SHIELDS WILSON
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STRUCTURAL AND CIVIL ENGINEERING

PRELIMINARY DRAINAGE STRATEGY REPORT

UPON

PROPOSED RESIDENTIAL DEVELOPMENT

BARBERS DROVE NORTH

CROWLAND

PROJECT No: SW 20-102

DOCUMENT REF: SW 20-102-REP-01 rev B



Mr Patrick Burke
Burmor Construction

burmor construction

CONTENTS

1. INTRODUCTION 2
2. LOCATION & SITE DESCRIPTION 3
2.1. Site Location 3
2.2. Site Description 3
2.3. Site Geology 4
3. Flood Risk 4
4. SURFACE WATER 4
4.1. Existing Surface Water 4
4.2. SuDS Considerations 4
4.3. Surface Water drainage proposals 6
5. Foul Water 8
5.1. Existing Foul Water drainage 8
5.2. Foul Water drainage proposals 8
6. Management & Mainteanance strategy 9
7. Conclusions & Summuary 10
APPENDIX A – Location & Site Layout plan 11
APPENDIX B - Geology 14
APPENDIX C – Anglian Water Services Asset map 21
APPENDIX D – Proposed Drainage Arrangement Drawings 24
APPENDIX E – Surface Water model Calculations 28

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1. INTRODUCTION

Under the instruction of Burmor Construction, the following drainage strategy report has been prepared for a proposed residential development of 41 dwellings off Barbers Drove North, Crowland.

The strategy is based upon David Turnock Architects Site Plan drawing 2483/AL0205 rev F14

The object of this report is to clarify the design philosophies followed whilst preparing the proposed surface & foul water drainage arrangements for the site and to outline the proposed solution in sufficient detail for all relevant parties to be able to comment. This assessment also demonstrates that the proposals are within the guidance contained within the National Planning Policy Framework (NPPF)

This report has been prepared for the named client above and should not be relied upon by any other parties, expect the client and their specialist third party advisors, without the express written permission of Shields Wilson Limited.

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2. LOCATION & SITE DESCRIPTION

See Appendix A for a site Location plan and the proposed architectural site layout plan.

The Site layout is illustrated on David Turnock Architects drawing 2483/AL0205 F14.

2.1. Site Location

The site is approximately 1.3 hectares in size and is located North of James Road Crowland and accessed off Barbers Drove North.



2.2. Site Description

The proposed site is currently a grazing paddock sitting to the rear of a large detached dwelling accessed off Barbers Drove North.

The site is bound to the South West by Barbers Drove North, to the South East by James Road, to the North West by Dwellings and a large empty field and to the North East by the North Level IDB drain Greenbank Drain.

The site is a greenfield site used for grazing purposes and historically as agricultural land.

The topographical survey undertaken by MFM, drawing number 16170272-BR-CROW-3D-TOPO, illustrates that the current site levels vary from 1.3m – 1.7m AOD. Generally levels are lower in the Southern half of the site.

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2.3. Site Geology

The British Geological survey maps indicate the site to be underlain by Oxford Clay Formation, with superficial Tidal flat deposits of clay and silt.

A detailed Ground investigation has been undertaken by Ground Engineering, report No. C15122.

The report indicates explorations encountered deposits of sandy silty clay with silty marine sand below.

Despite the granular nature of the underlying ground conditions the report indicates that the infiltrations rates are generally poor. The ground water table was encountered at 2.0m below ground level.

Extracted borehole logs and BGS information are contained within Appendix B.

3. Flood Risk

A site-specific flood risk assessment has been prepared by Ellingham consulting Ltd. Report reference ECL0020.

The flood risk assessment has identified that a minimum floor level of 2.3m AOD is required.

4. SURFACE WATER

4.1. Existing Surface Water

The surrounding existing Highways and residential developments are served by a series of adopted Public Anglian Water sewers and the IDB drainage system.

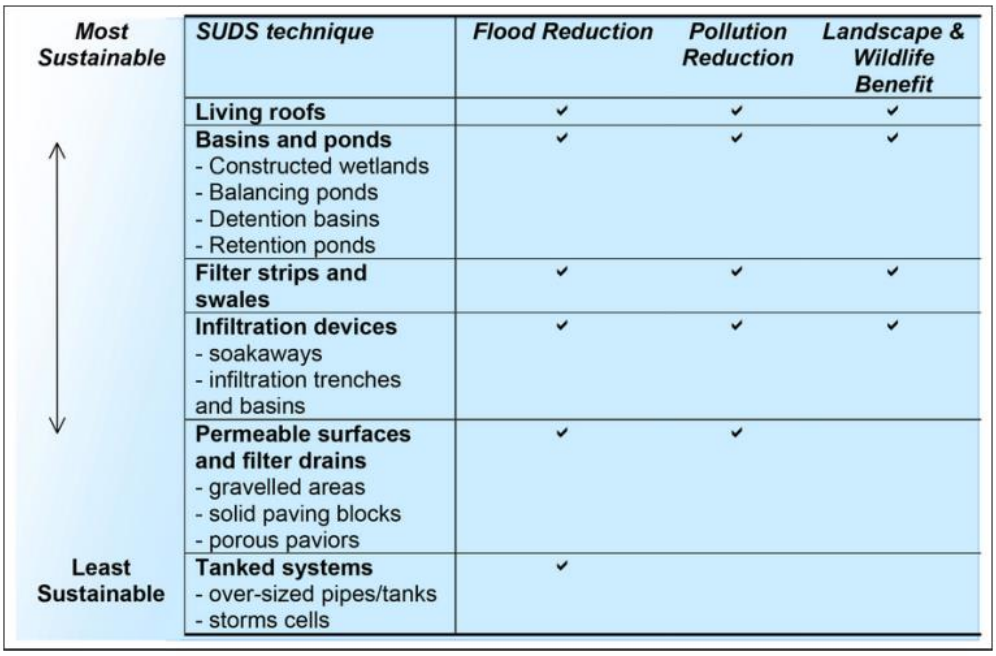
The site currently stands as a greenfield site with no active drainage system. The surface water run-off is served by the drain shared with James Road to the South East boundary and the IDB Greenbank Drain to the North East Boundary.

A copy of the Anglian water asset map is contained within Appendix C.

4.2. SuDS Considerations

The SuDS hierarchy has been given consideration during the design of the proposed surface water drainage system. As Highlighted previously within this report, it has been established that the sites geotechnical characteristics of poor infiltration rates and relatively high water table do not lend themselves to the use of an infiltration strategy.

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Most Sustainable	SUDS technique	Flood Reduction	Pollution Reduction	Landscape & Wildlife Benefit
	Living roofs	✔	✔	✔
	Basins and ponds - Constructed wetlands - Balancing ponds - Detention basins - Retention ponds	✔	✔	✔
	Filter strips and swales	✔	✔	✔
	Infiltration devices - soakaways - infiltration trenches and basins	✔	✔	✔
	Permeable surfaces and filter drains - gravelled areas - solid paving blocks - porous paviors	✔	✔	
Least Sustainable	**Tanked systems** - over-sized pipes/tanks - storms cells	✔		

The following table outlines considerations given for the proposed development following the hierarchy of SuDS within the CIRIA SuDS manual, as extracted above.

SUDS Technique	Commentary	Suitability
Infiltration by Soakaway	The underlying soil conditions do not lend themselves to an infiltration system with a development density of this rate.	No
Green Roofs	Green roofs are not considered suitable for traditional style dwellings, and considered uneconomical for housing.	No
Permeable Paving	Whilst infiltration techniques are not suitable for large collections of surface water from roofs and highways, the conditions are suitable for the use of permeable surfacing to the shared private drives and parking spaces. The underlying ground conditions are not suitable for the use of an permeable surface for the adopted Highway as the CBR values are below 3%.	Yes
Attenuation and discharge to surface water sewer	Initial conversations with North Level IDB engineer John Stubley indicate that a restricted flow discharge to the Greenbank IDB drain to the North boundary of the site would be acceptable.	Yes

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	The discharge rates would need to be restricted to Qbar or greenfield run-off rates to be acceptable to the IDB and LLFA in accordance with current guidance.	
Swales	A reasonable economical block plan for this site with a mix of general and affordable housing is considered not able to accommodate the space required for swales.	No
Detention Basins	There is area of shared public amenity space adjacent James Road and the IDB drain. This space could be utilised to locate an attenuation basin. Further attenuation may be necessary, and due to the generally very flat nature of the site is likely to be required in the form of buried tanks.	Yes
Ponds & Wetlands	Given the topographical and geological characteristics of the site a pond or permanent wetland is deemed unsuitable. The space required would negatively impact on the ability to develop an economical block plan.	No

4.3. Surface Water drainage proposals

As indicated in the SuDS review above initial discussions were had with North Level IDB engineer John Stubley to establish the viability of discharging the proposed system into the Greenbank drain. It was indicated to us that this would be a viable and acceptable route for the surface water from the development.

Initial plans were also sent for review and preliminary comment from local Highways officer Jon Sharpe who commented that they welcomed the inclusion of filter drains as a method of surface water collection and provision of suitable treatment train.

The natural topography on the site would preclude traditional gravity draining techniques due to the flat nature. However the minimum Floor level specified within the FRA generally raises the levels on site between 0.6m – 1.0m this has provided sufficient fall and cover for a gravity drainage system.

It is proposed to utilise a system of SuDS and traditional features to collect the surface water run-off, which will then be discharged into the main carrier drain running beneath the adopted highway.

The adopted Highways will be drained utilising filter drains, to be detailed in accordance with the Lincolnshire Highways Estate road specification. This will

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provide a suitable treatment train and slowing of the run-off from the highway. In accordance with guidance within the CIRIA SuDS manual.

The dwelling roof runoff water will be collected via. Downpipe and gutters, and will be discharged into a system of adopted Anglian water drains running underneath the adopted highways.

