FLOOD RISK ASSESSMENT

AND

DRAINAGE STRATEGY

for

PRINGLE HOMES

PROPOSED RESIDENTIAL DEVELOPMENT

on

LAND AT CROW TREES FARM

CROW TREES BROW, CHATBURN, BB7 4AA

SEPTEMBER 2022

REFORD

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CONTENTS

1. INTRODUCTION

1.1 This flood risk assessment and drainage strategy has been produced on behalf of Pringle Homes in support of a planning application for a proposed residential development on land at Crow Trees Farm, Crow Trees Brow, Chatburn, BB7 4AA. A location plan is included within Appendix A.

1.2 The Flood Risk Assessment (FRA) is compliant with the requirements set out in the National Planning Policy Framework (NPPF) and the Planning Practice Guidance (NPPG) in relation to Flood Risk and Coastal Change, and describes the existing site conditions and proposed development. It assesses the potential sources of flooding to the site from tidal, fluvial, groundwater, surface water and other sources, taking a risk based approach in accordance with National Policy.

1.3 The drainage strategy describes the existing site conditions and proposed development. It assesses the potential impact of proposals on existing drainage and includes a proposed strategy for the provision of new drainage to serve the development.

Site summary

Site Name	Land at Crow Trees Farm
Location	Crow Trees Brow, Chatburn, BB7 4AA
NGR (approx.)	SD767439
Application site area	1.68 ha approx.
Development type	Residential
Vulnerability	More Vulnerable
Indicative Flood Zone	Flood Zone 1
Local Planning Authority	Ribble Valley Borough Council

2. DESCRIPTION OF THE SITE

Existing site

2.1 The proposal relates to land (1.68 hectares approx.) at Crow Trees Farm, Crow Trees Brow, Chatburn.

2.2 The site lies to the south of the centre of Chatburn. Crow Trees Brow lies along the site's northern boundary. A railway line lies along the southern boundary of the site in cutting.

2.3 The Heys Brook passes through the centre of Chatburn and lies approx. 100m to the east of the site where it crosses Bridge Road. The Heys Brook flows to the north to discharge into the River Ribble approx. 650m to the north of the centre of Chatburn.

2.4 The site comprises fields to the rear of the farmhouse; the farmhouse and buildings lie within the north east part of the site.

2.5 Access to the site is from Crow Trees Brow adjacent to the farmhouse and in the north west corner via an existing access to the fields and other residential properties to the south of the site.

2.6 The site has a fall from the western and southern edges to the north through the existing access through the existing farmhouse access.

Proposed development site

2.7 It is proposed that the development is for a residential development to comprise 39 dwellings, the refurbishment of the Grade II listed farm house and the conversion of existing barns to a residential unit.

2.8 The proposed layout is shown on drawing 21/139/P01 accompanying the planning application.

3. SCOPE OF THE ASSESSMENT

Flood risk planning policy

3.1 The National Planning Policy Framework (NPPF) sets out the Government's national policies on different aspects of land use planning in England in relation to flood risk. Supporting Planning Practice Guidance is also available.

3.2 The NPPF sets out the vulnerability to flooding of different land uses. It encourages development to be located away from areas at highest risk (whether existing or future), and states that where development is necessary in such areas, the development should be made safe for its lifetime. It also stresses the importance of preventing increases in flood risk offsite to the wider catchment area.

3.3 The NPPF also states that alternative sources of flooding, other than fluvial (river flooding), should also be considered when preparing a Flood Risk Assessment.

3.4 As set out in NPPF, local planning authorities should only consider development in flood risk areas appropriate where informed by a site specific Flood Risk Assessment. This document will identify and assess the risk associated with all forms of flooding to and from the development. Where necessary it will demonstrate how these flood risks will be managed so that the development remains safe throughout its lifetime, taking climate change into account.

3.5 This Flood Risk Assessment is written in accordance with the NPPF and the Planning Practice Guidance in relation to Flood Risk and Coastal Change.

Flood zones

3.6 In investigating the flood risk relating to the site, the Environment Agency flood zone mapping identifies the proposed development site lies within Flood Zone 1. Flood Zone 1 is the lowest risk and is identified as land assessed as having a less than 1 in 1000 annual probability of river or sea flooding (<0.1%).

3.7 An extract from the Environment Agency's Flood Zone Map for Planning showing the approx. development site boundary is shown below.

Strategic Flood Risk Assessment

3.8 The site is within the area covered by the Ribble Valley Borough Council Strategic Flood Risk Assessment, Revised Level One Assessment, April 2017.

3.9 No reference is made to the application site or Heys Brook within the SFRA.

Sequential Test

3.10 A requirement of NPPF is that all plans should apply a sequential, risk-based approach to the location of development, taking into account the current and future impacts of climate change so as to avoid, where possible, flood risk to people and property. The aim of the Sequential Test is to steer new development to areas with the lowest risk of flooding.

3.11 The purpose of the Sequential Test is to demonstrate that there are no reasonably available sites in areas with a lower probability of flooding that would be appropriate to the type of development or land use proposed. A sequential approach should be

used in areas known to be at risk from other forms of flooding. In areas at risk of river or sea flooding, preference should be given to locating new development in Flood Zone 1. If there is no reasonably available site in Flood Zone 1, the flood vulnerability of the proposed development can be taken into account in locating development in Flood Zone 2 and then Flood Zone 3. Within each Flood Zone new development should be directed to sites at the lowest probability of flooding from all sources as indicated by the SFRA.

3.12 Strategic Flood Risk Assessments refine information on the probability of flooding, taking other sources of flooding and the impacts of climate change into account. They provide the basis for applying the Sequential Test, on the basis of the flood zones in NPPG Table 1.

3.13 The flood zones are the starting point for this sequential approach. As already stated, the Environment Agency's flood mapping identifies the site as lying within Flood Zone 1, the lowest risk.

3.14 With reference to NPPF, Environment Agency Flood Maps and the SFRA, the site lies within an area identified as being potentially developable and following the sequential approach, all of the development is located within Flood Zone 1.

