to show the presence or absence of pathways or openings into the buildings that could allow floodwater to enter below the modelled breach flood level.

Please can you also provide the revised floor plan drawings, with all post-development floor levels. We can then confirm if the proposals are acceptable.

The buildings that are proposed to be converted are historic and close to the tidal defences. In the unlikely but high consequence event of a failure of the tidal defences the buildings could be subjected to high water velocities and deep flood water. How does the applicant propose to establish whether the structures would remain intact and able to provide temporary safe refuge to residents in the event of a breach flood event at the site?

Flood Warning Service

Lastly, we wanted to highlight something in your previous letter, dated 4 December 2020, that we hadn't expanded on before. On page 3, you state that, *'The Thames catchment is also served by a well-established flood warning system, and it is expected that there could be at least 12 hours warning of conditions which may result in a failure of the defences.'*

Although we are we are pleased with the recommendation that occupants register with the Environment Agency's flood warning service, 'FloodLine', so that they may prepare themselves in case of a flood event. If a defence failure occurred near the site there could be little or zero warning. Therefore, we recommend that this statement is clarified within the subsequent Flood Risk Assessment.

Please do not hesitate to contact us should you require any further information.

Yours sincerely

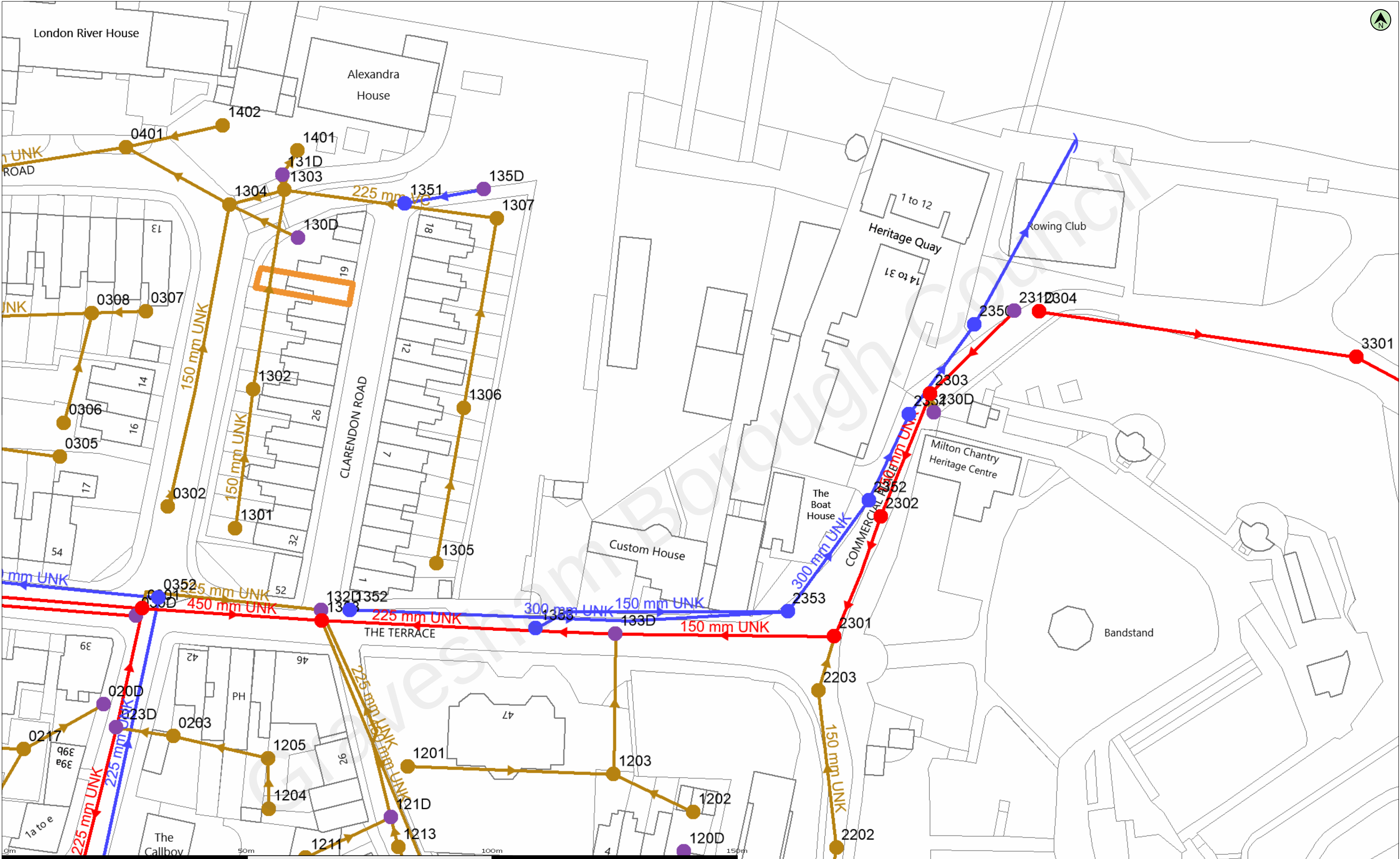
Ms Laura Edwards
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Appendix A.3 – Southern Water Asset Location Data