The carrier drain will be an adopted Anglian water sewer and will run generally North-Eastward towards the discharge into the IDB Greenbank drain.

Prior to outfall there will be a flow restriction device in the form of a hydro brake. The sites greenfield run-off rate will be unsuitably low due to the size of the site and as such a practical minimum of 5l/s will be utilised. This is generally accepted as the minimum acceptable in fenland areas due to the flat sites and systems generating very small orifice sizes for smaller flow values. It is also the preferred minimum of Anglian water who we propose will adopt the flow restriction device and take responsibility for on going maintenance.

Prior to the flow restriction device there will be a requirement for attenuation to be provided within the system to provide the necessary storage volumes.

The attenuation volumes required will be provided in two forms, one offline attenuation tank in the form of Geocelluar crates half way along the system and an online detention basin immediately prior to the flow restriction device.

The design proposals are illustrated on our arrangement and key details drawings SW20-102/100, 101 & 102, included within Appendix E.

The system has been modelled utilising Causeway Flow drainage design and simulation software. The calculation inputs and outputs are included within Appendix E.

The calculations demonstrate that the attenuated run-off volume is stored and completely contained below surface for the 1 in 100 year storm event within a 40% climate change and 10% urban creep allowance.

There are additional robustness built into the design in that the capacity of storage provided by the filter drains of approximately 14m³ has not been incorporated into the model.

To ensure that the high water table on the site do not effect the attenuation features no infiltration has been considered. This complies with he requirements of adoptable standards for these features.

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5. Foul Water

5.1. Existing Foul Water drainage

The existing foul water drainage serving the dwellings adjacent the site discharge into the public foul sewer within Barbers Drove North, which then runs Northward towards the system running along Peterborough road.

The Anglian water asset map is contained with Appendix C.

5.2. Foul Water drainage proposals

The proposed dwellings will have private buried pipe foul water network. There will be an adopted main sewer beneath the adopted highway conveying the foul water South-Westward towards an outfall into the existing Anglian Water network along Barbers Drove North.

The design proposals are illustrated on our drawings SW20-102/100 & 101, included within Appendix D.

Pipes and gradients are to be sized using a peak flow calculated in accordance with Codes for adoption, 4000 l/dwelling./day, considering all 41 plots as individual private dwellings.

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6. Management & Mainteanance strategy

The proposed systems contain the following assets which are all require to be in reasonable working order for the systems to function as a whole and operate as anticipated within the design models.

Permeable block paved drives and parking
Gutters, downpipes and other building rainwater goods
Buried pipe networks and chambers, surface and foul water
Hydrobrake Flow restriction deice
Attenuation tank
Detention Basin

The private drive and parking space areas should be constructed utilising a permeable paving system and will be conveyed into the ownership of the private dwelling owners whose responsibility their maintenance will be.

Building rainwater goods and buried pipe networks immediately around properties will also be private and fall under the ownership and responsibility of the private dwelling owners.

The Highways surface and the Filter drains will be constructed to Lincolnshire Highways adoptable standards and will be offered for adoption under Section 38 of the Highways Act.

The main carrier sewers under the adoptable highway, the attenuation basin and the detention basin will all be built to the standards and requirements of the CIRIA SuDS manual and Codes for adoption and be offered to Anglian Water Services Ltd for adoption under Section 104 of the Drainage Act.

The scope/nature of inspection and maintenance is such that various facilities and structures are inspected and maintained at yearly intervals, as well as after or during use and/or heavy storm events, in order that they continue to perform effectively.

The maintenance schedule for the foul water system, should as a minimum consist of annual inspections and 5 yearly rodding/jetting should no issue be encountered.

The maintenance schedule for the surface water system will comprise the following activities in accordance with the CIRIA publication C753 (The SuDS Manual)

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Activity	Frequency	Typical Tasks
Routine/regular maintenance (including inspections and monitoring)	Monthly	• Litter/debris removal • Grass cutting (in season) • Inspection and clearance of gullies and drainage channels • Inspection of pumping station
Occasional maintenance	Annually	• Silt removal from catchpits/gullies • Pipe drainage every 3-5 years: suction sweeping (to Water Jetting Association standards) and CCTV where necessary
Remedial maintenance	As required (tasks to repair problems due to damage or vandalism	• Silt removal • Inlet/outlet repair • Erosion repairs • System rehabilitation following a pollution event • Pump failure

On completion of the above, ensure the drainage system is running freely and cleanly. If not, repeat maintenance activities. Written records should be kept of all maintenance work carried out.

7. Conclusions & Summuary

As illustrated by our design proposals on drawings SW20-102/100,101 & 102 and the information outlined within this report, it is demonstrable that a viable and robust surface & foul water scheme that comply with the requirements of National Planning Guidance can be provided for the proposed residential development.

Under the proposals outlined within the report, all the drainage features will be either adopted or under private house holder ownership and as such have suitable management and on-going maintenance.

For and on behalf of **SHIELDS WILSON LIMITED**

A P Wilson CEng MIStructE **05th January 2021**

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APPENDIX A – Location & Site Layout plan

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HOUSE TYPE LEGEND

APARTMENT
2 No. 1-bed apartments
GIA 45m² (484 sq.ft.)
2 Storey

HT 1
2-bed house
GIA 71m² (762 sq.ft.)
2 Storey

HT 2
3-bed house
GIA 79m² (846 sq.ft.)
2 Storey

HT 3
3-bed house
GIA 88m² (947 sq.ft.)
2 Storey

HT 4 (Option 1)
*drawing reference 2483_AB0805a
3-bed house
GIA 97m² (1047sq.ft.)
2 Storey

HT 4 (Option 2)
*drawing reference 2483_AB0805
3-bed house
GIA 97m² (1047sq.ft.)
2 Storey

HT 5
3-bed house
GIA 100m² (1077 sq.ft.)
2.5 Storey

HT 6
3-bed house
GIA 105m² (1135 sq.ft.)
2 Storey

HT 7
4-bed house
GIA 124m² (1334 sq.ft.)
2.5 Storey

HT 8
Chalet bungalow
GIA 133m² (1431.6 sq.ft.)
1.5 Storey

new trees
existing trees
trees to be removed
RPAs of trees
F Feature Elevation



0 5 25 50m
Scale 1:500 @ A1

This drawing is copyright of DT Architects. Do not scale from this drawing. Check all dimensions onsite. The contractor shall bring any discrepancies immediately to the notice of the Architect.

revision	note	date
P01	planning application issue	08.01.21

client
Burmor Construction
(on behalf of Lion Investment Group LTD)

project title
Residential Development
at Barbers Drove North Crowland

drawing title
Site Plan Proposed

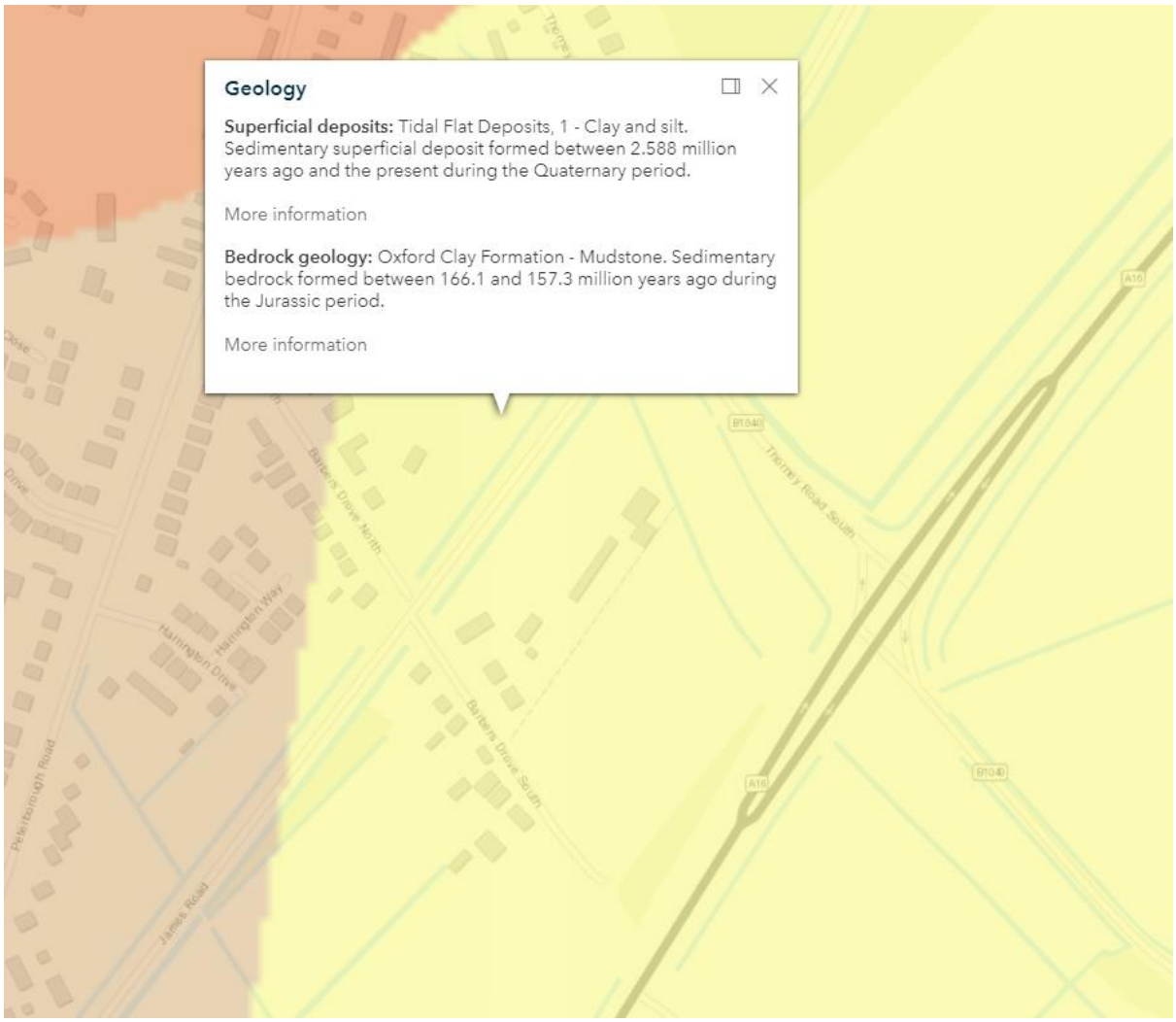
drawing status
Planning

scale	date	
1:500 @ A1	August 2020	
project number	drawing number	revision
2483	AL0205	P01

DT ARCHITECTS
01733 393010
www.dtarchitects.co.uk

APPENDIX B - Geology

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Extract British Geological Society maps

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GROUND ENGINEERING LIMITED
Tel: 01733-568568
www.groundengineering.co.uk

Site: BARBER'S DROVE, CROWLAND

TRIAL PIT TP1

Date: 06/08/20

Pit Size: 1.70m L x 0.60m W x 2.05m D.

