Our reference: 890701-L01-AS

Your Ref: 23/01931/APP

8th November 2023

Buckinghamshire Council
The Gateway
Gatehouse Road
Aylesbury
HP19 8FF

Dear Sir/Madam,

Conversion of 2No. Agricultural Barns to 7No. Residential dwellings (Use Class C3); associated amenity space, parking and landscaping.
Burston Ridge Farm, Aylesbury Road, Wingrave, Buckinghamshire, HP22 3RH

1. INTRODUCTION

RSK Land & Development Engineering Ltd (RSK) have been instructed by Burston Ridge Farm Developments Ltd to prepare a drainage statement providing the relevant information to discharge condition 7 of the planning permission reference 20/01931/APP. The condition wording is shown in italics below:

"No works (other than site clearance and general preparatory works) shall begin until a surface water drainage scheme for the site, based on sustainable drainage principles has been submitted to and approved in writing by the Local Planning Authority. The scheme shall subsequently be implemented in accordance with the approved details before the development is completed. The scheme shall also include:

Water quality assessment demonstrating that the total pollution mitigation index equals or exceeds the pollution hazard index; priority should be given to above ground SuDS components,

Existing and proposed discharge rates and volumes

Drainage layout detailing the connectivity between the dwellings and the drainage components, showing pipe numbers, gradients, and sizes, complete together with storage volumes of all SuDS components.

Calculation to demonstrate that the proposed drainage system can contain up to the 1in30 storm event without flooding. Any onsite flooding between the 1in30 and 1in100 plus climate change storm event should be safely contained within the site.

Construction details of all SuDS and drainage components

Details of how and when the full drainage system will be maintained, this should also include details of who will be responsible for the maintenance

Details of proposed overland flood flow routes in the event of system exceedance or failure, with demonstration of flow direction.

The information provided in this report and opinions expressed are subject to RSK Group Service Constraints contained in **Appendix A**.

2. SITE LOCATION AND PROPOSALS

The Site is a farmstead made up of a collection of barn buildings, located just west of and accessed from the A418 (Aylesbury Road). It is located at Burston Ridge Farm, Aylesbury Road, Wingrave Buckinghamshire HP22 4RH.

It is located 1.1 miles west of Wingrave and 0.7 miles south of Aston Abbotts and is surrounded by fields on all sides, with a 300-meter-long access gravel road leading to the buildings, along with the required amenity space, parking, and landscaping. The works would also include upgrading the existing access road.

A copy of the existing topographical survey and proposed site plan can be found in **Appendix B** and **C** respectively.

3. DEVELOPMENT DRAINAGE

3.1 EXISTING DRAINAGE

The site currently comprises of two agricultural barns that have guttering and rainwater pipes that either discharge onto the existing concrete hardstanding or into gullies. The gullies presumably are discharging into the existing ditch which runs adjacent to the existing buildings, as shown below:

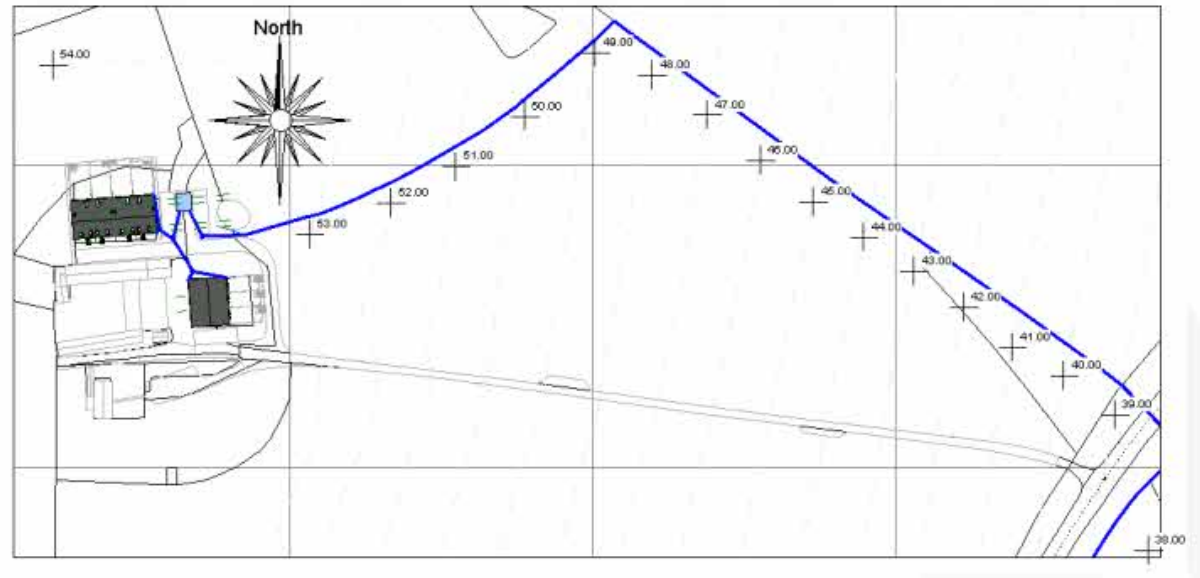


Figure 1

3.2 EXISTING AND PROPOSED RUNOFF RATES

This assessment includes an overview and comparison of the existing brownfield scenario and proposed development scenario. The existing and proposed areas are provided in the Table below:

	Post-development Area (m^2)	Post-development Area (m^2)
Impermeable Area	1300	2446

Table 1.1 – Pre and Post development Areas

The proposed development will substantially increase the area of impermeable surfaces, but this is mainly due to the plans to upgrade the existing gravel track with permeable paving. Without this, the development would only increase the impermeable area by 8%.

The existing and proposed impermeable areas plan are shown respectively in **Appendix D** and **E**.

As a developed site, the pre-development surface water runoff from the site has been calculated for a range of return periods using the Modified Rational method. The Modified Rational method uses the following equation to calculate peak runoff rate from an area:

Q = 2.78 Cv Cr i A

Where:

2.78 = Coefficient which accounts for the differences in units used for the inputs and the outputs of the equation.

