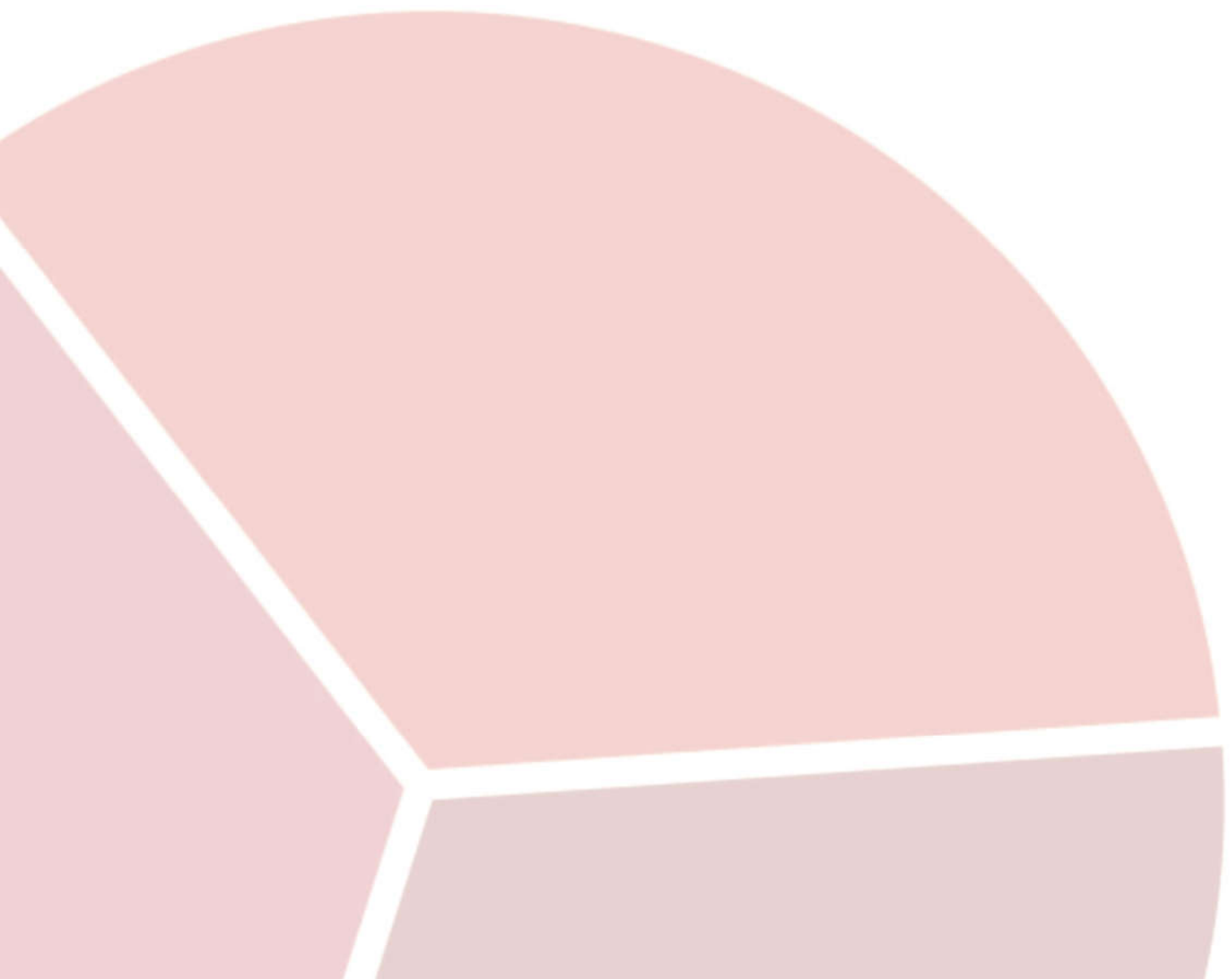




Drainage Strategy
Barnard Road, Norwich
HRL02791-02DS

002791-JPL-ZZ-ZZ-RP-D-2002-A3-C03





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1.0	Terms of Reference	3
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4.0	Water Quality Management	9
5.0	Summary of Drainage Strategy	12

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A	Topographic Survey
B	Utility Sub-scan Survey
C	Anglian Water Sewer Records
D	Catchment Layouts
E	Preliminary Hydraulic Drainage Calculations
F	Preliminary Drainage Strategy Layout
G	Overland Flood Routing Layout



1.0 Terms of Reference

1.1 Report Details

This Drainage Strategy has been prepared to reflect the requirements of the following standards:

- National Planning Policy Framework 2021 and guidance documents
- BS 8582:2013 Code of Practice for Surface Water Management for Development Sites
- Ciria Report C753 The SuDS Manual
- Building Regulations Part H

The report relates to the proposed redevelopment of the current Namco Funscape site between Dereham Road and Barnard Road, Norwich with a full planning application for construction of a Class E food store (Lidl) with associated access, car parking, servicing and landscaping.

The report is based on the following information:

- OS Explorer Series mapping
- Environment Agency mapping and consultation
- Sewerage Undertaker mapping and consultation

This study relies on statistical assessments and therefore positive conclusions with respect to flooding should not be interpreted as a guarantee against flooding of the study site.

1.2 Report History

Status - Revision	Author	Approved	Issued Date	Purpose
A3-C01	MW	MPW	15/11/2023	Draft Issue for Client Review
A3-C02	MW	MPW	29/11/2023	Issued for Planning Submission
A3-C03	MW	MPW	08/12/2023	Boundary line updated



2.0 Site Details

2.1 Existing Site Description

The proposed development site is located on the current Namco Funscape site located between Dereham Road and Barnard Road. There is an existing vehicular access which serves the existing site and the adjacent hotel off Barnard Road which is to be retained.

The north of the site is currently occupied by the existing building with the south mainly covered in car parking.

The site is located within Flood Zone 1 and falls from North to South from circa 29.m to 27.5m AOD. A copy of the topographic survey is contained within **Appendix A**.

HR Wallingford mapping suggest the site has a SOIL type of 1 which suggests that the site is underlain by granular material and infiltration is a possibility. An intrusive Ground Investigation has been undertaken on the site which identified varying layers of sand, silt, clay and chalk below the site. A falling head test was undertaken which resulted in an infiltration rate of $2.88 \times 10^{-6} \text{m/s}$ being calculated. The Norwich Infiltration Capacity Drainage Map however indicates the site may be located in an area where permeable surfacing is not suitable.

A site location plan and aerial photograph are provided below in **Figures 1 and 2**.

Table 1- Site Summary

Address	No. 10 Barnard Road, Bowthorpe Park Industrial Estate, Norwich NR5 9JB	
OS Grid Reference	E: 617681	N: 309954
Site Area	10.274 Ha	
Development Type	Commercial	
EA Development Control Area	East Anglia	
Local Planning Authority	Norwich City Council	