3.15 The current development proposals are classified as "More Vulnerable" for residential use. Table 3 within the PPG indicates Flood Risk Vulnerability and Flood Zone 'compatibility'. Using Zone 1 and the "More Vulnerable" classification, the PPG considers that a development of this type would be deemed appropriate for development within Flood Zone 1.

3.16 Subject to the suitable assessment of flood risk, the development would be considered sequentially preferable in this location.

4. CONSULTATIONS AND DATA ACQUISITIONS

Environment Agency

4.1 The Environment Agency's flood zone mapping confirms that the site lies within an area of Flood Zone 1, the lowest risk. There is no record of any historic flooding occurring at the site.

United Utilities

4.2 Sewer records have been obtained from United Utilities and are included within Appendix B.

4.3 The sewer records identify a 150mm combined sewer, running northeast along Crow Trees Brow. The sewer flows to the north to a sewage treatment plant located where the Heys Brook discharges into the River Ribble.

Private drainage

4.4 Existing drainage within the site allows surface and foul water from the existing farm buildings to discharge into the public combined sewer that lies within Crow Trees Brow.

Site Investigation

4.5 The online Soilscapes Viewer has identified the site lying in a region characterised by slowly permeable seasonally wet acid loamy and clayey soils with impeded drainage.

4.6 Based upon the ground conditions identified, infiltration is unlikely to provide a viable drainage solution for surface water runoff generated by the site. Infiltration tests have therefore not been carried out.

Topographical Survey

4.7 A topographical survey of the development site has been carried out.

4.8 The site has a fall from the western and southern edges to the north through the existing access through the existing farmhouse access.

5. SOURCES OF FLOOD RISK

5.1 Potential sources of flood risk to the site are identified below. The significance of these sources is investigated further into Section 6.

Fluvial flooding

5.2 The site to be developed is identified as lying within Flood Zone 1 on the Environment Agency's flood mapping, land assessed as having an annual probability of flooding of less than 1 in 1000 (<0.1%).

5.3 The Heys Brook passes through the centre of Chatburn and lies approx. 100m to the east of the site where it crosses Bridge Road. The Heys Brook flows to the north to discharge into the River Ribble approx. 650m to the north of the centre of Chatburn.

Tidal flooding

5.4 The site is a significant distance from the nearest tidal estuary and is, therefore, not at risk of flooding from the sea. The site is not identified as being at risk of flooding from the sea by any Environment Agency Flood Zone maps or within the SFRA for the area. As such, coastal and tidal flooding is not considered further within this assessment.

Canals, reservoirs and other artificial sources

5.5 There are no canals or other artificial sources local to the site.

5.6 The Environment Agency risk of flooding from reservoirs map doesn't identify the site being at risk of flooding from any reservoir.

Groundwater

5.7 Groundwater flooding tends to occur after much longer periods of sustained high rainfall. The areas that are at risk tend to be those low-lying areas where the water table is shallow. Flooding tends to occur in areas that are underlain by major aquifers, although groundwater flooding is also noted in localised floodplain sands and gravels. The main causes of groundwater flooding are:

- Natural groundwater rising due to tidal influence, or exceptionally wet periods leading to rapid recharge;
- Groundwater rebound due to cessation of abstraction and mine dewatering;
- Existence of confined aquifers and springs.

Sewers

5.8 Flooding from a drainage system occurs when flow entering a system exceeds its discharge capacity, the system becomes blocked or, in the case of surface water sewers, it cannot discharge due to high water level in the receiving watercourse. Sewer flooding is often caused by surface water discharging into the combined sewerage system, sewer capacity is exceeded in large rainfall events causing backing up of flood waters within properties or discharging through manholes.

5.9 United Utilities sewer records identify a 150mm combined sewer, running northeast along Crow Trees Brow. The sewer flows to the north to a sewage treatment plant located where the Heys Brook discharges into the River Ribble.

Pluvial runoff

5.10 The Environment Agency Risk of Flooding from Surface Water map indicates a very low risk to the site from surface water flooding. A very low risk means that each year this area has a chance of flooding of less than 0.1%.

5.11 It should be noted that surface water flooding can be difficult to predict, much more so than river or sea flooding as it is hard to forecast exactly where or how much rain will fall in any storm. In addition, local features can greatly affect the chance and severity of flooding.

Development drainage

5.12 Surface water (including the risk of sewers and culverted watercourses surcharging) poses the highest risk of more frequent flooding. Surface water drainage from new developments is critical in reducing the risk of localised flooding.

5.13 If surface water runoff is not managed appropriately, there may be an increased risk presented elsewhere from development drainage, and the aim should be to implement appropriate sustainable drainage systems (SuDS) to treat and contain flows and mimic the existing conditions.

5.14 Where possible the preference for dealing with surface water runoff from the developed site is for it to infiltrate back into the ground or alternatively to a waterbody or watercourse. Only if it is not possible for either of these options is surface water from the development to be allowed into public sewers.

5.15 The introduction of the development will increase the area of impermeable hardstanding on site and therefore has the potential to alter the surface water runoff regime of the site and to have an adverse effect on flood risk elsewhere in the wider catchment.

6. FLOOD RISK ASSESSMENT

6.1 This section of the Flood Risk Assessment looks at the flood risk to the site before any mitigation measures are put into place and hence identifies where mitigation will be required. Section 7 continues to explain the mitigation measures proposed and the residual risk following implementation of any proposed mitigation.

Risk of Flooding to Proposed Development

Fluvial Flood Risk

6.2 The site is identified as lying within Flood Zone 1 on the Environment Agency's flood mapping, the lowest risk.

6.3 The Heys Brook passes through the centre of Chatburn and lies approx. 100m to the east of the site where it crosses Bridge Road. The Heys Brook flows to the north to discharge into the River Ribble approx. 650m to the north of the centre of Chatburn.

6.4 The Environment Agency's flood mapping shows a fluvial flood risk from the Heys Brook within the centre of Chatburn, mainly along the route of the brook. The flood risk will not affect the proposed development site and the risk of fluvial flooding to the proposed development is therefore very low.