Ground Level:

Samples and In-situ Tests			(Date) Water	Description of Strata	Legend	Depth m	O.D. Level m
Depth m	Type	Result					
0.10	D1			MADE GROUND - Stiff, dark brown, slightly gravelly, silty CLAY. Gravel is sub-angular to rounded quartz, quartzite and flint.			
0.10	ES1						
0.10	V1	(80)				0.30	
0.40	D2			Firm, brown, orange brown and grey, sandy CLAY.			
0.40	V2	(42)					
0.50-0.80	B1			(TIDAL FLAT DEPOSIT)			
						0.80	
0.90	D3			Orange brown, very silty SAND. Sand is fine grained.			
1.20	D4			(MARINE SAND)			
1.45	D5					1.50	
1.60	D6			Grey and orange brown, silty SAND. Sand is fine grained.			
				(MARINE SAND)			
2.05	D7		▽c			2.05	
				Pit completed at 2.05m depth			

KEY
- D - Disturbed Sample
- B - Bulk Sample
- U - Undisturbed Sample
- R - Root Sample
- W - Water Sample
- ES - Environmental Sample
- ▽ Water Strike
- ▼ Water Rise
- ▼c Level on completion
- MP - Mackintosh Probe
- P( ) - Hand Penetrometer Cohesion ( ) kPa
- V - Vane Shear Test Cohesion ( ) kPa

REMARKS
1. Live roots observed to 1.45m depth
2. Pit sides unstable below 1.90m depth
3. Groundwater met at 2.05m depth
4. Water stood at 2.05m depth on completion

Project No 15122

Scale 1:25

Page 1/1

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SOAKAWAY TEST RESULTS

BRE DIGEST 365 - SOIL INFILTRATION RATE

Project: Barber's Drove, Crowland
Client: Burmor Construction

Project No: C15122
Sheet No: 1/2

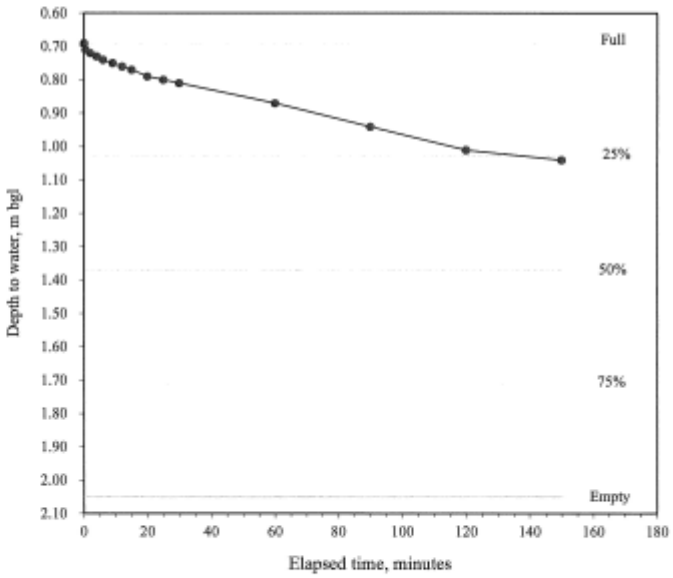
Trial Pit: TP1 FIRST FILLING
Depth: 2.05
Length: 1.70
Width: 0.60

Description of Stratum under test: Blue grey and orange brown mottled silty SAND.

Depth to water prior to test: 2.05 (Seepage)
(below ground level)

Elapsed Time min	Depth to Water m
0	0.69
1	0.71
2	0.72
4	0.73
6	0.74
9	0.75
12	0.76
15	0.77
20	0.79
25	0.80
30	0.81
60	0.87
90	0.94
120	1.01
150	1.04

DEPTH TO WATER vs ELAPSED TIME



f = (V75-V25)/A50(T75-T25)
V75-V25 = 0.694
A50 = 4.148
T75-T25 = 1570

ExtrapolatedSoil Infiltration Rate f = **1.78E-06** m/s

All dimensions given in metres

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GROUND ENGINEERING LIMITED
Tel: 01733-568568
www.groundengineering.co.uk

Site: BARBER'S DROVE, CROWLAND

TRIAL PIT TP2

Date: 06/08/20

Pit Size: 1.70m L x 0.60m W x 2.45m D.

Ground Level:

Samples and In-situ Tests			(Date) Water	Description of Strata	Legend	Depth m	O.D. Level m
Depth m	Type	Result					
0.05	V1	(90)		MADE GROUND - Stiff, dark brown, slightly gravelly, silty, organic CLAY. Gravel is angular to sub-rounded quartz, quartzite and flint.			
0.15	D1						
0.15	ES1					0.35	
0.40	D2			Firm, grey, brown and dark brown, sandy, silty CLAY. (TIDAL FLAT DEPOSIT)			
0.40	V2	(62)				0.50	
0.50-0.80	B1			Medium dense, light brown and orange brown, very silty SAND. Sand is fine grained.			
0.60	D3						
0.90-1.35	MP1	100					
1.20	D4			(MARINE SAND)			
						1.55	
1.60	D5			Grey and orange brown, silty SAND.			
2.00	D6			(MARINE SAND)			
2.45	D7		▼2			2.45	
				Pit completed at 2.45m depth			

KEY
- D - Disturbed Sample
- B - Bulk Sample
- U - Undisturbed Sample
- R - Root Sample
- W - Water Sample
- ES - Environmental Sample
- ▼ - Water Strike
- ▼ - Water Rise
- ▼c - Level on completion
- MP - Mackintosh Probe
- P( ) - Hand Penetrometer Cohesion ( ) kPa
- V - Vane Shear Test Cohesion ( ) kPa

REMARKS
1. Live roots observed to 1.20m depth
2. Groundwater seepage at 2.45m depth
3. Pit sides stable
4. Water stood at 2.45m depth on completion

Project No 15122

Scale 1:25

Page 1/1

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SOAKAWAY TEST RESULTS

BRE DIGEST 365 - SOIL INFILTRATION RATE

Project: Barber's Drove, Crowland
Client: Burmor Construction

Project No: C15122
Sheet No: 1/2

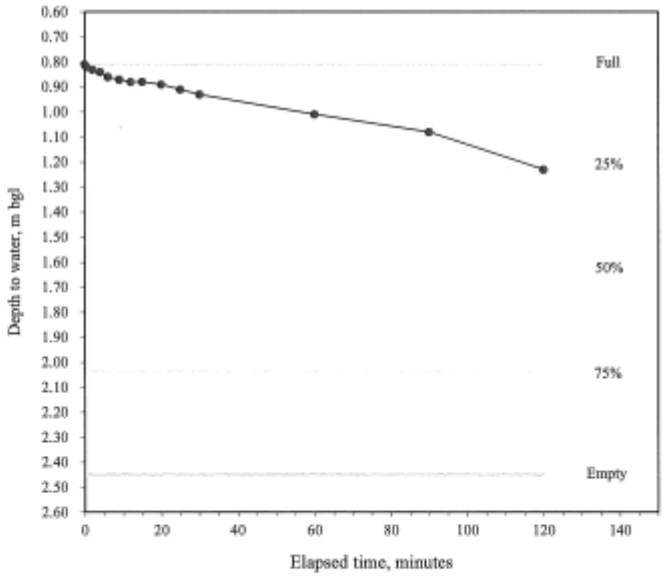
Trial Pit: TP2 FIRST FILLING
Depth: 2.45
Length: 1.70
Width: 0.60

Description of Stratum under test: Blue grey and orange brown mottled silty SAND.

Depth to water prior to test: 2.45 (Seepage)
(below ground level)

Elapsed Time min	Depth to Water m
0	0.81
1	0.82
2	0.83
4	0.84
6	0.86
9	0.87
12	0.88
15	0.88
20	0.89
25	0.91
30	0.93
60	1.01
90	1.08
120	1.23

DEPTH TO WATER vs ELAPSED TIME



f = (V75-V25)/A50(T75-T25)
V75-V25 = 0.836
A50 = 4.792
T75-T25 = 383

Extrapolated Soil Infiltration Rate f = **7.60E-06** m/s

All dimensions given in metres

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GROUND ENGINEERING LIMITED
Tel: 01733-566569
www.groundengineering.co.uk

Site: BARBER'S DROVE, CROWLAND

TRIAL PIT TP5

Date: 06/08/20

Pit Size: 1.70m L x 0.60m W x 2.90m D.

