STUDIO 11
architecture

PROPOSED RESIDENTIAL DEVELOPMENT AT LAND OFF COLBEACH LANE SOUTH, SURFLEET, LINCOLNSHIRE FOR SEAGATE HOMES LTD

DRAINAGE STRATEGY

STUDIO 11
The Boathouse, Harbour Square, Nene Parade, Wisbech PE13 3BH

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Revision	Author	Checked	Date of Issue	Status	Revision Details
00	S11	KB	28.02.2020	Information	Initial Issue
01	S11	KB	06.03.2020	Planning	Planning issue

Introduction
This drainage strategy report has been produced to accompany a planning application to South Holland District Council (SHDC) for a residential development on land off Colbeach Lane South, Surfleet. This document should be read in conjunction with the Concept Drainage Strategy drawing – 415-S11-00-SI-SK-C-9000, and also the Flood Risk Assessment (FRA) undertaken by S M Hemmings.

Site Description
The proposed site covers an area of approximately 2.3 hectares, and is a greenfield site. The proposal is to erect 60 dwellings on the site.

Drainage
For developments of 10 or more dwellings there is a requirement to apply sustainable drainage principles (SuDS) to the disposal of surface water from the site. Generally, the aim should be to discharge surface water as high up the following hierarchy of drainage options as reasonably practicable:

1. Into the ground (infiltration);
2. To a surface water body;
3. To a surface water sewer or highway drain;
4. To a combined sewer.

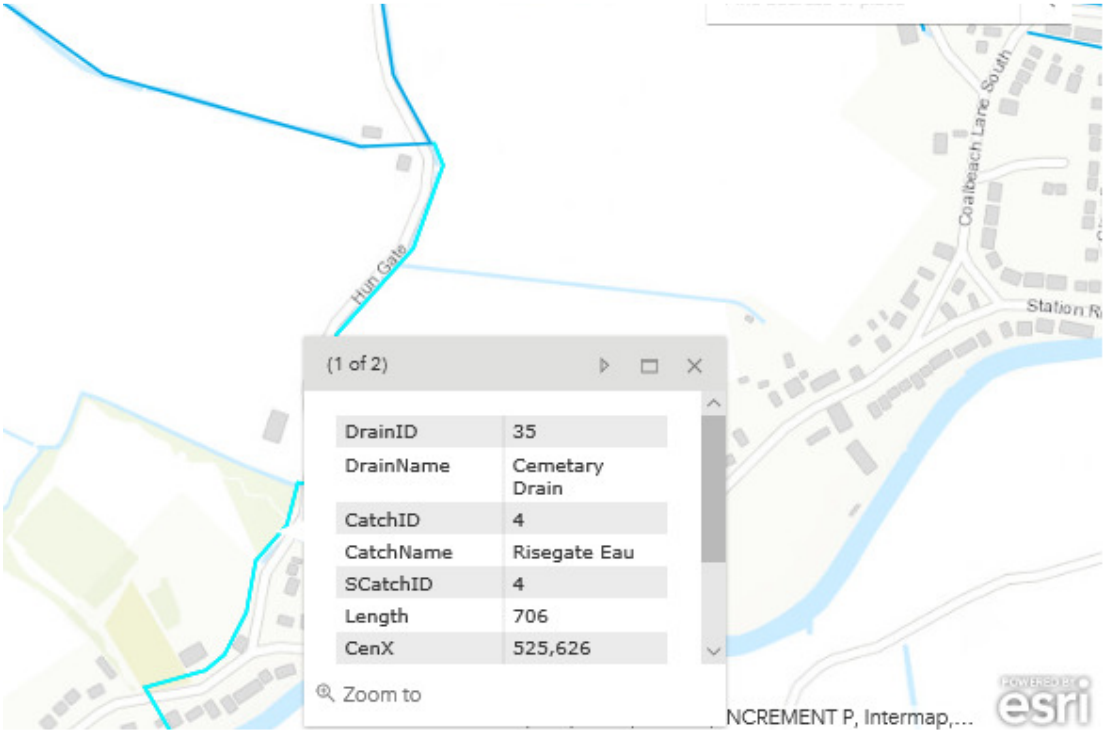
Infiltration
A ground investigation has been carried out by Ground Engineering, report reference No. C14949, and has been supplied as part of the overall planning application. The report notes that the ground water seepages were found up to 1.10m below the existing ground surface which is considered high - the technical requirement is that the water level should be a minimum of 1m below the base of infiltration devices.