Canals, reservoirs and other artificial sources

6.5 There are no canals or other artificial sources local to the site.

6.6 The Environment Agency risk of flooding from reservoirs map doesn't identify the site being at risk of flooding from any reservoir.

6.7 As such the risk of flooding from canals, reservoirs and other sources is very low.

Groundwater

6.8 There has been no historic flooding due to groundwater on the site.

6.9 The flood risk from groundwater is therefore low.

Sewer Flooding and Pluvial Runoff

6.10 United Utilities sewer records identify a 150mm combined sewer, running northeast along Crow Trees Brow. The sewer flows to the north to a sewage treatment plant located where the Heys Brook discharges into the River Ribble.

6.11 The ongoing operational and maintenance responsibility of the sewer is with United Utilities. Any exceedance flows that may occur from the sewer during an extreme event will be along Crow Trees Brow towards the Heys Brook. As such the risk is low from sewer flooding.

6.12 The Environment Agency Risk of Flooding from Surface Water map indicates a very low risk to the site from surface water flooding.

6.13 There is no record of the site previously flooding.

Effect of the Development on the Wider Catchment

Development Drainage

6.14 The proposed development will introduce an area of impermeable hardstanding on site, and has the potential to significantly alter the surface water run-off regime of the site and have an adverse effect on flood risk elsewhere in the wider catchment.

6.15 The online Soilscapes Viewer has identified the site lying in a region characterised by slowly permeable seasonally wet acid loamy and clayey soils with impeded drainage.

6.16 It is intended that surface water runoff from the developed site will be controlled to the existing pre-development Greenfield runoff rate, allowing surface water runoff generated by all rainfall events up to the 100 year critical rain storm plus 50% on stored volumes to discharge into the public sewer that lies within Crow Trees Brow.

6.17 Attenuation will be provided for rainfall events up to the 100 year critical rain storm plus 50% on stored volumes to restrict surface water runoff from the developed site to pre-development runoff rates prior to discharge. As such there will be no change to the flood risk upstream or downstream of this location and the risk of flooding from the development drainage is low.

7. PREDICTED IMPACTS AND MITIGATION

7.1 This section of the FRA sets out the mitigation measures recommended to reduce the risk of flooding to the proposed development and outlines any residual impacts.

Site arrangements

Access / Egress

7.2 If an extreme event was to occur, the access to the site would be from Crow Trees Brow, which lies within Flood Zone 1.

Upstream and downstream effects

7.3 There is no material effect on the floodplain due to the proposed development.

7.4 It is intended that surface water runoff from the developed site will be controlled to the existing pre-development Greenfield runoff rate, allowing surface water runoff generated by all rainfall events up to the 100 year critical rain storm plus 50% on stored volumes to discharge into the public sewer that lies within Crow Trees Brow.

7.5 As such there will be no change to the flood risk upstream or downstream of this location.

8. DRAINAGE STRATEGY

8.1 Existing drainage within the site allows surface and foul water from the existing farm buildings to discharge into the public combined sewer that lies within Crow Trees Brow.

8.2 As the Grade II listed farm house is to be refurbished and the existing barns converted, it is intended that the existing drainage system serving these buildings will remain unchanged and continue to discharge into the public combined sewer that lies within Crow Trees Brow.

8.3 Drainage for the proposed residential development, to comprise 39 dwellings, will be dealt with as follows.

Surface water drainage

8.4 Guidance for the disposal of surface water from a development site is for soakaways to be considered as the primary solution. If this is not practical, discharge to a waterbody or watercourse is to be considered as the next available alternative. Only if neither of these options is available, and other sustainable drainage methods not possible, should the use of the public sewerage system be considered.

8.5 The online Soilscapes Viewer has identified the site lying in a region characterised by slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils with impeded drainage that is not conducive to infiltration. Based upon the ground conditions identified, infiltration is unlikely to provide a viable drainage solution for surface water runoff generated by the site. Infiltration tests have therefore not been carried out.

8.6 The nearest watercourse is the Heys Brook that passes through the centre of Chatburn and lies approx. 100m to the east of the site where it crosses Bridge Road. It is not deemed viable for a surface water discharge to be made into the Heys Brook due to the works that would be required.

8.7 United Utilities sewer records identify a 150mm combined sewer, running northeast along Crow Trees Brow outside the site.

8.8 It is therefore intended that surface water runoff from the developed site will be controlled to the existing pre-development Greenfield runoff rate, allowing surface water runoff generated by all rainfall events up to the 100 year critical rain storm plus 50% on stored volumes to discharge into the public sewer that lies within Crow Trees Brow. The additional 50% is to allow for climate change and has been included in the surface water volume.

8.9 As it is intended for a surface water discharge to be made into the public sewer, surface water runoff from the developed site will be restricted to the Greenfield runoff rate, Qbar. Attenuation will be provided within the development site.

8.10 To determine the restricted surface water discharge rates from the developed site, the pre-development Greenfield runoff rates have been calculated using the 'Causeway Flow' programme. The calculations are based upon the developed area of the site of 1.11ha, having removed the areas of open space / landscaping measured at 0.56ha. The existing pre-development Greenfield runoff rates have been calculated as follows:

- Qbar 10.6 l/s
- Q1 9.0 l/s
- Q100 26.4 l/s

8.11 A preliminary surface water drainage design has been carried out for the proposed site development for all events up to the 100 year critical rain storm plus 50% on stored volumes. Attenuation is provided using underground storage under hardstanding areas. An additional 10% has been added to the residential properties areas to account for urban creep. The preliminary surface water drainage design is included within Appendix C.

Foul water drainage

8.12 The sewer records identify a 150mm combined sewer, running northeast along Crow Trees Brow. The sewer flows to the north to a sewage treatment plant located where the Heys Brook discharges into the River Ribble.

8.13 Existing drainage within the site allows foul water from the existing farm buildings to discharge into the public combined sewer that lies within Crow Trees Brow.

8.14 It is therefore intended that foul water from the proposed new dwellings is also to be collected by a piped system and discharged into the public sewer that lies within Crow Trees Brow.

