THOMAS CONSULTING
STRUCTURAL & CIVIL DESIGN ENGINEERS

T19360/DS/02/JP

DRAINAGE STRATEGY

AT

Land Adjacent to Waters Edge
Whitehaven
CA28 9PD

FOR

Gleeson Homes

REPORT VERIFICATION

Site Address	Land Adjacent to Waters Edge, Whitehaven, CA28 9PD

Document Reference	T19360/DS/02/JP
Version	02
Date released	24 May 2021
Originator	Julian Pearson BSc (Hons) EngTech MICE
Checked	Matt Johnson BSc (Hons)
Verified	Kieron Hounslow BEng (Hons) CEng MIStructE

Issue no	Date	Status	Report version	Issued by
01	30/09/2020	Final	01	JP
02	24/05/2021	Update	02	MJ

CONTENTS

APPENDICES

Land Adjacent to Waters Edge, Whitehaven, CA28 9PD

1 SURFACE WATER DRAINAGE STRATEGY

1.1 Site Areas

The total site area is 1.37ha (13,700m²). To support the exploration of options for site drainage, the spatial extent of different types of proposed land cover on the site have been assessed. Table 3.1 shows the estimated existing land cover areas. Table 3.2 shows the estimated proposed land cover areas, indicating housing roof areas cover 20% of the total site area, parking and paved areas cover 15%, road areas cover 10%. The remainder of the site is covered by gardens and soft landscaped areas (55%).

Table 3.1 Existing Land Cover Areas

Land Cover	Area		Percentage of total site area
	m²	Ha	
Total impermeable area	6000	0.600	44%
Remaining permeable area	7700	0.770	56%

Table 3.2 Proposed Land Cover Areas

Land Cover	Area		Percentage of total site area
	m²	Ha	
Total housing roof area + 10%	2697	0.270	20%
Total parking and paved area	2039	0.204	15%
Total road area	1406	0.141	10%
Garden & landscaped areas	7558	0.756	55%

The site can be subdivided into land cover that could be permeable and that which could be impermeable. Potential impermeable areas are regarded as housing, parking, roads, driveways and walkways. All other areas (principally gardens) are regarded as having a permeable surface. Table 3.3 gives the areas of potentially permeable and impermeable land cover and shows that impermeable areas could cover 55% of the site with permeable areas covering 45%.

Table 3.3 Area of Potentially Impermeable & Permeable Land Cover

Land Cover	Area		Percentage of total site area
	m²	Ha	
Total impermeable area	6142	0.614	45%
Remaining permeable area	7558	0.756	55%

1.2 Urban Creep

BS 8582:2013 outlines best practice with regard to Urban Creep. Although not a statutory requirement, future increase in impermeable area due to extensions and introduction of impervious positively drained areas has been considered. An uplift of 10% on impermeable areas associated with plots only (excluding roads) has been applied to the contributing areas as detailed above.

The inclusion of 10% is highly conservative due to the provision of adequate parking on the site and the density of the properties.

1.3 Rate of Runoff Assessment

Full details of the calculations and the methodology for deriving the Peak Rate of Runoff are in included in Appendix D. A summary of the results is included in Table 3.4 below.

Table 3.4 Surface Water Rate of Runoff Results – Entire development

Peak Rate of Runoff (l/s)			
Event	**Greenfield**	**Post-Development Brownfield**	**Proposed Post-Development Restriction**
Q1	9.3	44.8	6.0
QBAR	10.7	64.8	6.0
Q10	14.8	88.9	6.0
Q30	18.2	108.2	6.0
Q100	22.3	138.1	6.0
Q100 + 40% CC	31.2	193.4	6.0

1.4 Surface Water Disposal

Surface water disposal has been considered in line with the hierarchy outlined in the SuDS manual. The approach considers infiltration drainage in preference to disposal to watercourse, in preference to discharge to sewer.

1.5 Surface Water Drainage Design Parameters

The surface water drainage system has been designed on the following basis using the modified rational method and a generated rainfall profile:

1.5.1 Climate Change

Projections of future climate change indicate that more frequent short-duration, high intensity rainfall and more frequent periods of long-duration rainfall are likely to occur over the next few decades in the UK. These future changes will have implications for river flooding and for local flash flooding. These factors will lead to increased and new risks of flooding within the lifetime of planned developments.

In February 2016, new climate change guidance issued by the Environment Agency came into effect outlining the anticipated changes in extreme rainfall intensity.

Table 3.5 shows anticipated changes in extreme rainfall intensity in small and urban catchments. Guidance states that both the central and upper end allowances should be assessed to understand the range of impacts. A climate change allowance of 40% has been selected for the purpose of drainage design based on the 100-year anticipated design life of the proposed development. This upper end figure has been selected for conservative design based on advice from the Lead Local Flood Authority.

Table 3.5 Peak Rainfall Intensity Allowance in Small and Urban Catchments (use 1961 to 1990 baseline)

Applies across all of England	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Upper end	10%	20%	40%
Central	5%	10%	20%

1.5.2 Percentage Impermeability (PIMP)

The percentage impermeability (PIMP) for all impermeable areas is modelled as 100%. The entirety of the impermeable areas is therefore assumed to be positively drained.

1.5.3 Volumetric Runoff Coefficient (Cv)

The volumetric runoff coefficient describes the volume of surface water which runs off an impermeable surface following losses due to infiltration, depression storage, initial wetting and evaporation. The coefficient is dimensionless. Default industry standard volumetric runoff coefficients are 0.75 for summer and 0.84 for winter. However, it has been requested that these are both set to 1.0 by the Lead Local Flood Authority meaning that all water falling on impermeable areas will enter the below ground drainage system. This provides conservative design as the effect of evaporation, initial wetting and ponding are ignored.

1.5.4 Rainfall Model

The calculations use the REFH2 unit hydrograph methodology in line with best practice as outlined in the SuDS manual. The calculations use the most up to date available catchment descriptors (2013) provided by the Centre for Ecology and Hydrology Flood Estimation Handbook web service.

1.5.5 Design Infiltration Rate

Covered within the Flood Risk Assessment, FWS Geological & Geo-Environmental Consultants (FWS) undertook a Phase 1 and Phase 2 Geoenvironmental investigation (Report No. 8190OR03/October 2019). Intrusive investigations were carried out across the site between 22 and 23 of August 2019, which consisted of 10 trial pits being dug to a depth of between 1.4 – 3m deep to examine the natural strata make-up and any buried obstructions, 5 mini-percussion boreholes for SPT tests to be carried out at a depth between 2 – 4.45m, 7 machine excavated inspections pits in the stockpiles, chemical and geotechnical testing and monitoring well for groundwater and has measurements.

General ground conditions consisted of made ground to be at depths between 0.3 and >1.5m deep across the site, underlain by glacial till extending to depths of up to 4.45m bgl. Weathered sandstone bedrock was recovered at a depth between 0.4 and 2.3m bgl to the south east of the site. Groundwater seepages were encountered in the boreholes or trial pits at depths between 0.3 and 1.2m bgl. Further monitoring reports can be found in FWS's report and any more recent visits can be obtained by contacting FWS.

As groundwater is present at shallow depths it is concluded that infiltration is not feasible for this site.

1.6 Consideration of SuDS Components

A full range of SuDS components and techniques have been considered for the development of the site and their applicability to the site is discussed below.

- **Green roofs** - Discounted due to cost and limitations of water volume retention. Not suitable for conventional houses due to roof pitch.

- **Soakaways** – Underlying ground conditions are not suitable for infiltration-based SuDS and therefore soakaway systems would not be effective.

- **Water butts** – Are suitable for the site, but their effectiveness would depend on them being empty prior to a period of significant rainfall. This could occur during the summer when occupiers are likely to use the water but unlikely during the autumn and winter.

- **Permeable paving** – Underlying ground conditions are not suitable for infiltration-based SuDS and therefore permeable block paving systems would not be effective.

- **Swales** – Not considered suitable for the development as the site does not possess the required large open areas needed to make swales effective. There are also no open water retention features in which swales typically integrate with.

- **Filter drains** – Underlying ground conditions are not suitable for infiltration-based SuDS and therefore filter drains would not be effective.

- **Infiltration basin** – Not considered suitable due to ground conditions and insufficient open space.

- **Detention basins** – Not considered viable as lack of effective outfall available and insufficient open space.

- **Ponds / wetland** - Not considered viable as lack of effective outfall available and insufficient open space.

- **Rain gardens** – Not considered suitable due to maintenance costs for residential dwellings of this target market.

- **Geocellular Storage Tanks** – This is considered the best form of SuDS for this site due to the permeability of the ground being considered as poor and the restricted open usable space for SuDS features. A positive drainage solution to the Phase 1 development site (completed and occupied) which is currently being processed for adoption is deemed the most appropriate option and was part of the land sale agreement. This shall be done by restricting surface water runoff to the sewer and storing surcharging surface water runoff in geocellular tanks and oversized pipework below ground level prior to discharge. It is to be noted that the geocellular tanks will have to consider floatation due to groundwater and must be considered in any detailed design.

1.7 Surface Water Drainage Proposals

Based on the above assessment the following SuDS techniques are proposed:

- Geocellular Storage Tanks
- Oversized Pipework
- Restricted Run-Off Discharge (Flow Control Chamber)

Between January and March 2020 the Gleeson Homes, Watersedge site was being designed by Ashwood Design Associates and Thomas Consulting (TC). The site was to be purchased by Gleeson Homes on the basis Story Homes who currently owned the land would provide an accessible drainage connection location for both surface and foul water through their Phase 1 site which had been completed and occupied. This was due to the knowledge there was no other known foul drainage points surround the site and the land was impermeable with no watercourses within the vicinity. Story Homes had designed their system and were in the process of having the system adopted (The existing drainage layout can be found in Appendix E).

It was becoming clear that during the early design process that if standards were adhered to and a 50% reduction to the existing brownfield runoff (32.4l/s) was proposed it would cause issues for the existing Story Homes site, which was only designed to discharge at greenfield runoff (15.5l/s). Observing the plans there was no allowance for storage in the Phase 1 Story Homes site, even though the land was being sold based on a positive connection being provided. Therefore, discussions were opened up with Story Homes which continued through April to June, concluding in a flow rate that Story Homes could accept from our site to their system, whilst providing an improvement to their system to accept this agreed flow rate and an upgrade to their existing Hydro Brake.

The Story Homes Phase 1 Contingency Drainage Plans received 03/06/2020 can be found in Appendix F. It is to be understood from this point that all Phase 1 development and remediation is being delt with by Story Homes in co-ordination with United Utilities, proceeding through the adoption process and that TC must design the system with a restricted flow rate of 6l/s.

As can be seen in in Section 1.3 of this report this is 4.7l/s below greenfield runoff, therefore is a significant improvement to the site. Furthermore, the consideration to cost effectiveness of storing this volume of water must be made.

The SuDS have been sized to contain a future 1% AEP event of critical duration. Future climate change (40%) and urban creep (10% to housing area only) is accounted for. Although much of the paving areas surrounding the dwellings will not be positively drained, they have also been included with the drainage catchment areas for conservative design. The proposed foul and surface water drainage layout is included in Appendix G.

It is proposed the entirety of the dwellings roof runoff, paved runoff and surrounding access road is to be drained via rainwater downpipes, gullies and channel drains into a standalone surface water drainage network where runoff will be restricted to 6l/s prior to being discharged into the public sewer, located within the site boundary of the proposed site.

It is proposed that four stacks of geocellular crates (400mm deep) are used within the lower landscaped area of the proposed development therefore only requiring a minimum of 900mm cover. The crates will form an attenuation structure of 232m² providing 353m³ of storage (inclusive of void reduction). The geocellular tank will be accompanied by approx. 55m of oversized (900mm dia.) pipe. This size was chosen so that adoptable standard can be achieved within the carriageway and PVC pipework can be utilised. Finally, runoff discharge will be restricted prior to the site boundary and existing manhole (connection location) to 6l/s.

The system has been designed to adoptable standards with a minimum of 1.2m cover in hard standing areas and 0.9m cover in soft landscaped area. The system has been designed so that no surcharging occurs for a 2 year event, no flooding for a 30 year event and LLFA recommendations of no flooding for the 100 year event plus 40% climate change.

1.8 Designing for Local Drainage System Failure

In accordance with the general principles discussed in CIRIA Report C635 – Designing for Exceedance in Urban Drainage, the proposed surface water drainage, where practical, should be designed to ensure there is no increased risk of flooding to the buildings on the site or elsewhere as a result of extreme rainfall, lack of maintenance, blockages or other causes.

1.9 Blockage & Exceedance

The site drainage will be designed to store a 100-year design storm including a 40% allowance for climate change. The drainage systems will also provide capacity for lower probability (greater design storm events) which are not critical duration. Exceedance flows shall be retained on site within the drainage system as far as practical however for storms of a greater return period it may be necessary to pass forward more flow or spill flows. In this unlikely event, exceedance flows from the flow control chamber and routed down the existing soft landscaped area towards further existing greenfield land to the south.

1.10 Treatment Processes

Treatment of the surface water run-off from impermeable will be via advanced silt traps, which will be placed upstream plot drainage and the geocellular attenuation tank.

2 FOUL WATER DRAINAGE STRATEGY

Foul water from the site shall be connected to the existing foul water sewer provided by the Story Homes Phase 1 site located within the site boundary to the north west of the site as can be seen in the drainage layout drawing in Appendix G. As this sewer is currently under approval for adoption and Story Homes have agreed a connection there in no requirements for a connection application to UU.

Under Section 106 of The Water Industry Act 1991, 'the owner / occupier of any premises shall be entitled to have his drain or sewer communicate with the public sewer of any sewerage undertaker and thereby to discharge foul water and surface water from those premises or that private sewer.' Unless 'the making of the communication would be prejudicial to the undertaker's sewerage system'. The proposed foul drainage system shall be constructed to standards outlined in Sewers for Adoption 7th Edition and United Utilities S104 guidance documents and will be offered for adoption.

Preliminary foul water discharge calculations have been undertaken in accordance with Sewers for Adoption 7th Edition. The estimated predicted peak design flow rate from the development is 1.94l/s.

Table 2.1Foul Runoff Results

Sewers for Adoption 7th Edition, Clause B5.1	
Peak Load Based on Number of Dwellings, 42 no. units @ 4000 l/day	168,000
Total Foul Flow (l/s)	1.94

3 CONCLUSIONS

- The site is currently brownfield and is deemed to have impermeable properties due to shallow groundwater ingress.
- Surface water runoff shall be collected via a combination of downpipes, channel drains and gullies and drained via a dedicated surface water system. Via this system discharge off site shall be restricted to 6l/s (4.7l/s under greenfield runoff rate) and storage provided for surcharging surface water via oversized pipework and a geocellular attenuation tank. The proposed system will be connected via an existing surface water manhole provided by the Story Homes Phase 1 site within the site boundary.
- The foul water is to be drained via plot drainage to a dedicated foul water sewer connecting to an existing foul water manhole provided by the Story Homes Phase 1 site within the site boundary.
- All drainage is to be gravity fed and designed in accordance to Sewers for Adoption 7th edition and UU S104 guidance documents so that the systems can be offered up for adoption. Treatment is to be provided in the form of advanced silt traps across the site.
- The site layout and drainage systems have been designed to ensure that there is no increased risk of flooding on or off site as a result of extreme rainfall, lack of maintenance, blockages or other causes. The measures that will be implemented comprise additional flows allowed for adding 10% urban creep to the roof catchment and an additional 40% allowance for climate change.

4 REFERENCES

i. Ministry of Housing, Communities and Local Government, National Planning Policy Framework, July 2018.

ii. CIRIA, The SUDS Manual, Report C753, 2015.

iii. DEFRA EA, Preliminary rainfall runoff management for developments, W5-074/A/TR/1, Revision D, September 2005.

iv. BS8582:2013, Code of Practice for Surface Water Management, November 2013.

v. CIRIA, Designing for Exceedance in Urban Drainage – good practice, Report C635, London, 2006.

vi. Centre for Ecology and Hydrology, Flood Estimation Handbook, Vols. 1 – 5 & FEH CD-ROM 3, 2009.

vii. Institute of Hydrology, Flood Studies Report, Volume 1, Hydrological Studies, 1993.

viii. Institute of Hydrology, Flood Studies Supplementary Report No 14 – Review of Regional Growth Curves, August 1983.

ix. Marshall & Bayliss, 1994. Flood Estimation for Small Catchments, Report No. 124. Institute of Hydrology.

x. Cumbria County Council, 2017. Cumbria Design Guide. Final Draft.

xi. Sewers for Adoption, 2012. A Design and Construction Guide for Developers, 7th Edition. Water Research Centre.