Cv = Volumetric Runoff Coefficient - a co-efficient that describes the proportion of rainfall appearing in the surface water drainage system, assumed to be 0.95 for impermeable areas

Cr = Routing Coefficient - a routing co-efficient added to the Rational Method to represent runoff characteristics of a particular site or area in a more accurate manner, assumed to be 1.3 for urban areas

i = Rainfall Intensity (mm/hr) based on a 1 hour rainfall event

A = Area (ha)

Return period	Rainfall Intensity (mm)	Peak flow (l/s)
QBar	14.91	6.65
1 in 1 year	9.04	4.03
1 in 30 year	32.26	14.40
1 in 100 year	41.51	18.53

Table 1.2: Modified Rational Method pre-development surface water runoff

Abbey Park, Humber Road, Coventry CV3 4AQ UK
Tel +44 (0) 2476 505600
Email: LDEMids@rsk.co.uk

The existing gravel access road linking the site to the A418 was excluded from the calculations as it is assumed to be draining into the adjacent greenfield land.

Rainfall data has been taken from the Depth Duration Frequency rainfall calculator contained within the FEH 2022 web service, with the associated screenshots included in **Appendix F**.

Based on the peak flows shown on the table above, it is suggested that the future flows originating from the residential development could be restricted to 3 l/s, as this would represent a 50% betterment for the 1in1 year storm period. However, the LLFA has already agreed to restrict the surface water discharge from the residential development into the existing ditch to a maximum of 1 l/s.

Similarly, the future drainage draining the upgraded track road is proposed to be restricted to a maximum discharge rate of 1 l/s.

3.3 PROPOSED SURFACE WATER DRAINAGE STRATEGY

The proposed SuDS for the site include a combination use of tanked permeable paving, swale and raingardens. Permeable paving is to be provided at the new access road and at the existing track.
A swale is shown adjacent to plot 3 to promote biodiversity, amenities and retain flows from plot 1-3 roofs.

The SuDS measures are outlined in the Indicative Surface Water Strategy attached in **Appendix G**.
The estimated surface storage volume provided by the proposed drainage system is 193m^3 and is mainly provided within the aggregate subbase storage beneath the permeable pavement.

The calculations attached in **Appendix H**, demonstrate that the drainage system can successfully restrict the runoff to a limiting discharge rate of 1 l/s whilst accommodating the 1in100 plus 40% climate change storm events without flooding.

3.4 WATER QUALITY

The Simple Index Approach has been used to determine the pollution hazard index for the runoff and appropriate mitigation measures through SuDS and proprietary treatment features. The strategy is to treat runoff at source prior to discharge to the existing drainage ditches.

The runoff from the plot roofs will be initially treated by SuDS features such as the rain gardens and the swale that will be built adjacent to plot 3. The access road and existing track runoff will be treated within the aggregate sub-base.

Table 26.1 of the SUDS Manual indicates that for the Simple Index Approach:

> Simple pollution hazard indices should be based on land use (e.g. Table 26.2); and
> Risk reduction for Surface Water should be done using Simple SuDS hazard mitigation indices (e.g. Table 26.3)

Extracts of Tables 26.2 and 26.3 are replicated below, highlighting the relevant features applicable to this site:

Table 1.3: Extract of SuDS Manual Table 26.2: Pollution hazard indices for different land use classifications

Land Use	Pollution Hazard Level	Total Suspended Solids (TSS)	Metals	Hydro-carbons
Residential Roofs	Very Low	0.2	0.2	0.05
Commercial yard and delivery areas, non-residential car parking with frequent change (eg hospitals, retail), all roads except low traffic roads and trunk roads/motorways	Medium	0.7	0.6	0.7
Total		0.9	0.80	0.75

Table 1.4: Extract of Table 26.3: Indicative SuDS mitigation indices for discharges to surface waters [highlight lines that are appropriate]

	Mitigation Indices		
	TSS	Metals	Hydro-carbons
Raingarden	0.8	0.8	0.8
Swale	0.5	0.6	0.6
Permeable Pavement	0.7	0.6	0.7
Total	1.4	1.4	1.35

The SuDS Manual States the following:

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

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

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

In conclusion, the proposed features listed above will achieve the water treatment requirements for the development.

3.5 MAINTENANCE AND OPERATION CONSIDERATIONS

All pipes, inspection chambers, manholes and SuDS features will remain in private ownership and the future landowner or a private management company will be responsible for the inspection and maintenance.

A detailed SuDS Management Strategy for the proposed development is contained in **Appendix K**.

Construction Details of all SuDS components to be implemented on site are shown in **Appendix L**.

3.6 EXCEEDANCE FLOWS

Exceedance flows have been considered for the proposed development and generally follow the existing topography towards the lowest part of the site near the site entrance adjacent to A418 (Aylesbury Road).

Exceedance flows are conveyed by the development towards the access road, with proposed residential dwellings set a minimum 150mm above external ground levels.

A copy of the exceedance flow routing plan is shown in **Appendix M**.

4. CONCLUSION

The Drainage Statement and associated Drainage Strategy demonstrates that the proposed development drainage complies with the Buckinghamshire LLFA requirements, with the main principles listed below:

- Offsite surface water discharge rate limited to a minimum possible.
- Above ground sustainable urban drainage system techniques have been incorporated into the development proposals.
- The proposed surface water drainage system caters for 40% allowance in increase intensity due to climate change with no flooding events registered.
- Maintenance of drainage infrastructure to be provided by future landowner and/or private management company.
- The development proposals reduce the existing flood risk and does not increase flood risk on or offsite.

I trust that the information provided will be sufficient for discharge of Condition 7 of planning consent reference 23/01931/APP. Should you have any further queries or require further information please do not hesitate to get in contact.