9. CONCLUSIONS

9.1 This flood risk assessment and drainage strategy has been produced on behalf of Pringle Homes in support of a planning application for a proposed residential development on land at Crow Trees Farm, Crow Trees Brow, Chatburn, BB7 4AA.

Flood risk assessment

9.2 The Site lies within Flood Zone 1, the lowest risk which is identified as land assessed as having a less than 1 in 1000 annual probability of river or sea flooding (<0.1%). The risk of fluvial flooding is very low.

9.3 The risk of flooding from canals, reservoirs and other artificial sources is very low.

9.4 The flood risk from groundwater is low.

9.5 The Environment Agency Risk of Flooding from Surface Water map indicates a very low risk to the site from surface water flooding. The risk from pluvial runoff is very low.

9.6 The risk from sewer flooding is low.

9.7 The risk of flooding from the development drainage is low.

Drainage strategy

9.8 The existing drainage system from the Grade II listed farm house to be refurbished and the existing barns to be converted will remain unchanged and continue to discharge into the public combined sewer that lies within Crow Trees Brow.

9.9 Surface water runoff from the developed site will be controlled to the existing pre-development Greenfield runoff rate, allowing surface water runoff generated by all rainfall events up to the 100 year critical rain storm plus 50% on stored volumes to discharge into the public sewer that lies within Crow Trees Brow.

9.10 Foul water from the proposed new dwellings is to be collected by a piped system and discharged into the public sewer that lies within Crow Trees Brow.

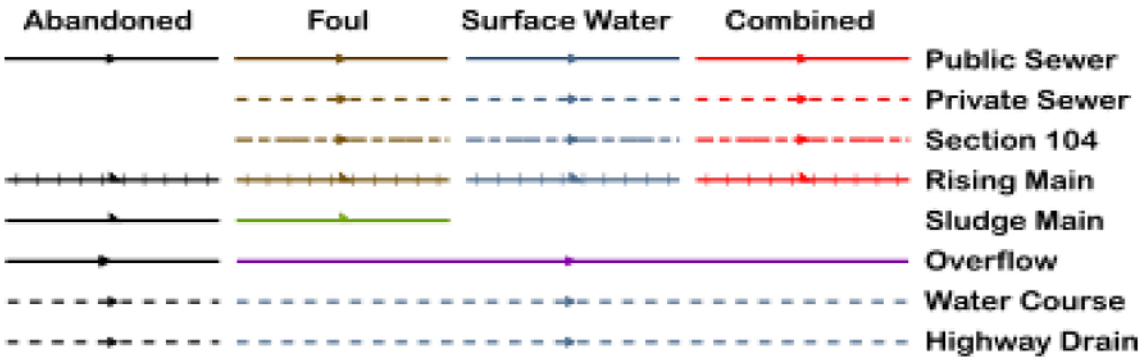
APPENDIX A

LOCATION PLAN

APPENDIX B

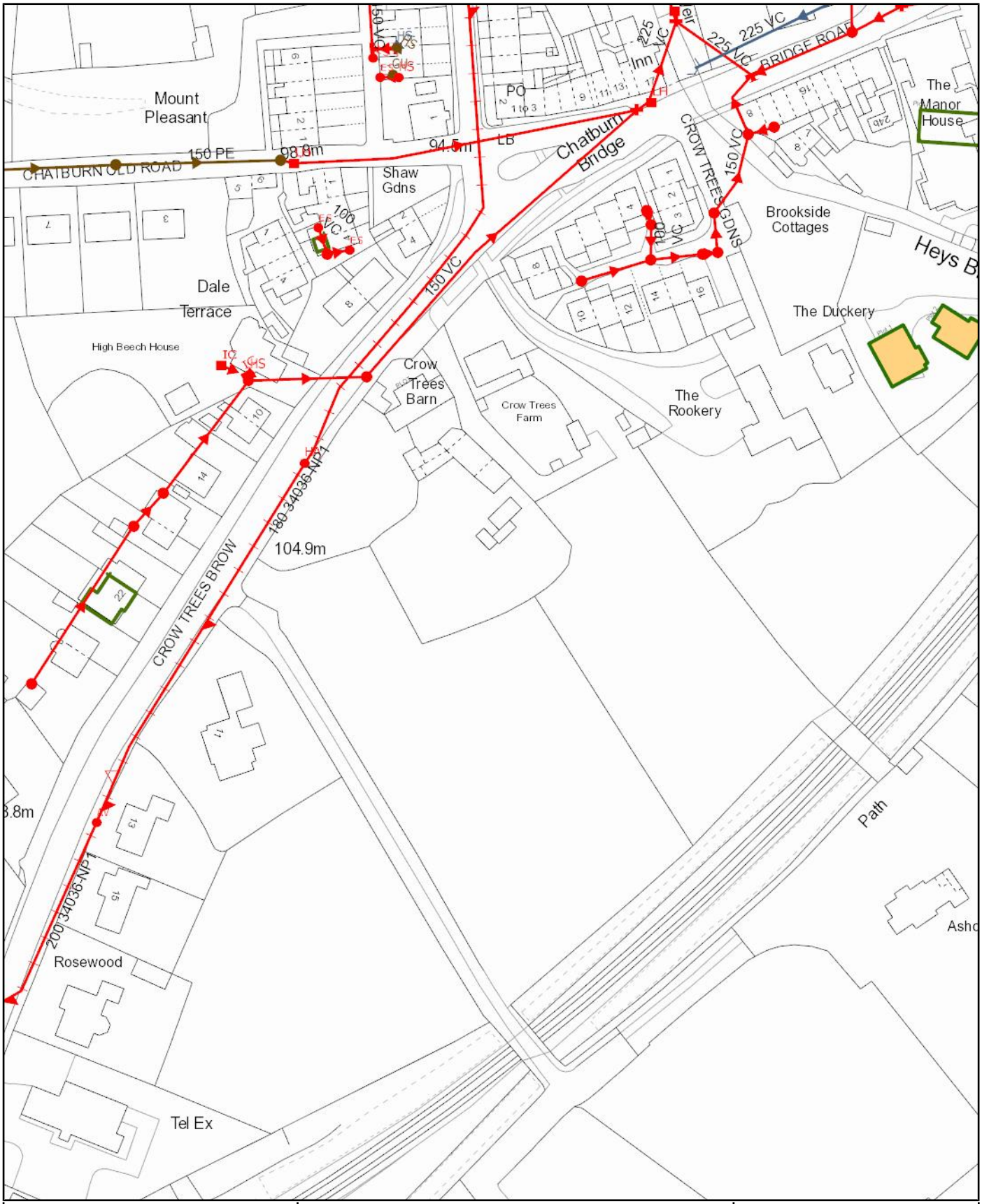
United Utilities
Water for the North West