APPENDIX A

TOPOGRAPHIC SURVEY

Notes :-

DO NOT SCALE FROM DRAWING
DIMENSIONS TO BE TAKEN ON SITE

Site Grid

Ordnance Survey Grid & Datum
(Trimble GPS System OSTN15 Transformation)
RTK Network

SURVEY STATIONS

Name	Easting	Northing	Height	Remark
R1	296756.113	516328.442	97.142	
R2	296758.192	516295.057	97.214	
R3	296750.327	516262.368	96.881	
R4	296765.074	516235.178	96.602	
S1	296763.927	516235.054	94.157	
S2	296758.915	516266.790	94.462	
S3	296756.278	516307.140	94.817	
S4	296754.578	516341.592	94.559	
STNF	296747.473	516306.166	94.766	

PRISM VOLUMES : PROJECTION TO Bases

Group	Volumes	
	Cut/Material	Fill/Void
Stockpile 01	5699.499	0.000
Stockpile 02	1246.814	0.000
Stockpile 03	889.507	0.000
Stockpile 04	804.789	0.000
Total	8640.609	0.000

REV	AMENDMENT	DRAWN	DATE

Water's Edge
High Road
Whitehaven
JOB TITLE

Gleeson Homes
CLIENT

Topographical
Survey
DRAWING TITLE

1:200 @ A0 SCALE
J D Gibson DRAWN
14/08/2019 DATE
J D Gibson APPROVED

GSM
GIBSON SURVEYING & MAPPING

Gibson Surveying and Mapping Ltd
21 West View,
Crook,
County Durham.
DL159EY.

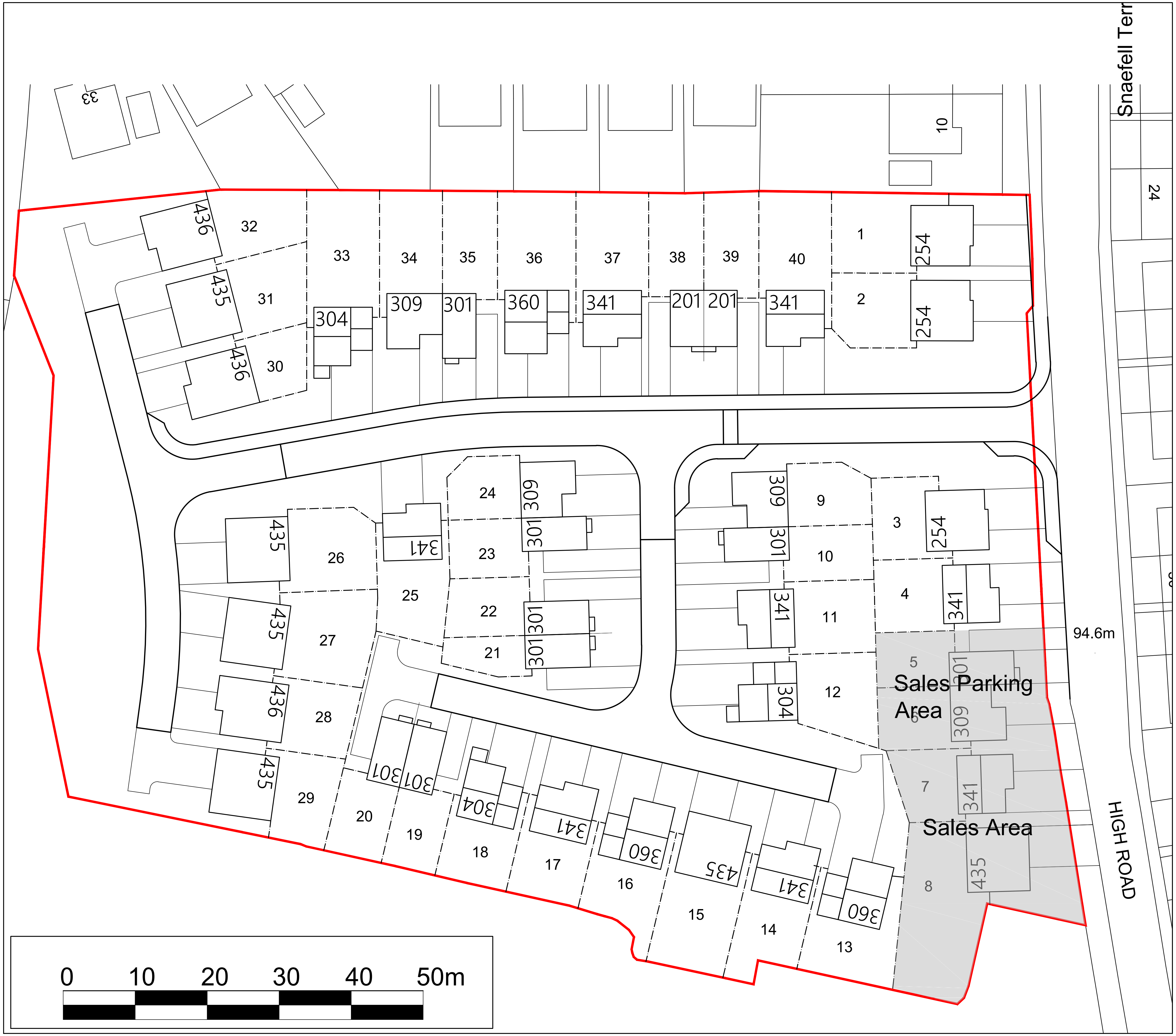
Mob. 07896698645
Tel. 01388 764106

email : info@gsmsurvey.co.uk
www.gsmsurvey.co.uk

PROJECT No.
GH/WE/TS01 DRG No.
REV

APPENDIX B

ARCHITECTS LAYOUT PLANS



NOTES AND AMENDMENTS

REVISIONS

Rev	Description	Drawn	Date

House Type	Quantity
201	2
254	3
301	8
309	4
304	3
341	8
360	3
435	6
436	3
Total#	40

N

ASHWOOD
DESIGN ASSOCIATES LTD
12A Clifford Court, Parkhouse Business Park, Carlisle CA3 0JG
t 01228 510616 e admin@ashwooddesign.co.uk
f 01228 520861 w www.ashwooddesign.co.uk

Purpose: Concept

Client: Gleeson Homes

Project: Waters Edge

Title: Block Plan

Scale:	Sheet Size:	Drawn:	Date:
1:500	A3	jc	03/2019

Project No:	Drawing No:	Revision:
1839	BP001	a

APPENDIX C

UU SEWER RECORDS

How to contact us:

United Utilities Water Limited
Property Searches
Haweswater House
Lingley Mere Business Park
Great Sankey
Warrington
WA5 3LP

Telephone: 0370 7510101

E-mail: propertysearches@uuplc.co.uk

Thomas Consulting Ltd

3
Friar Street,
Lancaster, Lancashire
LA1 1PZ

FAO:

Your Ref: T19360 - Waters Edge
Our Ref: UUPS-ORD-144839
Date: 10/01/2020

Dear Sirs

Location: Waters Edge Whitehaven

I acknowledge with thanks your request dated 09/01/2020 for information on the location of our services.

Please find enclosed plans showing the approximate position of United Utilities' apparatus known to be in the vicinity of this site.

The enclosed plans are being provided to you subject to the United Utilities terms and conditions for both the wastewater and water distribution plans which are shown attached.

If you are planning works anywhere in the North West, please read United Utilities' access statement before you start work to check how it will affect our network. http://www.unitedutilities.com/work-near-asset.aspx .

I trust the above meets with your requirements and look forward to hearing from you should you need anything further.

If you have any queries regarding this matter please contact us .

Yours Faithfully,

Karen McCormack
Property Searches Manager

United Utilities Water Limited
Registered In England & Wales No. 2366678
Registered Office Haweswater House, Lingley Mere Business Park, Lingley Green Avenue, Great Sankey, Warrington, WA5 3LP

TERMS AND CONDITIONS - WASTEWATER AND WATER DISTRIBUTION PLANS

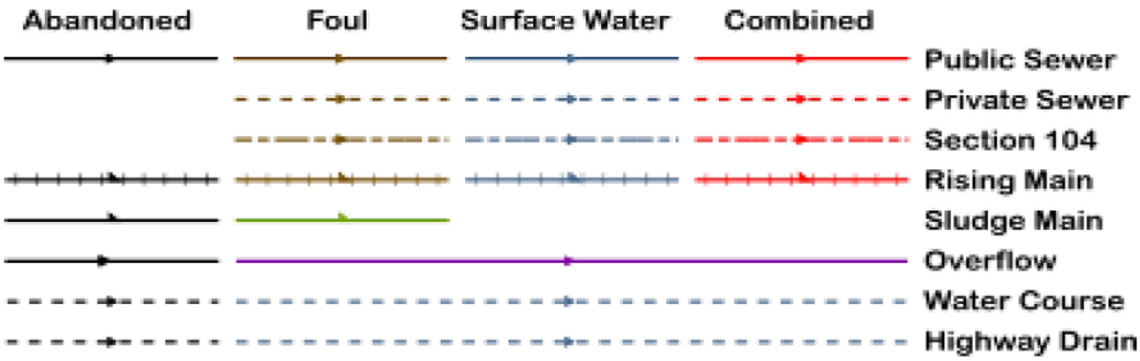
These provisions apply to the public sewerage, water distribution and telemetry systems (including sewers which are the subject of an agreement under Section 104 of the Water Industry Act 1991 and mains installed in accordance with the agreement for the self construction of water mains) (UUWL apparatus) of United Utilities Water Limited "(UUWL)".

TERMS AND CONDITIONS:

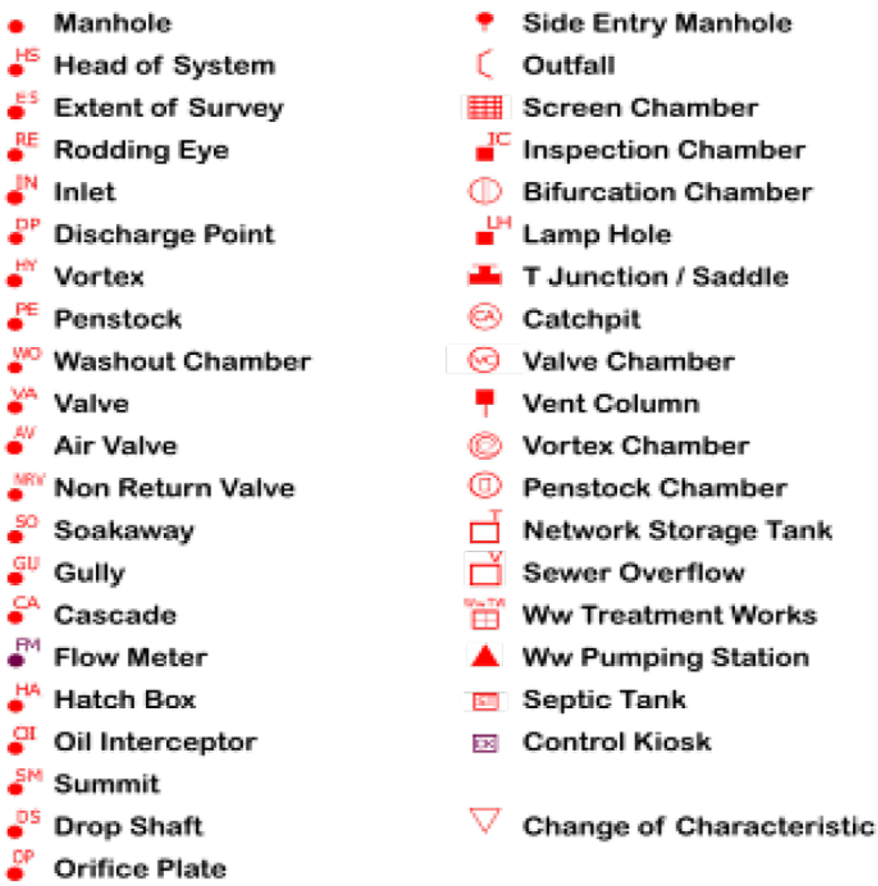
- This Map and any information supplied with it is issued subject to the provisions contained below, to the exclusion of all others and no party relies upon any representation, warranty, collateral contract or other assurance of any person (whether party to this agreement or not) that is not set out in this agreement or the documents referred to in it.
- This Map and any information supplied with it is provided for general guidance only and no representation, undertaking or warranty as to its accuracy, completeness or being up to date is given or implied.
- In particular, the position and depth of any UUWL apparatus shown on the Map are approximate only. UUWL strongly recommends that a comprehensive survey is undertaken in addition to reviewing this Map to determine and ensure the precise location of any UUWL apparatus. The exact location, positions and depths should be obtained by excavation trial holes.
- The location and position of private drains, private sewers and service pipes to properties are not normally shown on this Map but their presence must be anticipated and accounted for and you are strongly advised to carry out your own further enquiries and investigations in order to locate the same.
- The position and depth of UUWL apparatus is subject to change and therefore this Map is issued subject to any removal or change in location of the same. The onus is entirely upon you to confirm whether any changes to the Map have been made subsequent to issue and prior to any works being carried out.
- This Map and any information shown on it or provided with it must not be relied upon in the event of any development, construction or other works (including but not limited to any excavations) in the vicinity of UUWL apparatus or for the purpose of determining the suitability of a point of connection to the sewerage or other distribution systems.
- No person or legal entity, including any company shall be relieved from any liability howsoever and whensoever arising for any damage caused to UUWL apparatus by reason of the actual position and/or depths of UUWL apparatus being different from those shown on the Map and any information supplied with it.
- If any provision contained herein is or becomes legally invalid or unenforceable, it will be taken to be severed from the remaining provisions which shall be unaffected and continue in full force and affect.
- This agreement shall be governed by English law and all parties submit to the exclusive jurisdiction of the English courts, save that nothing will prevent UUWL from bringing proceedings in any other competent jurisdiction, whether concurrently or otherwise.

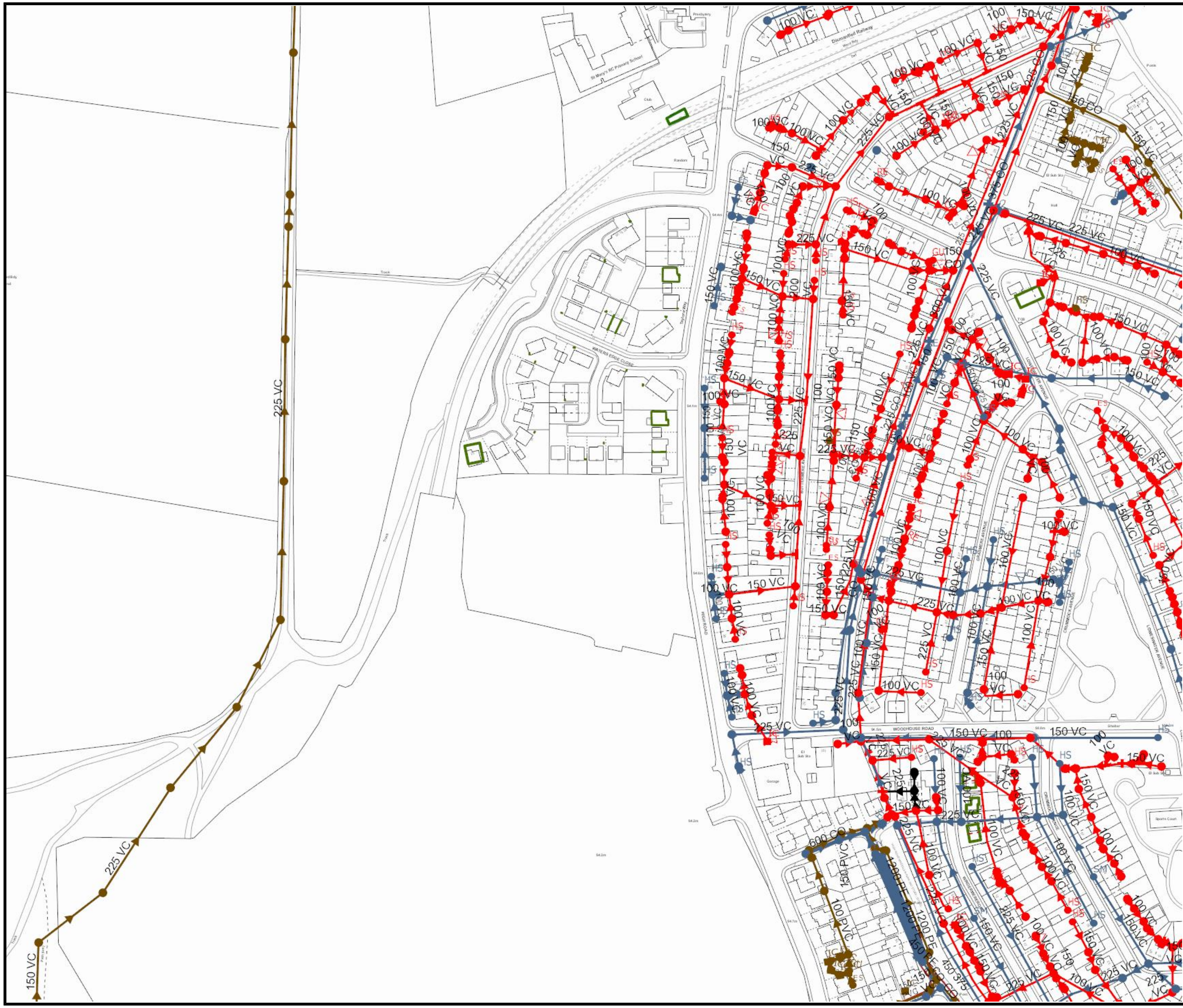
United Utilities Water Limited
Registered In England & Wales No. 2366678
Registered Office Haweswater House, Lingley Mere Business Park,
Lingley Green Avenue, Great Sankey, Warrington, WA5 3LP

Wastewater Symbology



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





United Utilities

helping life flow smoothly

SEWER RECORDS

Address or Site Reference

Waters Edge Whitehaven,

Scale:	1:2500
Date:	10/01/2020
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 D

PEAK RUNOFF RATE AND SURFACE WATER NETWORK CALCULATIONS

THOMAS CONSULTING STRUCTURAL & CIVIL DESIGN ENGINEERS	Job	Gleeson Homes	Job No.	T19360	Initial	JP
		Waters Edge	Date	May-21	Checked	MJ
		Whiteheaven	Page	1 of 6	Revision	B
	Title	Peak Rate of Run-Off Calculation				

Design Brief

The following peak rate of run-off calculations have been undertaken to determine changes in peak flow resulting from the development of a greenfield or brownfield site. These calculations are for the Peak Rate of Run-Off requirements only.