Ground Level:

Samples and In-situ Tests			(Date) Water	Description of Strata	Legend	Depth m	O.D. Level m
Depth m	Type	Result					
0.10	D1			MADE GROUND - Sandy TOPSOIL.		0.02	
0.10	ES1			MADE GROUND - Light brown, silty SAND AND GRAVEL. Gravel is sub-angular to rounded limestone.		0.15	
0.30	D2			MADE GROUND - Firm, dark brown, slightly gravelly, silty, organic CLAY. Gravel is sub-angular and sub-rounded quartz, quartzite, flint, coal, ash and brick fragments.			
0.30	ES2						
0.30	V1	(50)					
0.50-0.80	B1					0.80	
0.85	V2	(47)		Firm, grey and brown, sandy, silty CLAY.			
0.90	D3			(TIDAL FLAT DEPOSIT)		1.10	
1.20	D4			Grey, light brown and orange brown, very silty SAND. Sand is fine grained.			
1.50	D5						
2.00	D6			(MARINE SAND)		2.50	
				Grey, light brown and orange brown, silty SAND. Sand is fine grained.			
				(MARINE SAND)			
2.90	D7		▼c			2.90	
				Pit completed at 2.90m depth			

KEY
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- U - Undisturbed Sample
- R - Root Sample
- W - Water Sample
- ES - Environmental Sample
- ▽ Water Strike
- ▼ Water Rise
- ▼c Level on completion
- MP - Mackintosh Probe
- P( ) - Hand Penetrometer Cohesion ( ) kPa
- V - Vane Shear Test Cohesion ( ) kPa

REMARKS
1. Live roots observed to 1.40m depth
2. Groundwater met at 2.80m depth
3. Pit sides unstable below 1.40m depth
4. Water stood at 2.90m depth

Project No 15122

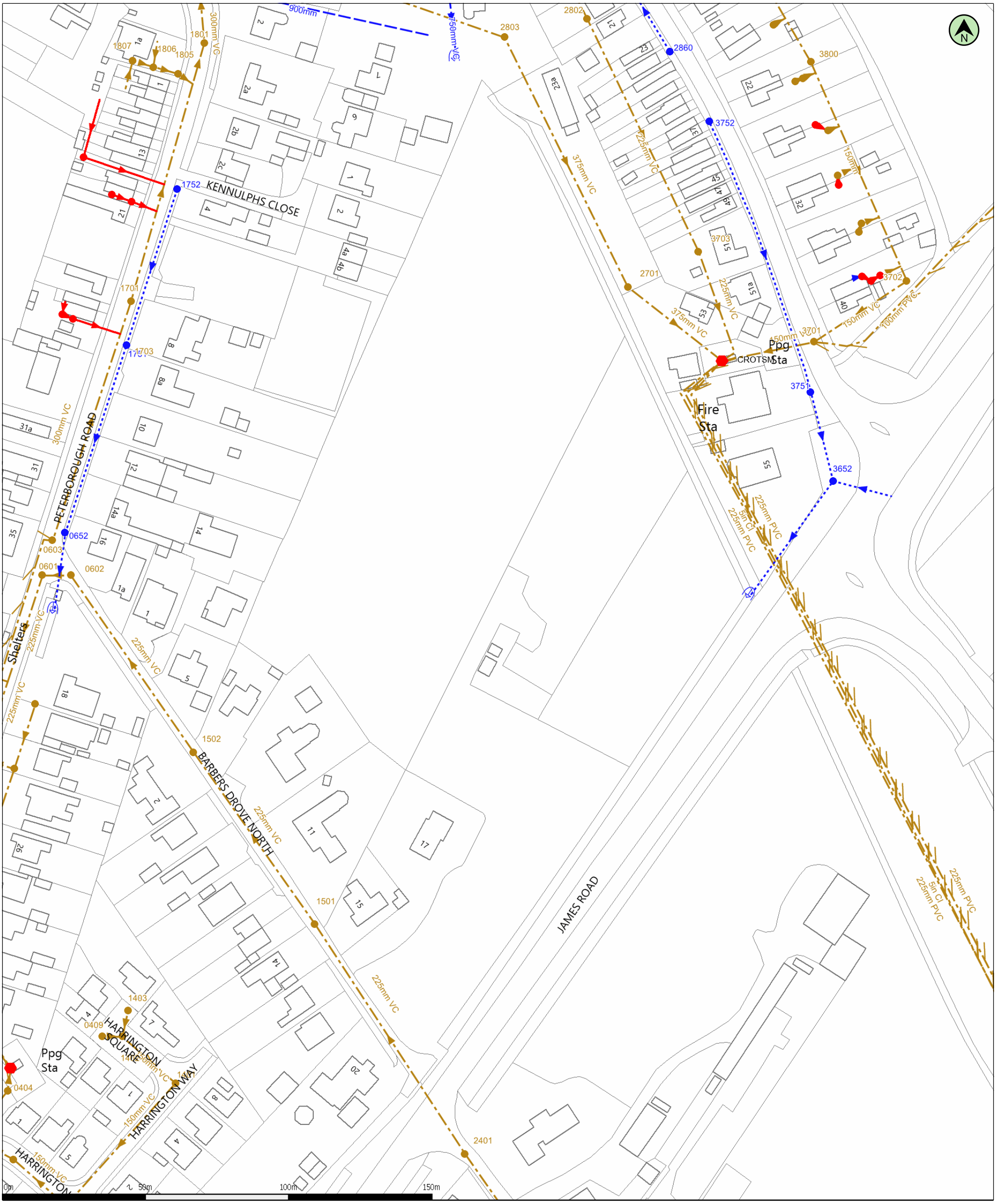
Scale 1:25

Page 1/1

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APPENDIX C – Anglian Water Services Asset map

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Scale: 1:1250 | Date: 27/07/20 | Wastewater Plan A3

Data updated: 01/07/20 | Map Centre: 524232,309628 | Our Ref: 419910 - 1 | Powered by digdat

- Foul Sewer
- Surface Sewer
- Combined Sewer
- Final Effluent
- Rising Main*
- Private Sewer*
- Decommissioned Sewer*
- Outfall*
- Inlet*
- Manhole*
- Sewage Treatment Works
- Public Pumping Station
- Decommissioned Pumping Station

*(Colour denotes effluent type)

adam@shieldswilson.co.uk

17 Barbers Drove N

love every drop anglianwater

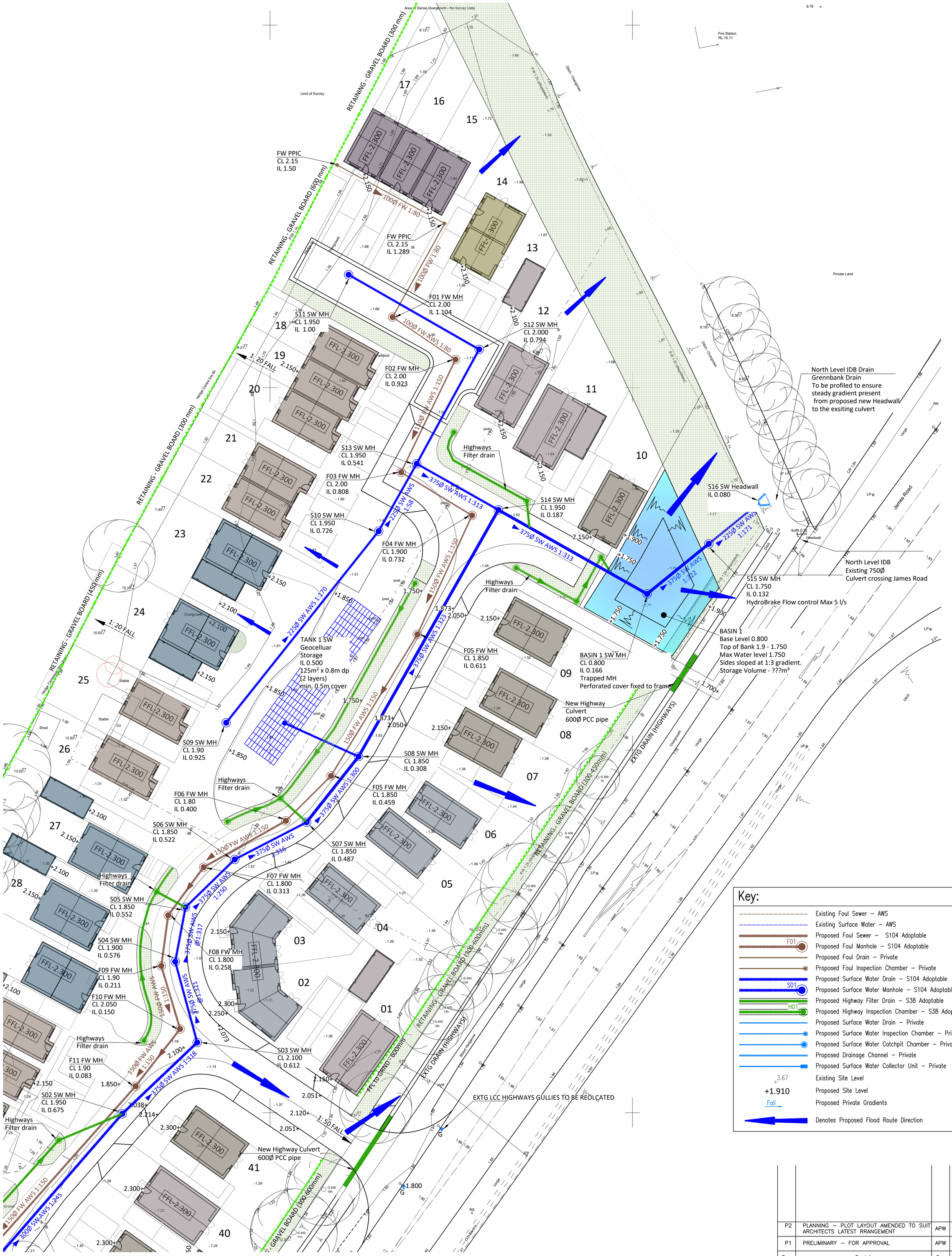
This plan is provided by Anglian Water pursuant its obligations under the Water Industry Act 1991 sections 198 or 199. It must be used in conjunction with any search results attached. The information on this plan is based on data currently recorded but position must be regarded as approximate. Service pipes, private sewers and drains are generally not shown. Users of this map are strongly advised to commission their own survey of the area shown on the plan before carrying out any works. The actual position of all apparatus MUST be established by trial holes. No liability whatsoever, including liability for negligence, is accepted by Anglian Water for any error or inaccuracy or omission, including the failure to accurately record, or record at all, the location of any water main, discharge pipe, sewer or disposal main or any item of apparatus. This information is valid for the date printed. This plan is produced by Anglian Water Services Limited (c) Crown copyright and database rights 2020 Ordnance Survey 100022432.This map is to be used for the purposes of viewing the location of Anglian Water plant only. Any other uses of the map data or further copies is not permitted. This notice is not intended to exclude or restrict liability for death or personal injury resulting from negligence.