Furthermore, the CBR values have been noted to be as low as 1% - typically porous paving would require a CBR of 3% to provide adequate support for the paving.

Lastly the boreholes generally describe the current ground conditions to be silt and clay, which generally provide no to very slow draining ground.

Given the above findings, infiltration has been ruled out on this site as it is not feasible.

Watercourses
There is an existing private shallow ditch which runs to the western perimeter of the site and then from the South West corner of the site through to the Welland and Deepings Internal Drainage Board (IDB) Drain – Cemetery Drain, which forms part of the Risegate Eau catchment. An extract of the IDB asset is shown overleaf.
The existing ditch is currently under riparian ownership and partly under stewardship of the current overall landowner. As part of the land sale, improvement works will be agreed to allow the site to be connect into this area.



Run-off Rates

In line with current guidelines, the developed site shall not exceed the pre-development greenfield run-off rate for the Q_{BAR} event - post development. The greenfield run-off for the site has been calculated in accordance with HR Wallingford's 'Greenfield runoff rate estimation', and their guidance has been followed when entering the data. The proposed run-off from the site will therefore be restricted to a maximum of 2.8l/s. An extract of the existing greenfield runoff is shown below, and the full calculation can be found in appendix A. An impermeable area plan has been provided as part of this application - 415-S11-00-SI-SK-C-9010.

Greenfield runoff rates

	Default	Edited
Q_{BAR} (l/s):	2.83	2.83
1 in 1 year (l/s):	2.46	2.46
1 in 30 years (l/s):	6.93	6.93
1 in 100 year (l/s):	10.08	10.08
1 in 200 years (l/s):	11.92	11.92

As the actual greenfield run-off from the site and the IDB rates for contribution differs, there will be the need to apply to the IDB for a consent to discharge surface water and pay for a development contribution.

Surface Water - Adopted Highway

As outlined previously, infiltration is not feasible for this site, therefore the SuDS strategy for the surface water highway drainage will be achieved using the provision of surface water conveyance, cleansing and attenuation. The site layout has been designed to provide a filter drain to one side of the carriageway in most cases, although the road will be designed to ensure that the entire carriageway drains to the filter drains. The filter drain will convey and treat the surface water run-off from the carriageways into the attenuation basin. Given the likely shallow gradient of the carriageway, it would be proposed that the filter drain will have an underdrain to provide adequate conveyance and to satisfy the requirements of Lincolnshire County Council (LCC). The filter drain will also provide additional attenuation within the voided stone when the system is surcharged, to lower the risk of flooding in storms of exceedance. As a requirement of LCC, the filter drain will undergo pre-treatment via a 'filter strip'.

Surface Water - Anglian Water Drainage

It is proposed that the general site drainage will be adopted by Anglian Water under a section 104 agreement, and will be designed and constructed to the latest design guidance.

Surface Water - Roofs

Roof water will be collected through a traditional gutter system and discharge either into the permeable paving serving the property's driveways or piped into the proposed.

Surface Water - Private Drives

All private drives will be permeable construction with a voided permeable sub-base and tanked to prevent groundwater entry. At detailed design stage, the porous paving should be utilised to provide additional attenuation during period where the drainage systems water levels are high.

Attenuation Basin

Given the restricted run-off rate from the site of 2.8l/s, the surface water will need to be attenuated before it ultimately enters the IDB watercourse. Storage will be provided in the form of an attenuation basin to the south of the site which during dry periods will be empty. It would be proposed that the online attenuation basin and associated headwalls be put forward for adoption to Anglian Water during the detailed design stage and section 104 application. In the event that this is not deemed suitable for adoption, the basin and downstream infrastructure will need to be maintained by an appointed management company. Given the high-water levels, it is likely that the base of the basin will be within the water table zone. Therefore, an impermeable liner will be required below the base of the bottom of the basin. The liner will have to be installed at sufficient depth below the base to ensure it is not susceptible for floatation.

The attenuation basin has been designed to store all storms, up to and including the 1 in 100 year + 40% climate change storm events. The maximum water level within the basin will be in excess of 1m below the lowest finished floor levels. Preliminary drainage calculations can be found in appendix B.