Baseline Information & References

The site area is less than 200ha and the Greenfield (pre-development) calculation has been undertaken in accordance with methodology described by Marshall & Bayliss, Institute of Hydrology, Report No. 124, Flood Estimation for Small

In addition, the following references have been used in the preparation of these calculations:

- Interim Code of Practice for Sustainable Drainage Systems (SUDS), CIRIA, 2004
- CIRIA, The SUDS Manual, Report C753, 2015
- Designing for Exceedance in Urban Drainage - Good Practice, CIRIA Report C635, 2006
- Flood Estimation Handbook (FEH)
- Flood Studies Report (FSR), Volume 1, Hydrological Studies, 1993
- Flood Studies Supplementary Report No 2 (FSSR2), The Estimation of Low Return Period Floods
- Flood Studies Supplementary Report No 14 (FSSR14), Review of Regional Growth Curves, 1983
- Planning Practice guidance of the National Planning Policy Framework, Recommended national

Proposed Land Use Changes

Changes to the existing site are as follows: Brownfield Site to Brownfield Site (Reduced Impermeable Area)

Results Summary

Rate of Run-Off (l/s)			
Event	Greenfield	Post-Development Brownfield	Proposed Post-Development Restriction
Q1	9.3	44.8	6.0
QBAR	10.7	64.8	6.0
Q10	14.8	88.9	6.0
Q30	18.2	108.2	6.0
Q100	22.3	138.1	6.0
Q100 + 40% CC	31.2	193.4	6.0

SITE AREAS

Existing Impermeable & Permeable Land Cover

Total Site Area: **1.37** **ha** **13700** **m²**

Existing Impermeable & Permeable Land Cover

Land Cover	Area		Percentage of total site area
	m²	ha	
Total impermeable area	6000.0	0.600	44%
Remaining permeable area	7700.0	0.770	56%

Proposed Land Cover Areas

Land Cover	Area		Percentage of total site area
	m²	ha	
Total housing roof area + 10%	2697.0	0.270	20%
Total parking and paved area	2039.0	0.204	15%
Total road area	1406.0	0.141	10%
Garden & landscaped areas	7558.0	0.756	55%

Proposed Impermeable & Permeable Land Cover

Land Cover	Area		Percentage of total site area
	m²	ha	
Total impermeable area	6142.0	0.614	45%
Remaining permeable area	7558.0	0.756	55%

ESTIMATION OF QBAR (GREENFIELD RUNOFF RATE)

IoH 124 based on research on small catchments < 25 km2

Method is based on regression analysis of response times
using catchments from 0.9 to 22.9 km^2

$QBAR_{rural}$ is mean annual flood on rural catchment
$QBAR_{rural}$ depends on SOIL, SAAR and AREA most significantly

$QBAR_{rural} = 0.00108 \times AREA^{0.89} \times SAAR^{1.17} \times SOIL^{2.17}$

For SOIL refer to FSR Vol 1, Section 4.2.3 and 4.2.6 and IoH 124

Contributing watershed area

Area, A	=	500000	m^2	insert 50 ha for EA
	=	0.500	km^2	small catchment method
	=	50.000	ha	
SAAR	=	**1058**	mm	From UKSuds website (point data)

Soil index based on soil type, SOIL $= \dfrac{(0.1S1+0.3S2+0.37S3+0.47S4+0.53S5)}{(S1+S2+S3+S4+S5)}$

Where: S1	=		%	
S2	=		%	
S3	=		%	
S4	=	**100**	%	
S5	=		%	
		100	%	
So, SOIL	=	**0.47**		

UK Suds website provides a value of 4 based on the equivalent Host value. This seems reasonable based on ground investigation.

Note: for very small catchments it is far better to rely on local site investigation information.

$QBAR_{rural}$	=	0.391	m^3/s
	=	391.4	l/s

Small rural catchments less than 50 ha
The Environment Agency recommends that this method should be used for development sizes from 0 to 50 ha and should linearly interpolate the formula to 50 ha.

So, catchment size	=	**13700**	m^2
	=	0.014	km^2
	=	1.370	ha
$QBAR_{rural\ site}$	=	0.01072	m^3/s
	=	**10.72**	l/s

Excluding significant open space which would remain disconnected from the positive drainage system during flood events.

GREENFIELD RETURN PERIODS

QBAR can be factored by the UK FSR regional growth curves for return periods <2 years and for all other return periods to obtain peak flow estimates for required return periods.

These regional growth curves are constant throughout a region, whatever the catchment type and size.

See Table 2.39 for region curve ordinates
Use FSSR2 Growth Curves to estimate Qbar

Reference- Pg 173-FSR V.1, ch 2.6.2

Region = **10**

Use Figure A1.1 to determine region

GREENFIELD RETURN PERIOD FLOW RATES

Return Period	Ordinate	Q (l/s)
1	0.87	9.33
2	0.93	9.97
5	1.19	12.76
10	1.38	14.80
25	1.64	17.59
30	1.7	18.23
50	1.85	19.84
100	2.08	22.31
200	2.32	24.88
500	2.73	29.28
1000	3.04	32.60

Ordinate from FSSR2

Interpolation taken from Figure 24.2 (pg 515)
SuDS Manual

ESTIMATE OF BROWNFIELD RETURN PERIODS

Total site impermeable area, A = **6142** m^2

M5-60 rainfall depth **16** mm — *[Flood Studies Report (NERC, 1975)]*

Ratio M5-60/M5-2Day, r **0.26** — *[The Wallingford Proceedure - V4 Modified Rational Method, Fig A.2 (Hydraulics Research, 1983)]*

Storm Duration 15 mins — Anticipated critical duration for the site - usually 15 minutes

Duration factor, Z1 0.57 — *[The Wallingford Proceedure - V4 Modified Rational Method, Fig A.3b (Hydraulics Research, 1983)]*

M5-15 rainfall depth = 9.2 mm

Return period ratio, Z2

M1-15	0.61
M10-15	1.21
M30-15	1.48
M100-15	1.89

[The Wallingford Proceedure - V4 Modified Rational Method, Table A1 (Hydraulics Research, 1983)]

Rainfall

	Depth (mm)	Intensity, i (mm/hr)
M1-15	5.6	22
M10-15	11.1	45
M30-15	13.6	54
M100-15	17.3	69

Peak discharge, Qp = Cv Cr i A

Where:

Cv = Volumetric Runoff Coefficient
Cr = Routing Coefficient
i = Rainfall intensity (mm/hour)

Cv = 0.9
Cr = 1.3

Peak Runoff

	l/s
Q1	44.8
Q10	88.9
Q30	108.2
Q100	138.1

ESTIMATION OF QBAR (BROWNFIELD RUNOFF RATE)

See Table 2.39 for region curve ordinates

Use FSSR2 Growth Curves to estimate Qbar

Reference- Pg 173-FSR V.1, ch 2.6.2

Region = **10**

Use Figure A1.1 to determine region

Return Period	Ordinate
1	0.87
2	0.93
5	1.19
10	1.38
25	1.64
30	1.70
50	1.85
100	2.08
200	2.32
500	2.73
1000	3.04

Ordinate from FSSR2

Interpolation taken from Figure 24.2 (pg 515) SuDS Manual

Qbar

Ordinate used	l/s
10 year	64.4
30 year	63.7
100 year	66.4

Proposed Brownfield Runoff, Qbar = 64.83 l/s

Using the average Qbar derived from three ordinates.

Design Settings

Rainfall Methodology	FEH-13	Maximum Time of Concentration (mins)	30.00	Preferred Cover Depth (m)	1.200
Return Period (years)	2	Maximum Rainfall (mm/hr)	50.0	Include Intermediate Ground	✓
Additional Flow (%)	0	Minimum Velocity (m/s)	1.00	Enforce best practice design rules	✓
CV	1.000	Connection Type	Level Soffits		
Time of Entry (mins)	15.00	Minimum Backdrop Height (m)	0.900		

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Sump (m)	Easting (m)	Northing (m)	Depth (m)
1	0.107	15.00	94.537	1200		296722.226	516310.932	1.425
8	0.027	15.00	94.528	1200		296714.859	516261.813	1.425
11	0.020	15.00	95.601	1200		296665.293	516273.537	2.401
9	0.071	15.00	95.361	1200		296692.032	516267.304	2.412
10	0.027	15.00	95.174	1200		296694.101	516278.141	2.291
2	0.122	15.00	94.199	1200		296693.775	516310.558	1.754
3	0.046	15.00	94.233	1200		296668.928	516310.259	1.893
6	0.034	15.00	94.904	1800		296623.527	516275.029	3.879
7	0.028	15.00	94.476	1800		296623.485	516292.044	3.484
4	0.070	15.00	94.080	1800		296621.416	516301.950	3.121
5	0.054	15.00	93.686	1800	0.300	296613.942	516331.225	3.072
Existing SW MH			93.000	1500		296609.459	516336.463	2.211
Offline Storage Out		15.00	94.000			296617.706	516300.111	2.420
Offline Storage In			94.000			296614.206	516279.028	2.420
Offline Storage Dummy		15.00	94.000			296614.206	516272.640	2.200

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	1	2	27.715	0.600	93.112	92.520	0.592	46.8	225	15.32	50.0
3.000	8	9	23.045	0.600	93.103	92.949	0.154	150.0	225	15.38	50.0
4.000	11	9	27.625	0.600	93.200	92.949	0.251	110.1	225	15.44	50.0
3.001	9	10	11.059	0.600	92.949	92.883	0.066	167.6	225	15.63	50.0
3.002	10	2	32.772	0.600	92.883	92.520	0.363	90.3	225	16.14	50.0
1.001	2	3	25.686	0.600	92.445	92.340	0.105	244.6	300	16.56	50.0
1.002	3	4	46.467	0.600	92.340	91.559	0.781	59.5	300	17.33	50.0
2.000	6	7	16.404	0.600	91.025	90.992	0.033	500.0	900	15.26	50.0
2.001	7	4	16.255	0.600	90.992	90.959	0.033	500.0	900	15.51	50.0
1.003	4	5	22.447	0.600	90.959	90.914	0.045	500.0	900	17.51	50.0
1.004	5	Existing SW MH	12.512	0.600	90.914	90.789	0.125	100.0	300	17.59	50.0
5.000	Offline Storage Out	4	4.141	0.600	91.580	91.559	0.021	200.0	300	15.06	27.6
6.000	Offline Storage Dummy	Offline Storage In	6.388	0.600	91.800	91.580	0.220	29.0	100	15.07	27.6

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
1.000	1.916	76.2	19.3	1.200	1.454	0.107	0.0	77	1.605
3.000	1.065	42.3	4.9	1.200	2.187	0.027	0.0	51	0.714
4.000	1.245	49.5	3.6	2.176	2.187	0.020	0.0	41	0.730
3.001	1.007	40.0	21.3	2.187	2.066	0.118	0.0	116	1.021
3.002	1.376	54.7	26.2	2.066	1.454	0.145	0.0	109	1.361
1.001	1.001	70.7	67.6	1.454	1.593	0.374	0.0	236	1.133
1.002	2.042	144.3	75.9	1.593	2.221	0.420	0.0	154	2.065
2.000	1.394	886.9	6.1	2.979	2.584	0.034	0.0	52	0.414
2.001	1.394	886.9	11.2	2.584	2.221	0.062	0.0	69	0.495
1.003	1.394	886.9	99.7	2.221	1.872	0.552	0.0	202	0.940
1.004	1.572	111.1	109.5	2.472	1.911	0.606	0.0	243	1.781
5.000	1.108	78.3	0.0	2.120	2.221	0.000	0.0	0	0.000
6.000	1.437	11.3	0.0	2.100	2.320	0.000	0.0	0	0.000

Pipeline Schedule

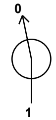
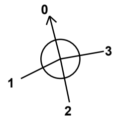
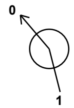
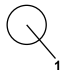
Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.000	27.715	46.8	225	Circular	94.537	93.112	1.200	94.199	92.520	1.454
3.000	23.045	150.0	225	Circular	94.528	93.103	1.200	95.361	92.949	2.187
4.000	27.625	110.1	225	Circular	95.601	93.200	2.176	95.361	92.949	2.187
3.001	11.059	167.6	225	Circular	95.361	92.949	2.187	95.174	92.883	2.066
3.002	32.772	90.3	225	Circular	95.174	92.883	2.066	94.199	92.520	1.454
1.001	25.686	244.6	300	Circular	94.199	92.445	1.454	94.233	92.340	1.593
1.002	46.467	59.5	300	Circular	94.233	92.340	1.593	94.080	91.559	2.221
2.000	16.404	500.0	900	Circular	94.904	91.025	2.979	94.476	90.992	2.584
2.001	16.255	500.0	900	Circular	94.476	90.992	2.584	94.080	90.959	2.221
1.003	22.447	500.0	900	Circular	94.080	90.959	2.221	93.686	90.914	1.872
1.004	12.512	100.0	300	Circular	93.686	90.914	2.472	93.000	90.789	1.911
5.000	4.141	200.0	300	Circular	94.000	91.580	2.120	94.080	91.559	2.221
6.000	6.388	29.0	100	Circular	94.000	91.800	2.100	94.000	91.580	2.320

Link	US Node	Dia (mm)	Sump (m)	Node Type	MH Type	DS Node	Dia (mm)	Sump (m)	Node Type	MH Type
1.000	1	1200		Manhole	Adoptable	2	1200		Manhole	Adoptable
3.000	8	1200		Manhole	Adoptable	9	1200		Manhole	Adoptable
4.000	11	1200		Manhole	Adoptable	9	1200		Manhole	Adoptable
3.001	9	1200		Manhole	Adoptable	10	1200		Manhole	Adoptable
3.002	10	1200		Manhole	Adoptable	2	1200		Manhole	Adoptable
1.001	2	1200		Manhole	Adoptable	3	1200		Manhole	Adoptable
1.002	3	1200		Manhole	Adoptable	4	1800		Manhole	Adoptable
2.000	6	1800		Manhole	Adoptable	7	1800		Manhole	Adoptable
2.001	7	1800		Manhole	Adoptable	4	1800		Manhole	Adoptable
1.003	4	1800		Manhole	Adoptable	5	1800	0.300	Manhole	Adoptable
1.004	5	1800	0.300	Manhole	Adoptable	Existing SW MH	1500		Manhole	Adoptable
5.000	Offline Storage Out			Junction		4	1800		Manhole	Adoptable
6.000	Offline Storage Dummy			Junction		Offline Storage In			Junction	

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Sump (m)	Connections	Link	IL (m)	Dia (mm)
1	296722.226	516310.932	94.537	1.425	1200		0	1.000	93.112	225
8	296714.859	516261.813	94.528	1.425	1200		0	3.000	93.103	225
11	296665.293	516273.537	95.601	2.401	1200		0	4.000	93.200	225
9	296692.032	516267.304	95.361	2.412	1200		1	4.000	92.949	225
							2	3.000	92.949	225
							0	3.001	92.949	225
10	296694.101	516278.141	95.174	2.291	1200		1	3.001	92.883	225
							0	3.002	92.883	225
2	296693.775	516310.558	94.199	1.754	1200		1	3.002	92.520	225
							2	1.000	92.520	225
							0	1.001	92.445	300
3	296668.928	516310.259	94.233	1.893	1200		1	1.001	92.340	300
							0	1.002	92.340	300
6	296623.527	516275.029	94.904	3.879	1800		0	2.000	91.025	900

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Sump (m)	Connections		Link	IL (m)	Dia (mm)
7	296623.485	516292.044	94.476	3.484	1800			1	2.000	90.992	900
								0	2.001	90.992	900
4	296621.416	516301.950	94.080	3.121	1800			1	5.000	91.559	300
								2	2.001	90.959	900
								3	1.002	91.559	300
								0	1.003	90.959	900
5	296613.942	516331.225	93.686	3.072	1800	0.300		1	1.003	90.914	900
								0	1.004	90.914	300
Existing SW MH	296609.459	516336.463	93.000	2.211	1500			1	1.004	90.789	300
Offline Storage Out	296617.706	516300.111	94.000	2.420				0	5.000	91.580	300
Offline Storage In	296614.206	516279.028	94.000	2.420				1	6.000	91.580	100
Offline Storage Dummy	296614.206	516272.640	94.000	2.200				0	6.000	91.800	100