Yours sincerely,

[redacted]

For RSK Land & Development Engineering Limited

Assif Salim

Enclosed:

Appendix A- RSK Group Service Constraints

Appendix B -Topographical Survey

Appendix C - Proposed Site Plan

Appendix D – Existing Impermeable Areas Plan

Appendix E – Proposed Impermeable Areas Plan

Appendix F – FEH Rainfall Data

Appendix G – Surface Water Drainage Strategy

Appendix H – Surface Water Design Calculations (Residential Development and Track Road)

Appendix I – SuDS Management Strategy

Appendix J – Drainage Construction Details

Appendix K – Exceedance Flow Plan

APPENDIX A
RSK GROUP SERVICE CONSTRAINTS

1. This report and the drainage design carried out in connection with the report (together the "Services") were compiled and carried out by RSK LDE Ltd (RSK) for Burston Ridge Farm Development Ltd (the "client") in accordance with the terms of a contract between RSK and the "client" dated 10th October 2023. The Services were performed by RSK with the skill and care ordinarily exercised by a reasonable civil engineer at the time the Services were performed. Further, and in particular, the Services were performed by RSK taking into account the limits of the scope of works required by the client, the time scale involved and the resources, including financial and manpower resources, agreed between RSK and the client.

2. Other than that expressly contained in paragraph 1 above, RSK provides no other representation or warranty whether express or implied, in relation to the Services.

3. Unless otherwise agreed in writing, the Services were performed by RSK exclusively for the purposes of the client. RSK is not aware of any interest of or reliance by any party other than the client in or on the Services. Unless expressly provided in writing, RSK does not authorise, consent or condone any party other than the client relying upon the Services. Should this report or any part of this report, or otherwise details of the Services or any part of the Services be made known to any such party, and such party relies thereon that party does so wholly at its own and sole risk and RSK disclaims any liability to such parties. Any such party would be well advised to seek independent advice from a competent environmental consultant and/or lawyer.

4. It is RSK's understanding that this report is to be used for the purpose described in the introduction to the report. That purpose was a significant factor in determining the scope and level of the Services. Should the purpose for which the report is used, or the proposed use of the site change, this report may no longer be valid and any further use of or reliance upon the report in those circumstances by the client without RSK's review and advice shall be at the client's sole and own risk. Should RSK be requested to review the report after the date of this report, RSK shall be entitled to additional payment at the then existing rates or such other terms as agreed between RSK and the client.

5. The passage of time may result in changes in site conditions, regulatory or other legal provisions, technology or economic conditions which could render the report inaccurate or unreliable. The information and conclusions contained in this report should not be relied upon in the future without the written advice of RSK. In the absence of such written advice of RSK, reliance on the report in the future shall be at the client's own and sole risk. Should RSK be requested to review the report in the future, RSK shall be entitled to additional payment at the then existing rate or such other terms as may be agreed between RSK and the client.

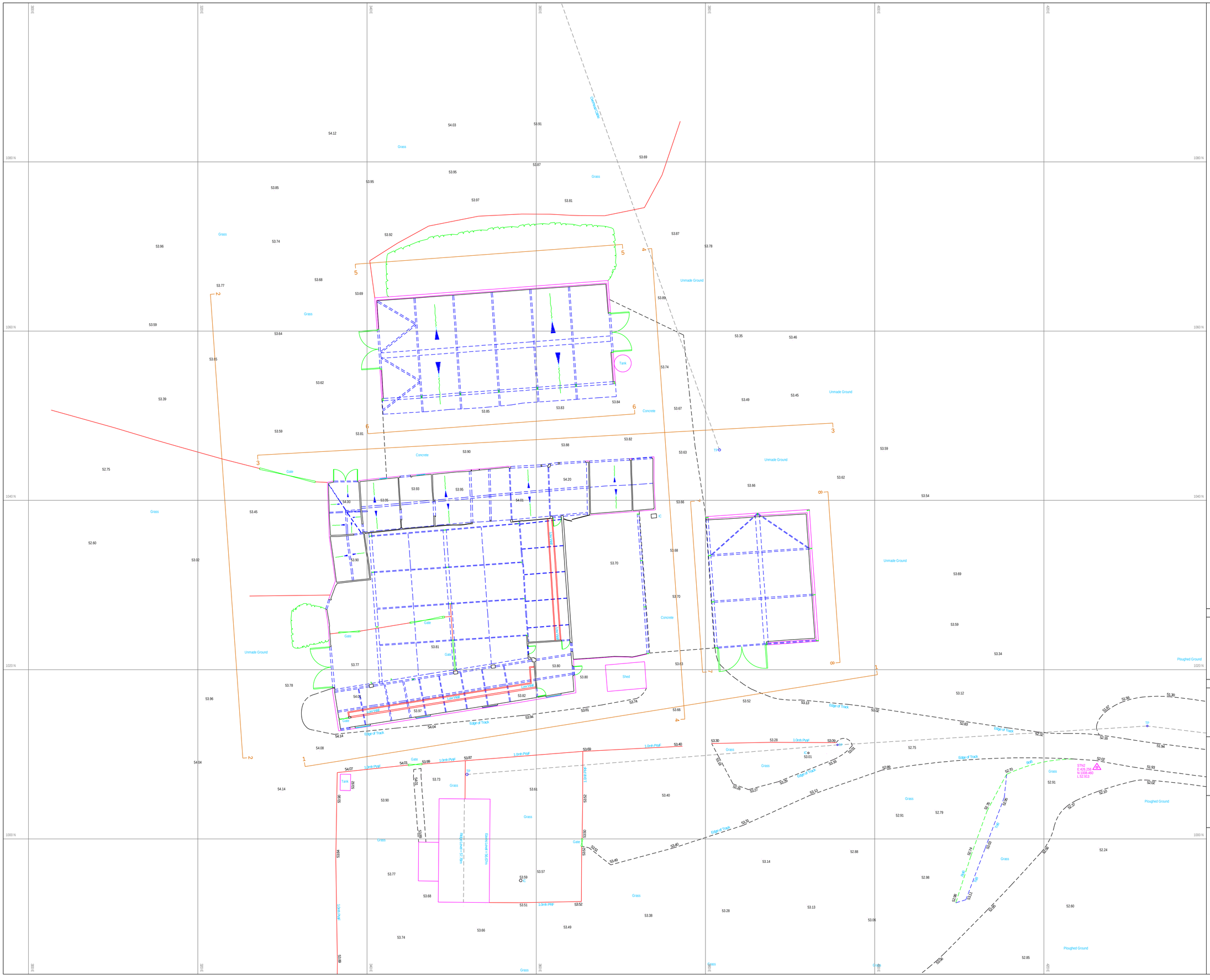
6. The observations and conclusions described in this report are based solely upon the Services, which were provided pursuant to the agreement between the client and RSK. RSK has not performed any observations, investigations, studies or testing not specifically set out or required by the contract between the client and RSK. RSK is not liable for the existence of any condition, the discovery of which would require performance of services not otherwise contained in the Services. For the avoidance of doubt, unless otherwise expressly referred to in the introduction to this report, RSK did not seek to evaluate the presence on or off the site of asbestos, electromagnetic fields, lead paint, heavy metals, radon gas or other radioactive or hazardous materials.