Pump

As the proposed outfall is so shallow, and to allow the proposed site to drain under gravity, it is necessary for the attenuation basin to be pumped. The packaged pumping station will be maintained by a management company. Pump unit to be complete with dual pumps and high-level alarm.

Existing Ditch

The topographical survey of the existing ditch highlighted that improvement works would be required to ensure that the flow from the site is conveyed into the IDB drain. It is proposed that the existing ditch will be laid to a constant fall of 1:500 from the edge of the site through to the IDB drain. To accommodate this, the final 100m (approximately) of the existing top of bank will need to be widened to accommodate the extra depth. The sides of the re-profiled ditch will be no steeper than 1.5 (horizontal) in 1 (vertical) and incorporate a 500mm flat base.

Flood Routing

In the event of device or feature failure, it is proposed that an overland flow route, in the form of an informal shallow swale will be provided to link into the existing ditch being connected into. This will ensure that flooding will have a safe and managed route which will sit a sufficient distance below the proposed FFL's and surrounding land levels. It is recommended that the base of this will be set at roughly 3.000 AOD.

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;

Residential roofs	- Very low
Individual property driveways	- Low
Private access	- Low
Adoptable cul-de-sac	- Low

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

TABLE 26.2 Pollution hazard indices for different land use classifications

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

TABLE 26.3 Indicative SuDS mitigation indices for discharges to surface waters			
	Mitigation indices[1]		
Type of SuDS component	TSS	Metals	Hydrocarbons
Filter strip	0.4	0.4	0.5
Filter drain	0.4[2]	0.4	0.4
Swale	0.5	0.6	0.6
Bioretention system	0.8	0.8	0.8
Permeable pavement	0.7	0.6	0.7
Detention basin	0.5	0.5	0.6
Pond[4]	0.7[3]	0.7	0.5
Wetland	0.8[3]	0.8	0.8
Proprietary treatment systems[5,6]	These must demonstrate that they can address each of the contaminant types to acceptable levels for frequent events up to approximately the 1 in 1 year return period event, for inflow concentrations relevant to the contributing drainage area.		

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

Total SuDS mitigation index ≥ pollution hazard index
(for each contaminant type) (for each contaminant type)

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

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

Where:

$$\textit{Mitigation index}_n = \textit{mitigation index for component } n$$

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

Roofs

0.2 0.2 0.05 = Detention Basin (0.5 0.5 0.6)

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

Individual property driveways

0.5 0.4 0.4 = Permeable Pavement (0.5 0.5 0.6) + Detention Basin 0.5(0.25 0.25 0.3)

The mitigation provided by the permeable paving alone satisfies the mitigation index, therefore sufficient treatment has been provided.

Private accessways

0.5 0.4 0.4 = Permeable Pavement (0.5 0.5 0.6) + Detention Basin 0.5(0.25 0.25 0.3)

The mitigation provided by the permeable paving alone satisfies the mitigation index, therefore sufficient treatment has been provided.

Adopted Cul-de-sacs

0.5 0.4 0.4 = Filter strip (0.4 0.4 0.5) + Filter drain 0.5(0.2 0.2 0.2) + Detention Basin 0.5(0.25 0.25 0.3)
Combined mitigation = 0.85 0.85 1.0

The combined mitigation provided by the three treatment stages above comfortably exceeds the pollution indices, therefore sufficient treatment has been provided.

All the methods above provide enough water quality in accordance with CIRIA's C753 document. Further evidence will need to be provided at detailed design stage.

Finished Floor Levels

All finished floor levels are to be set at a minimum 3.70m AOD, or a minimum of 300mm above existing ground levels in accordance with the Flood Risk Assessment submitted as part of this application.

Foul Water

We have identified the closest Anglian Water foul water sewer which runs in Coalbeach lane South, an extract of the asset map is shown below.



The nearest manholes are 2801 and 2905 and interpolating between these levels gives and approximate invert level of 0.700 AOD at the preferred connection point. Given the sufficient depth of the foul sewer and the proposed FFL's, all foul water will be able to drain via. gravity sewers, subject to an accepted section 106 application from Anglian Water. Exact invert levels at the proposed connection point will need to be confirmed prior to detailed design.

Conclusion

The above drainage strategy demonstrates that the site can be drained appropriately including the use of a Sustainable Drainage System.

The run-off rate from the developed site will be no higher than 2.8l/s for all storm events.

Discharge from the site will ultimately be to a Welland and Deepings maintained drain.

A maintenance strategy will be developed at the detailed design stage.