Simulation Settings

Rainfall Methodology	FEH-13	Analysis Speed	Detailed	Additional Storage (m³/ha)	20.0
Summer CV	1.000	Skip Steady State	✓	Check Discharge Rate(s)	x
Winter CV	1.000	Drain Down Time (mins)	240	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 %)
2	0	0	0	100	40	0	0
30	0	0	0				

Node 5 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	90.914	Product Number	CTL-SHE-0096-6000-2400-6000
Design Depth (m)	2.400	Min Outlet Diameter (m)	0.150
Design Flow (l/s)	6.0	Min Node Diameter (mm)	1200

Node Offline Storage Out Flow through Pond Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Porosity	0.95	Main Channel Length (m)	21.370
Side Inf Coefficient (m/hr)	0.00000	Invert Level (m)	91.580	Main Channel Slope (1:X)	100000.0
Safety Factor	2.0	Time to half empty (mins)		Main Channel n	0.010

Inlets

Offline Storage In

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	232.0	0.0	1.600	232.0	0.0	1.601	0.0	0.0

Results for 2 year Critical Storm Duration. Lowest mass balance: 96.45%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
30 minute summer	1	23	93.164	0.052	8.9	0.1362	0.0000	OK
30 minute summer	8	25	93.138	0.035	2.2	0.0523	0.0000	OK
30 minute summer	11	24	93.228	0.028	1.7	0.0369	0.0000	OK
30 minute summer	9	24	93.029	0.080	9.8	0.1370	0.0000	OK
30 minute summer	10	24	92.956	0.073	12.0	0.0998	0.0000	OK
30 minute summer	2	24	92.586	0.141	31.0	0.3563	0.0000	OK
30 minute summer	3	24	92.442	0.102	34.8	0.1654	0.0000	OK
480 minute summer	6	352	91.770	0.745	2.9	2.0270	0.0000	OK
480 minute summer	7	352	91.770	0.778	6.6	2.1050	0.0000	OK
480 minute summer	4	352	91.770	0.811	20.2	2.4278	0.0000	OK
480 minute summer	5	352	91.770	0.856	7.8	2.5119	0.0000	SURCHARGED
15 minute summer	Existing SW MH	1	90.789	0.000	4.7	0.0000	0.0000	OK
480 minute summer	Offline Storage Out	352	91.770	0.190	18.2	0.0000	0.0000	OK
480 minute summer	Offline Storage In	352	91.770	0.190	12.1	0.0000	0.0000	OK
15 minute summer	Offline Storage Dummy	1	91.800	0.000	0.0	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
30 minute summer	1	1.000	2	8.9	1.193	0.117	0.2302	
30 minute summer	8	3.000	9	2.2	0.284	0.052	0.1892	
30 minute summer	11	4.000	9	1.7	0.232	0.034	0.2135	
30 minute summer	9	3.001	10	9.8	0.827	0.245	0.1310	
30 minute summer	10	3.002	2	12.0	1.096	0.219	0.3586	
30 minute summer	2	1.001	3	31.0	1.156	0.438	0.6909	
30 minute summer	3	1.002	4	34.8	1.674	0.241	1.1009	
480 minute summer	6	2.000	7	-1.7	0.127	-0.002	9.3833	
480 minute summer	7	2.001	4	-5.6	0.058	-0.006	9.6264	
480 minute summer	4	1.003	5	5.9	0.183	0.007	13.7417	
480 minute summer	5	Hydro-Brake®	Existing SW MH	4.7				161.6
480 minute summer	Offline Storage Out	5.000	4	-18.2	-1.343	-0.233	0.2072	
480 minute summer	Offline Storage In	Flow through pond	Offline Storage Out	-12.1	-0.074	-0.003	41.9241	
15 minute summer	Offline Storage Dummy	6.000	Offline Storage In	0.0	0.000	0.000	0.0006	

Results for 30 year Critical Storm Duration. Lowest mass balance: 96.45%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
60 minute summer	1	38	93.194	0.082	21.6	0.2146	0.0000	OK
60 minute summer	8	38	93.157	0.054	5.5	0.0821	0.0000	OK
30 minute summer	11	24	93.243	0.043	4.0	0.0558	0.0000	OK
60 minute summer	9	38	93.083	0.134	23.9	0.2299	0.0000	OK
60 minute summer	10	38	93.001	0.118	29.4	0.1610	0.0000	OK
60 minute summer	2	38	92.691	0.246	75.7	0.6194	0.0000	OK
30 minute summer	3	20	92.506	0.166	83.8	0.2677	0.0000	OK
360 minute winter	6	352	92.313	1.288	2.1	3.5041	0.0000	SURCHARGED
360 minute winter	7	352	92.313	1.321	5.0	3.5741	0.0000	SURCHARGED
360 minute winter	4	352	92.313	1.354	31.0	4.0534	0.0000	SURCHARGED
360 minute winter	5	352	92.313	1.399	8.1	4.1055	0.0000	SURCHARGED
15 minute summer	Existing SW MH	1	90.789	0.000	4.7	0.0000	0.0000	OK
360 minute winter	Offline Storage Out	352	92.313	0.733	29.0	0.0000	0.0000	SURCHARGED
360 minute winter	Offline Storage In	352	92.313	0.733	14.5	0.0000	0.0000	OK
360 minute winter	Offline Storage Dummy	352	92.313	0.513	0.2	0.0000	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)
60 minute summer	1	1.000	2	21.6	1.177	0.283	0.6272	
60 minute summer	8	3.000	9	5.5	0.350	0.130	0.3681	
30 minute summer	11	4.000	9	4.0	0.279	0.081	0.4093	
60 minute summer	9	3.001	10	23.9	1.048	0.596	0.2521	
60 minute summer	10	3.002	2	29.4	1.152	0.537	0.8737	
60 minute summer	2	1.001	3	75.5	1.477	1.068	1.2964	
30 minute summer	3	1.002	4	83.8	2.057	0.580	2.4783	
360 minute winter	6	2.000	7	1.6	0.113	0.002	10.3964	
360 minute winter	7	2.001	4	-4.1	0.061	-0.005	10.3020	
360 minute winter	4	1.003	5	6.3	0.183	0.007	14.2263	
360 minute winter	5	Hydro-Brake®	Existing SW MH	4.7				152.9
360 minute winter	Offline Storage Out	5.000	4	-29.0	-1.259	-0.371	0.2916	
360 minute winter	Offline Storage In	Flow through pond	Offline Storage Out	-14.5	-0.081	-0.004	161.6746	
360 minute winter	Offline Storage Dummy	6.000	Offline Storage In	-0.2	-0.026	-0.013	0.0500	

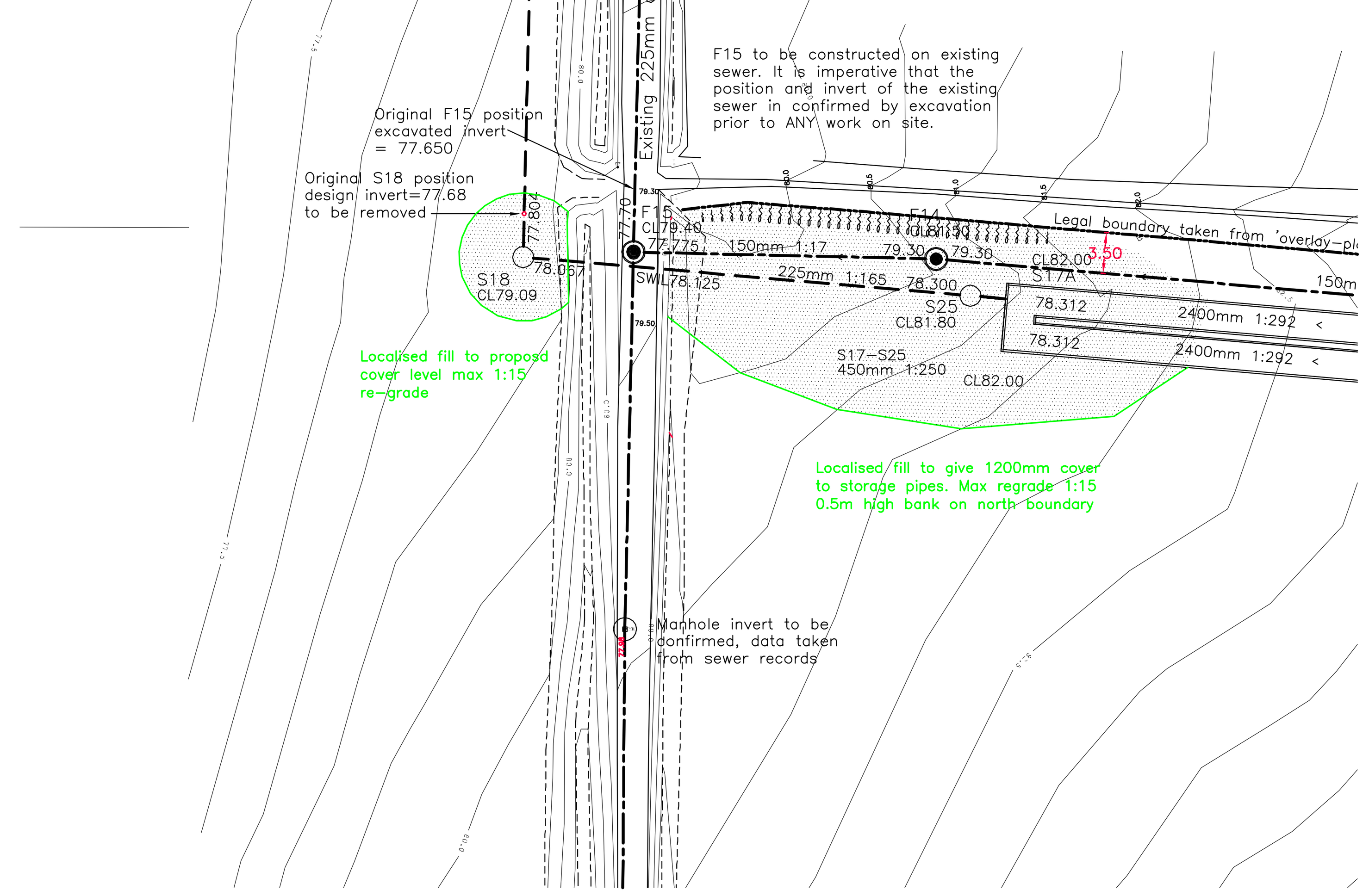
Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 96.45%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
60 minute summer	1	42	93.847	0.735	40.8	1.9348	0.0000	SURCHARGED
60 minute summer	8	43	94.099	0.996	10.3	1.5034	0.0000	SURCHARGED
60 minute summer	11	43	94.096	0.896	8.0	1.1630	0.0000	SURCHARGED
60 minute summer	9	43	94.090	1.141	39.4	1.9625	0.0000	SURCHARGED
60 minute summer	10	43	94.004	1.121	47.1	1.5321	0.0000	SURCHARGED
60 minute summer	2	42	93.690	1.245	125.7	3.1402	0.0000	SURCHARGED
360 minute winter	3	344	93.297	0.957	43.9	1.5472	0.0000	SURCHARGED
360 minute winter	6	336	93.297	2.272	11.7	6.1806	0.0000	SURCHARGED
360 minute winter	7	336	93.298	2.306	14.0	6.2387	0.0000	SURCHARGED
360 minute winter	4	344	93.297	2.338	56.7	6.9983	0.0000	SURCHARGED
360 minute winter	5	344	93.299	2.385	7.4	6.9976	0.0000	SURCHARGED
15 minute summer	Existing SW MH	1	90.789	0.000	4.7	0.0000	0.0000	OK
360 minute winter	Offline Storage Out	352	93.313	1.733	55.2	0.0000	0.0000	SURCHARGED
360 minute winter	Offline Storage In	344	93.325	1.745	27.6	0.0000	0.0000	OK
360 minute winter	Offline Storage Dummy	344	93.294	1.494	2.3	0.0000	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)
60 minute summer	1	1.000	2	37.6	1.176	0.494	1.1023	
60 minute summer	8	3.000	9	9.6	0.379	0.226	0.9165	
60 minute summer	11	4.000	9	9.0	0.301	0.182	1.0987	
60 minute summer	9	3.001	10	38.2	1.124	0.954	0.4398	
60 minute summer	10	3.002	2	47.2	1.186	0.862	1.3034	
60 minute summer	2	1.001	3	123.3	1.752	1.744	1.8088	
360 minute winter	3	1.002	4	43.9	1.192	0.304	3.2722	
360 minute winter	6	2.000	7	13.6	0.141	0.015	10.3964	
360 minute winter	7	2.001	4	-9.9	0.080	-0.011	10.3020	
360 minute winter	4	1.003	5	7.0	0.219	0.008	14.2263	
360 minute winter	5	Hydro-Brake®	Existing SW MH	6.0				184.1
360 minute winter	Offline Storage Out	5.000	4	-55.2	-1.200	-0.705	0.2916	
360 minute winter	Offline Storage In	Flow through pond	Offline Storage Out	-27.6	-0.061	-0.007	354.5635	
360 minute winter	Offline Storage Dummy	6.000	Offline Storage In	-2.3	-0.296	-0.205	0.0500	

APPENDIX E

STORY HOMES PHASE 1 EXISTING DRAINAGE PLAN



Manhole construction – refer to CPA technical bulletin Sept 2001 outlining changes to relevent Britishe Product Standards BS5911–200:1994.

All precast concret products are to be kitemarked or they will be rejected as part of an adoptable system. Manhole cover slabs to BS5911

Manhole covers to have a clear opening of 600 x 600mm and shall be class D400 to BSEN124 with 150mm deep frames.

Filled ground must be filled and consolidated under the supervision of UU before any sewer works are carried out.

All adoptable sewers to be BSI kitemarked,

Plastic channels are not acceptable

All custom built ironwork to be hot dipped galvanised prior to final fitting.

United Utilities are not obliged to accept filter drain / land drainagerunoff into the public sewer network or adoptable drainage network (directly or indirectly). An alternative method of disposal of land drainage runoff will therefore be required.

Cover slabs must carry the BSI kitemark or will be rejected by UU inspector. Where the clear opening of a kitmarked product is differant to that of the cover and frame a load bearing slab should be fitted bove the cover slab to bring the size down to 600x600mm for UU specified cover size. Please refer to CPSA technical bulletin Autumn 2004 for kitemarked cover slab opening sizes.

Sulphate resistant cement (C20–DC2) and precast concrete productes must be used or a laboratory report provided proving that such precautions are not nessesary.

Sewers to be laid in class S bedding (150mm graular bed and surround. Where depth of cover is less then 1.2m in highways and verges (or less then 900mm in non vehile access areas) then a concrete slab should be provided above the granular bed and surround.

The chamber size of manholes with more then one connection in them may need to be increased one increment to accomodate the connection and bends.

Contractors should be aware of significantly large diameter pipes and manhole chamber rings proposed in this design and precautions should be taken in movement and placing of such items. Also to be considered is the depth of excavation of the drainage works especially the large diameter components up to 6m deep excavations.

All adoptable sewer works and materials to be in accordance with Sewers for Adoption 6th edition. The relevant British / European and United Utilities standards / requirements / addendum & kitemarked

The adoptable sewers shall be a min 1.0m and manholes 0.5m from the kerb and service margins

Sewers must have 5m clearance from trees and hedges see SfA6 for restrictions on tree planting / types

Bedding and backfill material to conform with the Water Industry specification 4–08–02 (table A2)

EXISTING CHANNEL AND FOOTPATH LEVELS TO BE CONFIRMED PRIOR TO ANYCONSTRUCTION
ALL EXISTING DRAINAGE INVERTS, LOCATIONS & PIPE SIZES TO BE CONFIRMED

1A PROPOSED STREET LIGHTING
5m Aluminium column
Urbis Axia LED cool white luminair
Post mounted
5deg tilt
Optic setting 16LED Wh 5079 31313F
UMSUG code 4100210005100
Zodion SS6 photocell (35/18)

See Urbis specifction and drawing for full details
Specification as provided by Story Homes.

DRAINAGE STATEMENT

SURFACE WATER

It is intended to discharge surface water from the development to the existing land drainage / watercourse adjacent the site. Site investigations have located a number of existing pipes watercourses discharging to the existing cliff however it has been identified that two of the three are in poor condition. Discussions with David bechelli (Copeland land drainage dept) identified the existing 375mm piped watercourse north of the development would be more suitable due to its excellant condition. In that we aredischargeing to a watercourse the discharge rate from the site should be limited to greenfield runoff. Using ICPSUDS we have calculated the 1year greenfield runoff as 15.8 lts/sec, this includes a 27% allowence for the partially urbanized catchments ie existing concrete hardstanding (formally buildings).
The SW design will incorporate twin 2400mm diam on line storage pipes sized to discharge 15.5 lts/sec for the 100year including 30% climate change

FOUL WATER

It is intended to incorperate a 150mm diameter foul sewer network within the site terminating on the north west boundary. A foul water requisition will be served on United Utilities to provide the off site sewer and connection.