7. The Services are based upon RSK's observations of existing physical conditions at the site gained from a walk-over survey of the site together with RSK's interpretation of information including documentation, obtained from third parties and from the client on the history and usage of the site. The Services are also based on information and/or analysis provided by independent testing and information services or laboratories upon which RSK was reasonably entitled to rely. The Services clearly are limited by the accuracy of the information, including documentation, reviewed by RSK and the observations possible at the time of the walk-over survey. Further RSK was not authorised and did not attempt to independently verify the accuracy or completeness of information, documentation or materials received from the client or third parties, including laboratories and information services, during the performance of the Services. RSK is not liable for any inaccurate information or conclusions, the discovery of which inaccuracies required the doing of any act including the gathering of any information which was not reasonably available to RSK and including the doing of any independent investigation of the information provided to RSK save as otherwise provided in the terms of the contract between the client and RSK.

8. The phase II or intrusive environmental site investigation aspects of the Services is a limited sampling of the site at pre-determined borehole and soil vapour locations based on the operational configuration of the site. The conclusions given in this report are based on information gathered at the specific test locations and can only be extrapolated to an undefined limited area around those locations. The extent of the limited area depends on the soil and groundwater conditions, together with the position of any current structures and underground facilities and natural and other activities on site. In addition chemical analysis was carried out for a limited number of parameters [as stipulated in the contract between the client and RSK] [based on an understanding of the available operational and historical information,] and it should not be inferred that other chemical species are not present.

9. Any site drawing(s) provided in this report is (are) not meant to be an accurate base plan, but is (are) used to present the general relative locations of features on, and surrounding, the site. Features (boreholes, trial pits etc) annotated on site plans are not drawn to scale but are centred over the appropriate location. Such features should not be used for setting out and should be considered indicative only.

APPENDIX B
TOPOGRAPHICAL SURVEY



Legend

BoB	Bottom of Bank
BT	British Telecom
CATV	Cable Television
CB	Control Box
CBF	Closed Board Fence
CBP	Concrete Block Paving
CL	Cover Level
CLF	Chain Link Fence
CPS	Concrete Paving Slabs
DC	Drainage Channel
DP	Down Pipe
ER	Earth Rod
FB	Flowerbed
FH	Fire Hydrant
FP	Flag Pole
G	Gully
GV	Gas Valve
IC	Inspection Cover
IRF	Iron Railing Fence
IL	Invert Level
KW	Kerb Weir
LP	Lamp Post
MH	Manhole
MKR	Marker Post
PRF	Post & Rail Fence
PS	Pipe Size
PWF	Post and Wire Fence
RE	Rodding Eye
RN	Road Name
RS	Road Sign
SY	Stay Wire
0.3/4.0	Trunk(Dia)/Spread(Dia)/Height(Approx)
ToB	Top of Bank
TP	Telegraph Pole
VP	Vent Pipe
WV	Water Valve

HL	Window Head Level
CL	Window Cill Level
dl	Head of Door Level
+52.00m	Ceiling / Soffit Level
+50.00m	Floor Level

N

Sheet 1

Client

Amet Property
Ringstead Business Centre
1-3 Spencer Street
Ringstead, Kettering
Northamptonshire, NN14 4BX

Project Description

Burston Ridge Farm
Rowsham

Topographical Survey / Floor Plans

Levelling

Coordinates relate to local site grid and all levels relate to STN1.

Arbitrary Level = 50.00m

Scale

1:200 @ A1

Date of Survey

February 2020

Drawing Number

T-20-1141-01 (Sheet 1 of 4)

TB

Total Geomatics

Total Geomatics Ltd
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Smeaton Close
Aylesbury, Buckinghamshire
HP19 8SU