Wastewater Symbology



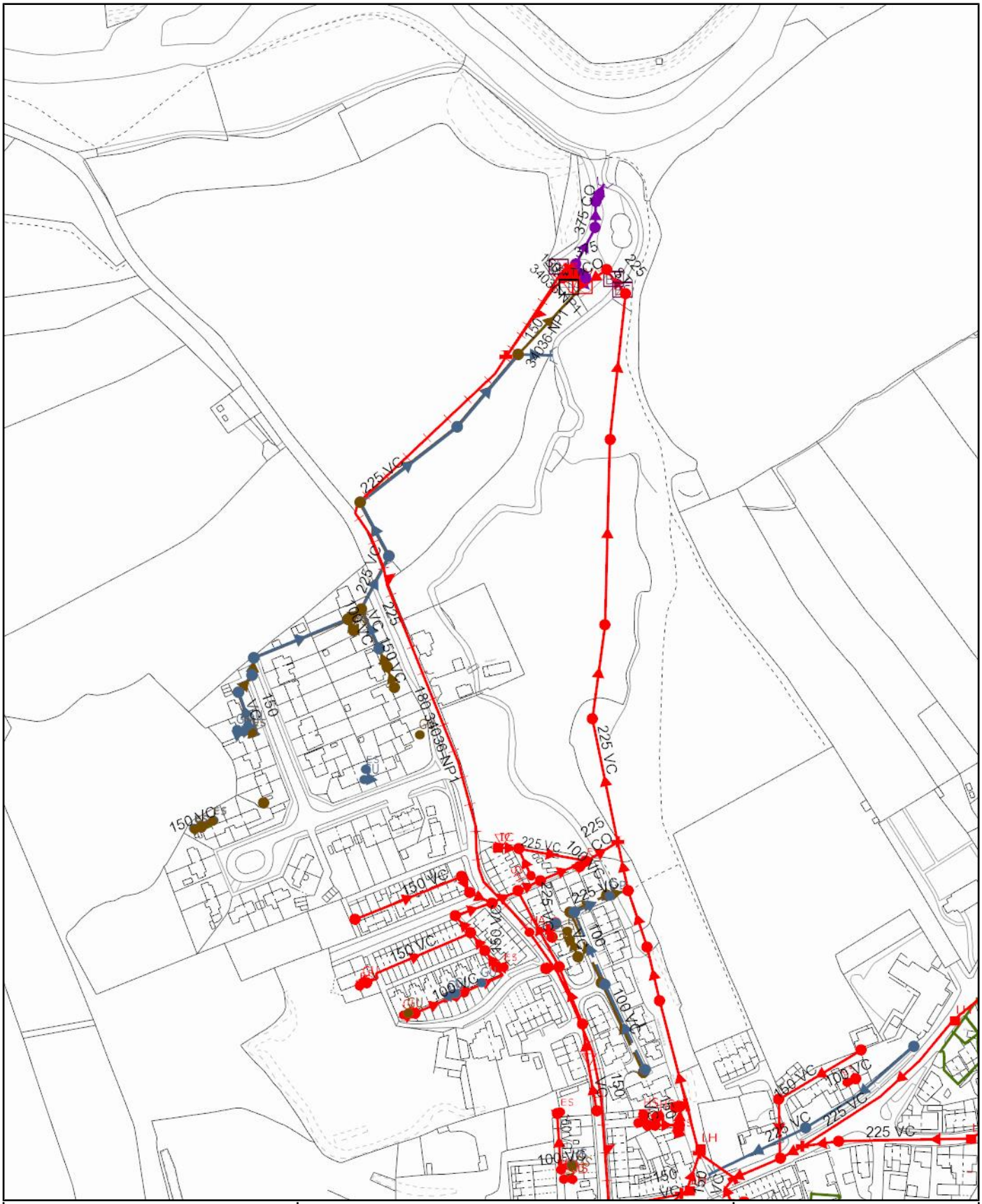
All point assets follow the standard colour convention: red – combined, brown - foul, blue – surface water, purple - overflow

- Manhole
- HS Head of System
- ES Extent of Survey
- RE Rodding Eye
- IN Inlet
- DP Discharge Point
- HY Vortex
- PE Penstock
- WO Washout Chamber
- VA Valve
- AV Air Valve
- NRV Non Return Valve
- SO Soakaway
- GU Gully
- CA Cascade
- FM Flow Meter
- HA Hatch Box
- OI Oil Interceptor
- SM Summit
- DS Drop Shaft
- OP Orifice Plate
- Side Entry Manhole
- Outfall
- Screen Chamber
- IC Inspection Chamber
- Bifurcation Chamber
- LH Lamp Hole
- T Junction / Saddle
- CA Catchpit
- VC Valve Chamber
- Vent Column
- Vortex Chamber
- Penstock Chamber
- T Network Storage Tank
- V Sewer Overflow
- WwTW Ww Treatment Works
- Ww Pumping Station
- ST Septic Tank
- CK Control Kiosk
- Change of Characteristic



Scale:	1:1506	**SEWER RECORDS**	United Utilities Water for the North West
Date:	25/05/2022		
Address or Site Reference:	crow trees brow		
Printed by:	Property Searches		

The position of the underground apparatus shown on this plan is approximate only and is given in accordance with the best information currently available. United Utilities Water will not accept liability for any loss or damage caused by the actual position being different from those shown.