FLOOD ROUTING

The site is designed such that any flooding within the development due to blockage or inadequate maintenance will discharge via road gullies on the northwest boundary of the site. Overland flows will take water away from the site, through the footpath tunnel and into the adjacent fields. The natural topography will encourage flows toward the cliffs and down to the sea.
Offsite overland flow from High Street will be routed through the site via road 1 from where it will take the same route to the sea.

Aco channel or similar located either in front of garage or on back edge to prevent drive water discharging on to highway see private drainage layout for further clarification

S.	F4–F15, S4–S18 & S3–S4 revised following changes to legal boundary and survey of F15 invert	16–3–15
R.	S17A added	24–10–14
Q.	Easements added to road3 gullies, Service strip added to roads 3&4, Lighting added to sootpath/steps, Footway extended on road1, footway added in front of 19–20, 26,27 34–38	6–10–14
P.	S4–S21 & F4–F18 revised, minor layout changes	26–9–14
N.	Annotation clarified on storage pipe.	10–7–14
M.	Plots 33 & 34 revised, private drainage adjusted throughout, street lighting added	26–6–14
L.	S15–22–23–24–17–25–18–19 revised	19–6–14
K.	Drainage statement revised	21–1–14
J.	Full drainage re–design, FFL adjusted	31–10–13
H.	Revised in line with new planning layout	28–7–13
H.	Revised in line with new planning layout	28–7–13
G.	Road 2A sewers revised	1–3–13
F.	Plots 16–19 revised floor level	28–2–13
E.	Drainage annotation revised in line with client instruction	27–2–13
D.	Plots 20 & 21 FFL revised following client instruction	25–2–13
C.	Plots 10, 20, 21, 36,& 40 FFL revised following client instruction path / steps removed from plots 18 & 19	25–2–13
B.	Drainage statement added	12–2–13
A.	Revised in line with planning layout, floor levels amended	11–2–13

rab R.A.B. ENGINEERING DESIGN LTD
21 BURNCROSS DRIVE
SHEFFIELD S35 1DJ
TEL.(0114)2570576

Story Homes

Waters Edge Tamar, Whitehaven
Engineering layout

DRAWN BY rab
SCALE 1:500 / 1:1000 DATE Feb13
DRAWING No 976–1 REV S

PRELIMINARY ONLY

APPENDIX F

STORY HOMES PHASE 1 CONTINGENCY DRAINAGE PLAN

Julian Pearson

From: Christopher Tweedl
Sent: 03 June 2020 16:39
To:
Cc:
Subject: RE: Waters Edge, Whitehaven
Attachments: 1839 Block Plan.pdf; Phase 2 SW Design Report 6ls with Additional Ph1 Storage.pdf; Waters Edge - Engineering Layout Phase 2 (6ls).pdf; 100yr Flood Basin Proposed Location.pdf

Hi Julian,

Further to your email below to Luke Walker, I have now reviewed the original Microdrainage design by DAB and can confirm that no allowance from Phase 2 has been included within the Phase 1 drainage network. I have also remodelled the drainage network and run longer storm durations. The worst case storm is in fact the 440minute storm therefore I can only assume that DAB didn't want to present anything after this. The site has been inspected pre lockdown to enable the site to be progressed on to maintenance however the certificate has not yet been issued. All properties on the development have been completed for some time.

As part of my review I have also modelled the phase 2 system based upon the attached Gleeson masterplan. I have run a number of scenarios and have managed to come up with a solution that minimises the flooding during the 100yr event within the phase 1 system whilst also providing enough attenuation within the phase 2 site without flooding.

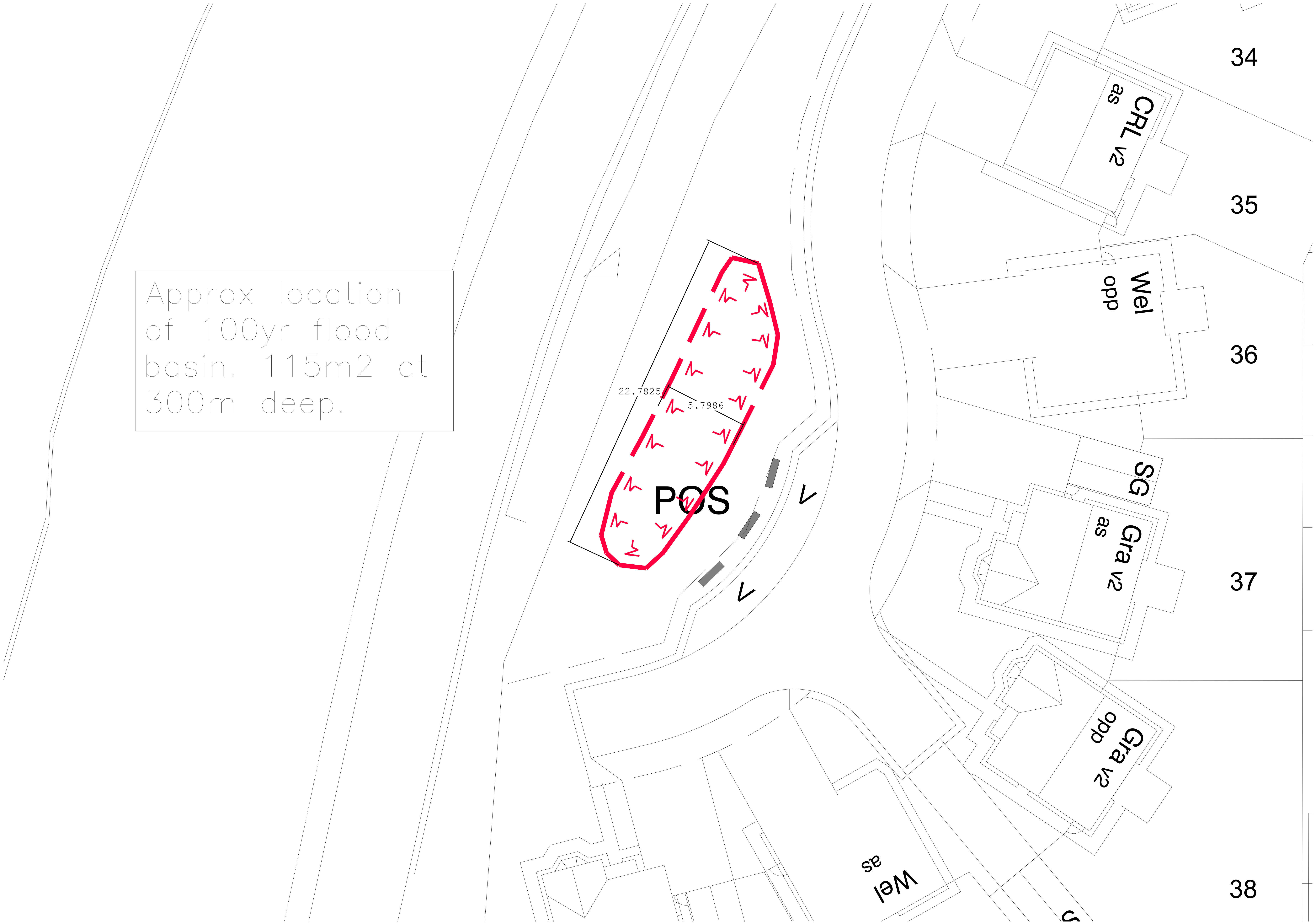
Please see attached high level drainage plan for you information. We can accept a maximum flow of 6l/s from the phase 2 site. This does require the phase 1 system to be amended to prevent flooding at the existing hydrobrake which Story Homes can undertake following UU approval. The proposed solution is to construct a additional manhole between S9 & S10 and restrict flows to 6l/s which then floods the system at this point during a 100yr event. The flood water can then be attenuated within a shallow basin in the POS area. Please note that there is some surcharging of this additional manhole during the 1yr event, I will discuss this with UU separately as it is only marginal. Please see attached design report. Attenuation on phase 2 can be accommodated within oversized pipes (30yr) and underground cellular storage (100yr +CC). The system has been design so that all plots on phase 2 can drain via gravity.

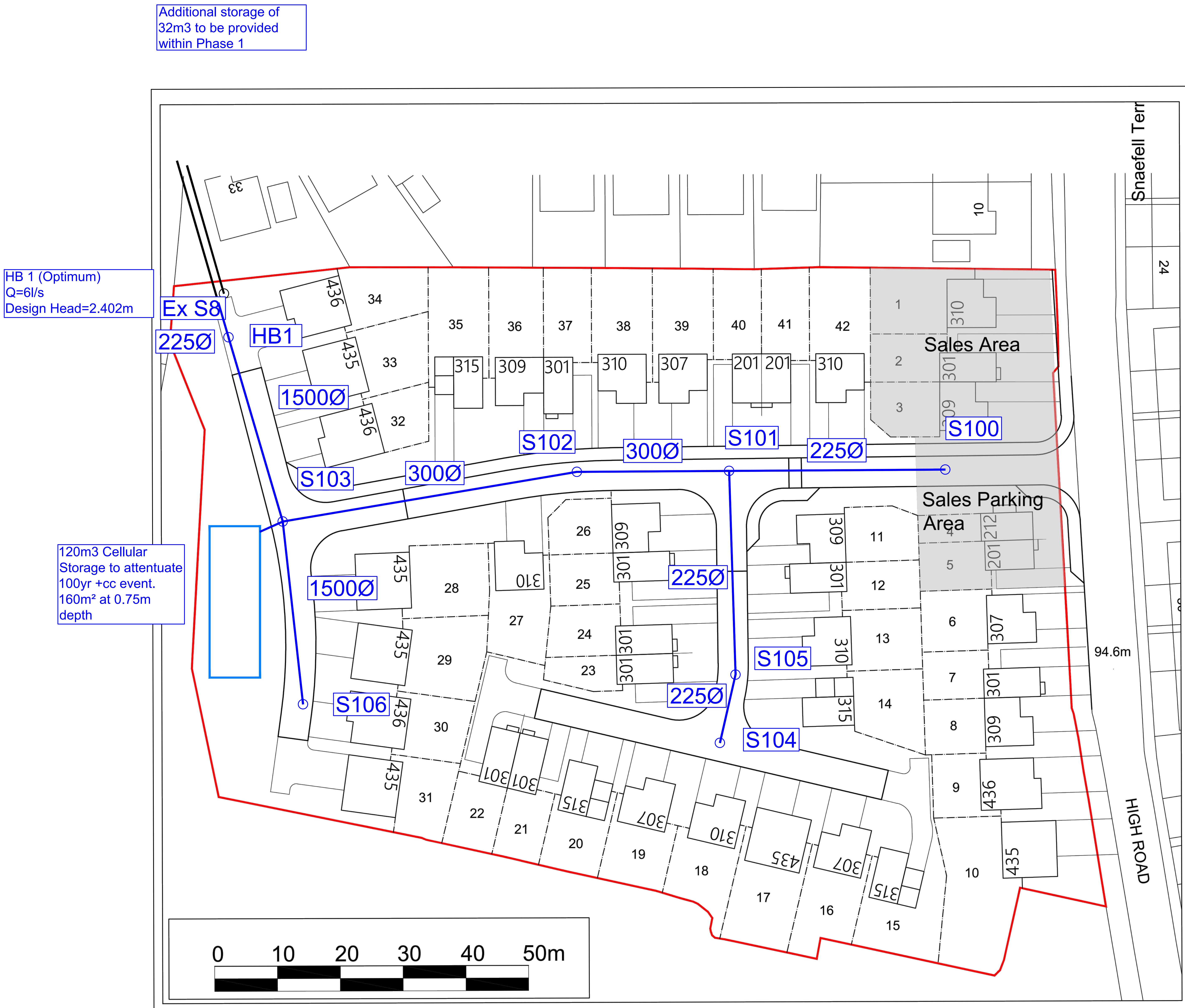
Should you wish to discuss or require any additional information then please do not hesitate to contact me.

Regards
Chris

Chris Tweedle
Senior Engineer
Story Homes Ltd - North West

www.storyhomes.co.uk


Approx location of 100yr flood basin. 115m2 at 300m deep.
22.7825
5.7986
POS
34
35
36
37
38
CRL v2
as
Wel
opp
SG
Gra v2
as
Gra v2
opp
Wel
as



NOTES AND AMENDMENTS

This drawing is copyright ©. Figured dimensions are to be followed in preference to scaled dimensions and particulars are to be taken from the actual work where possible. Any discrepancy must be reported to the architect immediately and before proceeding.

REVISIONS

Rev	Description	Drawn	Date

House Type	Quantity
201	3
212	1
301	9
309	5
307	4
315	4
310	6
435	6
436	4
Total#	42

ASHWOOD DESIGN ASSOCIATES LTD
12A Clifford Court, Parkhouse Business Park, Carlisle CA3 0JG
t 01228 510616 e admin@ashwooddesign.co.uk
f 01228 520861 w www.ashwooddesign.co.uk

Purpose: Concept

Client: Gleeson Homes

Project: Waters Edge

Title: Block Plan

Scale:	Sheet Size:	Drawn:	Date:
1:500	A3	jc	03/2019

Project No:	Drawing No:	Revision:
1839	BP001	-

Story HOMES

DEVELOPMENT

Waters Edge Phase 2

DRAWING

SW Drainage Appraisal (6l/s)

DRAWN BY	CT	DATE	27/05/2020
CHECKED BY	-	SCALE	1:500 @ A2

DRAWING NUMBER	--	REVISION -
SITE REFERENCE	--	

Revisions

-	-	-

Kensington House, Ackhurst Business Park, Foxhole Road, Chorley, PR7 1NY
Tel 01257 443250 Fax 01257 443251

Design Settings

Rainfall Methodology	FSR	Maximum Time of Concentration (mins)	30.00
Return Period (years)	2	Maximum Rainfall (mm/hr)	50.0
Additional Flow (%)	0	Minimum Velocity (m/s)	1.00
FSR Region	England and Wales	Connection Type	Level Soffits
M5-60 (mm)	16.000	Minimum Backdrop Height (m)	0.900
Ratio-R	0.263	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	0.192	5.00	92.775	1500	1.350
6	0.086	5.00	92.765	1500	1.365
7	0.048	5.00	92.449	1500	1.365
2	0.085	5.00	91.871	1500	1.437
8	0.000	5.00	93.054	1500	2.054
9	0.070	5.00	91.550	1500	1.250
9a	0.000		91.100	2400	1.320
10	0.072	5.00	90.884	1500	1.624
14	0.029	5.00	89.492	1500	1.525
3	0.085	5.00	89.052	1500	1.539
11	0.063	5.00	88.601	1500	1.350
12	0.138	5.00	88.235	1050	1.425
4	0.000		88.578	1500	2.160
5	0.000		86.462	1500	1.250
13	0.000		85.700	1500	1.277
15	0.000		85.299	1500	2.035
24	0.000		83.500	1800	5.445
17	0.000		81.530	1800	3.606
25	0.000		81.250	2400	3.337
18	0.000		78.878	1050	1.199
19	0.000		76.255	1050	1.521
20	0.000		71.564	1050	1.441
Outfall	0.000		70.320	1500	0.528
100	0.128	5.00	95.000	1500	2.000
101	0.085	5.00	94.750	1500	2.090
102	0.066	5.00	94.750	1500	2.189
103	0.056	5.00	95.000	3000	3.834
HB1	0.000		93.850	3000	2.752
104	0.114	5.00	95.000	1500	2.000
105	0.101	5.00	94.750	1500	1.824
106	0.066	5.00	95.000	3000	3.769
STORAGE	0.000	5.00	93.900	1500	0.762