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G	Gully
GV	Gas Valve
IC	Inspection Cover
IRF	Iron Railing Fence
IL	Invert Level
KW	Kerb Weir
LP	Lamp Post
MH	Manhole
MKR	Marker Post
PRF	Post & Rail Fence
PS	Pipe Size
PWF	Post and Wire Fence
RE	Rodding Eye
RN	Road Name
RS	Road Sign
SY	Stay Wire
0.3/140	Trunk(Dia)/Spread(Dia)/Height(Approx)
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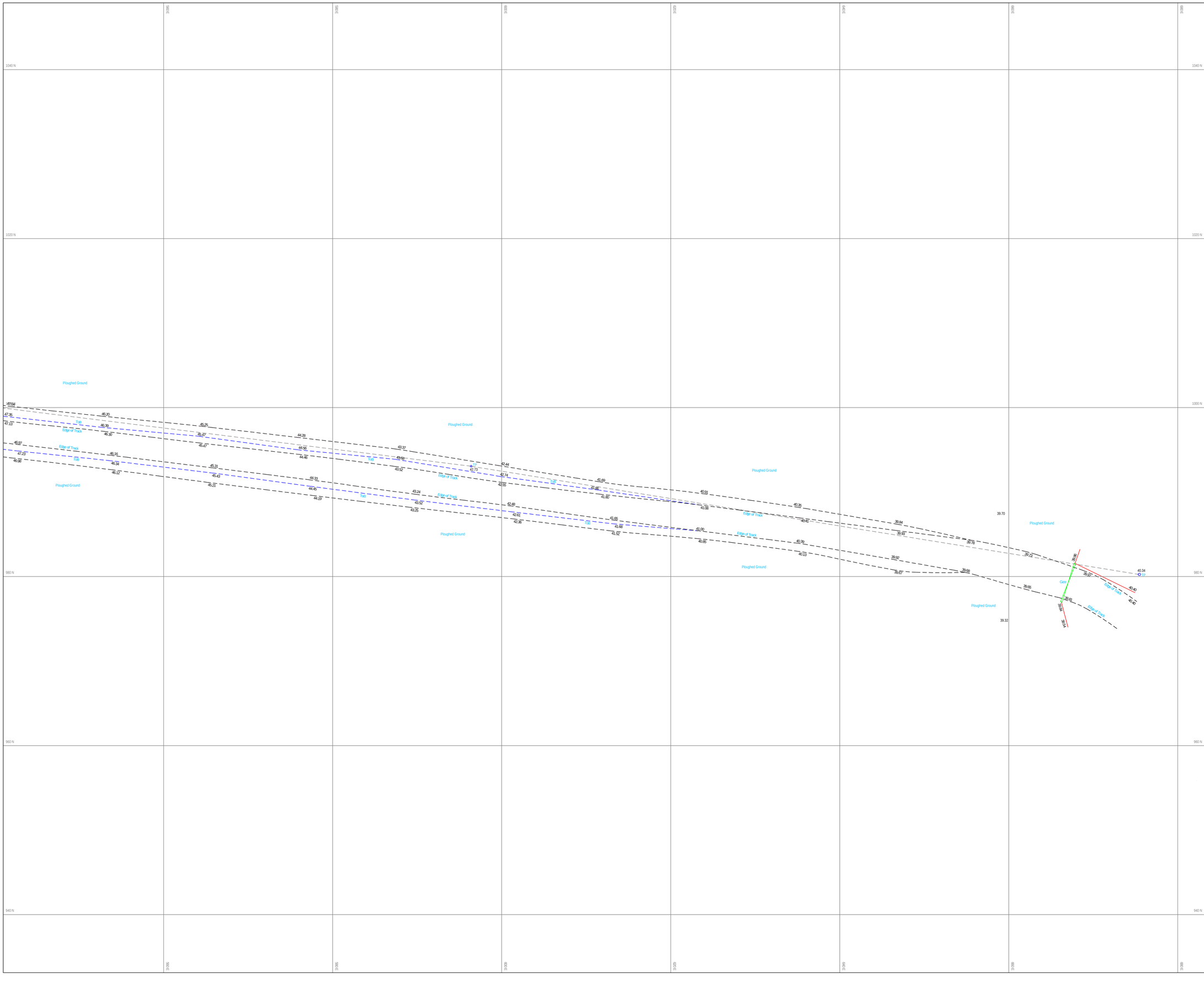

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Rowsham

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Scale

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Drawing Number

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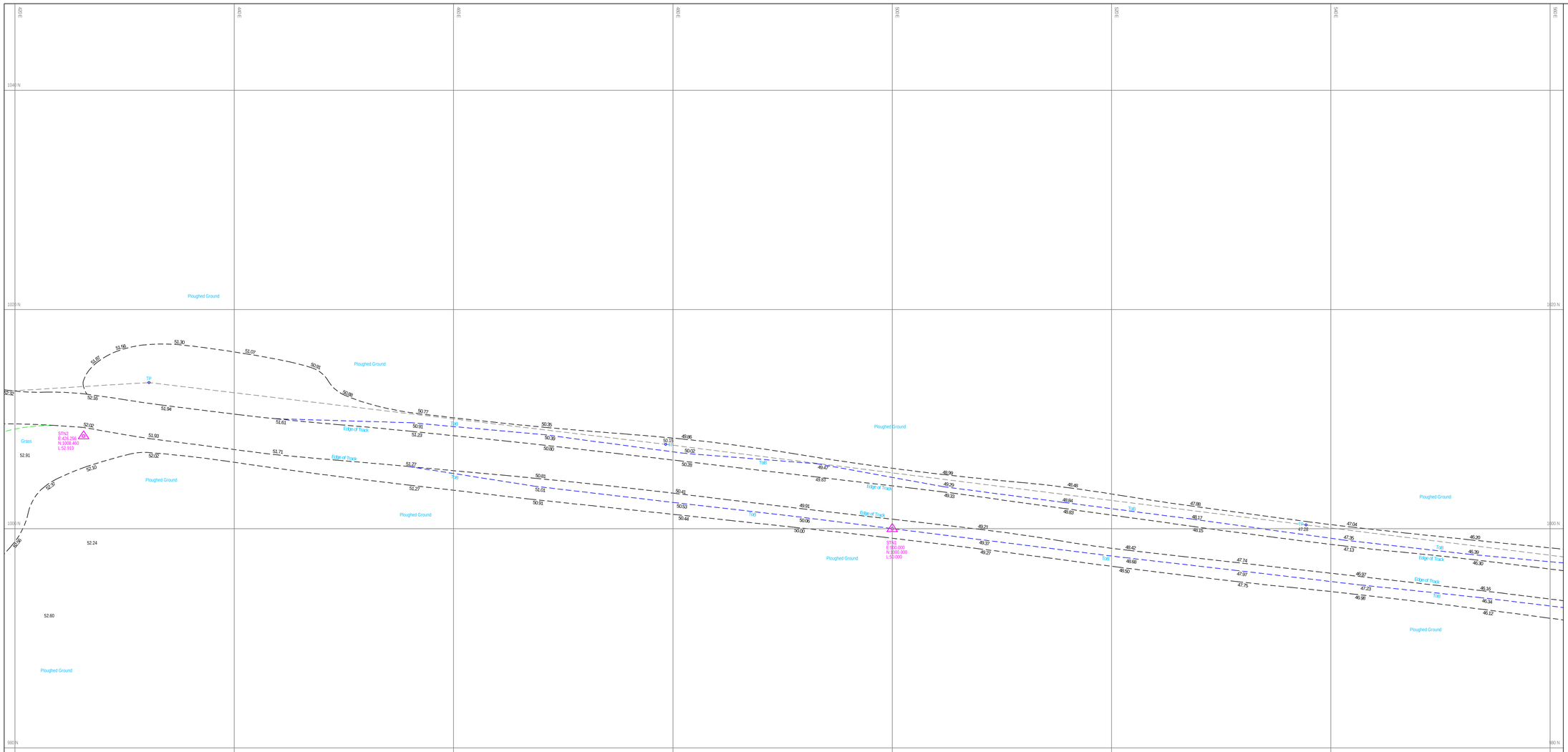