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert
0404	F	1.379	-1.157	2.536
0407	F	1.476	-0.934	2.41
0409	F	1.619	-0.627	2.246
0601	F	2.44	-1.29	3.73
0602	F	2.18	-1.3	3.48
0603	F	2.44	0.22	2.22
1401	F	1.537	-0.387	1.924
1402	F	1.573	-0.569	2.142
1403	F	-	0.65	-
1501	F	1.83	-0.89	2.72
1502	F	1.97	-1.07	3.04
1701	F	2.44	-0.08	2.52
1801	F	2.94	-0.19	3.13
1805	F	-	-	-
1806	F	-	-	-
1807	F	-	-	-
2401	F	1.66	-0.55	2.21
2701	F	2.519	-0.92	3.439
2802	F	2.49	0.54	1.95
2803	F	2.31	-0.56	2.87
3701	F	2.69	-0.622	3.312
3702	F	2.11	-0.26	2.37
3703	F	2.16	-0.17	2.33
3800	F	1.665	0.395	1.27
0652	S	2.34	0.98	1.36
1751	S	2.39	1.35	1.04
1752	S	2.62	1.83	0.79
2860	S	2.68	2.11	0.57
3652	S	1.85	0.77	1.08
3751	S	2.76	1.45	1.31
3752	S	2.65	2.17	0.48

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert

APPENDIX D – Proposed Drainage Arrangement Drawings

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Rev	Revision	Drn	App	Date
P2	PLANNING – PLOT LAYOUT AMENDED TO SUIT ARCHITECTS LATEST RRANGEMENT	APW	APW	01/21
P1	PRELIMINARY – FOR APPROVAL	APW	APW	12/20

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Status: PLANNING

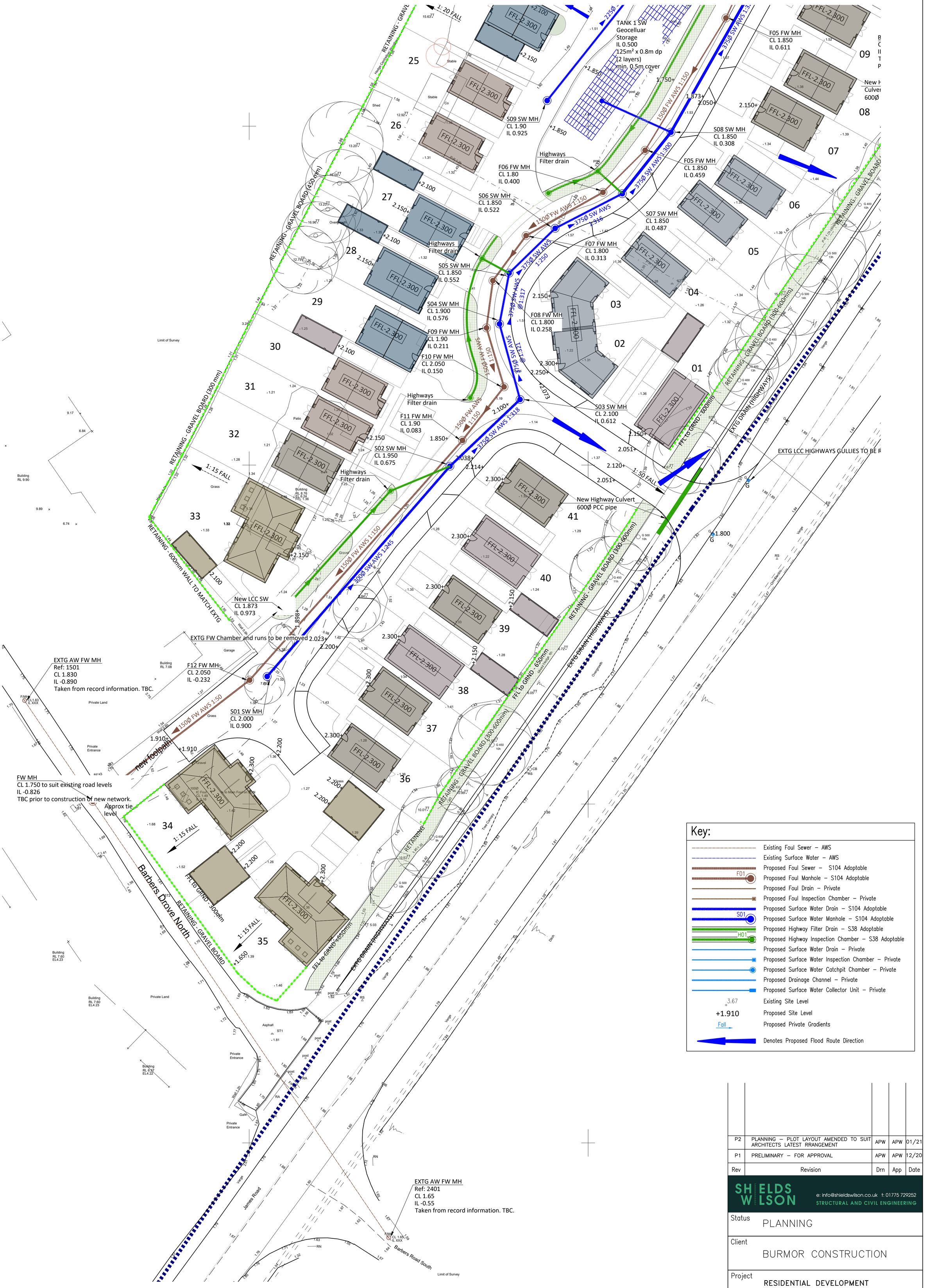
Client: BURMOR CONSTRUCTION

Project: RESIDENTIAL DEVELOPMENT
BARBERS DROVE NORTH, CROWLAND

Title: PROPOSED DRAINAGE STRAETGY
LAYOUT & LEVELS SHT 1

Date	DEC 20	Scales	Drawing No.	Rev
Appr	APW	1:250	20–102/100	P1

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Rev	Revision	Drn	App	Date
P2	PLANNING – PLOT LAYOUT AMENDED TO SUIT ARCHITECTS LATEST RRANGEMENT	APW	APW	01/21
P1	PRELIMINARY – FOR APPROVAL	APW	APW	12/20

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STRUCTURAL AND CIVIL ENGINEERING

Status: PLANNING

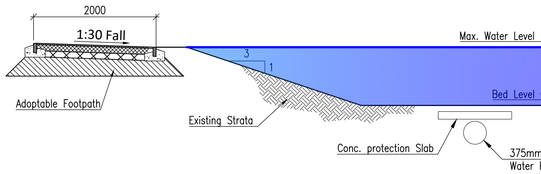
Client: BURMOR CONSTRUCTION

Project: RESIDENTIAL DEVELOPMENT
BARBERS DROVE NORTH, CROWLAND

Title: PROPOSED DRAINAGE STRAETGY
LAYOUT & LEVELS SHT 2

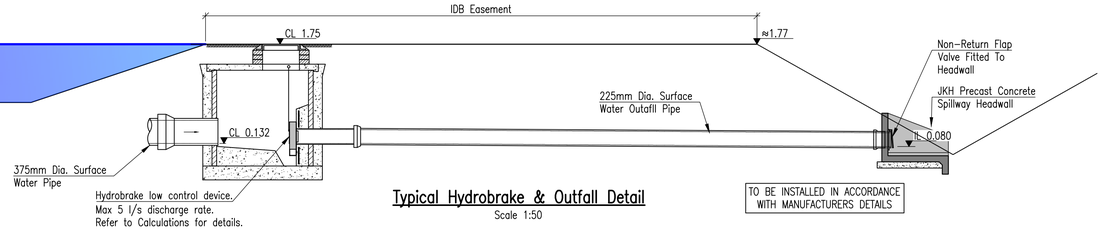
Date	DEC 20	Scales	Drawing No.	Rev
Appr	APW	1:250	20–102/101	P2

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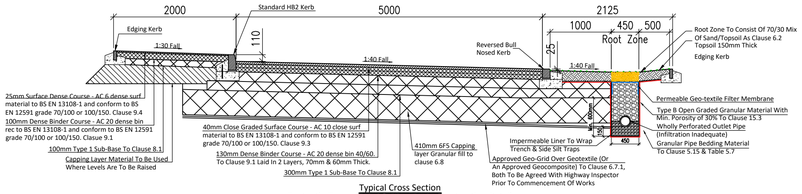
Typical Attenuation Basin Detail