Gravesham Borough Council

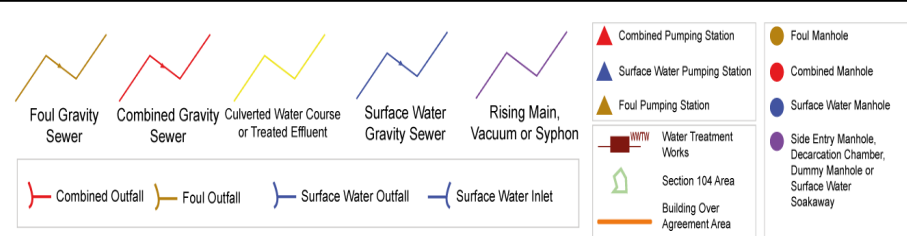


(c) Crown copyright and database rights 2020 Ordnance Survey 100031673 Date: 15/07/20 Scale: 1:500 Map Centre: 565198,174345 Data updated: 15/06/20 Our Ref: 416424 - 1 Wastewater Plan A2

The positions of pipes shown on this plan are believed to be correct, but Southern Water Services Ltd accept no responsibility in the event of inaccuracy. The actual positions should be determined on site. This plan is produced by Southern Water Services Ltd (c) Crown copyright and database rights 2020 Ordnance Survey 100031673. This map is to be used for the purposes of viewing the location of Southern Water plant only. Any other uses of the map data or further copies is not permitted.

WARNING: BAC pipes are constructed of Bonded Asbestos Cement.

WARNING: Unknown (UNK) materials may include Bonded Asbestos Cement.



flood@herringtonconsulting.co.uk
2813/KB



[illegible]

Appendix A.4 – Surface Water Management Calculations

Gravesham Borough Council

Design Settings

Rainfall Methodology	FEH-13	Minimum Velocity (m/s)	1.00
Return Period (years)	100	Connection Type	Level Soffits
Additional Flow (%)	40	Minimum Backdrop Height (m)	0.200
CV	0.750	Preferred Cover Depth (m)	0.700
Time of Entry (mins)	4.00	Include Intermediate Ground	✓
Maximum Time of Concentration (mins)	30.00	Enforce best practice design rules	x
Maximum Rainfall (mm/hr)	200.0		

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
1	0.055	4.00	7.600	1200	565172.609	174327.320	0.925
2	0.009	4.00	6.700	1200	565188.702	174338.897	0.925
3	0.039	4.00	5.600	1200	565191.160	174361.517	0.925
4	0.032	4.00	4.630	1200	565192.945	174378.919	0.925
5	0.042	4.00	5.440	1200	565203.077	174333.000	0.925
6	0.021	4.00	5.250	1200	565206.000	174348.982	0.925
7	0.028	4.00	4.800	1200	565209.001	174365.068	1.000
8	0.025	4.00	4.500	1200	565212.862	174386.006	1.000
9	0.044	4.00	4.200	1500	565200.530	174387.008	1.000
9_OUT			4.140	1200	565202.282	174399.932	0.970

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	1	2	19.825	0.600	6.675	5.775	0.900	22.0	225	4.12	198.4
2	2	3	22.753	0.600	5.775	4.675	1.100	20.7	225	4.25	198.4
3	3	4	17.493	0.600	4.675	3.705	0.970	18.0	225	4.34	198.4
4	4	9	11.089	0.600	3.705	3.200	0.505	22.0	225	4.41	198.4
5	5	6	16.247	0.600	4.515	4.325	0.190	85.5	225	4.19	198.4
6	6	7	16.364	0.600	4.325	3.875	0.450	36.4	225	4.32	198.4
7	7	8	21.291	0.600	3.800	3.500	0.300	71.0	300	4.51	198.4
8	8	9	12.373	0.600	3.500	3.250	0.250	49.5	300	4.60	198.4
9	9	9_OUT	13.042	0.600	3.200	3.170	0.030	434.7	150	4.80	198.4