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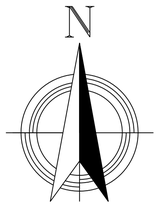

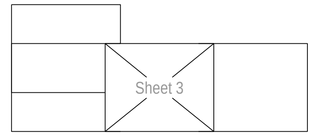

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Drawing Number

T-20-1141-01 (Sheet 3 of 4)

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APPENDIX C
PROPOSED SITE PLAN

DRAFT

0 2 4 6 8m
1:200

North

Permeable resin bound gravel surface over coarse graded aggregate sub-base and geotextile membrane

Porcelain paving slabs over sand blinding and Type 1 aggregate sub-base

Permeable resin bound gravel surface over coarse graded aggregate sub-base and geotextile membrane

Permeable resin bound gravel surface over coarse graded aggregate sub-base and geotextile membrane

Permeable interlocking block paving surface in herringbone bond, coarse graded aggregate sub-base to BS 7533-3 annex D.2.2 and geotextile membrane

Existing building (outside scope of works)

Existing building (outside scope of works)

Permeable interlocking block paving surface in herringbone bond, coarse graded aggregate sub-base to BS 7533-3 annex D.2.2 and geotextile membrane

Porcelain paving slabs over sand blinding and Type 1 aggregate sub-base

Existing building (outside scope of works)

Existing surface (outside scope of works)

Permeable resin bound gravel surface over coarse graded aggregate sub-base and geotextile membrane

Existing surface (outside scope of works)

Existing building (outside scope of works)

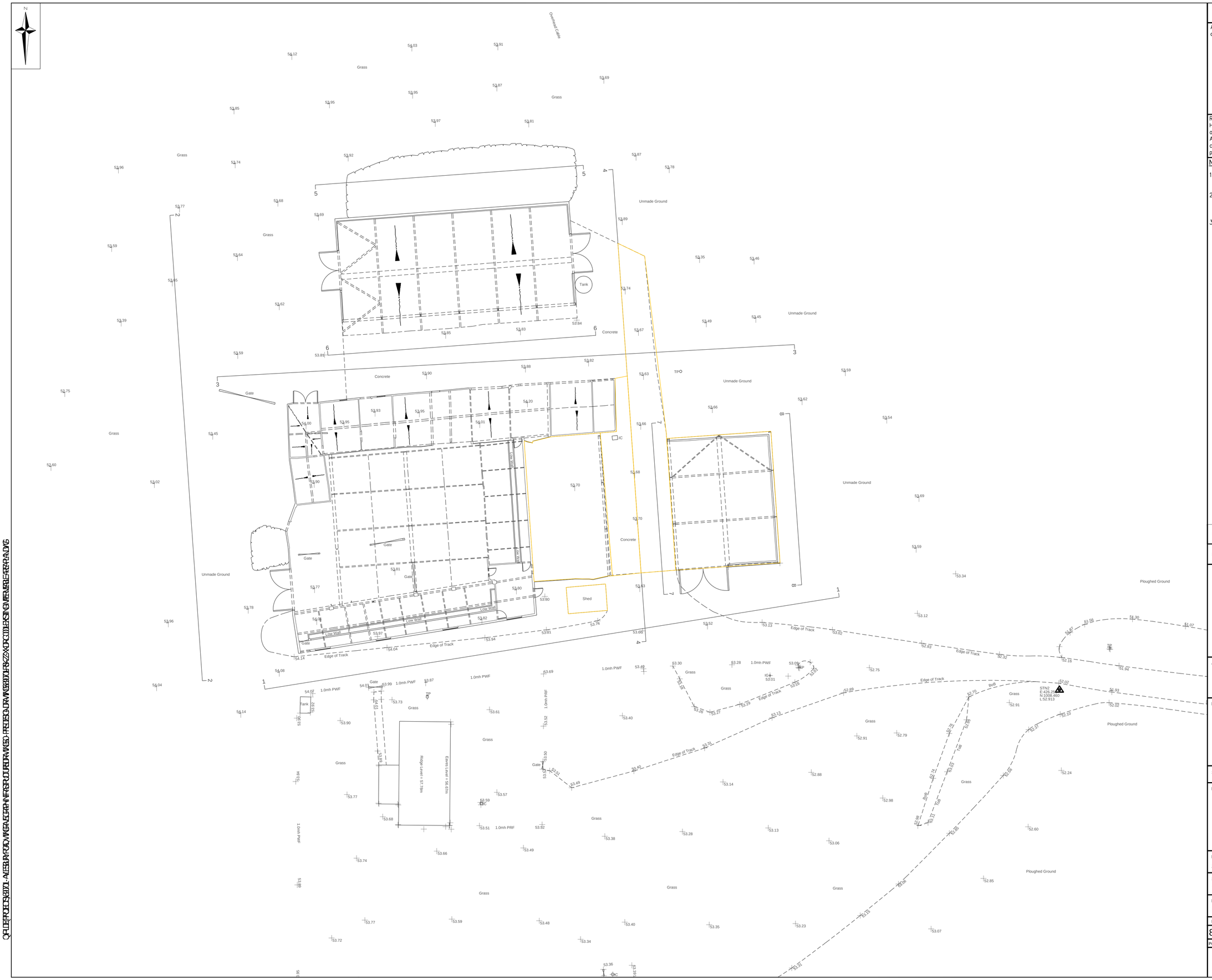
Permeable resin bound gravel surface over coarse graded aggregate sub-base and geotextile membrane

Access road improved with permeable tarmacadam surface

Access road improved with permeable tarmacadam surface

Rev	Description	Date

APPENDIX D
EXISTING IMPERMEABLE AREAS PLANS



CIVIL / STRUCTURAL DESIGN RISK MANAGEMENT

Abnormal or unusual residual risks associated with the design outcomes shown on this drawing are:–

RSK LDE LTD has followed its Design Risk Management process for Hazard Elimination and Risk reduction in developing the designs shown on this drawing.
Abnormal or unusual residual risks may be shown above where it is considered that such risk may not normally be expected by competent persons engaged on work of this nature or type.