Scale 1:50

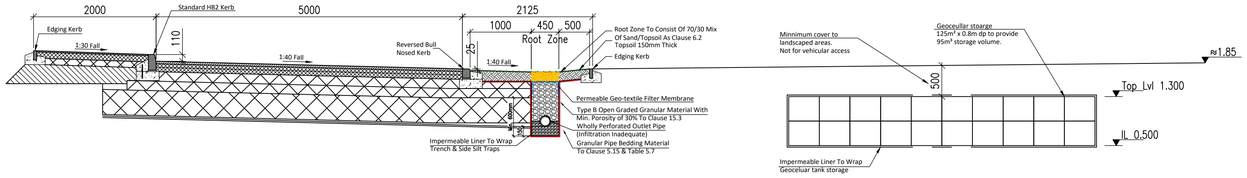


Typical Hydrobrake & Outfall Detail

Scale 1:50

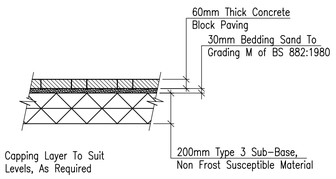


Typical Cross Section
Footpath, Tarmac Road & Filter Drain Construction Detail
NTS



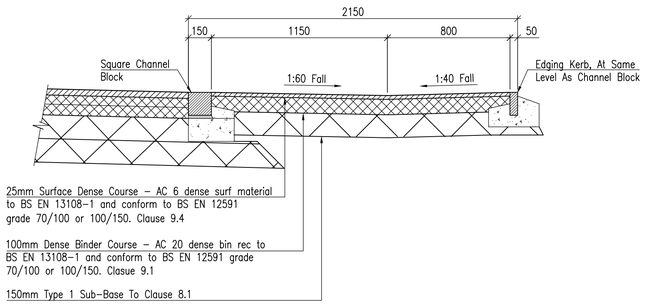
Typical Cross Section
Footpath, Tarmac Road & Filter Drain Construction Detail
NTS

Typical Cross Section
Geocellular tank storage Detail
NTS



Typical Shared Drive & Private parking Space Construction - Permeable Blocked Paved Surface Detail

Scale 1:25



Tarmac Vehicle Crossing Construction Detail Between Filter Drain Runs

Scale 1:25

Rev	Revision	Drn	App	Date
P2	PLANNING – STATUS UPDATED	APW	APW	01/21
P1	PRELIMINARY – FOR APPROVAL	APW	APW	12/20

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Status: PLANNING

Client: BURMOR CONSTRUCTION

Project: RESIDENTIAL DEVELOPMENT
BARBERS DROVE NORTH, CROWLAND

Title: PROPOSED DRAINAGE STRATEGY
KEY TYPICAL DETAILS

Date	DEC 20	Scales	Drawing No.	Rev
Appr	APW	1:50 1:25	20-10/102	P2

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APPENDIX E – Surface Water model Calculations

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Design Settings

Rainfall Methodology	FSR	Maximum Time of Concentration (mins)	30.00
Return Period (years)	2	Maximum Rainfall (mm/hr)	75.0
Additional Flow (%)	10	Minimum Velocity (m/s)	1.00
FSR Region	England and Wales	Connection Type	Level Soffits
M5-60 (mm)	20.000	Minimum Backdrop Height (m)	0.500
Ratio-R	0.400	Preferred Cover Depth (m)	0.800
CV	0.750	Include Intermediate Ground	✓
Time of Entry (mins)	5.00	Enforce best practice design rules	x

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Depth (m)
S01	0.087	5.00	2.000	1200	1.100
S02	0.071	5.00	1.900	1350	1.243
S03	0.015	5.00	2.100	1350	1.488
S04	0.014	5.00	1.850	1350	1.274
S05	0.056	5.00	1.850	1350	1.298
S06	0.005	5.00	1.850	1350	1.328
S07	0.069	5.00	1.850	1350	1.363
S08	0.017	5.00	1.850	1350	1.538
S09	0.033	5.00	1.950	1200	1.025
S10	0.010	5.00	1.950	1200	1.224
S11	0.020	5.00	1.950	1200	0.950
S12	0.002	5.00	1.950	1200	1.156
S13	0.035	5.00	1.950	1200	1.409
S14	0.046	5.00	1.950	1500	1.759
S15	0.000		1.750	1500	1.617
S16	0.000		1.750	1200	1.670
Basin 1	0.000	5.00	1.750	450	1.583
Tank 1	0.000	5.00	1.800	450	1.272

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	S01	S02	41.100	0.600	0.900	0.732	0.168	244.6	300	5.68	66.4
1.001	S02	S03	14.300	0.600	0.657	0.612	0.045	317.8	375	5.92	65.2
1.002	S03	S04	11.550	0.600	0.612	0.576	0.036	320.8	375	6.11	64.3
1.003	S04	S05	7.600	0.600	0.576	0.552	0.024	316.7	375	6.24	63.7
1.004	S05	S06	9.470	0.600	0.552	0.522	0.030	315.7	375	6.39	63.0
1.005	S06	S07	11.150	0.600	0.522	0.487	0.035	318.6	375	6.58	62.1

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	1.001	70.7	17.2	0.800	0.868	0.087	0.0	100	0.830
1.001	1.011	111.6	30.7	0.868	1.113	0.158	0.0	134	0.868
1.002	1.006	111.1	33.2	1.113	0.899	0.173	0.0	140	0.882
1.003	1.013	111.8	35.5	0.899	0.923	0.187	0.0	145	0.902
1.004	1.014	112.0	45.6	0.923	0.953	0.243	0.0	167	0.964
1.005	1.009	111.5	45.9	0.953	0.988	0.248	0.0	167	0.962

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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)
1.006	S07	S08	11.570	0.600	0.487	0.312	0.175	66.1	375	6.66	61.8
1.007	S08	S14	39.100	0.600	0.312	0.191	0.121	323.1	375	7.31	59.0
3.000	S09	S10	33.770	0.600	0.925	0.726	0.199	169.7	225	5.56	67.1
3.001	S10	S13	10.690	0.600	0.726	0.541	0.185	57.8	225	5.67	66.5
4.000	S11	S12	20.740	0.600	1.000	0.794	0.206	100.7	150	5.35	68.3
4.001	S12	S13	17.960	0.600	0.794	0.616	0.178	100.9	150	5.64	66.7
3.002	S13	S14	14.850	0.600	0.541	0.341	0.200	74.3	225	5.83	65.7
1.008	S14	Basin 1	7.500	0.600	0.191	0.167	0.024	312.5	375	7.44	58.6
1.009	Basin 1	S15	10.960	0.600	0.167	0.133	0.034	322.4	375	7.62	57.9
1.010	S15	S16	8.888	0.600	0.133	0.080	0.053	167.7	225	7.77	57.3
2.000	Tank 1	S08	11.200	0.600	0.528	0.462	0.066	169.7	225	5.19	69.2

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
1.006	2.231	246.4	58.4	0.988	1.163	0.317	0.0	123	1.838
1.007	1.002	110.7	58.8	1.163	1.384	0.334	0.0	194	1.017
3.000	1.001	39.8	6.6	0.800	0.999	0.033	0.0	62	0.746
3.001	1.724	68.5	8.5	0.999	1.184	0.043	0.0	53	1.181
4.000	1.001	17.7	4.1	0.800	1.006	0.020	0.0	49	0.815
4.001	1.000	17.7	4.4	1.006	1.184	0.022	0.0	51	0.830
3.002	1.519	60.4	19.6	1.184	1.384	0.100	0.0	88	1.363
1.008	1.019	112.6	83.8	1.384	1.208	0.480	0.0	242	1.113
1.009	1.003	110.8	82.8	1.208	1.242	0.480	0.0	242	1.096
1.010	1.007	40.0	82.0	1.392	1.445	0.480	0.0	225	1.025
2.000	1.001	39.8	0.0	1.047	1.163	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	41.100	244.6	300	Circular	2.000	0.900	0.800	1.900	0.732	0.868
1.001	14.300	317.8	375	Circular	1.900	0.657	0.868	2.100	0.612	1.113
1.002	11.550	320.8	375	Circular	2.100	0.612	1.113	1.850	0.576	0.899
1.003	7.600	316.7	375	Circular	1.850	0.576	0.899	1.850	0.552	0.923
1.004	9.470	315.7	375	Circular	1.850	0.552	0.923	1.850	0.522	0.953
1.005	11.150	318.6	375	Circular	1.850	0.522	0.953	1.850	0.487	0.988
1.006	11.570	66.1	375	Circular	1.850	0.487	0.988	1.850	0.312	1.163
1.007	39.100	323.1	375	Circular	1.850	0.312	1.163	1.950	0.191	1.384
3.000	33.770	169.7	225	Circular	1.950	0.925	0.800	1.950	0.726	0.999

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.000	S01	1200	Manhole	Adoptable	S02	1350	Manhole	Adoptable
1.001	S02	1350	Manhole	Adoptable	S03	1350	Manhole	Adoptable
1.002	S03	1350	Manhole	Adoptable	S04	1350	Manhole	Adoptable
1.003	S04	1350	Manhole	Adoptable	S05	1350	Manhole	Adoptable
1.004	S05	1350	Manhole	Adoptable	S06	1350	Manhole	Adoptable
1.005	S06	1350	Manhole	Adoptable	S07	1350	Manhole	Adoptable
1.006	S07	1350	Manhole	Adoptable	S08	1350	Manhole	Adoptable
1.007	S08	1350	Manhole	Adoptable	S14	1500	Manhole	Adoptable
3.000	S09	1200	Manhole	Adoptable	S10	1200	Manhole	Adoptable

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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)
3.001	10.690	57.8	225	Circular	1.950	0.726	0.999	1.950	0.541	1.184
4.000	20.740	100.7	150	Circular	1.950	1.000	0.800	1.950	0.794	1.006
4.001	17.960	100.9	150	Circular	1.950	0.794	1.006	1.950	0.616	1.184
3.002	14.850	74.3	225	Circular	1.950	0.541	1.184	1.950	0.341	1.384
1.008	7.500	312.5	375	Circular	1.950	0.191	1.384	1.750	0.167	1.208
1.009	10.960	322.4	375	Circular	1.750	0.167	1.208	1.750	0.133	1.242
1.010	8.888	167.7	225	Circular	1.750	0.133	1.392	1.750	0.080	1.445
2.000	11.200	169.7	225	Circular	1.800	0.528	1.047	1.850	0.462	1.163