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	2.800	111.3	41.1	0.700	0.700	0.055	0.0	94	2.594
2	2.889	114.9	48.2	0.700	0.700	0.064	0.0	102	2.766
3	3.095	123.1	77.3	0.700	0.700	0.103	0.0	130	3.266
4	2.804	111.5	101.1	0.700	0.775	0.134	0.0	168	3.161
5	1.415	56.2	31.4	0.700	0.700	0.042	0.0	120	1.451
6	2.176	86.5	47.0	0.700	0.700	0.062	0.0	118	2.220
7	1.868	132.1	68.4	0.700	0.700	0.091	0.0	153	1.884
8	2.240	158.3	87.2	0.700	0.650	0.116	0.0	159	2.292
9	0.476	8.4	221.4	0.850	0.820	0.294	0.0	150	0.485

Pipeline Schedule

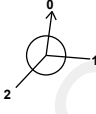
Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1	19.825	22.0	225	Circular	7.600	6.675	0.700	6.700	5.775	0.700
2	22.753	20.7	225	Circular	6.700	5.775	0.700	5.600	4.675	0.700
3	17.493	18.0	225	Circular	5.600	4.675	0.700	4.630	3.705	0.700
4	11.089	22.0	225	Circular	4.630	3.705	0.700	4.200	3.200	0.775
5	16.247	85.5	225	Circular	5.440	4.515	0.700	5.250	4.325	0.700
6	16.364	36.4	225	Circular	5.250	4.325	0.700	4.800	3.875	0.700
7	21.291	71.0	300	Circular	4.800	3.800	0.700	4.500	3.500	0.700
8	12.373	49.5	300	Circular	4.500	3.500	0.700	4.200	3.250	0.650
9	13.042	434.7	150	Circular	4.200	3.200	0.850	4.140	3.170	0.820

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1	1	1200	Manhole	Adoptable	2	1200	Manhole	Adoptable
2	2	1200	Manhole	Adoptable	3	1200	Manhole	Adoptable
3	3	1200	Manhole	Adoptable	4	1200	Manhole	Adoptable
4	4	1200	Manhole	Adoptable	9	1500	Manhole	Adoptable
5	5	1200	Manhole	Adoptable	6	1200	Manhole	Adoptable
6	6	1200	Manhole	Adoptable	7	1200	Manhole	Adoptable
7	7	1200	Manhole	Adoptable	8	1200	Manhole	Adoptable
8	8	1200	Manhole	Adoptable	9	1500	Manhole	Adoptable
9	9	1500	Manhole	Adoptable	9_OUT	1200	Manhole	Adoptable

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)	
1	565172.609	174327.320	7.600	0.925	1200		0	1	6.675	225
2	565188.702	174338.897	6.700	0.925	1200		1	1	5.775	225
						0	2	5.775	225	
3	565191.160	174361.517	5.600	0.925	1200		1	2	4.675	225
						0	3	4.675	225	
4	565192.945	174378.919	4.630	0.925	1200		1	3	3.705	225
						0	4	3.705	225	
5	565203.077	174333.000	5.440	0.925	1200		0	5	4.515	225
6	565206.000	174348.982	5.250	0.925	1200		1	5	4.325	225
						0	6	4.325	225	

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
7	565209.001	174365.068	4.800	1.000	1200		1 6	3.875	225
8	565212.862	174386.006	4.500	1.000	1200		0 7 1 7	3.800 3.500	300 300
9	565200.530	174387.008	4.200	1.000	1500		1 8 2 4	3.250 3.200	300 225
9_OUT	565202.282	174399.932	4.140	0.970	1200		0 9 1 9	3.200 3.170	150 150

Simulation Settings

Rainfall Methodology	FEH-13	Skip Steady State	x	Check Discharge Rate(s)	x
Summer CV	0.750	Drain Down Time (mins)	60	Check Discharge Volume	x
Analysis Speed	Normal	Additional Storage (m³/ha)	20.0		

Storm Durations

15 | 30 | 60 | 120 | 180 | 240 | 360

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

Node 9 Online Orifice Control

Flap Valve	x	Invert Level (m)	3.200	Discharge Coefficient	0.600
Replaces Downstream Link	✓	Diameter (m)	0.001		

Node 9 Soakaway Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	3.200	Depth (m)	0.850
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)		Inf Depth (m)	
Safety Factor	2.0	Pit Width (m)	10.500	Number Required	1
Porosity	0.95	Pit Length (m)	20.000		

Results for 2 year +40% CC Critical Storm Duration. Lowest mass balance: 99.47%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	1	10	6.724	0.049	11.4	0.1136	0.0000	OK
15 minute summer	2	10	5.827	0.052	13.4	0.0690	0.0000	OK
15 minute summer	3	10	4.738	0.063	21.5	0.1247	0.0000	OK
15 minute summer	4	9	3.796	0.091	28.1	0.1648	0.0000	OK
15 minute summer	5	10	4.577	0.062	8.7	0.1254	0.0000	OK
15 minute summer	6	10	4.386	0.061	13.0	0.0966	0.0000	OK
15 minute summer	7	10	3.878	0.078	18.9	0.1331	0.0000	OK
15 minute summer	8	10	3.584	0.084	24.1	0.1376	0.0000	OK
360 minute summer	9	424	3.562	0.362	13.5	73.1781	0.0000	SURCHARGED
15 minute summer	9_OUT	1	3.170	0.000	0.0	0.0000	0.0000	OK