Scale:	1:3291	**SEWER RECORDS**	United Utilities Water for the North West
Date:	12/07/2022		
Address or Site Reference:	crow trees brow		
Printed by:	Property Searches		

The position of the underground apparatus shown on this plan is approximate only and is given in accordance with the best information currently available. United Utilities Water will not accept liability for any loss or damage caused by the actual position being different from those shown.

APPENDIX C

PRELIMINARY SURFACE WATER DRAINAGE LAYOUT

Design Settings

Rainfall Methodology	FSR	Maximum Time of Concentration (mins)	30.00
Return Period (years)	2	Maximum Rainfall (mm/hr)	75.0
Additional Flow (%)	0	Minimum Velocity (m/s)	1.00
FSR Region	England and Wales	Connection Type	Level Soffits
M5-60 (mm)	19.000	Minimum Backdrop Height (m)	3.000
Ratio-R	0.250	Preferred Cover Depth (m)	1.200
CV	0.750	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)	Depth (m)
1	0.019	5.00	105.600	1200	1.425
2	0.048	5.00	104.400	1200	1.425
3	0.021	5.00	105.400	1200	2.543
4	0.066	5.00	104.900	1200	2.208
5	0.053	5.00	104.300	1200	1.797
6	0.036	5.00	104.000	1200	1.627
7	0.052	5.00	102.800	1200	1.500
8	0.040	5.00	102.000	1200	1.500
9	0.043	5.00	101.200	1200	1.575
10	0.052	5.00	101.400	1200	3.286
11	0.035	5.00	100.800	1500	2.821
12	0.043	5.00	101.200	1200	1.425
13	0.035	5.00	101.000	1500	1.425
14	0.054	5.00	100.000	1500	2.118
15	0.026	5.00	99.400	1500	1.575
16	0.000		99.400	1500	1.625
17	0.000		99.400	1500	1.778

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)
2.000	1	3	10.000	0.600	104.175	102.857	1.318	7.6	225	5.03	52.3
1.000	2	3	20.000	0.600	102.975	102.857	0.118	169.5	225	5.33	51.2
1.001	3	4	28.000	0.600	102.857	102.692	0.165	169.7	225	5.80	49.6
1.002	4	5	32.000	0.600	102.692	102.503	0.189	169.3	225	6.33	48.0
1.003	5	6	22.000	0.600	102.503	102.373	0.130	169.2	225	6.70	46.9
1.004	6	7	22.000	0.600	102.373	101.375	0.998	22.0	225	6.83	46.6
1.005	7	8	16.000	0.600	101.300	100.500	0.800	20.0	300	6.90	46.4
1.006	8	9	22.000	0.600	100.500	99.700	0.800	27.5	300	7.03	46.0
1.007	9	11	28.000	0.600	99.625	97.979	1.646	17.0	375	7.13	45.8
3.000	10	11	15.000	0.600	98.114	98.052	0.062	241.9	300	5.25	51.5
1.008	11	14	31.000	0.600	97.979	97.882	0.097	319.6	375	7.64	44.5
4.000	12	13	24.000	0.600	99.775	99.575	0.200	120.0	225	5.34	51.2
4.001	13	14	28.000	0.600	99.575	98.032	1.543	18.1	225	5.49	50.7
1.009	14	15	18.000	0.600	97.882	97.825	0.057	315.8	375	7.94	43.8

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)
2.000	4.779	190.0	2.7	1.200	2.318	0.019	0.0
1.000	1.001	39.8	6.7	1.200	2.318	0.048	0.0
1.001	1.001	39.8	11.8	2.318	1.983	0.088	0.0
1.002	1.002	39.8	20.0	1.983	1.572	0.154	0.0
1.003	1.002	39.8	26.3	1.572	1.402	0.207	0.0
1.004	2.799	111.3	30.7	1.402	1.200	0.243	0.0
1.005	3.531	249.6	37.1	1.200	1.200	0.295	0.0
1.006	3.009	212.7	41.8	1.200	1.200	0.335	0.0
1.007	4.411	487.2	46.9	1.200	2.446	0.378	0.0
3.000	1.006	71.1	7.3	2.986	2.448	0.052	0.0
1.008	1.008	111.3	56.0	2.446	1.743	0.465	0.0
4.000	1.192	47.4	6.0	1.200	1.200	0.043	0.0
4.001	3.086	122.7	10.7	1.200	1.743	0.078	0.0
1.009	1.014	112.0	70.8	1.743	1.200	0.597	0.0

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)
1.010	15	16	16.000	0.600	97.825	97.775	0.050	320.0	375	8.21	43.1
1.011	16	17	26.000	0.600	97.775	97.622	0.153	169.9	225	8.64	42.2

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)
1.010	1.007	111.2	72.9	1.200	1.250	0.623	0.0
1.011	1.000	39.8	71.3	1.400	1.553	0.623	0.0

Simulation Settings

Rainfall Methodology	FSR	Summer CV	0.750	Drain Down Time (mins)	240
FSR Region	England and Wales	Winter CV	0.840	Additional Storage (m³/ha)	20.0
M5-60 (mm)	19.000	Analysis Speed	Normal	Check Discharge Rate(s)	x
Ratio-R	0.250	Skip Steady State	x	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 %)	Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
1	0	0	0	100	0	0	0
30	0	0	0	100	50	0	0

Node 16 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	97.775	Product Number	CTL-SHE-0141-1060-1600-1060
Design Depth (m)	1.600	Min Outlet Diameter (m)	0.225
Design Flow (l/s)	10.6	Min Node Diameter (mm)	1500

Node 10 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	98.114
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.95	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	87.0	0.0	1.200	87.0	0.0	1.201	0.0	0.0

Node 11 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	97.979
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.95	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	100.0	0.0	1.200	100.0	0.0	1.201	0.0	0.0

Node 14 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	97.882
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.95	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	120.0	0.0	1.200	120.0	0.0	1.201	0.0	0.0