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
3.001	S10	1200	Manhole	Adoptable	S13	1200	Manhole	Adoptable
4.000	S11	1200	Manhole	Adoptable	S12	1200	Manhole	Adoptable
4.001	S12	1200	Manhole	Adoptable	S13	1200	Manhole	Adoptable
3.002	S13	1200	Manhole	Adoptable	S14	1500	Manhole	Adoptable
1.008	S14	1500	Manhole	Adoptable	Basin 1	450	Manhole	Adoptable
1.009	Basin 1	450	Manhole	Adoptable	S15	1500	Manhole	Adoptable
1.010	S15	1500	Manhole	Adoptable	S16	1200	Manhole	Adoptable
2.000	Tank 1	450	Manhole	Adoptable	S08	1350	Manhole	Adoptable

Manhole Schedule

Node	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
S01	2.000	1.100	1200	0	1.000	0.900	300
S02	1.900	1.243	1350	1	1.000	0.732	300
				0	1.001	0.657	375
S03	2.100	1.488	1350	1	1.001	0.612	375
				0	1.002	0.612	375
S04	1.850	1.274	1350	1	1.002	0.576	375
				0	1.003	0.576	375
S05	1.850	1.298	1350	1	1.003	0.552	375
				0	1.004	0.552	375
S06	1.850	1.328	1350	1	1.004	0.522	375
				0	1.005	0.522	375
S07	1.850	1.363	1350	1	1.005	0.487	375
				0	1.006	0.487	375

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Manhole Schedule

Node	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
S08	1.850	1.538	1350	1	2.000	0.462	225
				2	1.006	0.312	375
				0	1.007	0.312	375
S09	1.950	1.025	1200	0	3.000	0.925	225
S10	1.950	1.224	1200	1	3.000	0.726	225
				0	3.001	0.726	225
S11	1.950	0.950	1200	0	4.000	1.000	150
S12	1.950	1.156	1200	1	4.000	0.794	150
				0	4.001	0.794	150
S13	1.950	1.409	1200	1	4.001	0.616	150
				2	3.001	0.541	225
				0	3.002	0.541	225
S14	1.950	1.759	1500	1	3.002	0.341	225
				2	1.007	0.191	375
				0	1.008	0.191	375
S15	1.750	1.617	1500	1	1.009	0.133	375
				0	1.010	0.133	225
S16	1.750	1.670	1200	1	1.010	0.080	225
Basin 1	1.750	1.583	450	1	1.008	0.167	375
				0	1.009	0.167	375
Tank 1	1.800	1.272	450	0	2.000	0.528	225

Simulation Settings

Rainfall Methodology	FSR	Analysis Speed	Normal
FSR Region	England and Wales	Skip Steady State	x
M5-60 (mm)	20.000	Drain Down Time (mins)	240
Ratio-R	0.400	Additional Storage (m³/ha)	10.0
Summer CV	0.750	Check Discharge Rate(s)	✓
Winter CV	0.840	2 year (l/s)	2.8

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Simulation Settings

30 year (l/s)	7.9	Check Discharge Volume	✓
100 year (l/s)	11.1	100 year +40% 360 minute (m³)	350

Storm Durations

15	30	60	120	180	240	360	480	600	720	960	1440

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
2	0	0	0
30	10	5	0
100	40	10	0

Pre-development Discharge Rate

Site Makeup	Greenfield	Growth Factor 30 year	2.55
Greenfield Method	IH124	Growth Factor 100 year	3.56
Positively Drained Area (ha)	1.200	Betterment (%)	0
SAAR (mm)	554	QBar	2.6
Soil Index	3	Q 2 year (l/s)	2.3
SPR	0.37	Q 30 year (l/s)	6.7
Region	5	Q 100 year (l/s)	9.3
Growth Factor 2 year	0.89		

Pre-development Discharge Volume

Site Makeup	Greenfield	Return Period (years)	100
Greenfield Method	FSR/FEH	Climate Change (%)	40
Positively Drained Area (ha)	1.200	Storm Duration (mins)	360
Soil Index	3	Betterment (%)	0
SPR	0.37	PR	0.334
CWI	83.556	Runoff Volume (m³)	350

Node S15 Online Hydro-Brake® Control

Flap Valve	✓	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	x	Sump Available	✓
Invert Level (m)	0.133	Product Number	CTL-SHE-0095-5000-1700-5000
Design Depth (m)	1.700	Min Outlet Diameter (m)	0.150
Design Flow (l/s)	5.0	Min Node Diameter (mm)	1200

Node Basin 1 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	0.800
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	81.9	0.0	0.950	237.4	0.0

Node Tank 1 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	0.528
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.95	Time to half empty (mins)	

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Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	125.0	0.0	0.800	125.0	0.0	0.801	0.0	0.0

Other (defaults)

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

Link Loss Overrides

Link	Exit Loss
2.000	1.000
5.000	1.000

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
2 year 15 minute summer	141.566	40.058
2 year 15 minute winter	99.345	40.058
2 year 30 minute summer	91.753	25.963
2 year 30 minute winter	64.388	25.963
2 year 60 minute summer	61.301	16.200
2 year 60 minute winter	40.727	16.200
2 year 120 minute summer	37.449	9.897
2 year 120 minute winter	24.880	9.897
2 year 180 minute summer	28.672	7.378
2 year 180 minute winter	18.637	7.378
2 year 240 minute summer	22.636	5.982
2 year 240 minute winter	15.039	5.982
2 year 360 minute summer	17.235	4.435
2 year 360 minute winter	11.203	4.435
2 year 480 minute summer	13.550	3.581
2 year 480 minute winter	9.003	3.581
2 year 600 minute summer	11.088	3.033
2 year 600 minute winter	7.576	3.033
2 year 720 minute summer	9.878	2.647
2 year 720 minute winter	6.639	2.647
2 year 960 minute summer	8.113	2.136
2 year 960 minute winter	5.374	2.136
2 year 1440 minute summer	5.891	1.579
2 year 1440 minute winter	3.959	1.579
30 year +10% CC +5% A 15 minute summer	295.577	83.638
30 year +10% CC +5% A 15 minute winter	207.423	83.638
30 year +10% CC +5% A 30 minute summer	192.422	54.449
30 year +10% CC +5% A 30 minute winter	135.033	54.449
30 year +10% CC +5% A 60 minute summer	128.248	33.892
30 year +10% CC +5% A 60 minute winter	85.205	33.892
30 year +10% CC +5% A 120 minute summer	77.482	20.476
30 year +10% CC +5% A 120 minute winter	51.477	20.476
30 year +10% CC +5% A 180 minute summer	58.628	15.087
30 year +10% CC +5% A 180 minute winter	38.110	15.087
30 year +10% CC +5% A 240 minute summer	45.764	12.094
30 year +10% CC +5% A 240 minute winter	30.405	12.094
30 year +10% CC +5% A 360 minute summer	34.344	8.838

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Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
30 year +10% CC +5% A 360 minute winter	22.324	8.838
30 year +10% CC +5% A 480 minute summer	26.756	7.071
30 year +10% CC +5% A 480 minute winter	17.776	7.071
30 year +10% CC +5% A 600 minute summer	21.731	5.944
30 year +10% CC +5% A 600 minute winter	14.848	5.944
30 year +10% CC +5% A 720 minute summer	19.238	5.156
30 year +10% CC +5% A 720 minute winter	12.929	5.156
30 year +10% CC +5% A 960 minute summer	15.636	4.117
30 year +10% CC +5% A 960 minute winter	10.358	4.117
30 year +10% CC +5% A 1440 minute summer	11.177	2.995
30 year +10% CC +5% A 1440 minute winter	7.511	2.995
100 year +40% CC +10% A 15 minute summer	488.233	138.153
100 year +40% CC +10% A 15 minute winter	342.620	138.153
100 year +40% CC +10% A 30 minute summer	320.551	90.705
100 year +40% CC +10% A 30 minute winter	224.948	90.705
100 year +40% CC +10% A 60 minute summer	214.603	56.713
100 year +40% CC +10% A 60 minute winter	142.577	56.713
100 year +40% CC +10% A 120 minute summer	129.587	34.246
100 year +40% CC +10% A 120 minute winter	86.094	34.246
100 year +40% CC +10% A 180 minute summer	97.729	25.149
100 year +40% CC +10% A 180 minute winter	63.526	25.149
100 year +40% CC +10% A 240 minute summer	75.977	20.078
100 year +40% CC +10% A 240 minute winter	50.477	20.078
100 year +40% CC +10% A 360 minute summer	56.677	14.585
100 year +40% CC +10% A 360 minute winter	36.841	14.585
100 year +40% CC +10% A 480 minute summer	43.979	11.622
100 year +40% CC +10% A 480 minute winter	29.219	11.622
100 year +40% CC +10% A 600 minute summer	35.604	9.738
100 year +40% CC +10% A 600 minute winter	24.327	9.738
100 year +40% CC +10% A 720 minute summer	31.433	8.424
100 year +40% CC +10% A 720 minute winter	21.125	8.424
100 year +40% CC +10% A 960 minute summer	25.432	6.697
100 year +40% CC +10% A 960 minute winter	16.847	6.697
100 year +40% CC +10% A 1440 minute summer	18.055	4.839
100 year +40% CC +10% A 1440 minute winter	12.134	4.839