A drainage sketch can be found on Studio 11's Concept Drainage Strategy drawing: 415-S11-00-SI-SK-C-9000.

As the run-off from the site is being restricted to greenfield run-off the risk of flooding as a result of the site's development will not increase.

Informal conversations have been held between Studio 11 and the Lead Local Flood Authority, and this strategy has been agreed in principle.

Appendices

Appendix A – Greenfield Run-off

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Studio 11
Site name:	Coalbeach Lane
Site location:	Surfleet

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

Site Details

Latitude:	52.84539° N
Longitude:	0.12563° W
Reference:	1877469400
Date:	Feb 26 2020 21:47

Runoff estimation approach

IH124

Site characteristics

Total site area (ha): 2.0165

Methodology

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

Soil characteristics

	Default	Edited
SOIL type:	2	2
HOST class:	N/A	N/A
SPR/SPRHOST:	0.3	0.3

Hydrological characteristics

	Default	Edited
SAAR (mm):	560	560
Hydrological region:	5	5
Growth curve factor 1 year:	0.87	0.87
Growth curve factor 30 years:	2.45	2.45
Growth curve factor 100 years:	3.56	3.56
Growth curve factor 200 years:	4.21	4.21

Notes

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

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

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

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

(3) Is SPR/SPRHOST ≤ 0.3?

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

Greenfield runoff rates

	Default	Edited
Q_{BAR} (l/s):	2.83	2.83
1 in 1 year (l/s):	2.46	2.46
1 in 30 years (l/s):	6.93	6.93
1 in 100 year (l/s):	10.08	10.08
1 in 200 years (l/s):	11.92	11.92

This report was produced using the greenfield runoff tool developed by HR Wallingford and available at www.uksuds.com. The use of this tool is subject to the UK SuDS terms and conditions and licence agreement , which can both be found at www.uksuds.com/terms-and-conditions.htm. The outputs from this tool are estimates of greenfield runoff rates. The use of these results is the responsibility of the users of this tool. No liability will be accepted by HR Wallingford, the Environment Agency, CEH, Hydrosolutions or any other organisation for the use of this data in the design or operational characteristics of any drainage scheme.

Appendix B - Calculations

Design Settings

Rainfall Methodology	FSR	Maximum Time of Concentration (mins)	30.00
Return Period (years)	2	Maximum Rainfall (mm/hr)	80.0
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	0.750	Include Intermediate Ground	✓
Time of Entry (mins)	5.00	Enforce best practice design rules	✓

Simulation Settings

Rainfall Methodology	FSR	Analysis Speed	Normal
FSR Region	England and Wales	Skip Steady State	x
M5-60 (mm)	20.000	Drain Down Time (mins)	240
Ratio-R	0.400	Additional Storage (m³/ha)	20.0
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 %)
2	0	0	0
30	0	0	0
100	40	6	0

Node Headwall Out Online Pump Control

Flap Valve	x	Design Depth (m)	1.700	Switch off depth (m)	0.000
Replaces Downstream Link	✓	Design Flow (l/s)	2.8		
Invert Level (m)	0.500	Switch on depth (m)	0.050		

Depth (m)	Flow (l/s)
2.200	3.624

Node S22 Flow through Pond Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Main Channel Length (m)	15.000
Side Inf Coefficient (m/hr)	0.00000	Invert Level (m)	0.625	Main Channel Slope (1:X)	1000.0
Safety Factor	2.0	Time to half empty (mins)	0	Main Channel n	0.030