Link Event (Outflow)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	1	1	2	11.4	1.719	0.102	0.1315	
15 minute summer	2	2	3	13.4	1.676	0.117	0.1824	
15 minute summer	3	3	4	21.5	1.851	0.175	0.2080	
15 minute summer	4	4	9	28.5	2.807	0.256	0.1306	
15 minute summer	5	5	6	8.7	0.993	0.155	0.1424	
15 minute summer	6	6	7	13.0	1.536	0.150	0.1386	
15 minute summer	7	7	8	18.9	1.227	0.143	0.3283	
15 minute summer	8	8	9	24.0	1.557	0.152	0.1908	
360 minute summer	9	Orifice	9_OUT	0.0				0.0

Results for 10 year +40% CC Critical Storm Duration. Lowest mass balance: 99.47%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	1	10	6.749	0.074	24.6	0.1706	0.0000	OK
15 minute summer	2	10	5.852	0.077	28.9	0.1023	0.0000	OK
15 minute summer	3	10	4.770	0.095	46.3	0.1876	0.0000	OK
15 minute summer	4	9	3.841	0.136	60.4	0.2473	0.0000	OK
15 minute summer	5	10	4.609	0.094	18.8	0.1917	0.0000	OK
15 minute summer	6	10	4.419	0.094	28.1	0.1480	0.0000	OK
15 minute summer	7	10	3.920	0.120	40.9	0.2038	0.0000	OK
360 minute summer	8	392	3.841	0.341	9.3	0.5555	0.0000	SURCHARGED
360 minute summer	9	400	3.841	0.641	23.9	129.4854	0.0000	SURCHARGED
15 minute summer	9_OUT	1	3.170	0.000	0.0	0.0000	0.0000	OK

Link Event (Outflow)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	1	1	2	24.6	2.119	0.221	0.2302	
15 minute summer	2	2	3	28.9	2.075	0.252	0.3175	
15 minute summer	3	3	4	46.2	2.295	0.375	0.3549	
15 minute summer	4	4	9	61.0	2.993	0.547	0.2873	
15 minute summer	5	5	6	18.8	1.198	0.334	0.2550	
15 minute summer	6	6	7	28.1	1.878	0.325	0.2450	
15 minute summer	7	7	8	41.0	1.463	0.310	0.5962	
15 minute summer	8	8	9	52.3	1.891	0.330	0.3421	
360 minute summer	9	Orifice	9_OUT	0.0				0.0

Results for 30 year +40% CC Critical Storm Duration. Lowest mass balance: 99.47%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	1	10	6.762	0.087	33.2	0.2016	0.0000	OK
15 minute summer	2	10	5.865	0.090	38.9	0.1201	0.0000	OK
15 minute summer	3	10	4.789	0.114	62.4	0.2250	0.0000	OK
360 minute summer	4	424	4.043	0.338	14.4	0.6135	0.0000	SURCHARGED
15 minute summer	5	10	4.628	0.113	25.4	0.2296	0.0000	OK
15 minute summer	6	10	4.437	0.112	38.0	0.1774	0.0000	OK
360 minute summer	7	416	4.043	0.243	9.7	0.4132	0.0000	OK
360 minute summer	8	416	4.043	0.543	12.4	0.8859	0.0000	SURCHARGED
360 minute summer	9	408	4.043	0.843	30.7	170.4349	0.0000	FLOOD RISK
15 minute summer	9_OUT	1	3.170	0.000	0.0	0.0000	0.0000	OK

Link Event (Outflow)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	1	1	2	33.2	2.289	0.298	0.2876	
15 minute summer	2	2	3	38.9	2.220	0.339	0.3989	
15 minute summer	3	3	4	62.3	2.400	0.506	0.4514	
15 minute summer	4	4	9	82.0	3.035	0.735	0.3705	
15 minute summer	5	5	6	25.4	1.278	0.451	0.3228	
15 minute summer	6	6	7	38.0	2.019	0.439	0.3081	
15 minute summer	7	7	8	55.4	1.555	0.419	0.7580	
15 minute summer	8	8	9	70.6	2.026	0.446	0.4930	
360 minute summer	9	Orifice	9_OUT	0.0				0.0

Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 99.47%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	1	10	6.777	0.102	43.4	0.2359	0.0000	OK
15 minute summer	2	10	5.880	0.105	51.0	0.1396	0.0000	OK
15 minute summer	3	10	4.817	0.142	81.8	0.2795	0.0000	OK
180 minute summer	4	132	4.218	0.513	33.3	0.9313	0.0000	SURCHARGED
15 minute summer	5	10	4.649	0.134	33.2	0.2733	0.0000	OK
15 minute summer	6	10	4.459	0.134	49.7	0.2111	0.0000	OK
120 minute summer	7	120	4.211	0.411	29.2	0.6985	0.0000	SURCHARGED
120 minute summer	8	120	4.205	0.705	37.5	1.1496	0.0000	FLOOD RISK
360 minute summer	9	216	4.200	1.000	41.6	172.3217	65.5766	FLOOD
15 minute summer	9_OUT	1	3.170	0.000	0.0	0.0000	0.0000	OK

Link Event (Outflow)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	1	1	2	43.5	2.446	0.391	0.3524	
15 minute summer	2	2	3	51.1	2.322	0.445	0.5059	
15 minute summer	3	3	4	81.3	2.339	0.661	0.5789	
15 minute summer	4	4	9	103.9	3.034	0.932	0.4410	
15 minute summer	5	5	6	33.2	1.347	0.590	0.4004	
15 minute summer	6	6	7	49.7	2.142	0.575	0.3797	
15 minute summer	7	7	8	72.4	1.632	0.548	0.9442	
15 minute summer	8	8	9	92.3	2.092	0.583	0.6500	
120 minute summer	9	Orifice	9_OUT	0.0				0.0

Design Settings

Rainfall Methodology	FEH-13	Minimum Velocity (m/s)	1.00
Return Period (years)	100	Connection Type	Level Soffits
Additional Flow (%)	40	Minimum Backdrop Height (m)	0.200
CV	0.750	Preferred Cover Depth (m)	0.700
Time of Entry (mins)	4.00	Include Intermediate Ground	✓
Maximum Time of Concentration (mins)	30.00	Enforce best practice design rules	x
Maximum Rainfall (mm/hr)	200.0		

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
1	0.055	4.00	7.600	1200	565172.609	174327.320	0.925
2	0.009	4.00	6.700	1200	565188.702	174338.897	0.925
3	0.039	4.00	5.600	1200	565191.160	174361.517	0.925
4	0.032	4.00	4.630	1200	565192.945	174378.919	0.925
5	0.042	4.00	5.440	1200	565203.077	174333.000	0.925
6	0.021	4.00	5.250	1200	565206.000	174348.982	0.925
7	0.028	4.00	4.800	1200	565209.001	174365.068	1.000
8	0.025	4.00	4.500	1200	565212.862	174386.006	1.000
9	0.044	4.00	4.200	1500	565200.530	174387.008	1.000
9_OUT			4.140	1200	565202.282	174399.932	0.970

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	1	2	19.825	0.600	6.675	5.775	0.900	22.0	225	4.12	198.4
2	2	3	22.753	0.600	5.775	4.675	1.100	20.7	225	4.25	198.4
3	3	4	17.493	0.600	4.675	3.705	0.970	18.0	225	4.34	198.4
4	4	9	11.089	0.600	3.705	3.200	0.505	22.0	225	4.41	198.4
5	5	6	16.247	0.600	4.515	4.325	0.190	85.5	225	4.19	198.4
6	6	7	16.364	0.600	4.325	3.875	0.450	36.4	225	4.32	198.4
7	7	8	21.291	0.600	3.800	3.500	0.300	71.0	300	4.51	198.4
8	8	9	12.373	0.600	3.500	3.250	0.250	49.5	300	4.60	198.4
9	9	9_OUT	13.042	0.600	3.200	3.170	0.030	434.7	150	4.80	198.4

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	2.800	111.3	41.1	0.700	0.700	0.055	0.0	94	2.594
2	2.889	114.9	48.2	0.700	0.700	0.064	0.0	102	2.766
3	3.095	123.1	77.3	0.700	0.700	0.103	0.0	130	3.266
4	2.804	111.5	101.1	0.700	0.775	0.134	0.0	168	3.161
5	1.415	56.2	31.4	0.700	0.700	0.042	0.0	120	1.451
6	2.176	86.5	47.0	0.700	0.700	0.062	0.0	118	2.220
7	1.868	132.1	68.4	0.700	0.700	0.091	0.0	153	1.884
8	2.240	158.3	87.2	0.700	0.650	0.116	0.0	159	2.292
9	0.476	8.4	221.4	0.850	0.820	0.294	0.0	150	0.485