Notes:

1. This drawing is to be read in conjunction with all relevant Architects and engineering drawings.
2. This drawing has been prepared only for planning purposes, no liability is accepted by LDE for any use of this drawing other than for the purpose which it was originally prepared.
3. Base layout taken from Aspect Consultants Hard Landscaping Plan drawing number 901 dated 17/10/2023.

KEY

Total Existing Impermeable Area = 1300m²

Rev.	Date	Amendment	Drawn	Chkd.	Appd.
P01	08.11.23	Preliminary Issue	SH	AS	RD

LDE
CIVILS | STRUCTURES | HYDROLOGY
an RSK company

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CV3 4AQ
United Kingdom

Tel: +44 (0) 24 7650 5600
Fax: +44 (0) 24 7650 1417
Email: info@rsk.co.uk
Web: www.rsk.co.uk

Client

BURSTON RIDGE FARM DEVELOPMENTS LTD

Project Title

BURSTON RIDGE FARM, WINGRAVE

Status: PRELIMINARY

Drawing Title

EXISTING IMPERMEABLE AREAS PLAN

Drawn	Date	Checked	Date	Approved	Date
SH	08.11.23	AS	08.11.23	RD	08.11.23

Scale	Orig Size	Dimensions
1:200	A1	m

Project No.: 890701

Drawing File: 890701-RSK-ZZ-XX-DR-C-0001-Existing Impermeable Area Plan.dwg

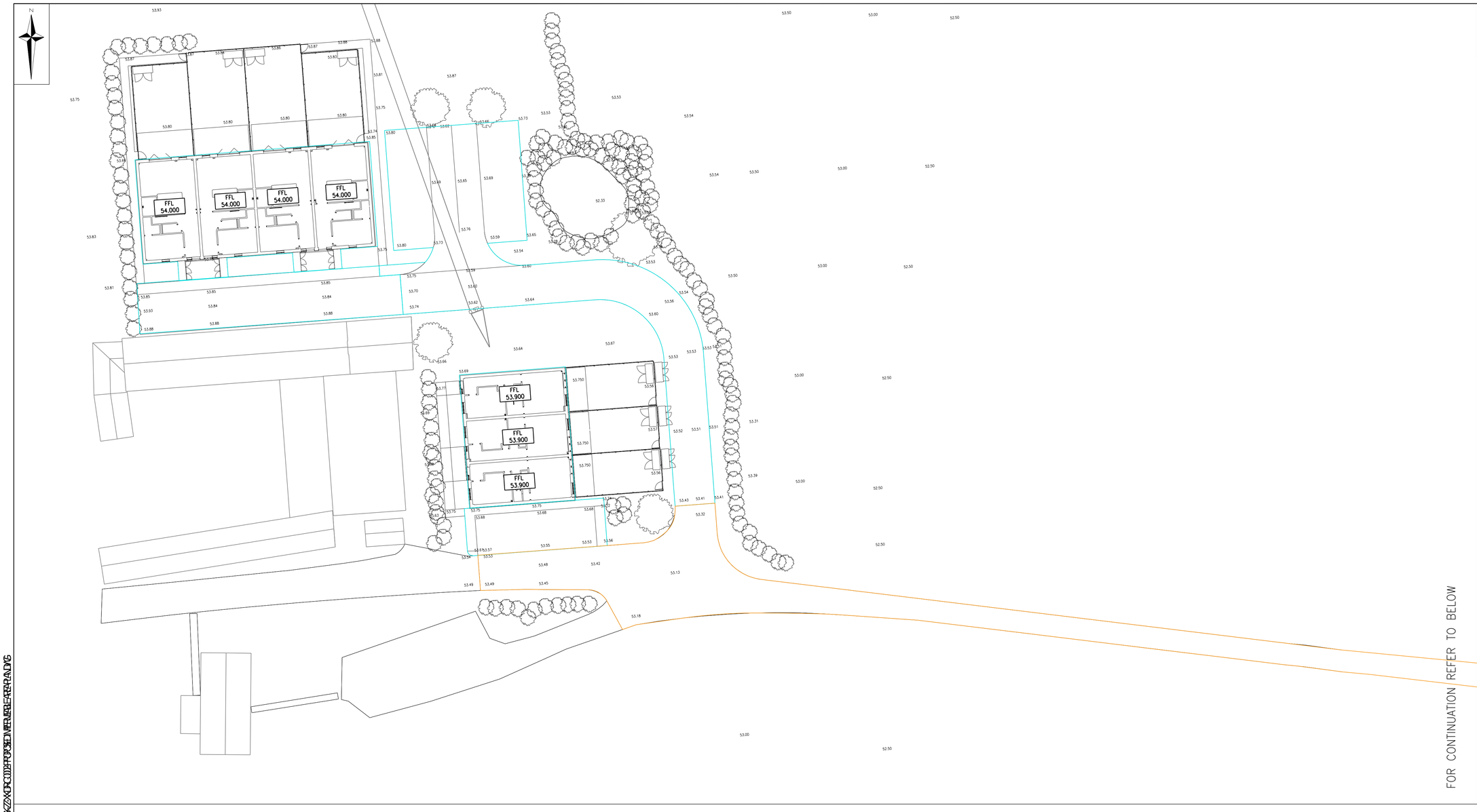
Drawing No.: 890701 | RSK | ZZ | XX | DR | C | 0001 | Rev. P01

(Project | Orig. | Vol./Sys. | Lev./Loc. | Type | Role | Draw. No.)

Scale 1:200

0 2 4 6 8 10m

APPENDIX E
PROPOSED IMPERMEABLE AREAS PLAN



CIVIL / STRUCTURAL DESIGN RISK MANAGEMENT

Abnormal or unusual residual risks associated with the design outcomes shown on this drawing are:–

RSK LDE LTD has followed its Design Risk Management process for Hazard Elimination and Risk reduction in developing the designs shown on this drawing.
Abnormal or unusual residual risks may be shown above where it is considered that such risk may not normally be expected by competent persons engaged on work of this nature or type.