Figure 1 – Site Location Plan

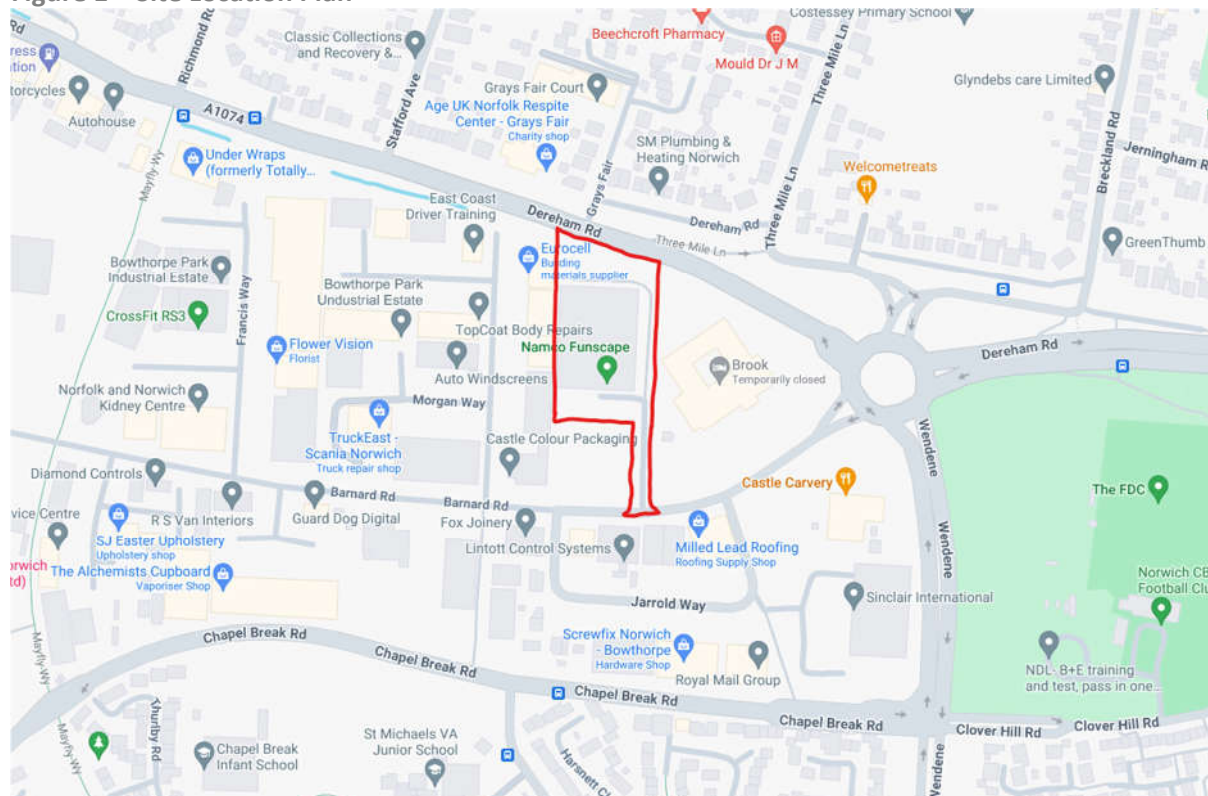


Figure 2 – Aerial Photograph



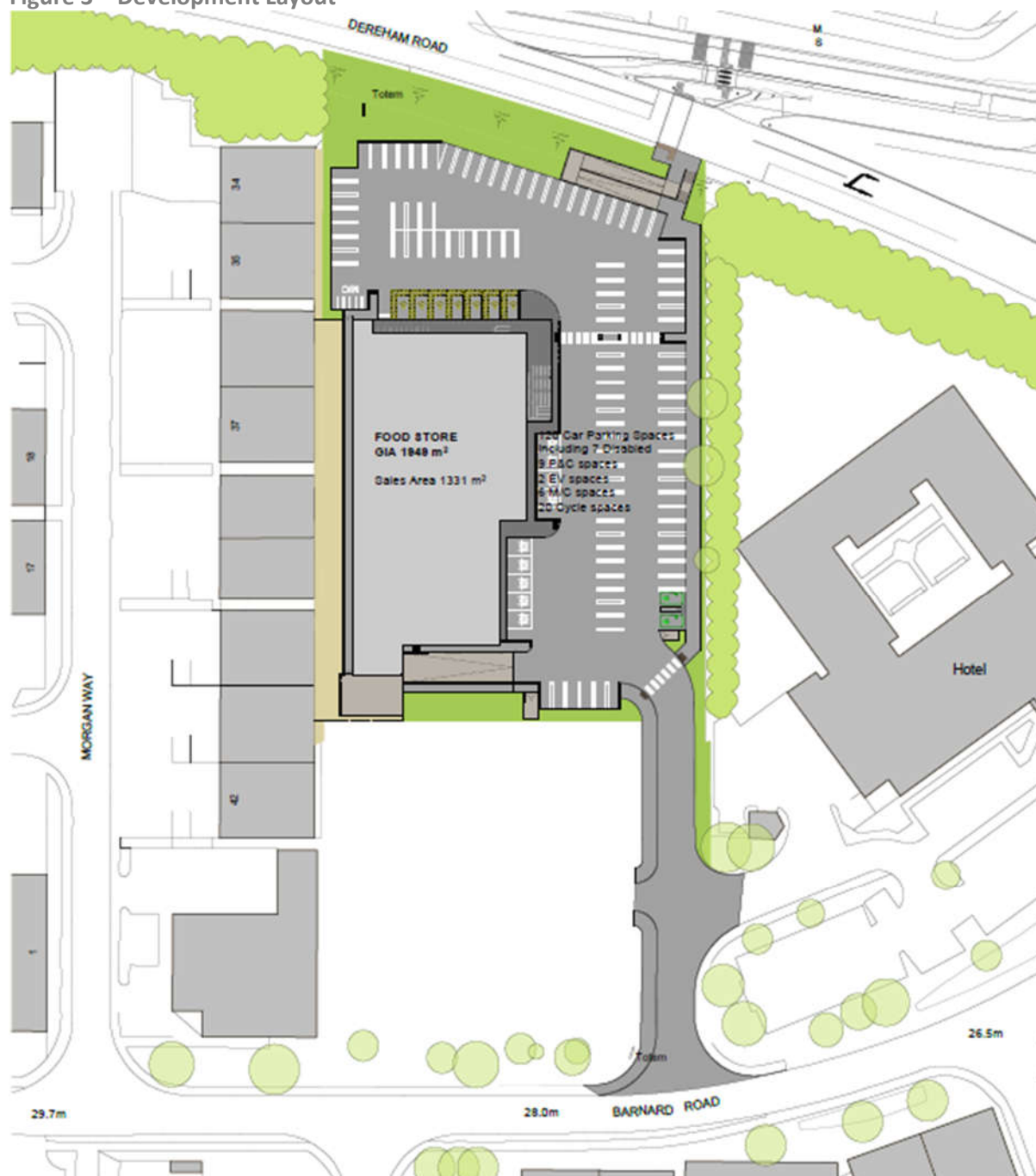


2.2 Proposed Site Description

The proposed development comprises the construction of a food store and associated car parking and service areas. The existing access is to be retained and a new pedestrian access from the northern boundary is to be provided.

A proposed development layout is provided below in **Figure 3**.

Figure 3 – Development Layout





3.0 Site Drainage

3.1 Existing Drainage Network

The existing site is positively drained through separate foul and surface water drainage networks which discharge into the respective foul and surface water sewers in Barnard Close. The site is understood to include an unrestricted surface water discharge. A copy of the utility sub-scan indicating the separate drainage networks is included in **Appendix B**.

3.2 Proposed Drainage Network

3.2.1 Proposed Foul Water Drainage Network

Foul water from the development is proposed to be routed through a new foul water network and discharge through a new connection onto the adopted 300mm diameter Anglian Water sewer below Barnard Road, as per the existing method.

3.2.2 Proposed Storm Water Drainage Network

The National Planning Policy Framework Technical Guidance seeks to promote the use of Sustainable Drainage Systems (SuDS) for new developments to limit both peak discharges and the volumes of surface water leaving sites.

CIRIA C753 The SuDS Manual defines numerous SuDS components which should be used in combination to create a SuDS Management Train to control the frequency of runoff, the flow rates and volume of runoff and to reduce concentrations of contaminants to acceptable levels. Consideration of suitable development drainage proposals has been undertaken with consideration being given to these components and commentary in relation to the decision making process is presented below in **Table 3**.

The whole site extends to 1.027Ha with the existing site containing 0.725Ha of impermeable area. The proposed development contains 0.853Ha. A catchment layout of the existing and proposed areas is included **Appendix D**.

As set out within the accompanying Flood Risk Assessment, and on the basis that infiltration is not feasible given the poor infiltration rate identified through the falling head test, it is proposed to limit the site to 5.0l/s which provides a significant 95% betterment on existing flows.

A preliminary drainage strategy layout is included in **Appendix F**. This identifies the main features of the surface water network including gullies and channel drains to collect runoff, pipes to convey the water to the attenuation and resultant flow control before discharging into the adopted 825mm diameter sewer in Barnard Road.

Causeway Flow has been used to produce a hydraulic model of the preliminary surface water drainage scheme which identifies that circa 685m³ of below ground storage is required. A copy of these calculations is provided in **Appendix E**. As set out in the Norwich City Local Policy FEH data has been used within the calculations as well as including all return periods up to the 1:100 year plus a 40% climate change allowance.



Table 3 – Consideration of Appropriate SuDS Components

Component Type	Commentary	Suitability
Rainwater Harvesting	Rainwater Harvesting could be incorporated into the drainage scheme subject to its compatibility with the building's M&E design.	?
Green Roofs	Green roofs are fairly heavy features which are not typical on this type of building and are not compatible with the current architectural proposals.	X
Infiltration	The feasibility of infiltration is unclear at this stage. Additional intrusive ground investigation works are required to confirm if infiltration is possible.	?
Proprietary Treatment Systems	Proprietary Treatment Systems could be incorporated into the drainage scheme such as a bypass separator.	✓
Filter Strips/Drains	Filter Strips and Drains could be incorporated into the drainage scheme.	✓
Swales	There is insufficient space within the development layout to accommodate large open storage features.	X
Bioretention Systems	Bioretention systems could be used subject to the maintenance requirements and adoptability. However, other forms of SuDS are likely to be more appropriate.	?
Trees	Trees could be incorporated however other forms of SuDS are likely to be more appropriate.	?
Pervious Pavements	Pervious Pavements could be incorporated into the drainage scheme.	✓
Attenuation Storage Tanks	Attenuation Storage Tanks could be incorporated into the drainage scheme.	✓
Detention Basins	There is insufficient space within the development layout to accommodate large open storage features.	X
Ponds and Wetlands	There is insufficient space within the development layout to accommodate large open storage features.	X

The proposed preliminary drainage scheme includes a bypass separator and filter drain as SuDS features.



4.0 Water Quality Management

Table 4 – Minimum Water Quality Management Requirements

Land Use	Pollution Hazard Level	Requirements for discharge to Surface Waters, including Coasts and Estuaries	Requirements for discharge to Groundwater
Residential roofs	Very Low	Removal of gross solids and sediments only	
Individual property driveways, roofs (excluding residential), residential car parks, low traffic roads (e.g. cul-de-sacs, home zones, general access roads), non-residential car parking within infrequent change (e.g. schools, offices)	Low	Simple index approach (Note: extra measures may be required for discharges to protected resources)	
Commercial yard and delivery areas, non-residential car parking with frequent change (e.g. hospitals, retail), all roads except low traffic roads and trunk roads/motorways	Medium	Simple index approach (Note: extra measures may be required for discharges to protected resources)	Simple index approach (Note: extra measures may be required for discharges to protected resources) In England and Wales, Risk Screening must be undertaken first to determine whether consultation with the environmental regulator is required. In Northern Ireland the need for Risk Screening should be agreed with the environmental regulator.
Trunk roads and motorways	High	Follow the guidance and risk assessment process set out in HA (2009)	
Sites with heavy pollution (e.g. haulage yards, lorry parks, highly frequented lorry approaches to industrial estates, waste sites), sites where chemicals and fuels (other than domestic fuel oil) are to be delivered, handled, stored, used or manufactured, industrial sites	High	Discharges may require an environmental licence or permit. Obtain pre-permitting advice from the environmental regulator. Risk assessment is likely to be required.	

Note: Table recreated from Table 4.3 of the CIRIA C753, The SuDS Manual; 2015.



Based on **Table 4** above the development proposals would be considered to be **Medium** and therefore a simple approach to the assessment of water quality improvement is appropriate.

Table 5 – Pollution Hazard Indices for Different Land Use Classifications

Land Use	Pollution Hazard Level	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Residential roofs	Very Low	0.2	0.2	0.05
Other roofs (typically commercial/industrial roofs)	Low	0.3	0.2 (up to 0.8 where there is potential for metals to leach from the roof)	0.05
Individual property driveways, residential car parks, low traffic roads (e.g. cul-de-sacs, home zones, general access roads), non-residential car parking within infrequent change (e.g. schools, offices) i.e. <300 traffic movements/day	Low	0.5	0.4	0.4
Commercial yard and delivery areas, non-residential car parking with frequent change (e.g. hospitals, retail), all roads except low traffic roads and trunk roads/motorways	Medium	0.7	0.6	0.7
Sites with heavy pollution (e.g. haulage yards, lorry parks, highly frequented lorry approaches to industrial estates, waste sites), sites where chemicals and fuels (other than domestic fuel oil) are to be delivered, handled, stored, used or manufactured, industrial sites, trunk roads and motorways	High	0.8	0.8	0.9

Note: Table recreated from Table 26.2 of the CIRIA C753, The SuDS Manual; 2015.

Based on **Table 4** above the appropriate SuDS mitigation Index required for the site are as highlighted above in **Table 5**.