Inlets

Headwall In

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	240.0	0.0	2.200	1056.3	0.0

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Results for 2 year Critical Storm Duration. Lowest mass balance: 99.20%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	S1	10	2.133	0.083	11.3	0.1692	0.0000	OK
15 minute winter	S2	10	1.943	0.137	22.1	0.2622	0.0000	OK
15 minute winter	S3	11	1.921	0.150	33.0	0.2841	0.0000	OK
15 minute winter	S4	11	1.832	0.169	32.9	0.1916	0.0000	OK
15 minute winter	S5	10	2.266	0.066	7.3	0.1188	0.0000	OK
15 minute winter	S6	11	2.012	0.109	14.6	0.1836	0.0000	OK
15 minute winter	S7	11	1.820	0.131	18.9	0.1896	0.0000	OK
15 minute winter	S8	11	1.798	0.247	56.0	0.3518	0.0000	OK
15 minute winter	S9	11	1.756	0.233	60.1	0.3306	0.0000	OK
15 minute winter	S10	11	2.242	0.042	3.1	0.0595	0.0000	OK
15 minute winter	S11	11	1.938	0.083	11.3	0.1425	0.0000	OK
15 minute winter	S12	12	1.698	0.127	19.3	0.2087	0.0000	OK
15 minute winter	S13	12	1.690	0.277	86.5	0.6252	0.0000	OK
15 minute winter	S14	12	1.627	0.285	93.6	0.6413	0.0000	OK
15 minute winter	S15	12	1.536	0.302	98.2	0.6541	0.0000	OK
15 minute winter	S16	12	1.474	0.347	103.9	0.7454	0.0000	OK
15 minute winter	S17	12	1.447	0.344	109.6	0.7402	0.0000	OK
15 minute winter	S18	12	1.405	0.364	117.0	0.8227	0.0000	OK
15 minute winter	S19	12	1.373	0.354	129.8	0.9116	0.0000	OK
15 minute winter	S20	12	1.323	0.330	143.0	0.8487	0.0000	OK
1440 minute winter	S21	1380	1.302	0.479	9.6	1.5794	0.0000	OK
1440 minute winter	Headwall In	1380	1.302	0.662	9.3	0.0000	0.0000	OK
1440 minute winter	S22	1380	1.302	0.677	5.1	0.0000	0.0000	SURCHARGED
1440 minute winter	Headwall Out	1380	1.301	0.801	1.3	0.9060	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 winter	S1	1.000	S2	10.9	0.849	0.275	0.3706	
15 minute winter	S2	1.001	S3	21.8	0.653	0.305	0.2820	
15 minute winter	S3	1.002	S4	32.9	0.879	0.460	0.9907	
15 minute winter	S4	1.003	S8	32.6	0.848	0.456	0.3479	
15 minute winter	S5	2.000	S6	7.1	0.675	0.403	0.3134	
15 minute winter	S6	2.001	S7	14.3	1.082	0.806	0.1831	
15 minute winter	S7	2.002	S8	18.8	0.777	0.473	0.3040	
15 minute winter	S8	1.004	S9	55.5	0.920	0.778	0.4075	
15 minute winter	S9	1.005	S13	59.7	1.109	0.836	0.4548	
15 minute winter	S10	3.000	S11	3.0	0.744	0.168	0.1082	
15 minute winter	S11	3.001	S12	11.1	0.855	0.279	0.4612	
15 minute winter	S12	3.002	S13	18.4	0.661	0.257	0.6571	
15 minute winter	S13	1.006	S14	85.0	0.974	0.740	1.8945	
15 minute winter	S14	1.007	S15	92.0	1.023	0.801	2.9985	
15 minute winter	S15	1.008	S16	97.8	1.144	0.851	0.8579	
15 minute winter	S16	1.009	S17	103.3	0.810	0.647	1.2966	
15 minute winter	S17	1.010	S18	108.7	0.812	0.681	3.3649	
15 minute winter	S18	1.011	S19	116.1	0.861	0.727	1.1929	
15 minute winter	S19	1.012	S20	129.2	0.999	0.809	1.3545	
15 minute winter	S20	1.013	S21	141.0	1.281	0.883	4.2349	
15 minute winter	S21	1.014	Headwall In	154.2	1.317	0.709	1.3395	
15 minute summer	Headwall In	Flow through pond	S22	81.6	0.111	0.001	74.3881	
15 minute winter	S22	4.000	Headwall Out	6.2	0.662	0.350	0.2200	
1440 minute winter	Headwall Out	Pump		1.3				89.2