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	1	2	15.550	0.600	91.425	90.510	0.915	17.0	150	5.11	44.9
2.000	6	7	22.990	0.600	91.400	91.084	0.316	72.8	150	5.32	44.3
2.001	7	2	25.590	0.600	91.084	90.509	0.575	44.5	150	5.61	43.4
1.001	2	3	47.520	0.600	90.434	87.588	2.846	16.7	225	5.85	42.7
3.000	8	9	20.500	0.600	91.000	90.300	0.700	29.3	300	7.31	39.0
3.001	9	9a	36.300	0.600	90.300	89.780	0.520	69.8	300	7.63	38.3
3.001a	9a	10	36.300	0.600	89.780	89.260	0.520	69.8	300	7.96	37.6
3.002	10	14	17.590	0.600	89.260	87.967	1.293	13.6	300	8.02	37.5
3.003	14	3	9.930	0.600	87.967	87.520	0.447	22.2	300	8.07	37.4
1.002	3	4	9.590	0.600	87.513	86.493	1.020	9.4	300	8.10	37.3
4.000	11	12	13.710	0.600	87.251	86.884	0.367	37.4	150	5.14	44.8
4.001	12	4	35.640	0.600	86.810	86.572	0.238	149.8	225	5.70	43.1
1.003	4	5	18.580	0.600	86.418	85.212	1.206	15.4	375	8.17	37.2
1.004	5	13	24.690	0.600	85.212	84.423	0.789	31.3	375	8.30	37.0
1.005	13	15	18.310	0.600	84.423	83.264	1.159	15.8	375	8.36	36.8
1.006	15	24	37.570	0.600	83.264	80.080	3.184	11.8	375	8.48	36.6
1.007	24	17	38.500	0.600	78.055	77.924	0.131	293.9	2400	8.68	36.2
1.008	17	25	3.050	0.600	77.924	77.913	0.011	277.2	450	8.72	36.2
1.009	25	18	38.560	0.600	77.913	77.679	0.234	164.8	375	9.17	35.3
1.010	18	19	93.370	0.600	77.679	74.734	2.945	31.7	375	9.66	34.5
1.011	19	20	99.130	0.600	74.734	70.123	4.611	21.5	375	10.08	33.9
1.012	20	Outfall	14.150	0.600	70.123	69.792	0.331	42.7	375	10.16	33.7
10.000	100	101	34.280	0.600	93.000	92.771	0.229	150.0	225	5.54	43.6
10.001	101	102	24.130	0.600	92.660	92.561	0.099	243.7	300	6.11	42.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
1.000	2.455	43.4	23.4	1.200	1.211	0.192	0.0	78	2.497
2.000	1.180	20.8	10.3	1.215	1.215	0.086	0.0	75	1.178
2.001	1.512	26.7	15.8	1.215	1.212	0.134	0.0	83	1.573
1.001	3.217	127.9	47.6	1.212	1.239	0.411	0.0	94	2.981
3.000	2.915	206.0	65.2	1.754	0.950	0.616	0.0	116	2.596
3.001	1.884	133.2	71.3	0.950	1.020	0.686	0.0	156	1.914
3.001a	1.884	133.2	70.0	1.020	1.324	0.686	0.0	154	1.906
3.002	4.285	302.9	77.1	1.324	1.225	0.758	0.0	103	3.601
3.003	3.351	236.9	79.8	1.225	1.232	0.787	0.0	120	3.035
1.002	5.156	364.5	129.9	1.239	1.785	1.283	0.0	123	4.735
4.000	1.651	29.2	7.7	1.200	1.201	0.063	0.0	52	1.395
4.001	1.066	42.4	23.5	1.200	1.781	0.201	0.0	120	1.093
1.003	4.636	512.1	149.7	1.785	0.875	1.484	0.0	138	4.041
1.004	3.248	358.8	148.7	0.875	0.902	1.484	0.0	168	3.102
1.005	4.577	505.5	148.2	0.902	1.660	1.484	0.0	139	4.000
1.006	5.298	585.2	147.2	1.660	3.045	1.484	0.0	128	4.446
1.007	3.325	30080.9	145.8	3.045	1.206	1.484	0.0	115	0.912
1.008	1.216	386.8	145.5	3.156	2.887	1.484	0.0	191	1.134
1.009	1.408	311.1	142.2	2.962	0.824	1.484	0.0	178	1.377
1.010	3.228	712.9	138.9	0.824	1.146	1.484	0.0	112	2.526
1.011	3.922	866.3	136.2	1.146	1.066	1.484	0.0	100	2.893
1.012	2.778	613.5	135.6	1.066	0.153	1.484	0.0	119	2.246
10.000	1.065	42.3	15.1	1.775	1.754	0.128	0.0	93	0.977
10.001	1.002	70.9	48.7	1.790	1.889	0.428	0.0	183	1.078

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)
10.002	102	103	47.290	0.600	92.561	92.366	0.195	243.0	300	6.90	40.0
10.003	103	HB1	30.440	0.600	91.166	91.098	0.068	450.0	1500	7.15	39.4
10.004	HB1	8	5.710	0.600	91.098	91.085	0.013	450.0	1500	7.20	39.3
11.000	104	105	11.100	0.600	93.000	92.926	0.074	150.0	225	5.17	44.7
11.001	105	101	32.310	0.600	92.926	92.735	0.191	169.2	225	5.71	43.1
12.000	106	103	29.150	0.600	91.231	91.166	0.065	450.0	1500	5.24	44.5
13.000	STORAGE	103	5.000	0.600	93.138	93.116	0.022	225.0	225	5.10	45.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
10.002	1.004	71.0	53.5	1.889	2.334	0.494	0.0	195	1.100
10.003	2.015	3561.0	65.8	2.334	1.252	0.616	0.0	137	0.811
10.004	2.015	3561.0	65.6	1.252	0.469	0.616	0.0	137	0.811
11.000	1.065	42.3	13.8	1.775	1.599	0.114	0.0	88	0.955
11.001	1.002	39.8	25.1	1.599	1.790	0.215	0.0	130	1.058
12.000	2.015	3561.0	8.0	2.269	2.334	0.066	0.0	51	0.433
13.000	0.867	34.5	0.0	0.537	1.659	0.000	0.0	0	0.000

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.000	15.550	17.0	150	Circular	92.775	91.425	1.200	91.871	90.510	1.211
2.000	22.990	72.8	150	Circular	92.765	91.400	1.215	92.449	91.084	1.215
2.001	25.590	44.5	150	Circular	92.449	91.084	1.215	91.871	90.509	1.212
1.001	47.520	16.7	225	Circular	91.871	90.434	1.212	89.052	87.588	1.239
3.000	20.500	29.3	300	Circular	93.054	91.000	1.754	91.550	90.300	0.950
3.001	36.300	69.8	300	Circular	91.550	90.300	0.950	91.100	89.780	1.020
3.001a	36.300	69.8	300	Circular	91.100	89.780	1.020	90.884	89.260	1.324
3.002	17.590	13.6	300	Circular	90.884	89.260	1.324	89.492	87.967	1.225
3.003	9.930	22.2	300	Circular	89.492	87.967	1.225	89.052	87.520	1.232
1.002	9.590	9.4	300	Circular	89.052	87.513	1.239	88.578	86.493	1.785
4.000	13.710	37.4	150	Circular	88.601	87.251	1.200	88.235	86.884	1.201
4.001	35.640	149.8	225	Circular	88.235	86.810	1.200	88.578	86.572	1.781
1.003	18.580	15.4	375	Circular	88.578	86.418	1.785	86.462	85.212	0.875

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.000	1	1500	Manhole	Adoptable	2	1500	Manhole	Adoptable
2.000	6	1500	Manhole	Adoptable	7	1500	Manhole	Adoptable
2.001	7	1500	Manhole	Adoptable	2	1500	Manhole	Adoptable
1.001	2	1500	Manhole	Adoptable	3	1500	Manhole	Adoptable
3.000	8	1500	Manhole	Adoptable	9	1500	Manhole	Adoptable
3.001	9	1500	Manhole	Adoptable	9a	2400	Manhole	Adoptable
3.001a	9a	2400	Manhole	Adoptable	10	1500	Manhole	Adoptable
3.002	10	1500	Manhole	Adoptable	14	1500	Manhole	Adoptable
3.003	14	1500	Manhole	Adoptable	3	1500	Manhole	Adoptable
1.002	3	1500	Manhole	Adoptable	4	1500	Manhole	Adoptable
4.000	11	1500	Manhole	Adoptable	12	1050	Manhole	Adoptable
4.001	12	1050	Manhole	Adoptable	4	1500	Manhole	Adoptable
1.003	4	1500	Manhole	Adoptable	5	1500	Manhole	Adoptable

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)
1.004	24.690	31.3	375	Circular	86.462	85.212	0.875	85.700	84.423	0.902
1.005	18.310	15.8	375	Circular	85.700	84.423	0.902	85.299	83.264	1.660
1.006	37.570	11.8	375	Circular	85.299	83.264	1.660	83.500	80.080	3.045
1.007	38.500	293.9	2400	Storage	83.500	78.055	3.045	81.530	77.924	1.206
1.008	3.050	277.2	450	Storage	81.530	77.924	3.156	81.250	77.913	2.887
1.009	38.560	164.8	375	Storage	81.250	77.913	2.962	78.878	77.679	0.824
1.010	93.370	31.7	375	Storage	78.878	77.679	0.824	76.255	74.734	1.146
1.011	99.130	21.5	375	Storage	76.255	74.734	1.146	71.564	70.123	1.066
1.012	14.150	42.7	375	Storage	71.564	70.123	1.066	70.320	69.792	0.153
10.000	34.280	150.0	225	Circular	95.000	93.000	1.775	94.750	92.771	1.754
10.001	24.130	243.7	300	Circular	94.750	92.660	1.790	94.750	92.561	1.889
10.002	47.290	243.0	300	Circular	94.750	92.561	1.889	95.000	92.366	2.334
10.003	30.440	450.0	1500	Circular	95.000	91.166	2.334	93.850	91.098	1.252
10.004	5.710	450.0	1500	Circular	93.850	91.098	1.252	93.054	91.085	0.469
11.000	11.100	150.0	225	Circular	95.000	93.000	1.775	94.750	92.926	1.599
11.001	32.310	169.2	225	Circular	94.750	92.926	1.599	94.750	92.735	1.790
12.000	29.150	450.0	1500	Circular	95.000	91.231	2.269	95.000	91.166	2.334
13.000	5.000	225.0	225	Circular	93.900	93.138	0.537	95.000	93.116	1.659

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.004	5	1500	Manhole	Adoptable	13	1500	Manhole	Adoptable
1.005	13	1500	Manhole	Adoptable	15	1500	Manhole	Adoptable
1.006	15	1500	Manhole	Adoptable	24	1800	Manhole	Adoptable
1.007	24	1800	Manhole	Adoptable	17	1800	Manhole	Adoptable
1.008	17	1800	Manhole	Adoptable	25	2400	Manhole	Adoptable
1.009	25	2400	Manhole	Adoptable	18	1050	Manhole	Adoptable
1.010	18	1050	Manhole	Adoptable	19	1050	Manhole	Adoptable
1.011	19	1050	Manhole	Adoptable	20	1050	Manhole	Adoptable
1.012	20	1050	Manhole	Adoptable	Outfall	1500	Manhole	Adoptable
10.000	100	1500	Manhole	Adoptable	101	1500	Manhole	Adoptable
10.001	101	1500	Manhole	Adoptable	102	1500	Manhole	Adoptable
10.002	102	1500	Manhole	Adoptable	103	3000	Manhole	Adoptable
10.003	103	3000	Manhole	Adoptable	HB1	3000	Manhole	Adoptable
10.004	HB1	3000	Manhole	Adoptable	8	1500	Manhole	Adoptable
11.000	104	1500	Manhole	Adoptable	105	1500	Manhole	Adoptable
11.001	105	1500	Manhole	Adoptable	101	1500	Manhole	Adoptable
12.000	106	3000	Manhole	Adoptable	103	3000	Manhole	Adoptable
13.000	STORAGE	1500	Manhole	Adoptable	103	3000	Manhole	Adoptable

Simulation Settings

Rainfall Methodology	FSR	Analysis Speed	Normal
FSR Region	England and Wales	Skip Steady State	x
M5-60 (mm)	16.000	Drain Down Time (mins)	240
Ratio-R	0.263	Additional Storage (m³/ha)	50.0
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 %)
1	0	0	0
30	0	0	0
100	30	0	0

Node 25 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	77.913	Product Number	CTL-SHE-0147-1550-3100-1550
Design Depth (m)	3.100	Min Outlet Diameter (m)	0.225
Design Flow (l/s)	15.5	Min Node Diameter (mm)	1500

Node HB1 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	91.098	Product Number	CTL-SHE-0096-6000-2402-6000
Design Depth (m)	2.402	Min Outlet Diameter (m)	0.150
Design Flow (l/s)	6.0	Min Node Diameter (mm)	1200

Node 9a Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	89.780	Product Number	CTL-SHE-0110-6000-1320-6000
Design Depth (m)	1.320	Min Outlet Diameter (m)	0.150
Design Flow (l/s)	6.0	Min Node Diameter (mm)	1200

Node STORAGE Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	93.138
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	264

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	192.0	0.0	0.750	192.0	0.0

Results for 1 year Critical Storm Duration. Lowest mass balance: 95.58%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	1	10	91.497	0.072	18.9	0.6381	0.0000	OK
15 minute winter	6	10	91.466	0.066	8.4	0.3252	0.0000	OK
15 minute winter	7	11	91.159	0.075	12.9	0.2651	0.0000	OK
15 minute winter	2	11	90.521	0.087	38.8	0.4107	0.0000	OK
30 minute summer	8	31	91.031	0.031	4.7	0.0552	0.0000	OK
15 minute winter	9	11	90.358	0.058	11.2	0.2635	0.0000	OK
60 minute winter	9a	46	90.190	0.410	8.6	1.8532	0.0000	SURCHARGED
15 minute winter	10	11	89.301	0.041	11.9	0.1614	0.0000	OK
15 minute winter	14	11	88.017	0.050	14.6	0.1368	0.0000	OK
15 minute winter	3	11	87.605	0.092	61.6	0.4188	0.0000	OK
15 minute winter	11	10	87.299	0.048	6.2	0.1966	0.0000	OK
15 minute winter	12	11	86.918	0.108	19.6	0.6186	0.0000	OK
15 minute winter	4	11	86.520	0.102	80.7	0.1794	0.0000	OK
15 minute winter	5	11	85.342	0.130	80.8	0.2296	0.0000	OK
15 minute winter	13	11	84.532	0.109	80.8	0.1924	0.0000	OK
15 minute winter	15	11	83.360	0.096	80.8	0.1700	0.0000	OK
180 minute winter	24	140	78.463	0.408	30.2	1.0387	0.0000	OK
180 minute winter	17	136	78.463	0.539	24.2	1.3723	0.0000	SURCHARGED
180 minute winter	25	136	78.463	0.550	15.9	2.4890	0.0000	SURCHARGED
180 minute winter	18	136	77.715	0.036	13.1	0.0311	0.0000	OK
180 minute winter	19	140	74.766	0.032	13.1	0.0278	0.0000	OK
180 minute winter	20	140	70.162	0.039	13.1	0.0336	0.0000	OK
180 minute winter	Outfall	140	69.830	0.038	13.1	0.0000	0.0000	OK
15 minute winter	100	11	93.084	0.084	12.6	0.4159	0.0000	OK
15 minute winter	101	11	92.833	0.173	40.3	0.6594	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	1.000	2	18.3	2.278	0.423	0.1252	
15 minute winter	6	2.000	7	8.2	1.015	0.393	0.1868	
15 minute winter	7	2.001	2	12.7	1.469	0.475	0.2213	
15 minute winter	2	1.001	3	39.1	2.807	0.305	0.6613	
30 minute summer	8	3.000	9	4.7	1.037	0.023	0.1323	
15 minute winter	9	3.001	9a	10.9	0.755	0.082	1.2501	
60 minute winter	9a	Hydro-Brake®	10	6.0				
15 minute winter	10	3.002	14	11.9	1.787	0.039	0.1181	
15 minute winter	14	3.003	3	14.7	1.448	0.062	0.1206	
15 minute winter	3	1.002	4	61.7	3.606	0.169	0.1642	
15 minute winter	11	4.000	12	6.0	1.272	0.206	0.0647	
15 minute winter	12	4.001	4	19.0	1.029	0.449	0.6591	
15 minute winter	4	1.003	5	80.8	2.799	0.158	0.5381	
15 minute winter	5	1.004	13	80.8	2.681	0.225	0.7456	
15 minute winter	13	1.005	15	80.8	3.312	0.160	0.4470	
15 minute winter	15	1.006	24	80.3	3.694	0.137	0.8168	
180 minute winter	24	1.007	17	24.2	0.216	0.001	48.5816	
180 minute winter	17	1.008	25	15.9	0.330	0.041	0.9665	
180 minute winter	25	Hydro-Brake®	18	13.1				
180 minute winter	18	1.010	19	13.1	1.334	0.018	0.9206	
180 minute winter	19	1.011	20	13.1	1.254	0.015	1.0399	
180 minute winter	20	1.012	Outfall	13.1	1.120	0.021	0.1659	197.5
15 minute winter	100	10.000	101	12.1	0.916	0.286	0.4528	
15 minute winter	101	10.001	102	40.2	0.951	0.567	1.0285	

Results for 1 year Critical Storm Duration. Lowest mass balance: 95.58%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	102	12	92.739	0.178	46.3	0.5845	0.0000	OK
240 minute winter	103	184	91.682	0.516	14.2	4.0266	0.0000	OK
240 minute winter	HB1	184	91.682	0.584	8.6	4.1272	0.0000	OK
15 minute winter	104	10	93.082	0.082	11.2	0.3778	0.0000	OK
15 minute winter	105	11	93.043	0.117	20.8	0.5320	0.0000	OK
240 minute winter	106	184	91.683	0.452	3.7	3.5895	0.0000	OK
15 minute summer	STORAGE	1	93.138	0.000	0.0	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	102	10.002	103	45.0	1.082	0.634	1.9649	
240 minute winter	103	10.003	HB1	8.6	0.274	0.002	17.8132	
240 minute winter	HB1	Hydro-Brake®	8	4.7				
15 minute winter	104	11.000	105	10.9	0.657	0.257	0.1868	
15 minute winter	105	11.001	101	20.3	0.996	0.510	0.6587	
240 minute winter	106	12.000	103	-2.1	0.080	-0.001	14.3244	
15 minute summer	STORAGE	13.000	103	0.0	0.000	0.000	0.0000	