4.1 Simple Index Approach

Table 6 – Indicative SuDS Mitigation Indices for Discharges to Surface Waters

Type of SuDS Component	Mitigation Indices		
	TSS	Metals	Hydrocarbons
Filter Strip	0.4	0.4	0.5
Filter Drain	0.4	0.4	0.4
Swale	0.5	0.6	0.6
Bioretention System	0.8	0.8	0.8
Permeable Pavement	0.7	0.6	0.7
Detention Basin	0.5	0.5	0.6
Pond	0.7	0.7	0.5
Wetland	0.8	0.8	0.8
Proprietary Treatment Systems	These must demonstrate that they can address each of the contaminant types to acceptable levels for frequent events up to approximately the 1 in 1 year return period event, for inflow concentrations relevant to the contributing drainage area.		

Note: Table recreated from Table 26.3 of the CIRIA C753, The SuDS Manual; 2015.

Table 7 – Proposed SuDS Mitigation Indices

Type of SuDS Component	Mitigation Indices		
	TSS	Metals	Hydrocarbons
Filter Drain	0.4	0.4	0.4
Bypass Separator	Specification dependent	Specification dependent	Specification dependent
Total	TBC	TBC	TBC

The proposed total mitigation indices in **Table 7** above will be greater than the required indices indicated in **Table 5** once an appropriate bypass separator is chosen and therefore the proposed SuDS features and drainage scheme provides adequate treatment.



5.0 Summary of Drainage Strategy

The proposed development is to comprise separate foul and surface water drainage networks and discharge separately into the existing Anglian Water sewers in Barnard Road.

The surface water from the development is to be restricted to a maximum discharge rate of 5.0l/s in all return periods up to and including the 1:100 year plus a 40% climate change allowance. FEH rainfall data is to be used for all hydraulic modelling of the development drainage system to comply with local policy.

Attenuation is to be provided through the use of below ground storage crates and SuDS features including filter drains and bypass separators are proposed to comply with the Simple Index Approach as set out in **Section 4.0** of this report.

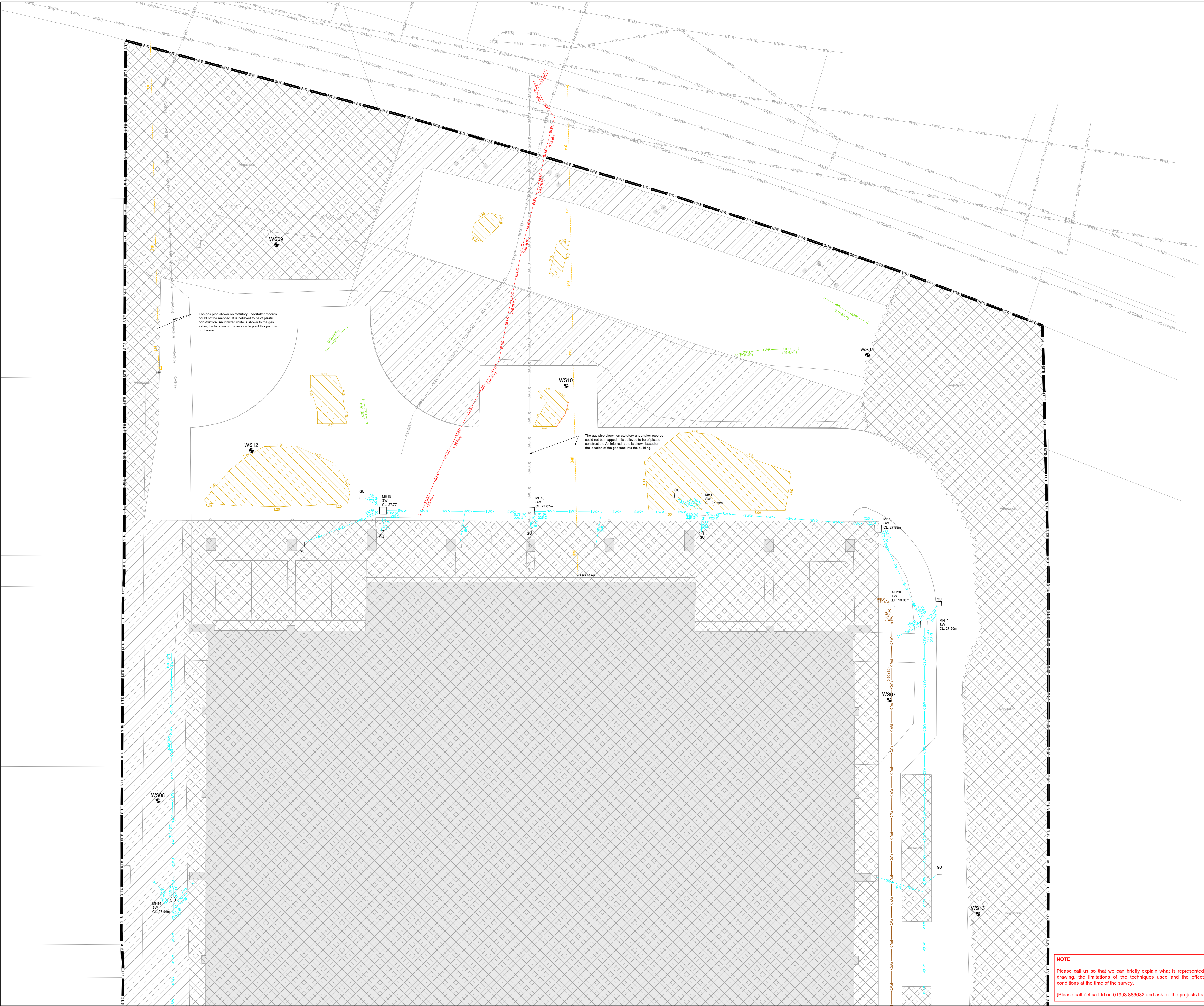
Appendix A

Topographic Survey

[illegible][illegible]

Appendix B

Utility Sub-scan Survey



Notes			
A Base map taken from topographic survey.			
B Limitations imposed by site conditions and current technologies mean that there can be no guarantee of detection for utility services. It is the responsibility of the user to satisfy themselves as to the location of site services prior to undertaking any excavation.			
C Zetlica do not accept responsibility for the accuracy of information supplied by third parties.			
D Where they could be obtained, the depths for apparatus that were traced by RFL are identified alongside the apparatus in metres below ground level. The depths obtained are modelled and do not necessarily indicate the exact depth to a duct or pipe.			
E Factors such as multiple utility services can reduce the detectability of utility services.			
F Survey conducted to PAS 128:2022 Type M3P.			
G Where PAS128 utility detection and location quality levels could be determined the level is shown in brackets alongside the apparatus. The table below shows the correlating accuracies for each quality level.			
Level	Horizontal Accuracy	Vertical Accuracy	Supporting Data
A	±50 mm	±25 mm	Visual inspection
B1P	±150 mm or ±15% of detected depth, whichever is greater	±15% of detected depth	Two techniques with post processing
B1	±150 mm or ±15% of detected depth, whichever is greater	±15% of detected depth	Two techniques no post processing
B2P	±250 mm or ±40% of detected depth, whichever is greater	±40% of detected depth	One technique with post processing
B2	±250 mm or ±40% of detected depth, whichever is greater	±40% of detected depth	One technique no post processing
B3P	±500 mm	Undefined	One technique with post processing
B3	±500 mm	Undefined	One technique no post processing
B4	Undefined	Undefined	Inferred location
H Drawing should be read in conjunction with report P13248-23-R1-A.			

Legend

Utility Services

Communications Cables

- BT British Telecom cables
- Cable television cables

Drainage

- Arrow indicates flow direction
- Combined water sewer
- Surface water sewer

Electricity Cables

- Electricity cables
- Electricity - high voltage cables

Fuel Pipes

- Gas pipes

Water Pipes

- Water pipes

Statutory Undertakers Information

- Utility service information from statutory undertakers records (linetype indicates service)

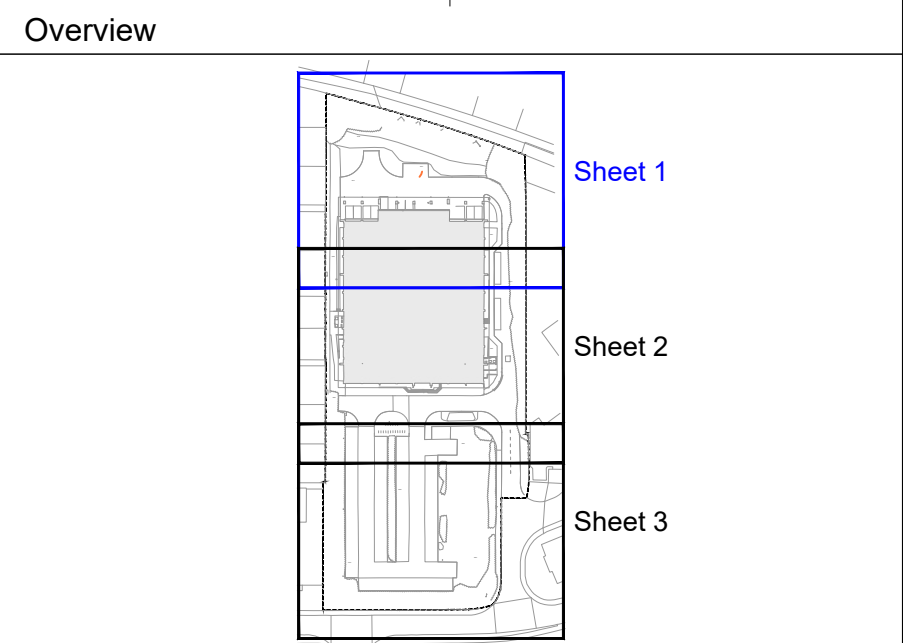
Other

- Site boundary
- GPR detected linear feature
- Unknown utility service
- Inferred route

Abbreviations and annotations

- UTL Unable to lift
- I Unable to trace or service runs off site
- PO Post
- ABG Service runs above ground
- BDG Service runs to a building
- LP Lamp post
- MH Manhole
- GU Gully
- DP Downpipe
- TL Traffic light

- British Telecom cables (overhead)
- Communication cables
- Foul water sewer
- Electricity cables (overhead)
- Electricity - low voltage cables
- Oil pipes
- Overhead utility service information from statutory undertakers records (linetype indicates service)
- Inaccessible
- Inaccessible for GPR
- Disturbed ground
- Telegraph pole
- Electric pole
- CCTV pole
- Earth rod
- Fire hydrant
- Water valve
- Water main
- Gas valve
- Marker post



Draft

User to check for latest issue

Client

BRD Environmental Ltd.