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Results for 30 year Critical Storm Duration. Lowest mass balance: 99.20%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	S1	12	2.440	0.390	21.4	0.7995	0.0000	SURCHARGED
15 minute winter	S2	12	2.412	0.606	42.8	1.1560	0.0000	SURCHARGED
15 minute winter	S3	12	2.402	0.631	56.1	1.1930	0.0000	SURCHARGED
15 minute winter	S4	12	2.351	0.688	52.2	0.7784	0.0000	SURCHARGED
15 minute winter	S5	13	2.637	0.437	13.8	0.7855	0.0000	SURCHARGED
15 minute winter	S6	13	2.547	0.644	25.7	1.0809	0.0000	SURCHARGED
15 minute winter	S7	12	2.363	0.674	28.3	0.9748	0.0000	SURCHARGED
15 minute winter	S8	12	2.329	0.778	76.7	1.1066	0.0000	SURCHARGED
15 minute winter	S9	12	2.270	0.747	82.3	1.0602	0.0000	SURCHARGED
15 minute winter	S10	10	2.260	0.060	5.9	0.0844	0.0000	OK
15 minute winter	S11	12	2.240	0.385	21.6	0.6645	0.0000	SURCHARGED
15 minute winter	S12	12	2.207	0.636	34.2	1.0456	0.0000	SURCHARGED
15 minute winter	S13	12	2.192	0.779	120.6	1.7609	0.0000	SURCHARGED
15 minute winter	S14	12	2.082	0.740	132.8	1.6676	0.0000	SURCHARGED
15 minute winter	S15	12	1.898	0.664	143.4	1.4367	0.0000	SURCHARGED
15 minute winter	S16	12	1.805	0.678	154.2	1.4544	0.0000	SURCHARGED
15 minute winter	S17	12	1.757	0.654	165.6	1.4058	0.0000	SURCHARGED
15 minute winter	S18	12	1.659	0.618	181.1	1.3970	0.0000	SURCHARGED
1440 minute winter	S19	1380	1.642	0.623	12.6	1.6046	0.0000	SURCHARGED
1440 minute winter	S20	1380	1.643	0.650	13.9	1.6726	0.0000	SURCHARGED
1440 minute winter	S21	1410	1.642	0.819	15.0	2.7003	0.0000	SURCHARGED
1440 minute winter	Headwall In	1410	1.642	1.002	14.7	0.0000	0.0000	OK
1440 minute winter	S22	1410	1.642	1.017	8.0	0.0000	0.0000	SURCHARGED
1440 minute winter	Headwall Out	1410	1.640	1.140	1.9	1.2898	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 winter	S1	1.000	S2	21.4	0.893	0.539	1.1451	
15 minute winter	S2	1.001	S3	35.9	0.694	0.503	0.5964	
15 minute winter	S3	1.002	S4	52.2	0.926	0.731	1.8297	
15 minute winter	S4	1.003	S8	44.9	0.833	0.629	0.5957	
15 minute winter	S5	2.000	S6	12.3	0.767	0.694	0.5225	
15 minute summer	S6	2.001	S7	19.8	1.129	1.118	0.2438	
15 minute winter	S7	2.002	S8	25.9	0.797	0.652	0.4272	
15 minute winter	S8	1.004	S9	76.9	1.092	1.076	0.4750	
15 minute winter	S9	1.005	S13	83.7	1.189	1.172	0.5879	
15 minute winter	S10	3.000	S11	5.7	0.883	0.319	0.3225	
15 minute summer	S11	3.001	S12	20.4	0.916	0.512	1.4139	
15 minute winter	S12	3.002	S13	28.5	0.674	0.399	1.2249	
15 minute winter	S13	1.006	S14	122.5	1.111	1.066	2.3621	
15 minute winter	S14	1.007	S15	134.9	1.223	1.174	3.5761	
15 minute winter	S15	1.008	S16	145.7	1.321	1.268	1.0458	
15 minute winter	S16	1.009	S17	156.5	0.988	0.980	1.5714	
15 minute winter	S17	1.010	S18	167.5	1.057	1.049	3.9850	
15 minute winter	S18	1.011	S19	181.2	1.144	1.135	1.3935	
15 minute winter	S19	1.012	S20	207.4	1.309	1.299	1.6614	
15 minute winter	S20	1.013	S21	234.5	1.527	1.469	5.5129	
15 minute winter	S21	1.014	Headwall In	261.8	1.590	1.203	1.8843	
15 minute winter	Headwall In	Flow through pond	S22	139.1	0.117	0.001	155.6902	
15 minute summer	S22	4.000	Headwall Out	7.4	0.671	0.414	0.2200	
1440 minute winter	Headwall Out	Pump		1.9				125.3