Results for 1 year Critical Storm Duration. Lowest mass balance: 99.67%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	1	10	104.192	0.017	2.2	0.0238	0.0000	OK
15 minute winter	2	10	103.031	0.056	5.5	0.1004	0.0000	OK
15 minute winter	3	11	102.932	0.075	10.0	0.0976	0.0000	OK
15 minute winter	4	11	102.795	0.103	17.1	0.1779	0.0000	OK
15 minute winter	5	11	102.630	0.127	22.8	0.2193	0.0000	OK
15 minute winter	6	11	102.451	0.078	26.7	0.1224	0.0000	OK
15 minute winter	7	11	101.374	0.074	32.2	0.1343	0.0000	OK
15 minute winter	8	11	100.588	0.087	36.4	0.1456	0.0000	OK
15 minute winter	9	10	99.699	0.074	40.9	0.1244	0.0000	OK
60 minute winter	10	41	98.149	0.035	3.6	2.9047	0.0000	OK
120 minute winter	11	90	98.111	0.132	21.3	12.7696	0.0000	OK
15 minute winter	12	10	99.825	0.050	4.9	0.0872	0.0000	OK
15 minute winter	13	11	99.616	0.041	8.8	0.0925	0.0000	OK
120 minute winter	14	90	98.110	0.228	26.5	26.4739	0.0000	OK
120 minute winter	15	90	98.109	0.284	11.9	0.5956	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 winter	1	2.000	3	2.2	0.438	0.011	0.0646	
15 minute winter	2	1.000	3	5.4	0.568	0.136	0.1912	
15 minute winter	3	1.001	4	9.8	0.669	0.246	0.4105	
15 minute winter	4	1.002	5	17.1	0.837	0.429	0.6539	
15 minute winter	5	1.003	6	22.8	1.293	0.572	0.3888	
15 minute winter	6	1.004	7	26.6	2.249	0.239	0.2599	
15 minute winter	7	1.005	8	32.1	2.115	0.129	0.2436	
15 minute winter	8	1.006	9	36.3	2.203	0.171	0.3628	
15 minute winter	9	1.007	11	41.2	2.967	0.085	0.5778	
60 minute winter	10	3.000	11	2.0	0.419	0.028	0.0936	
120 minute winter	11	1.008	14	20.5	0.693	0.184	1.6192	
15 minute winter	12	4.000	13	4.8	0.836	0.101	0.1382	
15 minute winter	13	4.001	14	8.6	1.775	0.070	0.1364	
120 minute winter	14	1.009	15	10.8	0.508	0.096	1.4361	
120 minute winter	15	1.010	16	10.7	0.330	0.096	1.5452	

Results for 1 year Critical Storm Duration. Lowest mass balance: 99.67%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
120 minute winter	16	90	98.109	0.334	10.7	0.5893	0.0000	SURCHARGED
15 minute summer	17	1	97.622	0.000	9.4	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)
120 minute winter	16	Hydro-Brake®	17	10.4				84.1

Results for 30 year Critical Storm Duration. Lowest mass balance: 99.67%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	1	10	104.201	0.026	5.3	0.0361	0.0000	OK
15 minute winter	2	10	103.064	0.089	13.4	0.1607	0.0000	OK
15 minute winter	3	12	103.019	0.162	24.4	0.2100	0.0000	OK
15 minute winter	4	12	102.975	0.283	42.1	0.4889	0.0000	SURCHARGED
15 minute winter	5	11	102.794	0.291	49.7	0.5013	0.0000	SURCHARGED
15 minute winter	6	11	102.498	0.125	59.4	0.1966	0.0000	OK
15 minute winter	7	11	101.416	0.116	72.9	0.2111	0.0000	OK
15 minute winter	8	11	100.640	0.140	83.3	0.2331	0.0000	OK
15 minute winter	9	11	99.736	0.111	94.3	0.1854	0.0000	OK
180 minute winter	10	148	98.432	0.318	13.8	26.7188	0.0000	SURCHARGED
180 minute winter	11	148	98.432	0.453	35.4	43.9181	0.0000	SURCHARGED
15 minute winter	12	10	99.855	0.080	12.0	0.1391	0.0000	OK
15 minute winter	13	10	99.640	0.065	21.6	0.1468	0.0000	OK
180 minute winter	14	148	98.431	0.549	31.4	63.8454	0.0000	SURCHARGED
180 minute winter	15	148	98.430	0.605	12.3	1.2695	0.0000	SURCHARGED

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 winter	1	2.000	3	5.3	0.703	0.028	0.1637	
15 minute winter	2	1.000	3	13.2	0.717	0.333	0.4325	
15 minute winter	3	1.001	4	23.7	0.785	0.595	0.9854	
15 minute winter	4	1.002	5	36.9	0.966	0.926	1.2727	
15 minute winter	5	1.003	6	49.9	1.513	1.253	0.6863	
15 minute winter	6	1.004	7	59.2	2.738	0.532	0.4759	
15 minute winter	7	1.005	8	72.8	2.545	0.292	0.4584	
15 minute winter	8	1.006	9	83.0	2.715	0.390	0.6731	
15 minute winter	9	1.007	11	94.3	3.245	0.194	1.2592	
180 minute winter	10	3.000	11	-9.3	0.424	-0.130	1.0563	
180 minute winter	11	1.008	14	23.1	0.628	0.208	3.4192	
15 minute winter	12	4.000	13	11.8	1.069	0.250	0.2661	
15 minute winter	13	4.001	14	21.3	2.287	0.173	0.4534	
180 minute winter	14	1.009	15	10.7	0.503	0.095	1.9853	
180 minute winter	15	1.010	16	10.9	0.319	0.098	1.7648	

Results for 30 year Critical Storm Duration. Lowest mass balance: 99.67%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
180 minute winter	16	148	98.430	0.655	10.9	1.1569	0.0000	SURCHARGED
15 minute summer	17	1	97.622	0.000	10.5	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)
180 minute winter	16	Hydro-Brake®	17	10.6				225.1