Project

Norwich Utility Survey

Location

Site off Barnard Rd, Norwich

Title

Utility Services Plan

Drawn by

N. Haynes

Checked by

J. Hunt

Horizontal Scale (A1)

1:150

Date of Survey

07/08/23-09/08/23

Issue Date

17/08/2023

Project Code

P13248-23

Drawing No.

DWG01

Sheet

1 of 3

Issue

B

Issue	Remarks	Drawn	Checked	Date
A	Draft issue, for comment	NH	JH	14/08/2023
B	Draft issue, for comment	NH	JH	17/08/2023

NOTE

Please call us so that we can briefly explain what is represented on this drawing, the limitations of the techniques used and the effect of site conditions at the time of the survey.
(Please call Zetlica Ltd on 01993 886682 and ask for the projects team)

Zetlica Ltd

Zetlica House

Southfield Road

Eynsham

OX29 4BS

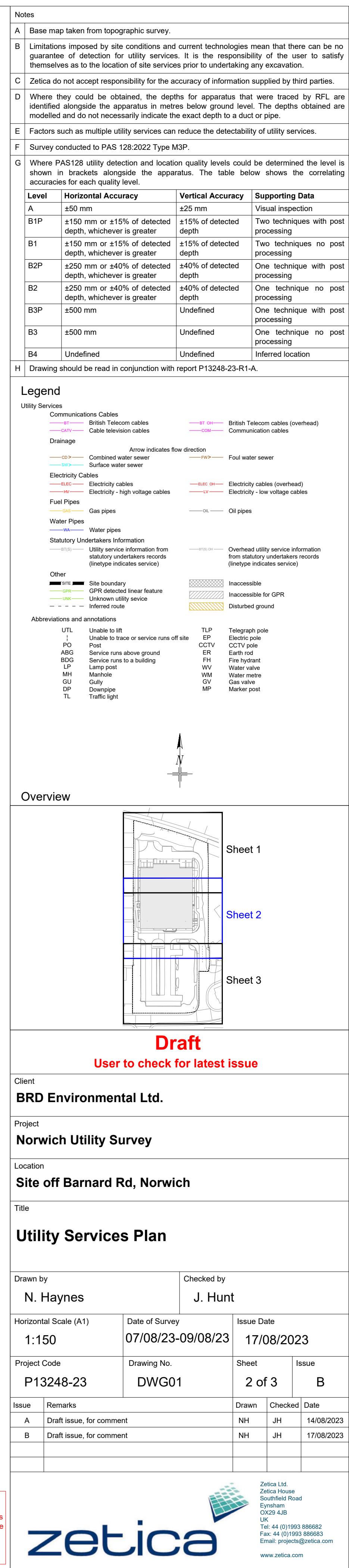
UK

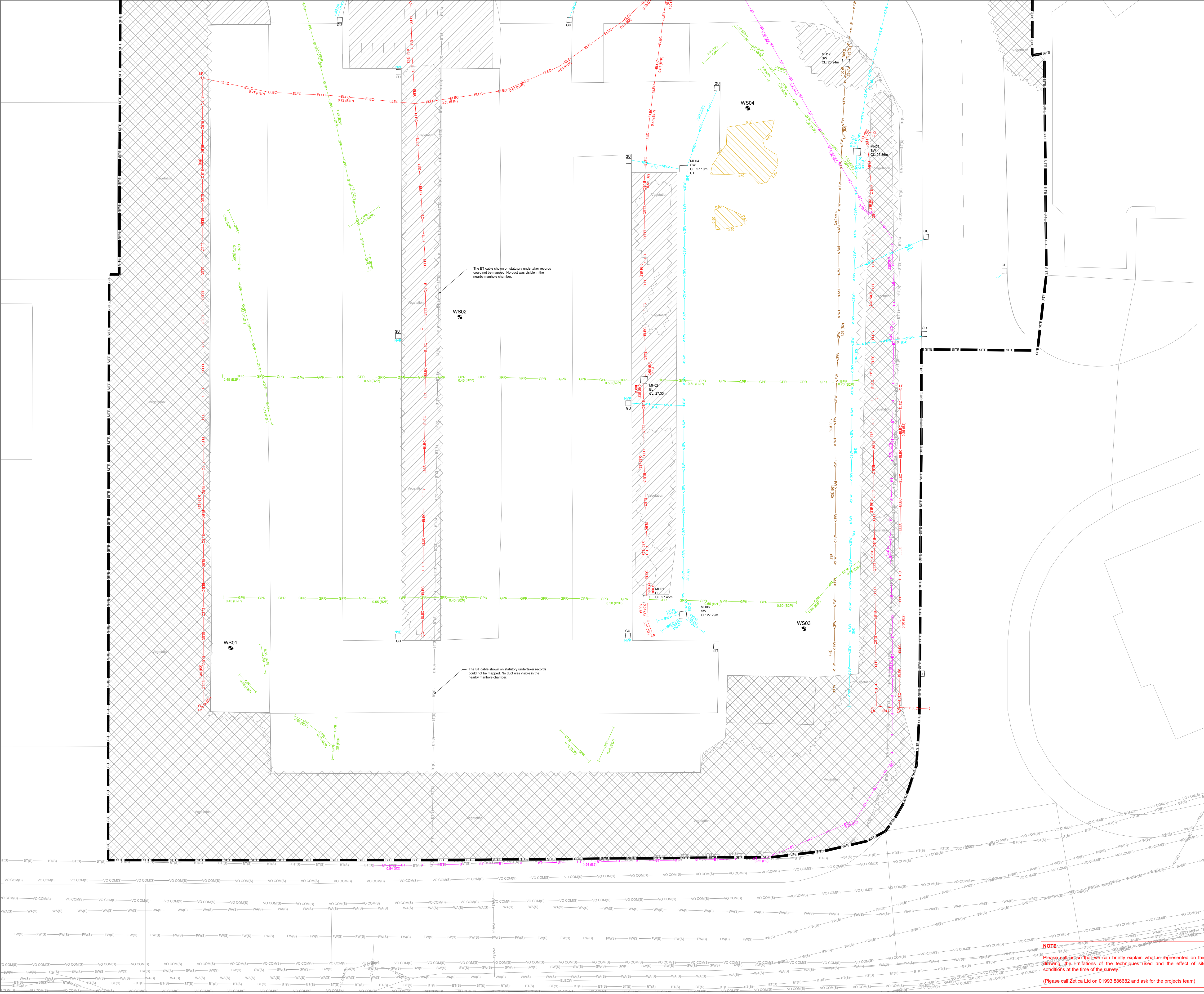
Tel: 44 (0)1993 886682

Fax: 44 (0)1993 886683

Email: projects@zetlica.com

www.zetlica.com





Notes

A Base map taken from topographic survey.

B Limitations imposed by site conditions and current technologies mean that there can be no guarantee of detection for utility services. It is the responsibility of the user to satisfy themselves as to the location of site services prior to undertaking any excavation.

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B3	±500 mm	Undefined	One technique with post processing
B4	Undefined	Undefined	Inferred location

H Drawing should be read in conjunction with report P13248-23-R1-A.

Legend

Utility Services

Communications Cables

- British Telecom cables
- Cable television cables
- British Telecom cables (overhead)
- Communication cables

Drainage

- Arrow indicates flow direction
- Combined water sewer
- Surface water sewer
- Foul water sewer

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- Electricity cables
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- Electricity cables (overhead)
- Electricity - low voltage cables

Fuel Pipes

- Gas pipes
- Oil pipes

Water Pipes

- Water pipes

Statutory Undertakers Information

- Utility service information from statutory undertakers records (linetype indicates service)
- Overhead utility service information from statutory undertakers records (linetype indicates service)

Other

- Site boundary
- GPR detected linear feature
- Unknown utility service
- Inferred route
- Inaccessible
- Inaccessible for GPR
- Disturbed ground

Abbreviations and annotations

UTL	Unable to lift	TLP	Telegraph pole
I	Unable to trace or service runs off site	EP	Electric pole
PO	Post	CCTV	CCTV pole
ABG	Service runs above ground	ER	Earth rod
BDO	Service runs to a building	FH	Fire hydrant
LP	Lamp post	WV	Water valve
Mtr	Manhole	VM	Water metre
GU	Gully	GV	Gas valve
DP	Downpipe	MP	Marker post
TL	Traffic light		

Overview

Sheet 1

Sheet 2

Sheet 3

Draft

User to check for latest issue

Client

BRD Environmental Ltd.

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Norwich Utility Survey

Location

Site off Barnard Rd, Norwich

Title

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Drawn by

N. Haynes

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J. Hunt

Horizontal Scale (A1)

1:150

Date of Survey

07/08/23-09/08/23

Issue Date

17/08/2023

Project Code

P13248-23

Drawing No.

DWG01

Sheet

3 of 3

Issue

B

Issue	Remarks	Drawn	Checked	Date
A	Draft issue, for comment	NH	JH	14/08/2023
B	Draft issue, for comment	NH	JH	17/08/2023

NOTE

Please call as so that we can briefly explain what is represented on this drawing, the limitations of the techniques used and the effect of site conditions at the time of the survey.