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Results for 2 year Critical Storm Duration. Lowest mass balance: 96.72%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	S01	11	0.994	0.094	15.9	0.1815	0.0000	OK
15 minute winter	S02	12	0.867	0.210	27.8	0.4209	0.0000	OK
30 minute summer	S03	19	0.855	0.243	28.4	0.3723	0.0000	OK
15 minute winter	S04	12	0.858	0.282	31.8	0.4348	0.0000	OK
15 minute winter	S05	12	0.855	0.303	40.7	0.5653	0.0000	OK
15 minute summer	S06	13	0.848	0.326	39.3	0.4791	0.0000	OK
15 minute summer	S07	13	0.845	0.358	52.5	0.6942	0.0000	OK
15 minute summer	S08	12	0.848	0.536	43.9	0.8269	0.0000	SURCHARGED
15 minute winter	S09	10	0.985	0.060	6.0	0.0866	0.0000	OK
15 minute winter	S10	13	0.842	0.116	7.7	0.1406	0.0000	OK
15 minute winter	S11	10	1.046	0.046	3.6	0.0612	0.0000	OK
15 minute winter	S12	14	0.846	0.052	3.9	0.0600	0.0000	OK
15 minute summer	S13	12	0.850	0.309	16.8	0.4256	0.0000	SURCHARGED
15 minute winter	S14	14	0.840	0.649	46.6	1.3175	0.0000	SURCHARGED
15 minute winter	S15	14	0.848	0.715	13.0	1.2626	0.0000	SURCHARGED
120 minute winter	S16	50	0.131	0.051	4.6	0.0000	0.0000	OK
15 minute winter	Basin 1	14	0.842	0.675	27.5	3.7162	0.0000	SURCHARGED
120 minute winter	Tank 1	114	0.801	0.273	21.0	32.5118	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	S01	1.000	S02	15.4	0.814	0.218	0.9829	
15 minute winter	S02	1.001	S03	27.4	0.759	0.245	0.9917	
30 minute summer	S03	1.002	S04	24.7	0.683	0.222	0.9390	
15 minute winter	S04	1.003	S05	30.5	0.689	0.273	0.7012	
15 minute winter	S05	1.004	S06	33.9	0.914	0.302	0.9072	
15 minute summer	S06	1.005	S07	35.3	1.013	0.316	1.1725	
15 minute summer	S07	1.006	S08	40.1	1.108	0.163	1.2658	
15 minute summer	S08	1.007	S14	-31.9	0.560	-0.288	4.3126	
15 minute winter	S09	3.000	S10	5.9	0.788	0.148	0.4541	
15 minute winter	S10	3.001	S13	8.8	0.741	0.129	0.3227	
15 minute winter	S11	4.000	S12	3.5	0.767	0.201	0.0976	
15 minute winter	S12	4.001	S13	3.8	0.750	0.217	0.2071	
15 minute summer	S13	3.002	S14	17.9	1.091	0.296	0.5906	
15 minute winter	S14	1.008	Basin 1	27.5	0.628	0.244	0.8272	
15 minute winter	S15	1.010	S16	4.6	0.671	0.114	0.0604	39.4
15 minute winter	Basin 1	1.009	S15	13.0	0.498	0.117	1.2089	
120 minute winter	Tank 1	2.000	S08	-21.0	-0.835	-0.528	0.4454	

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Results for 30 year +10% CC +5% A Critical Storm Duration. Lowest mass balance: 96.72%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	S01	11	1.164	0.264	34.8	0.5170	0.0000	OK
240 minute winter	S02	232	1.159	0.502	11.8	1.0187	0.0000	SURCHARGED
240 minute winter	S03	228	1.158	0.546	11.6	0.8393	0.0000	SURCHARGED
180 minute winter	S04	180	1.159	0.583	14.9	0.9015	0.0000	SURCHARGED
180 minute winter	S05	184	1.158	0.606	19.2	1.1423	0.0000	SURCHARGED
180 minute winter	S06	180	1.159	0.637	19.3	0.9371	0.0000	SURCHARGED
180 minute winter	S07	176	1.159	0.672	25.5	1.3182	0.0000	SURCHARGED
180 minute winter	S08	180	1.159	0.847	26.7	1.3103	0.0000	SURCHARGED
180 minute winter	S09	180	1.159	0.234	3.0	0.3432	0.0000	SURCHARGED
180 minute winter	S10	176	1.159	0.433	3.9	0.5266	0.0000	SURCHARGED
180 minute winter	S11	180	1.159	0.159	1.8	0.2145	0.0000	SURCHARGED
180 minute winter	S12	180	1.159	0.365	2.0	0.4189	0.0000	SURCHARGED
180 minute winter	S13	180	1.159	0.618	8.2	0.8597	0.0000	SURCHARGED
180 minute winter	S14	180	1.159	0.968	20.2	1.9761	0.0000	SURCHARGED
180 minute winter	S15	180	1.159	1.026	6.5	1.8125	0.0000	SURCHARGED
15 minute summer	S16	230	0.131	0.051	4.6	0.0000	0.0000	OK
180 minute winter	Basin 1	180	1.159	0.992	19.9	40.1188	0.0000	SURCHARGED
180 minute winter	Tank 1	180	1.159	0.631	22.2	75.0076	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	S01	1.000	S02	31.2	0.882	0.441	2.7951	
240 minute winter	S02	1.001	S03	10.6	0.541	0.095	1.5772	
240 minute winter	S03	1.002	S04	11.4	0.489	0.103	1.2739	
180 minute winter	S04	1.003	S05	14.5	0.450	0.130	0.8383	
180 minute winter	S05	1.004	S06	18.8	0.517	0.168	1.0445	
180 minute winter	S06	1.005	S07	19.1	0.617	0.171	1.2298	
180 minute winter	S07	1.006	S08	25.1	0.654	0.102	1.2761	
180 minute winter	S08	1.007	S14	8.4	0.364	0.076	4.3126	
180 minute winter	S09	3.000	S10	3.0	0.584	0.075	1.3431	
180 minute winter	S10	3.001	S13	3.4	0.411	0.049	0.4252	
180 minute winter	S11	4.000	S12	1.8	0.613	0.102	0.3651	
180 minute winter	S12	4.001	S13	1.9	0.493	0.105	0.3162	
180 minute winter	S13	3.002	S14	8.0	0.659	0.132	0.5906	
180 minute winter	S14	1.008	Basin 1	19.9	0.418	0.177	0.8272	
180 minute winter	S15	1.010	S16	4.6	0.671	0.114	0.0604	95.0
180 minute winter	Basin 1	1.009	S15	6.5	0.265	0.058	1.2089	
180 minute winter	Tank 1	2.000	S08	-22.2	-0.597	-0.557	0.4454	

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Results for 100 year +40% CC +10% A Critical Storm Duration. Lowest mass balance: 96.72%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	S01	11	1.860	0.960	60.2	1.9211	0.0000	FLOOD RISK
15 minute winter	S02	11	1.752	1.095	102.4	2.2551	0.0000	FLOOD RISK
360 minute winter	S03	352	1.749	1.137	16.2	1.7534	0.0000	SURCHARGED
360 minute winter	S04	352	1.749	1.173	18.2	1.8206	0.0000	FLOOD RISK
360 minute winter	S05	352	1.749	1.197	22.6	2.2815	0.0000	FLOOD RISK
360 minute winter	S06	344	1.749	1.227	23.5	1.8068	0.0000	FLOOD RISK
360 minute winter	S07	352	1.749	1.262	28.3	2.5094	0.0000	FLOOD RISK
360 minute winter	S08	352	1.750	1.438	29.4	2.2339	0.0000	FLOOD RISK
360 minute winter	S09	352	1.749	0.824	3.1	1.2230	0.0000	FLOOD RISK
360 minute winter	S10	352	1.749	1.023	3.8	1.2489	0.0000	FLOOD RISK
360 minute winter	S11	352	1.749	0.749	1.9	1.0206	0.0000	FLOOD RISK
360 minute winter	S12	352	1.749	0.955	1.9	1.0979	0.0000	FLOOD RISK
360 minute winter	S13	352	1.749	1.208	8.6	1.6960	0.0000	FLOOD RISK
360 minute winter	S14	352	1.749	1.558	37.6	3.2020	0.0000	FLOOD RISK
360 minute winter	S15	352	1.749	1.616	7.5	2.8551	0.0000	FLOOD RISK
360 minute winter	S16	352	0.132	0.052	4.8	0.0000	0.0000	OK
360 minute winter	Basin 1	352	1.749	1.582	37.1	151.6888	0.0000	FLOOD RISK
360 minute winter	Tank 1	352	1.751	1.223	17.1	95.2538	0.0000	FLOOD RISK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	S01	1.000	S02	54.8	0.935	0.775	2.8942	
15 minute winter	S02	1.001	S03	99.0	0.898	0.887	1.5772	
360 minute winter	S03	1.002	S04	17.1	0.465	0.154	1.2739	
360 minute winter	S04	1.003	S05	18.1	0.418	0.162	0.8383	
360 minute winter	S05	1.004	S06	23.1	0.485	0.206	1.0445	
360 minute winter	S06	1.005	S07	21.8	0.592	0.195	1.2298	
360 minute winter	S07	1.006	S08	27.8	0.648	0.113	1.2761	
360 minute winter	S08	1.007	S14	26.8	0.328	0.242	4.3126	
360 minute winter	S09	3.000	S10	2.9	0.512	0.072	1.3431	
360 minute winter	S10	3.001	S13	3.6	0.416	0.053	0.4252	
360 minute winter	S11	4.000	S12	1.7	0.543	0.096	0.3651	
360 minute winter	S12	4.001	S13	1.7	0.467	0.098	0.3162	
360 minute winter	S13	3.002	S14	8.4	0.640	0.140	0.5906	
360 minute winter	S14	1.008	Basin 1	37.1	0.411	0.330	0.8272	
360 minute winter	S15	1.010	S16	4.8	0.681	0.120	0.0628	157.3
360 minute winter	Basin 1	1.009	S15	7.5	0.237	0.068	1.2089	
360 minute winter	Tank 1	2.000	S08	-17.1	-0.429	-0.429	0.4454	

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