Results for 100 year Critical Storm Duration. Lowest mass balance: 99.67%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	1	10	104.204	0.029	6.8	0.0406	0.0000	OK
15 minute winter	2	12	103.314	0.339	17.3	0.6122	0.0000	SURCHARGED
15 minute winter	3	12	103.296	0.439	29.2	0.5693	0.0000	SURCHARGED
15 minute winter	4	12	103.212	0.520	45.9	0.8984	0.0000	SURCHARGED
15 minute winter	5	12	102.928	0.425	61.5	0.7318	0.0000	SURCHARGED
15 minute winter	6	12	102.514	0.141	71.0	0.2219	0.0000	OK
15 minute winter	7	11	101.429	0.129	88.1	0.2359	0.0000	OK
15 minute winter	8	11	100.659	0.159	101.7	0.2645	0.0000	OK
15 minute winter	9	11	99.748	0.123	116.4	0.2068	0.0000	OK
240 minute winter	10	224	98.650	0.536	13.2	45.0502	0.0000	SURCHARGED
240 minute winter	11	224	98.650	0.671	38.0	65.0639	0.0000	SURCHARGED
15 minute winter	12	10	99.867	0.092	15.5	0.1601	0.0000	OK
15 minute winter	13	10	99.650	0.075	27.9	0.1684	0.0000	OK
240 minute winter	14	224	98.649	0.767	27.0	89.2011	0.0000	SURCHARGED
240 minute winter	15	224	98.649	0.824	11.9	1.7271	0.0000	SURCHARGED

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 winter	1	2.000	3	6.8	0.717	0.036	0.2138	
15 minute winter	2	1.000	3	15.7	0.742	0.395	0.7954	
15 minute winter	3	1.001	4	26.3	0.789	0.661	1.1136	
15 minute winter	4	1.002	5	44.9	1.130	1.128	1.2727	
15 minute winter	5	1.003	6	60.5	1.659	1.520	0.7254	
15 minute winter	6	1.004	7	71.1	2.850	0.639	0.5491	
15 minute winter	7	1.005	8	88.1	2.640	0.353	0.5356	
15 minute winter	8	1.006	9	101.8	2.846	0.479	0.7872	
15 minute winter	9	1.007	11	116.5	3.314	0.239	1.5063	
240 minute winter	10	3.000	11	-8.6	0.440	-0.121	1.0563	
240 minute winter	11	1.008	14	19.5	0.634	0.175	3.4192	
15 minute winter	12	4.000	13	15.3	1.143	0.323	0.3217	
15 minute winter	13	4.001	14	27.5	2.451	0.224	0.5990	
240 minute winter	14	1.009	15	10.5	0.506	0.093	1.9853	
240 minute winter	15	1.010	16	10.9	0.318	0.098	1.7648	

Results for 100 year Critical Storm Duration. Lowest mass balance: 99.67%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
240 minute winter	16	224	98.648	0.873	10.9	1.5426	0.0000	SURCHARGED
15 minute summer	17	1	97.622	0.000	10.6	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)
240 minute winter	16	Hydro-Brake®	17	10.6				265.2

Results for 100 year +50% CC Critical Storm Duration. Lowest mass balance: 99.67%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	1	10	104.210	0.035	10.3	0.0495	0.0000	OK
15 minute winter	2	12	104.117	1.142	25.9	2.0620	0.0000	FLOOD RISK
15 minute winter	3	12	104.080	1.223	38.6	1.5844	0.0000	SURCHARGED
15 minute winter	4	12	103.909	1.217	66.1	2.1034	0.0000	SURCHARGED
15 minute winter	5	12	103.319	0.816	88.3	1.4040	0.0000	SURCHARGED
15 minute winter	6	12	102.571	0.198	104.3	0.3123	0.0000	OK
15 minute winter	7	11	101.465	0.165	128.8	0.3011	0.0000	OK
15 minute winter	8	11	100.707	0.207	148.8	0.3441	0.0000	OK
15 minute winter	9	11	99.776	0.151	169.9	0.2529	0.0000	OK
360 minute winter	10	336	99.300	1.186	15.3	99.7410	0.0000	SURCHARGED
360 minute winter	11	336	99.300	1.321	43.5	116.7093	0.0000	SURCHARGED
15 minute winter	12	10	99.891	0.116	23.2	0.2020	0.0000	OK
15 minute winter	13	10	99.669	0.093	41.8	0.2111	0.0000	OK
360 minute winter	14	336	99.299	1.417	29.4	140.0844	0.0000	SURCHARGED
360 minute winter	15	336	99.299	1.474	11.4	3.0904	0.0000	FLOOD RISK

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 winter	1	2.000	3	10.3	0.685	0.054	0.2188	
15 minute winter	2	1.000	3	20.1	0.733	0.505	0.7954	
15 minute winter	3	1.001	4	37.9	0.952	0.952	1.1136	
15 minute winter	4	1.002	5	64.8	1.629	1.626	1.2727	
15 minute winter	5	1.003	6	87.8	2.211	2.204	0.8455	
15 minute winter	6	1.004	7	104.1	2.993	0.936	0.7640	
15 minute winter	7	1.005	8	128.5	2.818	0.515	0.7321	
15 minute winter	8	1.006	9	148.0	3.063	0.696	1.0623	
15 minute winter	9	1.007	11	169.7	3.448	0.348	2.0048	
360 minute winter	10	3.000	11	-9.8	0.423	-0.138	1.0563	
360 minute winter	11	1.008	14	15.5	0.629	0.139	3.4192	
15 minute winter	12	4.000	13	22.9	1.268	0.483	0.4359	
15 minute winter	13	4.001	14	41.8	2.726	0.341	0.7062	
360 minute winter	14	1.009	15	10.1	0.505	0.091	1.9853	
360 minute winter	15	1.010	16	10.8	0.311	0.097	1.7648	

Results for 100 year +50% CC Critical Storm Duration. Lowest mass balance: 99.67%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
360 minute winter	16	336	99.298	1.523	10.8	2.6913	0.0000	FLOOD RISK
15 minute summer	17	1	97.622	0.000	10.6	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)
360 minute winter	16	Hydro-Brake®	17	10.6				320.4