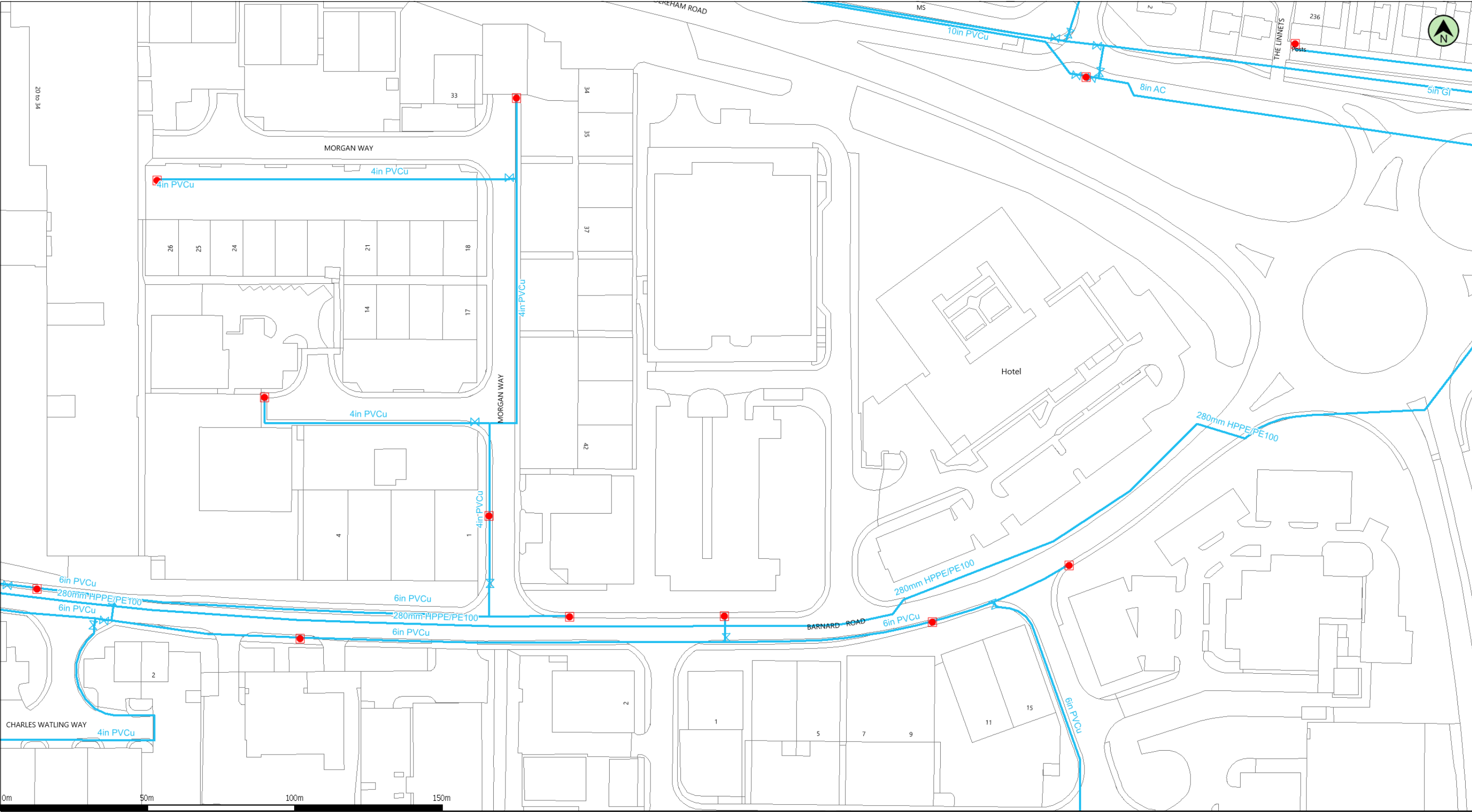
(Please call Zetica Ltd on 01993 886682 and ask for the projects team)

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Zetica House
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Fax: 44 (0)1993 886683
Email: projects@zetica.com
www.zetica.com

Appendix C

Anglian Water Sewer Records



(c) Crown copyright and database rights 2019 Ordnance Survey 100022432 Date: 08/07/19 Scale: 1:1250 Map Centre: 617680,309919 Data updated: 30/06/19 Our Ref: 324585 - 1 Clean Water Plan A3

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 2019 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.

Potable Water
Raw Water
Decommissioned Water



Fitting
Hydrant

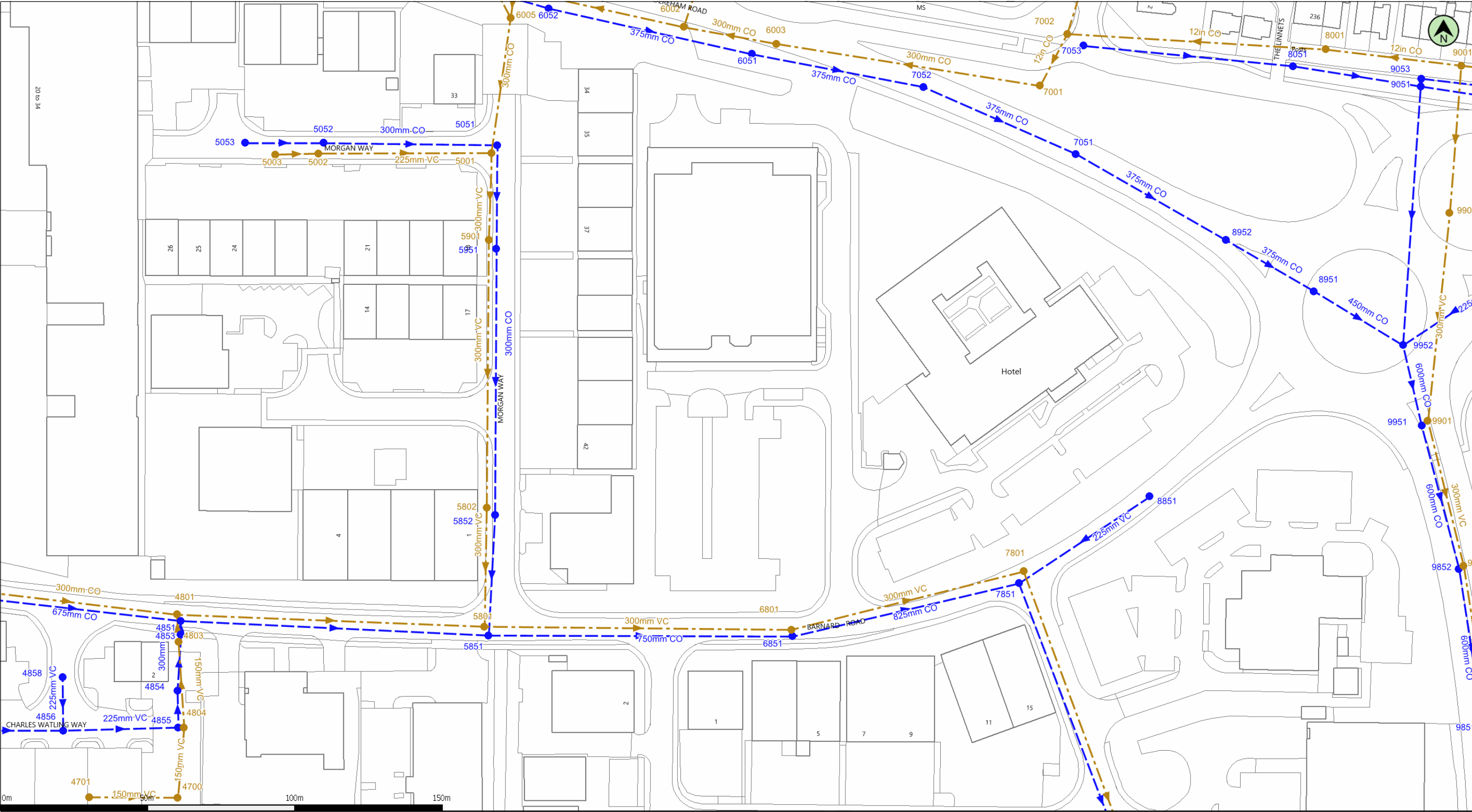


sallen@cw-architects.co.uk

Barnard Rd, Norwich

Could you please provide me with a plan showing you cables / kit for the attached site and immediate surrounding area.





(c) Crown copyright and database rights 2019 Ordnance Survey 100022432 Date: 08/07/19 Scale: 1:1250 Map Centre: 617680,309919 Data updated: 30/06/19 Our Ref: 324585 - 2 Wastewater Plan A3

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 2019 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.

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

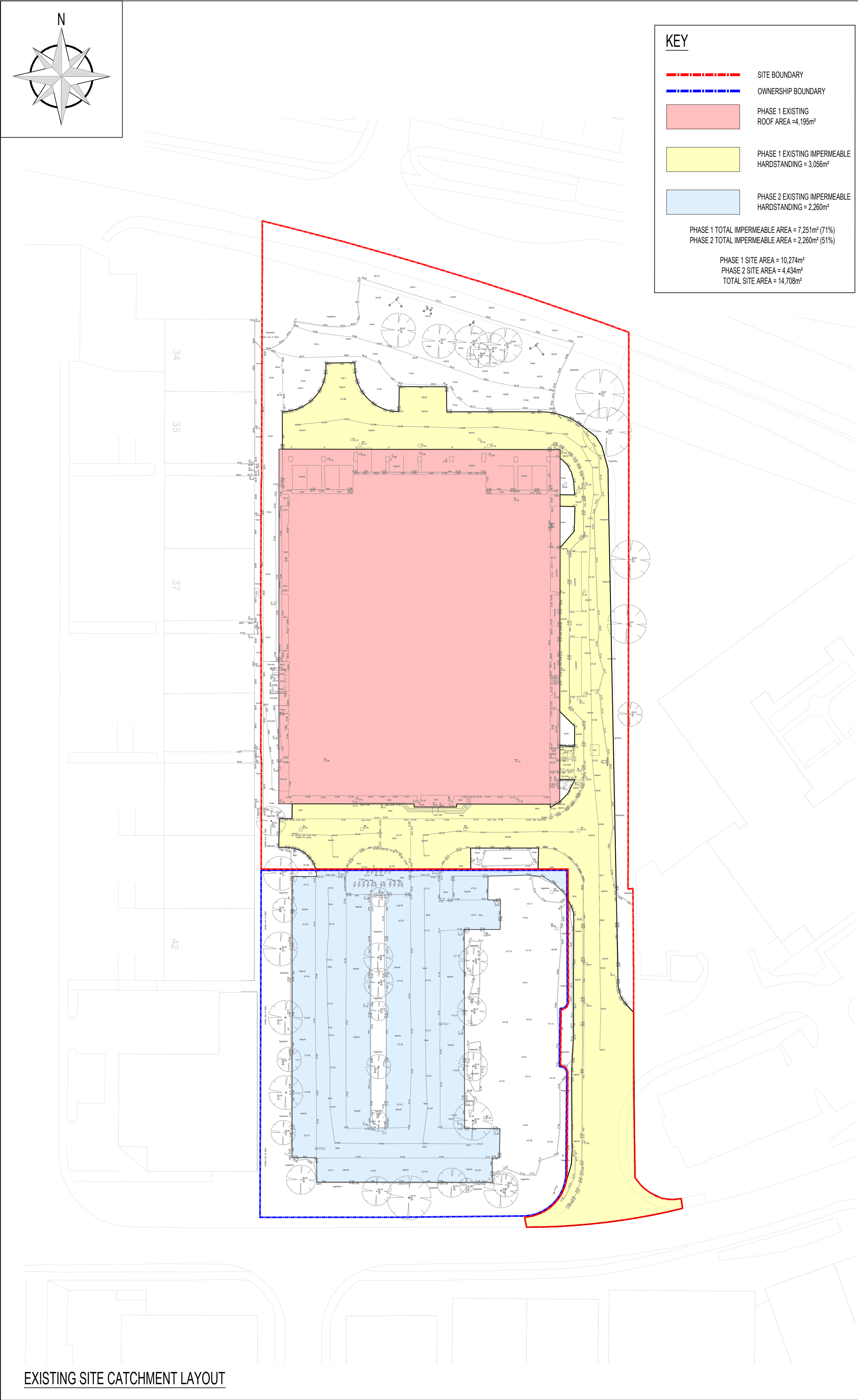
*(Colour denotes effluent type)

sallen@cw-architects.co.uk
Barnard Rd, Norwich
Could you please provide me with a plan showing you cables / kit for the attached site and immediate surrounding area.