Results for 30 year Critical Storm Duration. Lowest mass balance: 95.58%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	1	12	91.594	0.169	45.3	1.5015	0.0000	SURCHARGED
15 minute winter	6	11	91.527	0.127	20.3	0.6222	0.0000	OK
15 minute winter	7	12	91.309	0.225	30.9	0.7939	0.0000	SURCHARGED
15 minute winter	2	10	90.577	0.143	88.9	0.6740	0.0000	OK
360 minute winter	8	296	91.033	0.033	5.3	0.0583	0.0000	OK
240 minute winter	9	232	91.015	0.715	8.4	3.2643	0.0000	SURCHARGED
240 minute winter	9a	232	91.014	1.234	8.1	5.5806	0.0000	FLOOD RISK
15 minute winter	10	10	89.315	0.055	22.9	0.2207	0.0000	OK
15 minute winter	14	10	88.038	0.071	29.6	0.1928	0.0000	OK
15 minute winter	3	10	87.664	0.151	137.5	0.6828	0.0000	OK
15 minute winter	11	10	87.326	0.075	14.9	0.3087	0.0000	OK
15 minute winter	12	11	87.025	0.215	47.3	1.2276	0.0000	OK
15 minute winter	4	10	86.579	0.161	179.5	0.2842	0.0000	OK
15 minute winter	5	10	85.420	0.208	179.0	0.3677	0.0000	OK
15 minute winter	13	11	84.595	0.172	178.1	0.3038	0.0000	OK
15 minute winter	15	11	83.413	0.149	178.9	0.2638	0.0000	OK
360 minute winter	24	352	79.237	1.182	42.1	3.0074	0.0000	OK
360 minute winter	17	352	79.237	1.313	28.1	3.3413	0.0000	SURCHARGED
360 minute winter	25	352	79.236	1.323	29.8	5.9863	0.0000	SURCHARGED
30 minute summer	18	21	77.715	0.036	13.2	0.0312	0.0000	OK
30 minute summer	19	98	74.766	0.032	13.2	0.0278	0.0000	OK
30 minute summer	20	99	70.162	0.039	13.2	0.0336	0.0000	OK
30 minute summer	Outfall	99	69.830	0.038	13.2	0.0000	0.0000	OK
15 minute winter	100	12	93.169	0.169	30.2	0.8389	0.0000	OK
15 minute winter	101	12	93.107	0.447	85.5	1.6993	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	1.000	2	42.4	2.653	0.978	0.2717	
15 minute winter	6	2.000	7	19.6	1.173	0.942	0.3846	
15 minute winter	7	2.001	2	27.0	1.689	1.009	0.4449	
15 minute winter	2	1.001	3	88.0	3.407	0.688	1.2275	
360 minute winter	8	3.000	9	5.3	0.997	0.026	0.7646	
240 minute winter	9	3.001	9a	8.1	0.490	0.061	2.5562	
240 minute winter	9a	Hydro-Brake®	10	6.0				
15 minute winter	10	3.002	14	22.8	2.118	0.075	0.1901	
15 minute winter	14	3.003	3	29.4	1.408	0.124	0.2286	
15 minute winter	3	1.002	4	136.7	4.305	0.375	0.3047	
15 minute winter	11	4.000	12	14.7	1.379	0.504	0.1769	
15 minute winter	12	4.001	4	44.3	1.222	1.046	1.2914	
15 minute winter	4	1.003	5	179.0	3.319	0.350	1.0022	
15 minute winter	5	1.004	13	178.1	3.190	0.496	1.3803	
15 minute winter	13	1.005	15	178.9	3.974	0.354	0.8249	
15 minute winter	15	1.006	24	180.4	4.585	0.308	1.4787	
360 minute winter	24	1.007	17	28.1	0.174	0.001	182.0982	
360 minute winter	17	1.008	25	29.8	0.120	0.077	0.9665	
360 minute winter	25	Hydro-Brake®	18	13.2				
30 minute summer	18	1.010	19	13.2	1.337	0.018	0.9233	
30 minute summer	19	1.011	20	13.2	1.256	0.015	1.0430	
30 minute summer	20	1.012	Outfall	13.2	1.121	0.021	0.1664	181.5
15 minute winter	100	10.000	101	29.5	0.987	0.697	1.2297	
15 minute winter	101	10.001	102	78.7	1.117	1.110	1.6992	

Results for 30 year Critical Storm Duration. Lowest mass balance: 95.58%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	102	12	92.949	0.388	92.3	1.2705	0.0000	SURCHARGED
360 minute winter	103	296	92.904	1.738	25.1	13.5560	0.0000	SURCHARGED
360 minute winter	HB1	296	92.903	1.805	10.7	12.7569	0.0000	SURCHARGED
15 minute winter	104	12	93.350	0.350	26.9	1.6153	0.0000	SURCHARGED
15 minute winter	105	12	93.324	0.398	44.8	1.8063	0.0000	SURCHARGED
360 minute winter	106	304	92.904	1.673	6.7	13.2868	0.0000	SURCHARGED
15 minute summer	STORAGE	1	93.138	0.000	0.0	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	102	10.002	103	91.2	1.325	1.285	3.0655	
360 minute winter	103	10.003	HB1	10.7	0.221	0.003	53.5891	
360 minute winter	HB1	Hydro-Brake®	8	5.3				
15 minute winter	104	11.000	105	22.3	0.718	0.526	0.4415	
15 minute winter	105	11.001	101	39.6	1.058	0.993	1.2850	
360 minute winter	106	12.000	103	-3.7	0.074	-0.001	51.3181	
15 minute summer	STORAGE	13.000	103	0.0	0.000	0.000	0.0000	

Results for 100 year +30% CC Critical Storm Duration. Lowest mass balance: 95.58%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	1	12	92.217	0.792	75.3	7.0326	0.0000	SURCHARGED
15 minute winter	6	13	92.112	0.712	33.7	3.5019	0.0000	SURCHARGED
15 minute winter	7	13	91.703	0.619	38.4	2.1812	0.0000	SURCHARGED
15 minute winter	2	11	90.608	0.174	114.1	0.8210	0.0000	OK
60 minute winter	8	38	91.121	0.121	6.0	0.2143	0.0000	OK
60 minute winter	9	38	91.119	0.819	20.6	3.7403	0.0000	SURCHARGED
720 minute winter	9a	390	91.100	1.320	8.8	5.9717	29.0755	FLOOD
15 minute winter	10	10	89.327	0.067	33.9	0.2680	0.0000	OK
15 minute winter	14	10	88.057	0.090	45.2	0.2437	0.0000	OK
15 minute winter	3	11	87.701	0.188	187.9	0.8530	0.0000	OK
15 minute winter	11	12	87.581	0.330	24.7	1.3518	0.0000	SURCHARGED
15 minute winter	12	12	87.372	0.562	70.9	3.2067	0.0000	SURCHARGED
15 minute winter	4	11	86.618	0.200	251.9	0.3529	0.0000	OK
15 minute winter	5	11	85.477	0.265	251.9	0.4684	0.0000	OK
15 minute winter	13	11	84.638	0.215	251.7	0.3800	0.0000	OK
15 minute winter	15	11	83.446	0.182	251.6	0.3219	0.0000	OK
480 minute winter	24	344	80.557	2.502	264.1	6.3674	0.0000	SURCHARGED
480 minute winter	17	344	80.558	2.634	207.7	6.7030	0.0000	SURCHARGED
480 minute winter	25	344	80.557	2.644	25.0	11.9611	0.0000	SURCHARGED
480 minute winter	18	344	77.716	0.037	14.4	0.0325	0.0000	OK
480 minute winter	19	352	74.767	0.033	14.3	0.0289	0.0000	OK
480 minute winter	20	352	70.164	0.041	14.3	0.0354	0.0000	OK
480 minute winter	Outfall	352	69.832	0.040	14.6	0.0000	0.0000	OK
15 minute winter	100	12	93.843	0.843	50.2	4.1853	0.0000	SURCHARGED
120 minute winter	101	78	93.774	1.114	68.2	4.2352	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	1.000	2	51.6	2.931	1.190	0.2738	
15 minute winter	6	2.000	7	21.8	1.236	1.044	0.4047	
15 minute winter	7	2.001	2	34.0	1.934	1.274	0.4461	
15 minute winter	2	1.001	3	113.2	3.555	0.885	1.5145	
60 minute winter	8	3.000	9	6.0	0.815	0.029	0.9953	
60 minute winter	9	3.001	9a	18.8	0.773	0.141	2.5562	
720 minute winter	9a	Hydro-Brake®	10	6.0				
15 minute winter	10	3.002	14	33.8	2.310	0.112	0.2589	
15 minute winter	14	3.003	3	45.0	1.472	0.190	0.3065	
15 minute winter	3	1.002	4	188.1	4.574	0.516	0.3939	
15 minute winter	11	4.000	12	20.4	1.388	0.698	0.2414	
15 minute winter	12	4.001	4	64.5	1.622	1.521	1.3846	
15 minute winter	4	1.003	5	251.9	3.513	0.492	1.3277	
15 minute winter	5	1.004	13	251.7	3.380	0.702	1.8348	
15 minute winter	13	1.005	15	251.6	4.249	0.498	1.0841	
15 minute winter	15	1.006	24	251.5	4.963	0.430	1.9040	
480 minute winter	24	1.007	17	-235.7	0.182	-0.008	347.0264	
480 minute winter	17	1.008	25	-194.4	-0.613	-0.503	0.9665	
480 minute winter	25	Hydro-Brake®	18	14.4				
480 minute winter	18	1.010	19	14.3	1.369	0.020	0.9766	
480 minute winter	19	1.011	20	14.3	1.284	0.016	1.1129	
480 minute winter	20	1.012	Outfall	14.6	1.156	0.024	0.1789	521.3
15 minute winter	100	10.000	101	35.3	0.987	0.835	1.3634	
120 minute winter	101	10.001	102	67.3	0.986	0.950	1.6992	

Results for 100 year +30% CC Critical Storm Duration. Lowest mass balance: 95.58%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
120 minute winter	102	78	93.733	1.172	77.8	3.8375	0.0000	SURCHARGED
480 minute winter	103	448	93.727	2.561	46.2	19.9760	0.0000	SURCHARGED
480 minute winter	HB1	448	93.725	2.627	14.7	18.5709	0.0000	FLOOD RISK
15 minute winter	104	13	94.125	1.125	44.7	5.1922	0.0000	SURCHARGED
15 minute winter	105	13	94.075	1.149	64.3	5.2138	0.0000	SURCHARGED
480 minute winter	106	448	93.727	2.496	11.0	19.8290	0.0000	SURCHARGED
480 minute winter	STORAGE	448	93.727	0.589	44.9	114.0939	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)
120 minute winter	102	10.002	103	77.6	1.220	1.093	3.3301	
480 minute winter	103	10.003	HB1	14.7	0.225	0.004	53.5891	
480 minute winter	HB1	Hydro-Brake®	8	6.3				
15 minute winter	104	11.000	105	28.8	0.724	0.680	0.4415	
15 minute winter	105	11.001	101	54.7	1.375	1.373	1.2850	
480 minute winter	106	12.000	103	7.8	0.077	0.002	51.3181	
480 minute winter	STORAGE	13.000	103	-44.9	-1.572	-1.301	0.1989	

APPENDIX G

PROPOSED DEVELOPMENT PLANS

DO NOT SCALE THIS DRAWING | A1

GENERAL NOTES:

1. Before construction commences, the setting out Engineer shall ensure that all setting out information is mutually compatible with all the drawings and documents provided by the designers. Where information is apparently contradictory or ambiguous, the design Engineer and/or the Architect is to be informed immediately. Thomas Consulting will accept no liability for setting out errors where work is constructed to incorrect information.

2. All drawings and documents are to be read in conjunction with one another, are mutually compatible and shall be read as such. All documents shall be checked to ensure that they are compatible by the contractor before construction commences. In the event of apparent ambiguity or contradiction the engineer and/or architect shall be notified immediately. Thomas Consulting accept no liability in the event of not being so notified and where construction work has commenced.

3. In accordance with CDM regulations 2015 this drawing has been prepared with due attention to identifying any unusual design hazards that may exist. Unusual design hazards are hazards that a reasonably competent contractor, experienced in this type of work may not be expected to identify. In dealing with unusual design hazards we have adopted the "ERIC" principle and where possible eliminated (E) the hazard at design stage, if it has not been possible to eliminate the hazard we have endeavoured to reduce (R) it. Where it has not been possible to eliminate these hazards, the hazard is noted on the drawing with appropriate information (I) in order that the hazard can be controlled (C) during construction. It is the contractor's responsibility to fully acquaint themselves with all construction drawings before commencing construction and if in doubt about any matter to ask for clarification from the designer.

4. All drawings issued electronically for this scheme are provided for the sole purpose of assisting the design, procurement or construction of the structures for which Thomas Consulting have been appointed as Design Engineers/Consultants. They may not be used for any other purpose, nor may they be amended, copied, redistributed or issued to third parties without the written agreement of Thomas Consulting. All drawings remain under copyright to, and the intellectual property of, Thomas Consulting. Upon completion of the project, all drawings are to be deleted from your computer systems and all other electronic copies destroyed. Where electronic copies of final drawings are to be issued, these will be provided in a digital only format by Thomas Consulting (no other copies may be retained). By opening and using this drawing, it is assumed that you agree to abide by these Terms and Conditions.

5. Unless expressly agreed with a director of Thomas Consulting Ltd, for the purposes of the CDM regulations 2015 Thomas Consulting are not the Principal Designer. The client has been advised that they are required to appoint a Principal Designer. For further information see http://www.hse.gov.uk/.

REVISIONS

REV	DATE	DESCRIPTION	DRAWN BY	CHECKED BY
A	30.09.20	Planning Issue	JP	MJ
B	03.03.21	Drainage amended to allow for 40% Climate Change	MJ	JP
C	20.05.21	Drainage amended to allow for Cv of 1.0. Exceedance flows added.	MJ	JP

DRAWING STATUS:

PRELIMINARY ISSUE

THOMAS CONSULTING
STRUCTURAL & CIVIL DESIGN ENGINEERS

Offices in Chorley, Lancaster & Shrewsbury
Tel: 01524 846022
e-mail: info@thomasconsulting.co.uk

CLIENT: gleeson

PROJECT:

WATERS EDGE
WHITEHEAVEN

DRAWING TITLE:

DRAINAGE
LAYOUT PLAN

DATE CREATED:	DRAWING SCALE:	DRAWN BY:	CHECKED BY:	QA CATEGORY:
06/03/2020	1:250	JP	MJ	1

DRAWING REF:	REV:
TC / T19360 / A1 / 100	C

DO NOT SCALE THIS DRAWING | A1

GENERAL NOTES:

1. Before construction commences, the setting out Engineer shall ensure that all setting out information is mutually compatible with all the drawings and documents provided by the designers. Where information is apparently contradictory or ambiguous, the design Engineer and/or the Architect is to be informed immediately. Thomas Consulting will accept no liability for setting out errors where work is constructed to incorrect information.

2. All drawings and documents are to be read in conjunction with one another, are mutually compatible and shall be read as such. All documents shall be checked to ensure that they are compatible by the contractor before construction commences. In the event of apparent ambiguity or contradiction the engineer and/or architect shall be notified immediately. Thomas Consulting accept no liability in the event of not being so notified and where construction work has commenced.

3. In accordance with CDM regulations 2015 this drawing has been prepared with due attention to identifying any unusual design hazards that may exist. Unusual design hazards are hazards that a reasonably competent contractor, experienced in this type of work may not be expected to identify. In dealing with unusual design hazards we have adopted the "ERIC" principle and where possible eliminated (E) the hazard at design stage, if it has not been possible to eliminate the hazard we have endeavoured to reduce (R) it. Where it has not been possible to eliminate these hazards, the hazard is noted on the drawing with appropriate information (I) in order that the hazard can be controlled (C) during construction. It is the contractor's responsibility to fully acquaint themselves with all construction drawings before commencing construction and if in doubt about any matter to ask for clarification from the designer.

4. All drawings issued electronically for this scheme are provided for the sole purpose of assisting the design, procurement or construction of the structures for which Thomas Consulting have been appointed as Design Engineers/Consultants. They may not be used for any other purpose, nor may they be amended, copied, redistributed or issued to third parties without the written agreement of Thomas Consulting. All drawings remain under copyright to, and the intellectual property of, Thomas Consulting. Upon completion of the project, all drawings are to be deleted from your computer systems and all other electronic copies destroyed. Where electronic copies of final drawings are to be issued, these will be provided in a digital only format by Thomas Consulting (no other copies may be retained). By opening and using this drawing, it is assumed that you agree to abide by these Terms and Conditions.

5. Unless expressly agreed with a director of Thomas Consulting Ltd, for the purposes of the CDM regulations 2015 Thomas Consulting are not the Principal Designer. The client has been advised that they are required to appoint a Principal Designer. For further information see http://www.hse.gov.uk/.