Pipeline Schedule

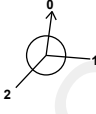
Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1	19.825	22.0	225	Circular	7.600	6.675	0.700	6.700	5.775	0.700
2	22.753	20.7	225	Circular	6.700	5.775	0.700	5.600	4.675	0.700
3	17.493	18.0	225	Circular	5.600	4.675	0.700	4.630	3.705	0.700
4	11.089	22.0	225	Circular	4.630	3.705	0.700	4.200	3.200	0.775
5	16.247	85.5	225	Circular	5.440	4.515	0.700	5.250	4.325	0.700
6	16.364	36.4	225	Circular	5.250	4.325	0.700	4.800	3.875	0.700
7	21.291	71.0	300	Circular	4.800	3.800	0.700	4.500	3.500	0.700
8	12.373	49.5	300	Circular	4.500	3.500	0.700	4.200	3.250	0.650
9	13.042	434.7	150	Circular	4.200	3.200	0.850	4.140	3.170	0.820

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1	1	1200	Manhole	Adoptable	2	1200	Manhole	Adoptable
2	2	1200	Manhole	Adoptable	3	1200	Manhole	Adoptable
3	3	1200	Manhole	Adoptable	4	1200	Manhole	Adoptable
4	4	1200	Manhole	Adoptable	9	1500	Manhole	Adoptable
5	5	1200	Manhole	Adoptable	6	1200	Manhole	Adoptable
6	6	1200	Manhole	Adoptable	7	1200	Manhole	Adoptable
7	7	1200	Manhole	Adoptable	8	1200	Manhole	Adoptable
8	8	1200	Manhole	Adoptable	9	1500	Manhole	Adoptable
9	9	1500	Manhole	Adoptable	9_OUT	1200	Manhole	Adoptable

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)	
1	565172.609	174327.320	7.600	0.925	1200		0	1	6.675	225
2	565188.702	174338.897	6.700	0.925	1200		1	1	5.775	225
							0	2	5.775	225
3	565191.160	174361.517	5.600	0.925	1200		1	2	4.675	225
							0	3	4.675	225
4	565192.945	174378.919	4.630	0.925	1200		1	3	3.705	225
							0	4	3.705	225
5	565203.077	174333.000	5.440	0.925	1200		0	5	4.515	225
6	565206.000	174348.982	5.250	0.925	1200		1	5	4.325	225
							0	6	4.325	225

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
7	565209.001	174365.068	4.800	1.000	1200		1 6	3.875	225
8	565212.862	174386.006	4.500	1.000	1200		0 7 1 7	3.800 3.500	300 300
9	565200.530	174387.008	4.200	1.000	1500		1 8 2 4	3.250 3.200	300 225
9_OUT	565202.282	174399.932	4.140	0.970	1200		0 9 1 9	3.200 3.170	150 150

Simulation Settings

Rainfall Methodology	FEH-13	Skip Steady State	x	Check Discharge Rate(s)	x
Summer CV	0.750	Drain Down Time (mins)	60	Check Discharge Volume	x
Analysis Speed	Normal	Additional Storage (m³/ha)	20.0		

Storm Durations

15 | 30 | 60 | 120 | 180 | 240 | 360

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

Node 9 Online Orifice Control

Flap Valve	x	Invert Level (m)	3.200	Discharge Coefficient	0.600
Replaces Downstream Link	✓	Diameter (m)	0.150		

Node 9 Soakaway Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	3.200	Depth (m)	0.850
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)	34	Inf Depth (m)	
Safety Factor	2.0	Pit Width (m)	10.500	Number Required	1
Porosity	0.95	Pit Length (m)	20.000		

Results for 2 year +40% CC Critical Storm Duration. Lowest mass balance: 99.91%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	1	10	6.724	0.049	11.4	0.1136	0.0000	OK
15 minute summer	2	10	5.827	0.052	13.4	0.0690	0.0000	OK
15 minute summer	3	10	4.738	0.063	21.5	0.1247	0.0000	OK
15 minute summer	4	9	3.796	0.091	28.1	0.1653	0.0000	OK
15 minute summer	5	10	4.577	0.062	8.7	0.1254	0.0000	OK
15 minute summer	6	10	4.386	0.061	13.0	0.0966	0.0000	OK
15 minute summer	7	10	3.878	0.078	18.9	0.1331	0.0000	OK
15 minute summer	8	10	3.584	0.084	24.1	0.1376	0.0000	OK
120 minute summer	9	76	3.337	0.137	27.2	27.7627	0.0000	OK
15 minute summer	9_OUT	1	3.170	0.000	7.0	0.0000	0.0000	OK