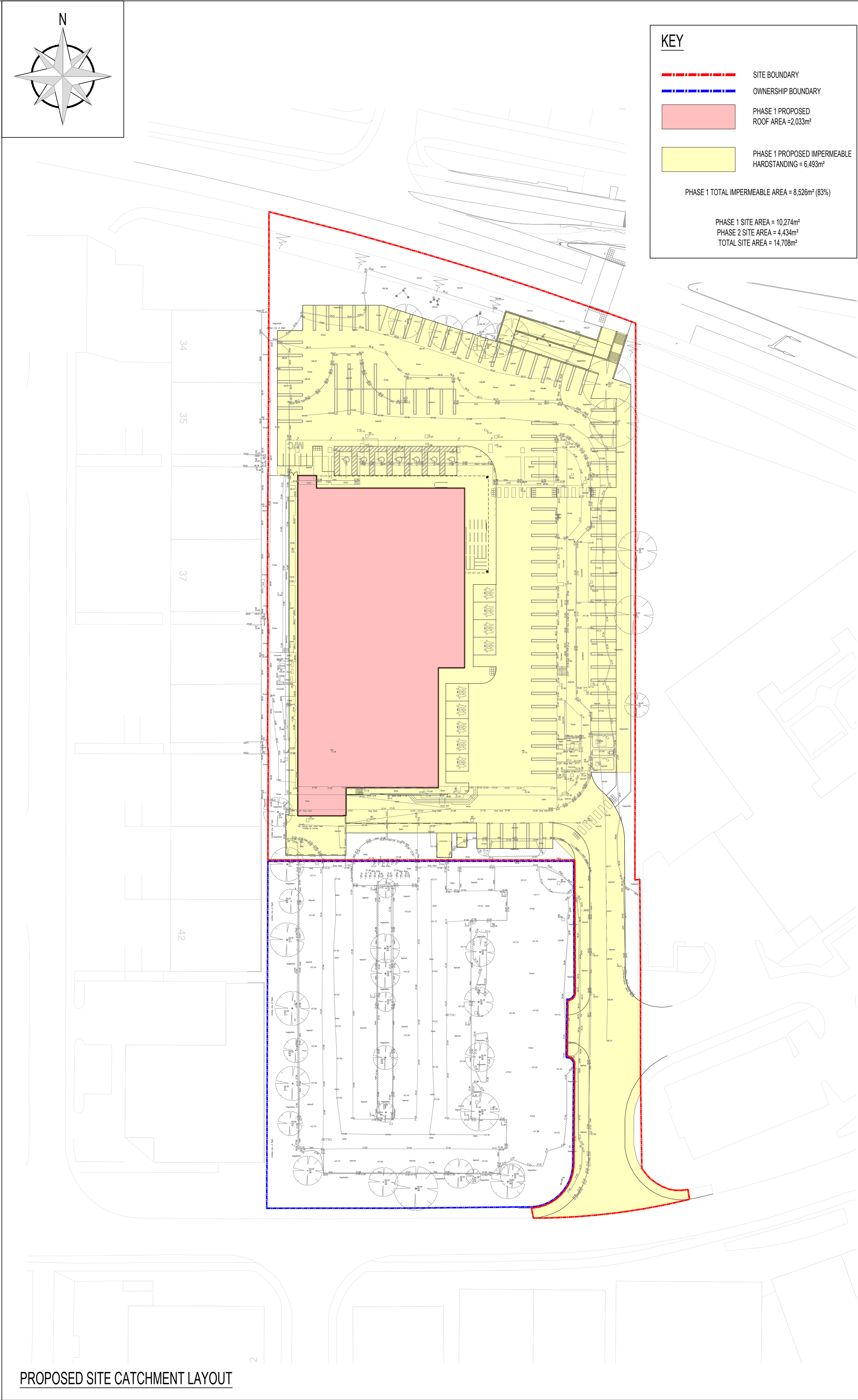


Appendix D

Catchment Layouts



EXISTING SITE CATCHMENT LAYOUT



PROPOSED SITE CATCHMENT LAYOUT

© Jackson Consulting Engineers Limited

A1

1. DO NOT SCALE THIS DRAWING. THE CONTRACTOR SHALL VERIFY ALL DIMENSIONS AND EXISTING CONDITIONS ON SITE PRIOR TO COMMENCING THE WORKS.

2. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS, ENGINEERS AND SPECIALISTS DRAWINGS AND SPECIFICATIONS.

3. ALL DIMENSIONS IN MILLIMETRES UNLESS NOTED OTHERWISE. ALL LEVELS IN METRES UNLESS NOTED OTHERWISE.

4. ANY DISCREPANCIES NOTED ON SITE ARE TO BE REPORTED TO THE ENGINEER IMMEDIATELY.

5. THIS DRAWING IS BASED ON THE FOLLOWING:

- CARTER JONAS DRAWING No. J0073959-23-01_ISSUE 09, DATED 01.09.2023
- CORSTORPHINE & WRIGHT DRAWING No. 19408-300, REV DR, DATED 03.10.2023

P01	15.11.23	ISSUED FOR INFORMATION	MWh	MPW				
Rev.	Date	Revision Description	Drawn	Auth'd				
Client								
HENRY RILEY LLP								
Project Title								
BARNARD ROAD, NORWICH								
Description								
CATCHMENT LAYOUT								
RIBA Stage								
Stage 2 - Concept Design								
JPL Ref.	- HRL02791	Scale	- 1:500 @ A1	Date - OCT 2023				
Project	Orig.	Vol.	Level	Type	Role	Number	Status	Revision
002791	JPL	ZZ	ZZ	DR	D	4001	S2	P01

Jackson

purdue lever

8 Bridge Point Drive, Fridge Park, Derby, DE24 8BX

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enquiries@jacksonjpl.co.uk

www.jacksonjpl.co.uk

Appendix E

Preliminary Hydraulic Drainage Calculations

Design Settings

Rainfall Methodology	FSR	Maximum Time of Concentration (mins)	30.00
Return Period (years)	100	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)	20.000	Minimum Backdrop Height (m)	0.200
Ratio-R	0.400	Preferred Cover Depth (m)	1.200
CV	0.750	Include Intermediate Ground	✓
Time of Entry (mins)	5.00	Enforce best practice design rules	x

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
S1	0.200	5.00	28.150	1200	617656.989	310011.761	1.875
S2	0.040	5.00	28.110	1350	617710.957	310011.761	2.285
S3	0.025	5.00	27.675	1200	617685.717	309929.873	1.775
S4	0.035	5.00	27.675	1200	617693.581	309929.874	1.810
S5			27.900	1200	617693.581	309976.526	2.245
S6	0.140	5.00	27.400	1200	617714.169	309950.897	1.575
S7			28.125	1200	617714.169	309976.526	2.550
S8			28.350	1350	617710.956	309976.526	3.000
S9	0.075	5.00	28.350	1350	617710.956	309972.269	3.060
S10	0.013	5.00	27.275	3000	617710.955	309937.258	2.085
S11	0.070	5.00	27.775	1200	617652.416	310002.505	1.800
S12	0.085	5.00	27.950	1200	617690.581	310002.509	2.125
S13	0.065	5.00	27.825	1200	617654.713	309925.163	1.500
S14	0.010	5.00	27.400	1200	617690.581	309925.392	1.990
S15	0.045	5.00	27.000	1350	617717.024	309925.530	1.840
S16	0.050	5.00	26.725	1350	617717.247	309887.483	1.650
S17			27.300	1800	617717.440	309854.710	2.300
S18			27.300	1200	617728.753	309847.142	2.360

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)
3.000	S1	S2	53.968	0.600	26.275	25.975	0.300	179.9	300	5.77	50.0
3.001	S2	S8	35.235	0.600	25.825	25.350	0.475	74.2	450	6.02	50.0
3.002	S8	S9	4.257	0.600	25.350	25.290	0.060	71.0	450	6.40	50.0
3.003	S9	S10	35.011	0.600	25.290	25.190	0.100	350.1	450	6.94	50.0
3.004	S10	S15	13.205	0.600	25.190	25.160	0.030	440.2	450	7.17	50.0
1.003	S15	S16	38.048	0.600	25.160	25.075	0.085	447.6	450	7.89	50.0
1.004	S16	S17	32.774	0.600	25.075	25.000	0.075	437.0	450	8.45	50.0

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)
3.000	1.169	82.6	27.1	1.575	1.835	0.200	0.0	118	1.050
3.001	2.362	375.7	32.5	1.835	2.550	0.240	0.0	88	1.469
3.002	2.416	384.2	59.6	2.550	2.610	0.440	0.0	119	1.776
3.003	1.081	171.8	69.8	2.610	1.635	0.515	0.0	199	1.026
3.004	0.962	153.1	71.6	1.635	1.390	0.528	0.0	217	0.948
1.003	0.954	151.8	108.8	1.390	1.200	0.803	0.0	283	1.034
1.004	0.966	153.6	115.6	1.200	1.850	0.853	0.0	292	1.056

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)
1.005	S17	S18	13.611	0.600	25.000	24.940	0.060	226.8	225	8.72	50.0
4.000	S3	S4	7.864	0.600	25.900	25.865	0.035	224.7	225	5.15	50.0
4.001	S4	S5	46.652	0.600	25.865	25.655	0.210	222.2	225	6.04	50.0
4.002	S5	S8	17.375	0.600	25.655	25.575	0.080	217.2	225	6.37	50.0
5.000	S6	S7	25.629	0.600	25.825	25.575	0.250	102.5	300	5.28	50.0
5.001	S7	S8	3.213	0.600	25.575	25.500	0.075	42.8	300	5.30	50.0
1.000	S11	S12	38.165	0.600	25.975	25.825	0.150	254.4	300	5.65	50.0
1.001	S12	S14	77.117	0.600	25.825	25.410	0.415	185.8	300	6.77	50.0
1.002	S14	S15	26.443	0.600	25.410	25.310	0.100	264.4	300	7.22	50.0
2.000	S13	S14	35.869	0.600	26.325	25.410	0.915	39.2	300	5.24	50.0