REVISIONS

REV	DATE	DESCRIPTION	DRAWN BY	CHECKED BY
A	30.09.20	Planning Issue	JP	MJ

DRAWING STATUS:
PRELIMINARY ISSUE

THOMAS CONSULTING
STRUCTURAL & CIVIL DESIGN ENGINEERS
Offices in Chorley, Lancaster & Shrewsbury
Tel: 01524 846022
e-mail: info@thomasconsulting.co.uk

CLIENT: gleeson

PROJECT:
WATERS EDGE
WHITEHEAVEN

DRAWING TITLE:
HIGHWAYS
LAYOUT PLAN

DATE CREATED:	DRAWING SCALE:	DRAWN BY:	CHECKED BY:	QA CATEGORY:
06/03/2020	1:250	JP	MJ	1

DRAWING REF:	REV:
TC / T19360 / A1 / 101	A

DO NOT SCALE THIS DRAWING | A1

GENERAL NOTES:

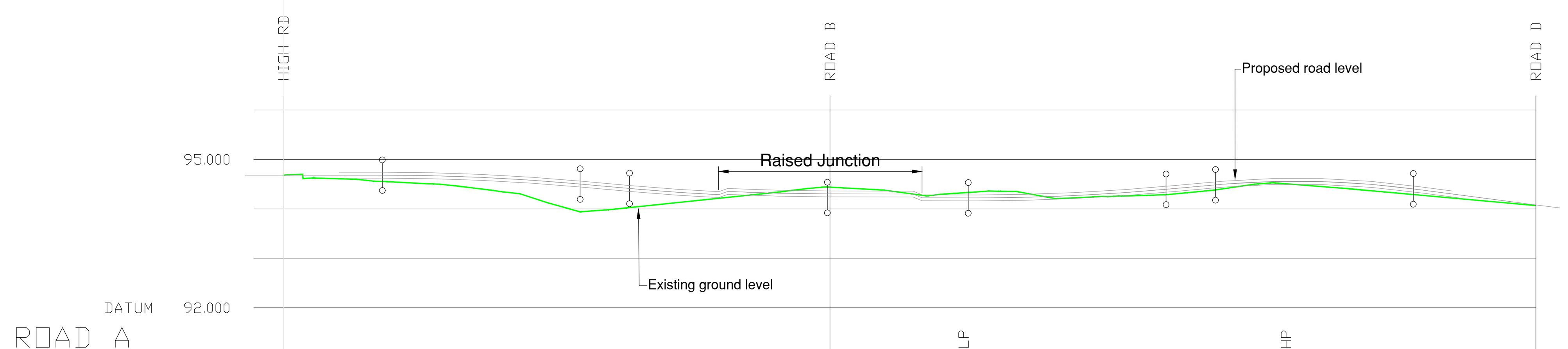
1. Before construction commences, the setting out Engineer shall ensure that all setting out information is mutually compatible with all the drawings and documents provided by the designers. Where information is apparently contradictory or ambiguous, the design Engineer and/or the Architect is to be informed immediately. Thomas Consulting will accept no liability for setting out errors where work is constructed to incorrect information.

2. All drawings and documents are to be read in conjunction with one another, are mutually compatible and shall be read as such. All documents shall be checked to ensure that they are compatible by the contractor before construction commences. In the event of apparent ambiguity or contradiction the engineer and/or architect shall be notified immediately. Thomas Consulting accept no liability in the event of not being so notified and where construction work has commenced.

3. In accordance with CDM regulations 2015 this drawing has been prepared with due attention to identifying any unusual design hazards that may exist. Unusual design hazards are hazards that a reasonably competent contractor, experienced in this type of work may not be expected to identify. In dealing with unusual design hazards we have adopted the "ERIC" principle and where possible eliminated (E) the hazard at design stage, if it has not been possible to eliminate the hazard we have endeavoured to reduce (R) it. Where it has not been possible to eliminate these hazards, the hazard is noted on the drawing with appropriate information (I) in order that the hazard can be controlled (C) during construction. It is the contractor's responsibility to fully acquaint themselves with all construction drawings before commencing construction and if in doubt about any matter to ask for clarification from the designer.

4. All drawings issued electronically for this scheme are provided for the sole purpose of assisting the design, procurement or construction of the structures for which Thomas Consulting have been appointed as Design Engineers/Consultants. They may not be used for any other purpose, nor may they be amended, copied, redistributed or issued to third parties without the written agreement of Thomas Consulting. All drawings remain under copyright to, and the intellectual property of, Thomas Consulting. Upon completion of the project, all drawings are to be deleted from your computer systems and all other electronic copies destroyed. Where electronic copies of final drawings are to be issued, these will be provided in a digital only format by Thomas Consulting (no other copies may be retained). By opening and using this drawing, it is assumed that you agree to abide by these Terms and Conditions.

5. Unless expressly agreed with a director of Thomas Consulting Ltd, for the purposes of the CDM regulations 2015 Thomas Consulting are not the Principal Designer. The client has been advised that they are required to appoint a Principal Designer. For further information see http://www.hse.gov.uk/.

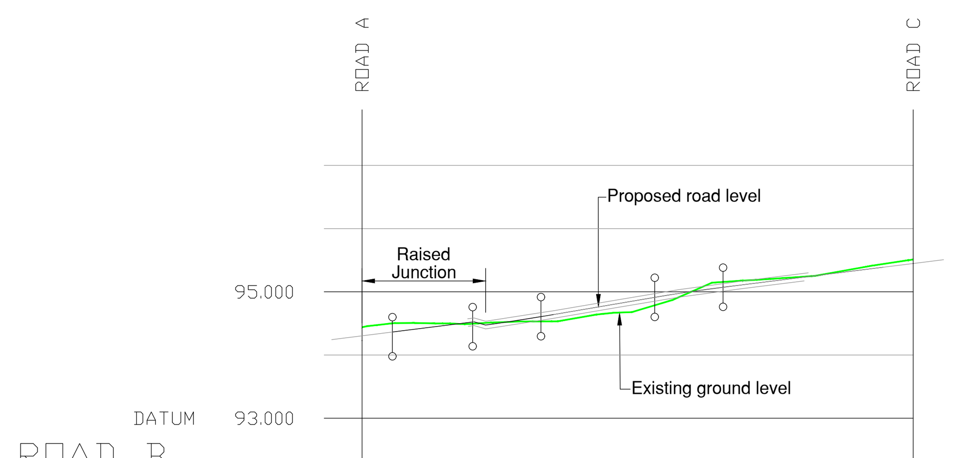


ROAD A

CHAINAGE	0.000, 5.663, 6.331, 10.000, 15.000, 20.000, 25.000, 30.000, 35.000, 40.000, 45.000, 50.000, 55.000, 55.266, 60.000, 69.245, 69.780, 70.000, 73.821, 75.000, 80.000, 85.000, 89.245, 90.000, 90.770, 94.245, 95.000, 100.000, 102.387, 105.000, 110.000, 114.245, 118.198, 118.844, 120.000, 126.648
EXISTING GROUND LEVEL	94.682, 94.555, 94.403, 93.941, 94.130, 94.338, 94.387, 94.342, 94.223, 94.300, 94.527, 94.367, 94.187, 94.067
ALIGNMENT LEVEL	94.682, 94.682, 94.670, 94.637, 94.581, 94.503, 94.413, 94.334, 94.352, 94.317, 94.304, 94.302, 94.222, 94.222, 94.222, 94.234, 94.270, 94.329, 94.397, 94.410, 94.486, 94.499, 94.553, 94.560, 94.552, 94.496, 94.404, 94.254, 94.143
VERTICAL ALIGNMENT	G= 0.000%; L= 20.000 KF= -11.16904; G= -1.791% 1: -55.8; KF= 11.48616 L= 20.000; G= -0.049% 1: -2022.7; KF= 10.83701 L= 20.000; G= 1.796% 1: 55.7; L= 20.000 KF= -4.53334; G= -2.616% 1: -38.2
HORIZONTAL ALIGNMENT	R= 102.400
LEFT HAND CHANNEL	94.742, 94.742, 94.742, 94.730, 94.697, 94.641, 94.563, 94.473, 94.394, 94.412, 94.377, 94.364, 94.362, 94.284, 94.282, 94.294, 94.330, 94.389, 94.470, 94.559, 94.613, 94.612, 94.556, 94.445, 94.361
RIGHT HAND CHANNEL	94.622, 94.622, 94.610, 94.577, 94.521, 94.443, 94.353, 94.274, 94.292, 94.257, 94.244, 94.242, 94.164, 94.162, 94.174, 94.210, 94.269, 94.350, 94.439, 94.493, 94.492, 94.436, 94.325, 94.241, 94.224

ROAD A - LONGITUDINAL SECTION

SCALE: 1:100 HORIZONTAL 1:500 VERTICAL

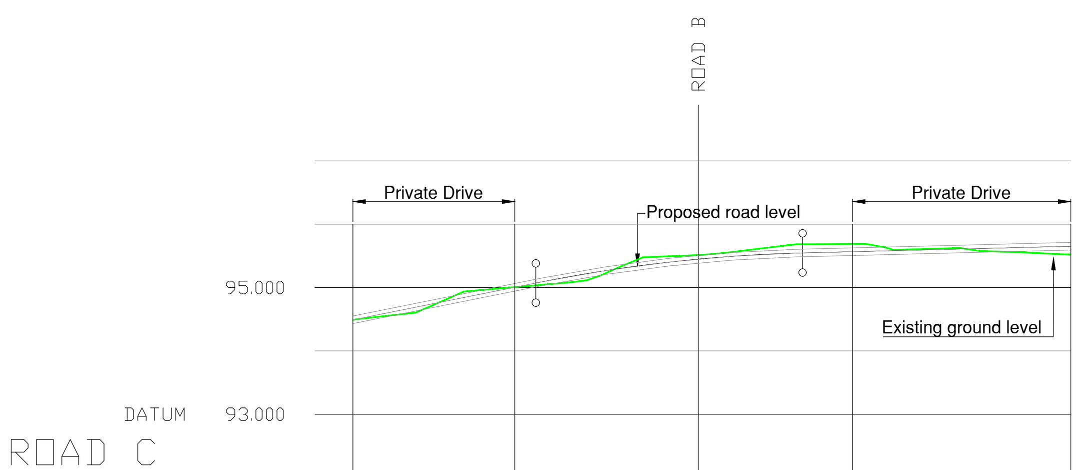


ROAD B

CHAINAGE	0.000, 2.400, 8.853, 9.767, 14.145, 20.000, 23.143, 25.000, 28.544, 30.000, 30.113, 34.959, 35.287, 35.560, 40.000, 43.584
EXISTING GROUND LEVEL	94.440, 94.511, 94.806, 95.176, 95.402, 95.512
ALIGNMENT LEVEL	94.364, 94.525, 94.474, 94.609, 94.806, 94.971, 94.973, 95.072, 95.108, 95.358, 95.388
VERTICAL ALIGNMENT	G= 2.500% 1: 40.0; KF= 6.0 L= 5.401; G= 3.400% 1: 29.4; L= 5.401 KF= -6.0; G= 2.500% 1: 40.0
HORIZONTAL ALIGNMENT	R= 22.400
LEFT HAND CHANNEL	94.586, 94.535, 94.670, 94.866, 95.033, 95.168, 95.293, 95.301
RIGHT HAND CHANNEL	94.466, 94.414, 94.549, 94.746, 94.913, 95.048, 95.172

ROAD B - LONGITUDINAL SECTION

SCALE: 1:100 HORIZONTAL 1:500 VERTICAL

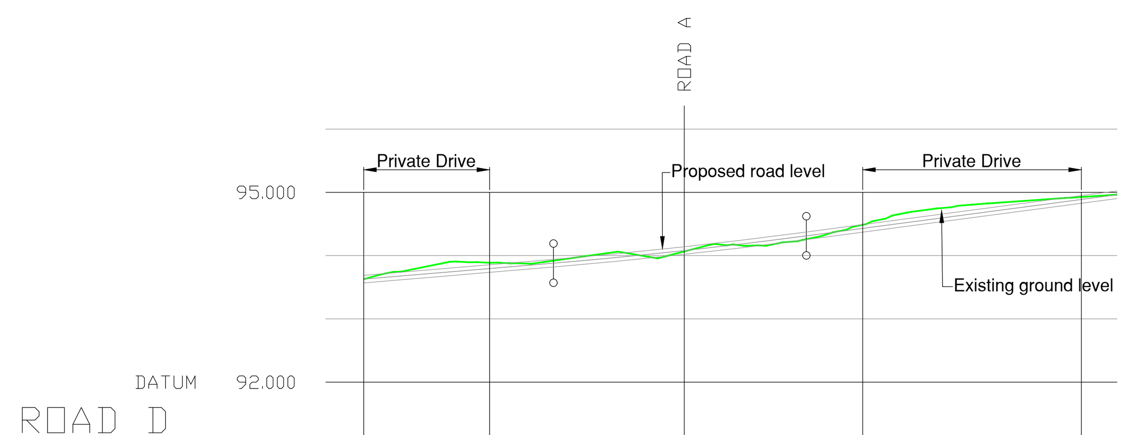


ROAD C

CHAINAGE	0.000, 10.000, 12.797, 14.461, 15.000, 20.000, 25.000, 27.300, 30.000, 35.000, 35.539, 39.487, 40.000, 50.000, 56.744
EXISTING GROUND LEVEL	94.490, 94.957, 95.228, 95.561, 95.689, 95.575, 95.519
ALIGNMENT LEVEL	94.490, 94.891, 95.070, 95.092, 95.267, 95.401, 95.493, 95.543, 95.546, 95.568, 95.618, 95.652
VERTICAL ALIGNMENT	G= 4.013% 1: 24.9; L= 21.078 KF= -6.0; G= 0.500% 1: 200.0
HORIZONTAL ALIGNMENT	
LEFT HAND CHANNEL	94.550, 94.751, 94.951, 95.152, 95.327, 95.461, 95.553, 95.603, 95.628, 95.653, 95.678, 95.703, 95.712
RIGHT HAND CHANNEL	94.430, 94.631, 94.831, 95.032, 95.207, 95.341, 95.433, 95.483, 95.508, 95.533, 95.558, 95.583, 95.592

ROAD C - LONGITUDINAL SECTION

SCALE: 1:100 HORIZONTAL 1:500 VERTICAL



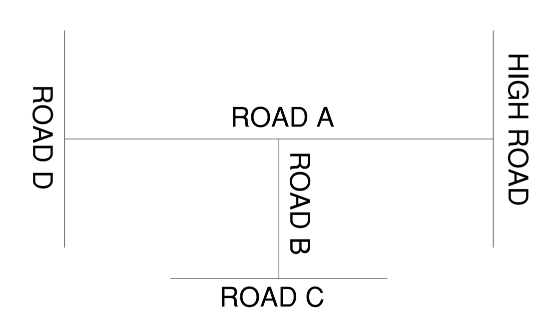
ROAD D

CHAINAGE	0.000, 9.954, 10.000, 15.000, 20.000, 23.742, 25.000, 25.347, 30.000, 35.000, 39.458, 40.000, 50.000, 55.740, 59.560
EXISTING GROUND LEVEL	93.628, 93.886, 94.060, 94.156, 94.525, 94.835, 94.962
ALIGNMENT LEVEL	93.628, 93.796, 93.880, 93.970, 94.072, 94.187, 94.313, 94.445, 94.710, 94.962
VERTICAL ALIGNMENT	G= 1.680% 1: 59.5; KF= 20.72485 L= 20.000; G= 2.645% 1: 37.8
HORIZONTAL ALIGNMENT	R= 82.400
LEFT HAND CHANNEL	93.688, 93.772, 93.856, 93.940, 94.030, 94.132, 94.247, 94.373, 94.505, 94.637, 94.770, 94.902, 95.022
RIGHT HAND CHANNEL	93.568, 93.652, 93.736, 93.820, 93.910, 94.012, 94.127, 94.253, 94.385, 94.517, 94.650, 94.782, 94.902

ROAD D - LONGITUDINAL SECTION

SCALE: 1:100 HORIZONTAL 1:500 VERTICAL

ROAD ID: KEY



REVISIONS

REV	DATE	DESCRIPTION	DRAWN BY	CHECKED BY
A	30.09.20	Planning Issue	JP	MJ
B	28.01.21	Raised junctions added.	JP	MJ
C	03.03.21	Raised junctions amended	MJ	JP
D	12.03.21	Private drives amended on Roads C & D	MJ	JP

DRAWING STATUS:
FOR BUILDING REGULATION APPROVAL

THOMAS CONSULTING
STRUCTURAL & CIVIL DESIGN ENGINEERS
Offices in Chorley, Lancaster & Shrewsbury
Tel: 01524 846022
e-mail: info@thomasconsulting.co.uk

CLIENT: gleeson

PROJECT: WATERS EDGE WHITEHAVEN

DRAWING TITLE: HIGHWAYS LONGITUDINAL SECTION

DATE CREATED:	DRAWING SCALE:	DRAWN BY:	CHECKED BY:	QA CATEGORY:
06.03.20	AS SHOWN	JP	MJ	1

DRAWING REF: TC / T19360 / A1 / 102

REV: D