Link Event (Outflow)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	1	1	2	11.4	1.719	0.102	0.1315	
15 minute summer	2	2	3	13.4	1.676	0.117	0.1824	
15 minute summer	3	3	4	21.5	1.843	0.175	0.2085	
15 minute summer	4	4	9	28.5	2.817	0.256	0.1284	
15 minute summer	5	5	6	8.7	0.993	0.155	0.1424	
15 minute summer	6	6	7	13.0	1.536	0.150	0.1386	
15 minute summer	7	7	8	18.9	1.227	0.143	0.3283	
15 minute summer	8	8	9	24.0	1.557	0.152	0.1908	
120 minute summer	9	Orifice	9_OUT	11.3				45.7

Results for 10 year +40% CC Critical Storm Duration. Lowest mass balance: 99.91%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	1	10	6.749	0.074	24.6	0.1706	0.0000	OK
15 minute summer	2	10	5.852	0.077	28.9	0.1022	0.0000	OK
15 minute summer	3	10	4.770	0.095	46.3	0.1874	0.0000	OK
15 minute summer	4	9	3.842	0.137	60.4	0.2484	0.0000	OK
15 minute summer	5	10	4.609	0.094	18.8	0.1917	0.0000	OK
15 minute summer	6	10	4.419	0.094	28.1	0.1480	0.0000	OK
15 minute summer	7	10	3.920	0.120	40.9	0.2038	0.0000	OK
15 minute summer	8	10	3.632	0.132	52.2	0.2146	0.0000	OK
120 minute summer	9	76	3.456	0.256	53.2	51.8209	0.0000	SURCHARGED
15 minute summer	9_OUT	1	3.170	0.000	17.2	0.0000	0.0000	OK

Link Event (Outflow)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	1	1	2	24.6	2.119	0.221	0.2302	
15 minute summer	2	2	3	28.9	2.076	0.252	0.3172	
15 minute summer	3	3	4	46.2	2.287	0.375	0.3561	
15 minute summer	4	4	9	61.0	3.006	0.547	0.2793	
15 minute summer	5	5	6	18.8	1.198	0.334	0.2550	
15 minute summer	6	6	7	28.1	1.878	0.325	0.2450	
15 minute summer	7	7	8	41.0	1.463	0.310	0.5961	
15 minute summer	8	8	9	52.3	1.891	0.330	0.3421	
120 minute summer	9	Orifice	9_OUT	20.0				92.4

Results for 30 year +40% CC Critical Storm Duration. Lowest mass balance: 99.91%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	1	10	6.762	0.087	33.2	0.2016	0.0000	OK
15 minute summer	2	10	5.865	0.090	38.9	0.1201	0.0000	OK
15 minute summer	3	10	4.789	0.114	62.4	0.2248	0.0000	OK
15 minute summer	4	9	3.872	0.167	81.5	0.3023	0.0000	OK
15 minute summer	5	10	4.628	0.113	25.4	0.2296	0.0000	OK
15 minute summer	6	10	4.437	0.112	38.0	0.1774	0.0000	OK
15 minute summer	7	10	3.944	0.144	55.3	0.2445	0.0000	OK
15 minute summer	8	10	3.659	0.159	70.6	0.2588	0.0000	OK
60 minute summer	9	43	3.550	0.350	107.7	70.7220	0.0000	SURCHARGED
15 minute summer	9_OUT	1	3.170	0.000	21.4	0.0000	0.0000	OK

Link Event (Outflow)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	1	1	2	33.2	2.289	0.298	0.2876	
15 minute summer	2	2	3	38.9	2.222	0.339	0.3987	
15 minute summer	3	3	4	62.3	2.399	0.506	0.4523	
15 minute summer	4	4	9	82.0	3.054	0.735	0.3652	
15 minute summer	5	5	6	25.4	1.278	0.451	0.3227	
15 minute summer	6	6	7	38.0	2.019	0.439	0.3081	
15 minute summer	7	7	8	55.4	1.556	0.419	0.7580	
15 minute summer	8	8	9	70.6	2.026	0.446	0.4613	
60 minute summer	9	Orifice	9_OUT	24.6				94.4

Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 99.91%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	1	10	6.777	0.102	43.5	0.2359	0.0000	OK
15 minute summer	2	10	5.880	0.105	51.0	0.1395	0.0000	OK
15 minute summer	3	10	4.817	0.142	81.8	0.2797	0.0000	OK
15 minute summer	4	10	4.046	0.341	106.5	0.6192	0.0000	SURCHARGED
15 minute summer	5	10	4.649	0.134	33.2	0.2733	0.0000	OK
15 minute summer	6	10	4.459	0.134	49.7	0.2111	0.0000	OK
15 minute summer	7	10	3.972	0.172	72.3	0.2915	0.0000	OK
15 minute summer	8	10	3.690	0.190	92.2	0.3099	0.0000	OK
120 minute summer	9	78	3.671	0.471	94.3	95.1677	0.0000	SURCHARGED
15 minute summer	9_OUT	1	3.170	0.000	25.7	0.0000	0.0000	OK