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Results for 100 year +40% CC +6% A Critical Storm Duration. Lowest mass balance: 99.20%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	S1	10	3.400	1.350	41.3	2.8418	6.7203	FLOOD
15 minute winter	S2	11	3.400	1.594	60.9	3.1179	4.9360	FLOOD
15 minute winter	S3	11	3.400	1.629	85.0	3.1570	2.8915	FLOOD
15 minute winter	S4	11	3.400	1.737	66.9	1.9645	0.0129	FLOOD
15 minute winter	S5	10	3.400	1.200	26.7	2.2056	5.3000	FLOOD
15 minute winter	S6	10	3.400	1.497	34.6	2.5629	4.1543	FLOOD
15 minute winter	S7	11	3.400	1.711	36.7	2.5083	0.4329	FLOOD
15 minute winter	S8	11	3.398	1.847	99.0	2.6620	0.0000	FLOOD RISK
15 minute winter	S9	11	3.374	1.851	104.2	2.6587	0.0000	FLOOD RISK
15 minute winter	S10	11	3.400	1.200	18.3	1.7172	1.2385	FLOOD
15 minute winter	S11	11	3.400	1.545	32.3	2.7223	1.1319	FLOOD
15 minute winter	S12	11	3.367	1.796	47.4	3.0099	0.0000	FLOOD RISK
15 minute winter	S13	11	3.324	1.911	158.0	4.3760	0.0000	FLOOD RISK
15 minute winter	S14	11	3.176	1.834	174.4	4.1844	0.0000	FLOOD RISK
15 minute winter	S15	12	2.891	1.657	196.4	3.6252	0.0000	SURCHARGED
15 minute winter	S16	12	2.731	1.604	217.3	3.4785	0.0000	SURCHARGED
15 minute winter	S17	12	2.641	1.538	238.9	3.3429	0.0000	SURCHARGED
15 minute winter	S18	12	2.443	1.402	269.6	3.2076	0.0000	SURCHARGED
15 minute winter	S19	12	2.304	1.285	324.5	3.3682	0.0000	SURCHARGED
1440 minute winter	S20	1410	2.221	1.228	26.4	3.2179	0.0000	SURCHARGED
1440 minute winter	S21	1410	2.221	1.398	29.1	4.6722	0.0000	SURCHARGED
1440 minute winter	Headwall In	1410	2.220	1.580	29.0	0.0000	0.0000	OK
1440 minute winter	S22	1410	2.220	1.595	15.6	0.0000	0.0000	SURCHARGED
1440 minute winter	Headwall Out	1410	2.217	1.717	2.8	1.9416	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	S1	1.000	S2	28.0	0.893	0.706	1.1451	
15 minute winter	S2	1.001	S3	43.8	0.705	0.613	0.5964	
15 minute winter	S3	1.002	S4	66.9	0.950	0.937	1.8297	
60 minute summer	S4	1.003	S8	59.9	0.851	0.839	0.5957	
15 minute winter	S5	2.000	S6	13.1	0.793	0.737	0.5225	
30 minute summer	S6	2.001	S7	22.8	1.293	1.282	0.2438	
15 minute winter	S7	2.002	S8	32.0	0.804	0.804	0.4272	
30 minute summer	S8	1.004	S9	97.5	1.384	1.365	0.4750	
30 minute summer	S9	1.005	S13	107.0	1.520	1.499	0.5879	
15 minute summer	S10	3.000	S11	9.6	0.912	0.538	0.4757	
15 minute summer	S11	3.001	S12	27.9	0.888	0.702	1.4139	
30 minute winter	S12	3.002	S13	48.3	0.686	0.676	1.2249	
15 minute winter	S13	1.006	S14	162.5	1.473	1.414	2.3621	
15 minute summer	S14	1.007	S15	180.3	1.635	1.569	3.5761	
15 minute summer	S15	1.008	S16	197.8	1.794	1.721	1.0458	
15 minute summer	S16	1.009	S17	217.9	1.376	1.365	1.5714	
15 minute summer	S17	1.010	S18	240.8	1.520	1.508	3.9850	
15 minute winter	S18	1.011	S19	273.0	1.723	1.710	1.3935	
15 minute winter	S19	1.012	S20	326.9	2.064	2.048	1.6614	
15 minute winter	S20	1.013	S21	380.9	2.404	2.386	6.0769	
15 minute winter	S21	1.014	Headwall In	435.3	2.031	2.001	2.4703	
15 minute winter	Headwall In	Flow through pond	S22	227.5	0.128	0.002	267.2815	
15 minute summer	S22	4.000	Headwall Out	5.3	0.698	0.298	0.2200	
1440 minute winter	Headwall Out	Pump		2.8				186.5

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