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)
1.005	0.864	34.3	115.6	2.075	2.135	0.853	0.0	225	0.880
4.000	0.868	34.5	3.4	1.550	1.585	0.025	0.0	47	0.552
4.001	0.873	34.7	8.1	1.585	2.020	0.060	0.0	74	0.717
4.002	0.883	35.1	8.1	2.020	2.550	0.060	0.0	73	0.721
5.000	1.552	109.7	19.0	1.275	2.250	0.140	0.0	84	1.172
5.001	2.408	170.2	19.0	2.250	2.550	0.140	0.0	67	1.606
1.000	0.981	69.3	9.5	1.500	1.825	0.070	0.0	75	0.693
1.001	1.150	81.3	21.0	1.825	1.690	0.155	0.0	103	0.968
1.002	0.962	68.0	31.2	1.690	1.390	0.230	0.0	143	0.942
2.000	2.518	178.0	8.8	1.200	1.690	0.065	0.0	45	1.324

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)
3.000	53.968	179.9	300	Circular	28.150	26.275	1.575	28.110	25.975	1.835
3.001	35.235	74.2	450	Circular	28.110	25.825	1.835	28.350	25.350	2.550
3.002	4.257	71.0	450	Circular	28.350	25.350	2.550	28.350	25.290	2.610
3.003	35.011	350.1	450	Circular	28.350	25.290	2.610	27.275	25.190	1.635
3.004	13.205	440.2	450	Circular	27.275	25.190	1.635	27.000	25.160	1.390
1.003	38.048	447.6	450	Circular	27.000	25.160	1.390	26.725	25.075	1.200
1.004	32.774	437.0	450	Circular	26.725	25.075	1.200	27.300	25.000	1.850
1.005	13.611	226.8	225	Circular	27.300	25.000	2.075	27.300	24.940	2.135
4.000	7.864	224.7	225	Circular	27.675	25.900	1.550	27.675	25.865	1.585
4.001	46.652	222.2	225	Circular	27.675	25.865	1.585	27.900	25.655	2.020

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
3.000	S1	1200	Manhole	Adoptable	S2	1350	Manhole	Adoptable
3.001	S2	1350	Manhole	Adoptable	S8	1350	Manhole	Adoptable
3.002	S8	1350	Manhole	Adoptable	S9	1350	Manhole	Adoptable
3.003	S9	1350	Manhole	Adoptable	S10	3000	Manhole	Adoptable
3.004	S10	3000	Manhole	Adoptable	S15	1350	Manhole	Adoptable
1.003	S15	1350	Manhole	Adoptable	S16	1350	Manhole	Adoptable
1.004	S16	1350	Manhole	Adoptable	S17	1800	Manhole	Adoptable
1.005	S17	1800	Manhole	Adoptable	S18	1200	Manhole	Adoptable
4.000	S3	1200	Manhole	Adoptable	S4	1200	Manhole	Adoptable
4.001	S4	1200	Manhole	Adoptable	S5	1200	Manhole	Adoptable

Pipeline Schedule

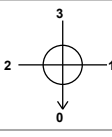
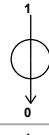
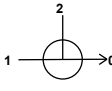
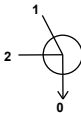
Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
4.002	17.375	217.2	225	Circular	27.900	25.655	2.020	28.350	25.575	2.550
5.000	25.629	102.5	300	Circular	27.400	25.825	1.275	28.125	25.575	2.250
5.001	3.213	42.8	300	Circular	28.125	25.575	2.250	28.350	25.500	2.550
1.000	38.165	254.4	300	Circular	27.775	25.975	1.500	27.950	25.825	1.825
1.001	77.117	185.8	300	Circular	27.950	25.825	1.825	27.400	25.410	1.690
1.002	26.443	264.4	300	Circular	27.400	25.410	1.690	27.000	25.310	1.390
2.000	35.869	39.2	300	Circular	27.825	26.325	1.200	27.400	25.410	1.690

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
4.002	S5	1200	Manhole	Adoptable	S8	1350	Manhole	Adoptable
5.000	S6	1200	Manhole	Adoptable	S7	1200	Manhole	Adoptable
5.001	S7	1200	Manhole	Adoptable	S8	1350	Manhole	Adoptable
1.000	S11	1200	Manhole	Adoptable	S12	1200	Manhole	Adoptable
1.001	S12	1200	Manhole	Adoptable	S14	1200	Manhole	Adoptable
1.002	S14	1200	Manhole	Adoptable	S15	1350	Manhole	Adoptable
2.000	S13	1200	Manhole	Adoptable	S14	1200	Manhole	Adoptable

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
S1	617656.989	310011.761	28.150	1.875	1200				
						0	3.000	26.275	300
S2	617710.957	310011.761	28.110	2.285	1350				
						0	3.001	25.825	450
S3	617685.717	309929.873	27.675	1.775	1200				
						0	4.000	25.900	225
S4	617693.581	309929.874	27.675	1.810	1200				
						0	4.001	25.865	225
S5	617693.581	309976.526	27.900	2.245	1200				
						0	4.002	25.655	225
S6	617714.169	309950.897	27.400	1.575	1200				
						0	5.000	25.825	300
S7	617714.169	309976.526	28.125	2.550	1200				
						0	5.001	25.575	300

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
S8	617710.956	309976.526	28.350	3.000	1350		1 5.001 2 4.002 3 3.001 0 3.002	25.500 25.575 25.350 25.350	300 225 450 450
S9	617710.956	309972.269	28.350	3.060	1350		1 3.002 0 3.003	25.290 25.290	450 450
S10	617710.955	309937.258	27.275	2.085	3000		1 3.003 0 3.004	25.190 25.190	450 450
S11	617652.416	310002.505	27.775	1.800	1200		0 1.000 1 1.000	25.975 25.825	300 300
S12	617690.581	310002.509	27.950	2.125	1200		1 1.001 0 1.001	25.825 25.825	300 300
S13	617654.713	309925.163	27.825	1.500	1200		0 2.000 1 2.000 2 1.001	26.325 25.410 25.410	300 300 300
S14	617690.581	309925.392	27.400	1.990	1200		1 3.004 2 1.002 0 1.003	25.160 25.310 25.160	450 300 450
S15	617717.024	309925.530	27.000	1.840	1350		1 1.003 0 1.004 1 1.004	25.075 25.075 25.000	450 450 450
S16	617717.247	309887.483	26.725	1.650	1350		1 1.005 0 1.005	25.000 24.940	225 225
S17	617717.440	309854.710	27.300	2.300	1800		1 1.005 0 1.005	25.000 24.940	225 225
S18	617728.753	309847.142	27.300	2.360	1200				

Simulation Settings

Rainfall Methodology	FEH-13	Analysis Speed	Normal	Additional Storage (m³/ha)	20.0
Summer CV	0.750	Skip Steady State	x	Check Discharge Rate(s)	x
Winter CV	0.840	Drain Down Time (mins)	240	Check Discharge Volume	x

Storm Durations

15	60	180	360	600	960	2160	4320	7200	10080
30	120	240	480	720	1440	2880	5760	8640	

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

Node S17 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	25.000	Product Number	CTL-SHE-0106-5000-1000-5000
Design Depth (m)	1.000	Min Outlet Diameter (m)	0.150
Design Flow (l/s)	5.0	Min Node Diameter (mm)	1200

Node S10 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	25.190
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.95	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	900.0	0.0	0.800	900.0	0.0	0.801	0.0	0.0

Other (defaults)