Link Event (Outflow)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	1	1	2	43.5	2.447	0.391	0.3524	
15 minute summer	2	2	3	51.1	2.323	0.445	0.5060	
15 minute summer	3	3	4	81.4	2.325	0.661	0.5791	
15 minute summer	4	4	9	104.3	3.058	0.935	0.4410	
15 minute summer	5	5	6	33.2	1.347	0.590	0.4004	
15 minute summer	6	6	7	49.7	2.142	0.575	0.3797	
15 minute summer	7	7	8	72.4	1.632	0.548	0.9441	
15 minute summer	8	8	9	92.4	2.120	0.583	0.6225	
120 minute summer	9	Orifice	9_OUT	29.6				165.1

Appendix A.5 – Indicative Drainage Layout

Gravesham Borough Council

House

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GENERAL NOTES

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ENGINEERS, ARCHITECTS AND SPECIALISTS DRAWINGS AND THE SPECIFICATION.
2. ALL WORK IS TO BE CARRIED OUT IN ACCORDANCE WITH THE RELEVANT BRITISH STANDARDS, EUROPEAN NORMS, CODES OF PRACTICE AND BUILDING PRACTICE.
3. ALL DIMENSIONS ARE TO BE CHECKED BY THE CONTRACTOR PRIOR TO STARTING THE WORKS ON SITE. ANY DISCREPANCIES ARE TO BE REPORTED TO THE ENGINEER IMMEDIATELY.
4. ALL DRAINAGE SYSTEMS WILL NEED TO BE INSTALLED AND DESIGNED FOR SUITABLE LOADING REQUIREMENTS.
5. THE CONTRACTOR SHALL OBTAIN PRIOR APPROVAL AND ALL NECESSARY LICENCES FROM THE HIGHWAY AUTHORITY AND/OR SEWERAGE UNDERTAKER BEFORE CARRYING OUT ANY WORKS.

KEY:

- CL: XX.XX IL: XX.XX — SURFACE WATER DRAIN
— SURFACE WATER MANHOLE
— FLOW CONTROL DEVICE
— GEOCELLULAR STORAGE

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Rev	Description	Author	Checked	Date
P1	First Issue	EC	SMB	28/04/21

CLIENT
MILE PROPERTY GROUP

PROJECT
SWMS - The Terrace, Gravesend

SCALE
1:200

PROJ REF
2813

ORIGINATOR
EC

CHECKED BY
SMB

DWG REF
INDICATIVE DRAINAGE LAYOUT

DWG No.
HC-2813-501



SCALE 1 : 200 @ A1
10 m 0 10 m

CLARENDON ROAD

18

12

7

1

19

FLAP VALVE

MH 9 OUT
CL: 4.14
IL: 3.18

CELLULAR STORAGE CRATE
AREA: 210m²
DEPTH: 0.85m
POROSITY: 0.95

MH 8
CL: 4.50
IL: 3.50

MH 4
CL: 4.63
IL: 3.71

MH 3
CL: 5.60
IL: 4.68

MH 2
CL: 6.70
IL: 5.78

MH 1
CL: 7.60
IL: 6.68

MH 5
CL: 5.44
IL: 4.52

MH 6
CL: 5.25
IL: 4.33

MH 7
CL: 4.80
IL: 3.80

1 to 12

14 to 31

Milton Chantry
Heritage Centre

Appendix A.6 – Maintenance Schedules

Gravesham Borough Council

Operation and Maintenance Schedule – Geo-Cellular Storage System		
Maintenance Schedule	Required Action	Typical 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 and sediment from the catchment surface, wherever it presents a risk to the performance of the drainage system,	Monthly, or as required based on inspection frequencies.
	Remove sediment from pre-treatment structures (e.g. sediment traps) and from internal forebays	Annually or as required based on inspection frequencies
Remedial Actions	Repair; inlets, outlets, overflow pipes, and vent mechanisms	As required, based on inspections
	Replace tank or geotextile if significant damage is observed or geotextile is torn.	As required
Monitoring	Inspect and check all inlets, outlets, vents, and overflows to ensure that they are in good condition and operating as designed.	Following installation, and annually hereafter
	Survey inside of tank, and at any sediment trap mechanisms, for sediment build-up and remove sediment if necessary. Use inspections to develop a regular maintenance and inspection procedure for sediment removal.	Every 5 years, or as required if inspections show high siltation rates.

General Operation and Maintenance Table for Geo-Cellular Storage Systems