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

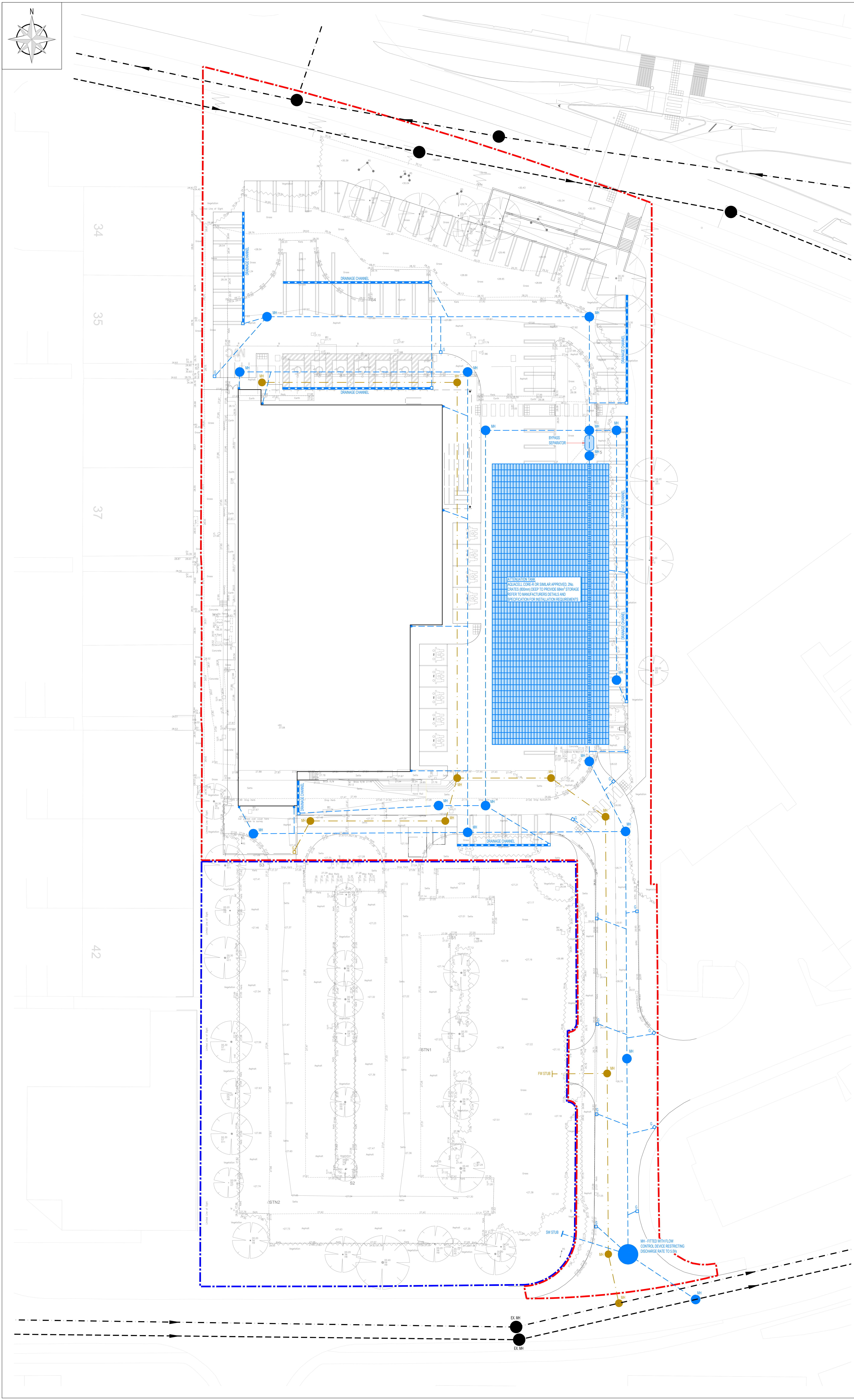
Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 99.73%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	S1	11	27.841	1.566	140.3	5.1101	0.0000	SURCHARGED
15 minute winter	S2	10	26.960	1.135	166.0	2.0222	0.0000	SURCHARGED
15 minute winter	S3	11	27.263	1.363	17.5	1.9261	0.0000	SURCHARGED
15 minute winter	S4	11	27.248	1.383	40.8	2.0987	0.0000	SURCHARGED
15 minute winter	S5	10	26.950	1.295	44.9	1.4646	0.0000	SURCHARGED
15 minute winter	S6	10	27.175	1.350	98.1	3.9261	0.0000	FLOOD RISK
15 minute winter	S7	10	26.916	1.341	101.5	1.5167	0.0000	SURCHARGED
15 minute winter	S8	10	26.841	1.491	320.9	2.1331	0.0000	SURCHARGED
15 minute winter	S9	9	26.726	1.436	374.8	2.7606	0.0000	SURCHARGED
720 minute winter	S10	705	25.970	0.780	46.7	672.7012	0.0000	SURCHARGED
15 minute winter	S11	11	27.017	1.042	49.1	1.9882	0.0000	SURCHARGED
15 minute winter	S12	11	26.932	1.107	99.0	2.1370	0.0000	SURCHARGED
15 minute winter	S13	10	26.427	0.102	45.6	0.2044	0.0000	OK
15 minute winter	S14	11	26.250	0.840	147.5	1.0341	0.0000	SURCHARGED
720 minute winter	S15	705	25.970	0.810	15.9	1.5564	0.0000	SURCHARGED
720 minute winter	S16	705	25.970	0.895	6.2	1.8233	0.0000	SURCHARGED
720 minute winter	S17	705	25.970	0.970	5.4	2.4686	0.0000	SURCHARGED
15 minute summer	S18	1	24.940	0.000	5.0	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	S1	3.000	S2	139.6	1.983	1.690	3.8004	
15 minute winter	S2	3.001	S8	171.3	1.081	0.456	5.5828	
15 minute winter	S3	4.000	S4	19.6	0.494	0.569	0.3128	
15 minute winter	S4	4.001	S5	44.9	1.130	1.295	1.8554	
15 minute winter	S5	4.002	S8	50.5	1.269	1.437	0.6910	
15 minute winter	S6	5.000	S7	101.5	1.442	0.925	1.8048	
15 minute winter	S7	5.001	S8	104.9	1.490	0.616	0.2263	
15 minute winter	S8	3.002	S9	325.3	2.053	0.847	0.6745	
15 minute winter	S9	3.003	S10	393.0	3.498	2.287	4.1180	
720 minute winter	S10	3.004	S15	-14.1	0.266	-0.092	2.0922	
15 minute winter	S11	1.000	S12	45.9	0.788	0.661	2.6876	
15 minute winter	S12	1.001	S14	99.1	1.408	1.219	5.4305	
15 minute winter	S13	2.000	S14	45.2	1.111	0.254	1.6431	
15 minute winter	S14	1.002	S15	149.0	2.116	2.191	1.8621	
720 minute winter	S15	1.003	S16	5.6	0.393	0.037	6.0285	
720 minute winter	S16	1.004	S17	5.4	0.233	0.035	5.1928	
720 minute winter	S17	Hydro-Brake®	S18	5.0				259.6

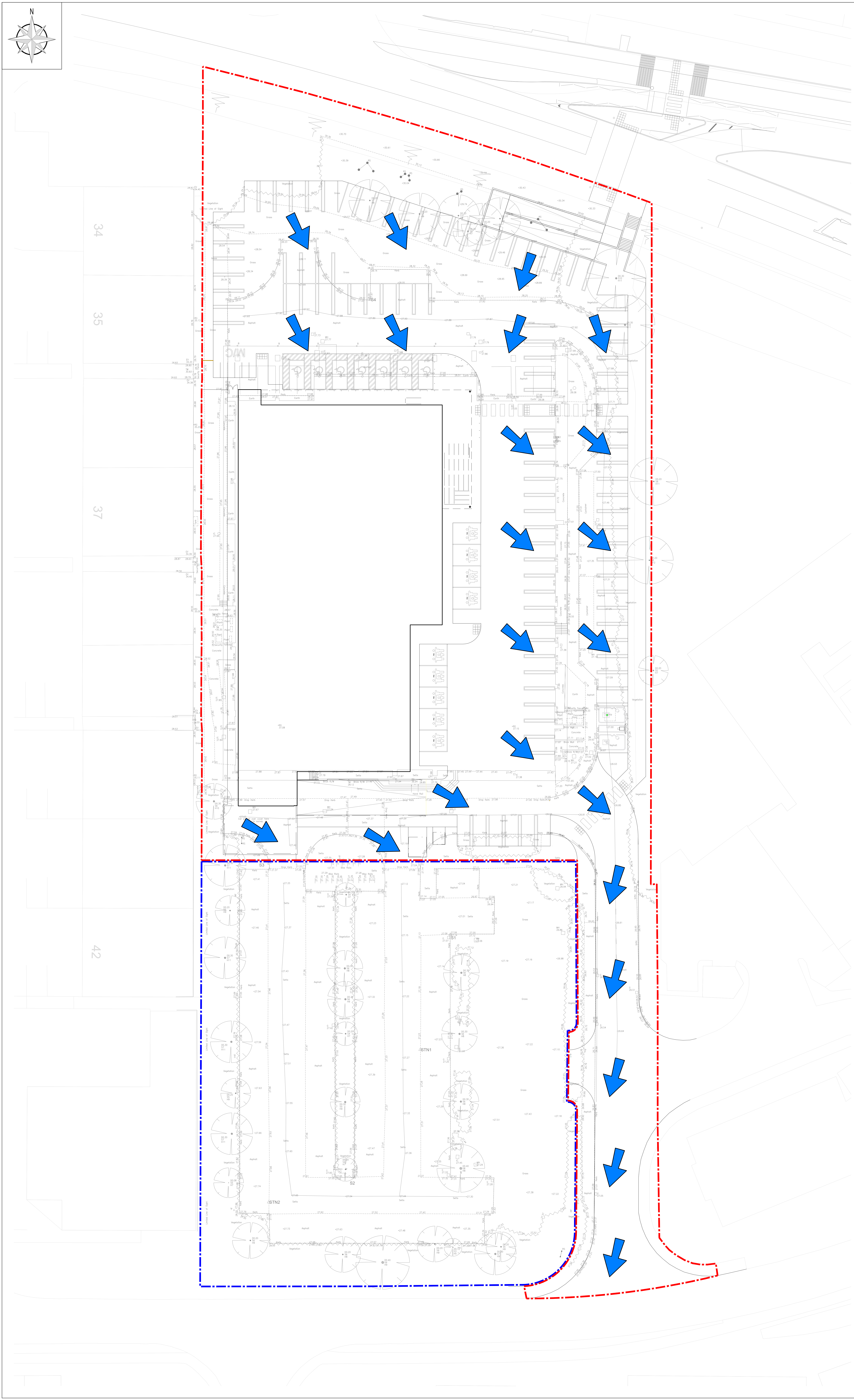
Appendix F

Preliminary Drainage Strategy Layout



Appendix G

Overland Flood Routing Layout



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1. DO NOT SCALE THIS DRAWING. THE CONTRACTOR SHALL VERIFY ALL DIMENSIONS AND EXISTING CONDITIONS ON SITE PRIOR TO COMMENCING THE WORKS.

2. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS, ENGINEERS AND SPECIALISTS DRAWINGS AND SPECIFICATIONS.

3. ALL DIMENSIONS IN MILLIMETRES UNLESS NOTED OTHERWISE. ALL LEVELS IN METRES UNLESS NOTED OTHERWISE.

4. ANY DISCREPANCIES NOTED ON SITE ARE TO BE REPORTED TO THE ENGINEER IMMEDIATELY.

5. THIS DRAWING IS BASED ON THE FOLLOWING:

- CARTER, JONAS DRAWING NO. 0073559-23-01, ISSUE 06, DATED 01.09.2023
- CORSTORPHINE & WRIGHT DRAWING NO. 19466-300, REV 03, DATED 03.10.2023

CDM RISK REGISTER

CLOSE PROXIMITY OF TREES AND BUILDINGS

ALL NECESSARY PRECAUTIONS TO BE TAKEN TO AVOID INCIDENTS WHEN DRAINING.

CONTAMINATED GROUND CONDITIONS

ALL CONSTRUCTION WORKERS TO HAVE APPROPRIATE PPE AND WASH DOWN FACILITIES PROVIDED.

EXISTING ON SITE / CROSS SITE SERVICES

LOCATE, DEMARK AND PROTECT OR MAKE SAFE ALL EXISTING ON SITE / CROSS SITE SERVICES PRIOR TO THE COMMENCEMENT OF ANY WORKS.

ADJACENT HIGHWAY

CLOSE PROXIMITY OF HIGHWAY. APPROPRIATE MEASURES TO BE IMPLEMENTED FOR SAFE ACCESS AND EGRESS ON SITE.

KEY

SITE BOUNDARY

OWNERSHIP BOUNDARY

KEY

OVERLAND FLOOD ROUTING DIRECTION

P01	15.11.23	ISSUED FOR INFORMATION	MWh	MPW		
Rev	Date	Revision Description	Drawn	Auth'd		
Client						
HENRY RILEY LLP						
Project Title						
BARNARD ROAD, NORWICH						
Description						
PRELIMINARY OVERLAND FLOOD ROUTING LAYOUT						
RIBA Stage						
Stage 2 - Concept Design						
JPL Ref.	HLR02791	Scale	1:200	@ A0	Date	OCT 2023
Project	Orig	Vol	Level	Type	Role	Number
002791	JPL	ZZ	ZZ	DR	D	4055
					Status	Revision
					S2	P01

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