Notes:

1. This drawing is to be read in conjunction with all relevant Architects and engineering drawings.
2. This drawing has been prepared only for planning purposes, no liability is accepted by LDE for any use of this drawing other than for the purpose which it was originally prepared.
3. Base layout taken from Aspect Consultants Hard Landscaping Plan drawing number 901 dated 17/10/2023.

Key

Proposed Impermeable Area = 1415m² (Development – 7No. Dwellings)

Proposed Impermeable Area = 1000m² (Upgraded Track Road)

Rev.	Date	Amendment	Drawn	Chkd.	Appd.
P01	08.11.23	Preliminary Issue	SH	AS	RD

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Web: www.rsk.co.uk

Client
BURSTON RIDGE FARM DEVELOPMENTS LTD

Project Title
BURSTON RIDGE FARM, WINGRAVE

Status
PRELIMINARY

Drawing Title
PROPOSED IMPERMEABLE AREAS PLAN

Drawn	Date	Checked	Date	Approved	Date
SH	08.11.23	AS	08.11.23	RD	08.11.23

Scale	Orig Size	Dimensions
1:250	A1	m

Project No.: 890701
Drawing File: 890701-RSK-ZZ-XX-DR-C-0002-Proposed Impermeable Area Plan.dwg

Drawing No.: 890701 | RSK | ZZ | XX | DR | C | 0002 | Rev. P01

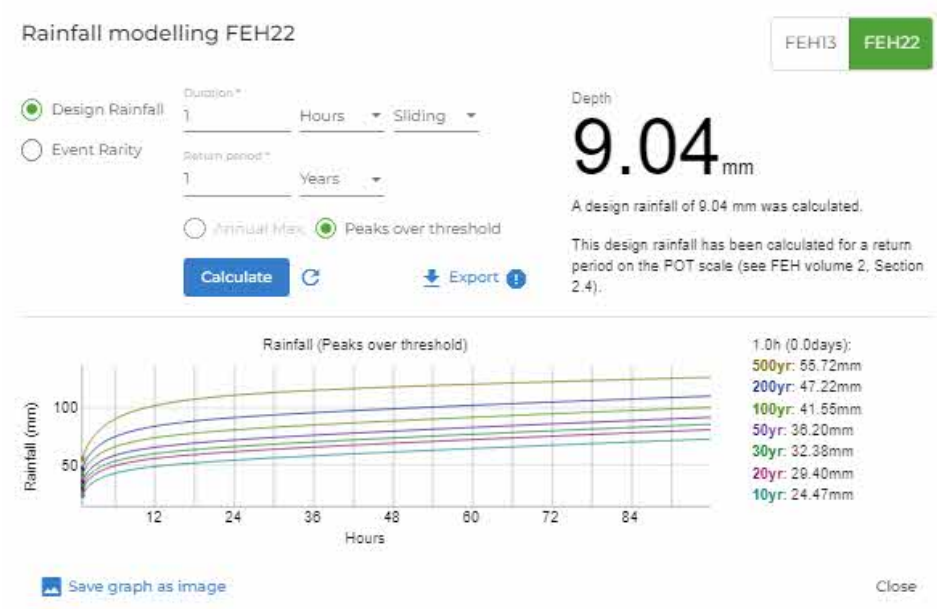
(Project | Orig. | Vol./Sys. | Lev./Loc. | Type | Role | Draw. No.)

Scale 1:200
0 2 4 6 8 10m

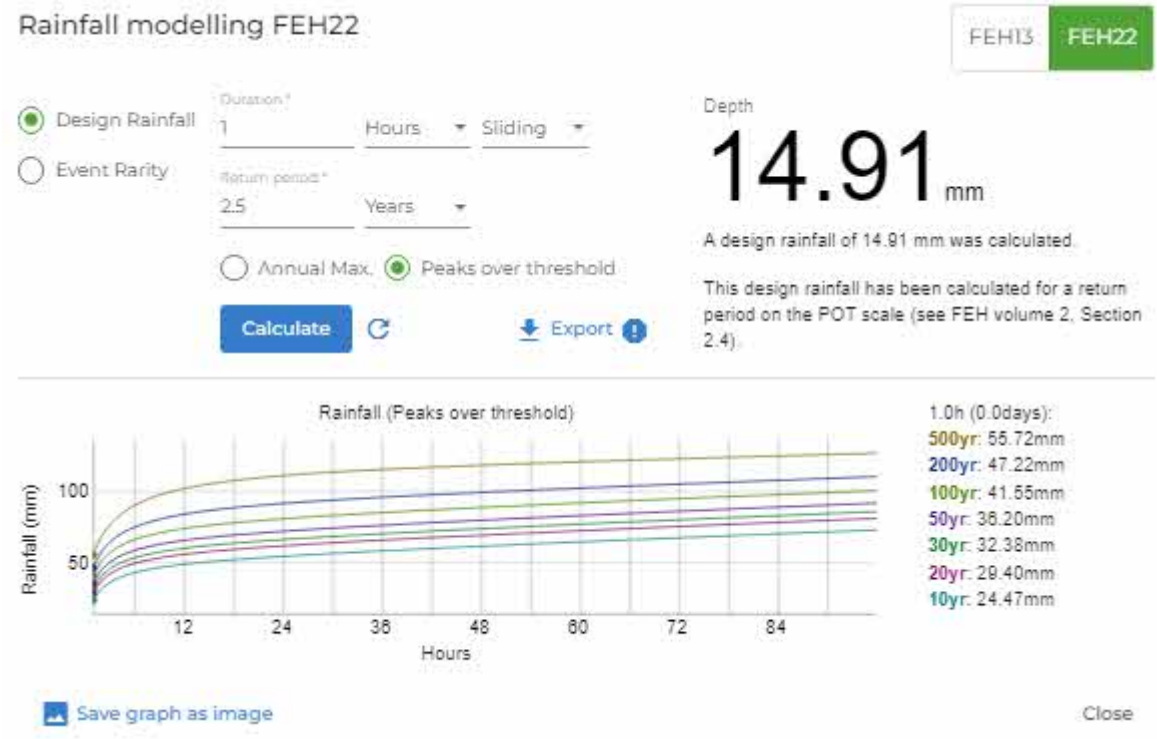
APPENDIX F
FEH RAINFALL DATA

FEH Rainfall Results Screen Shots

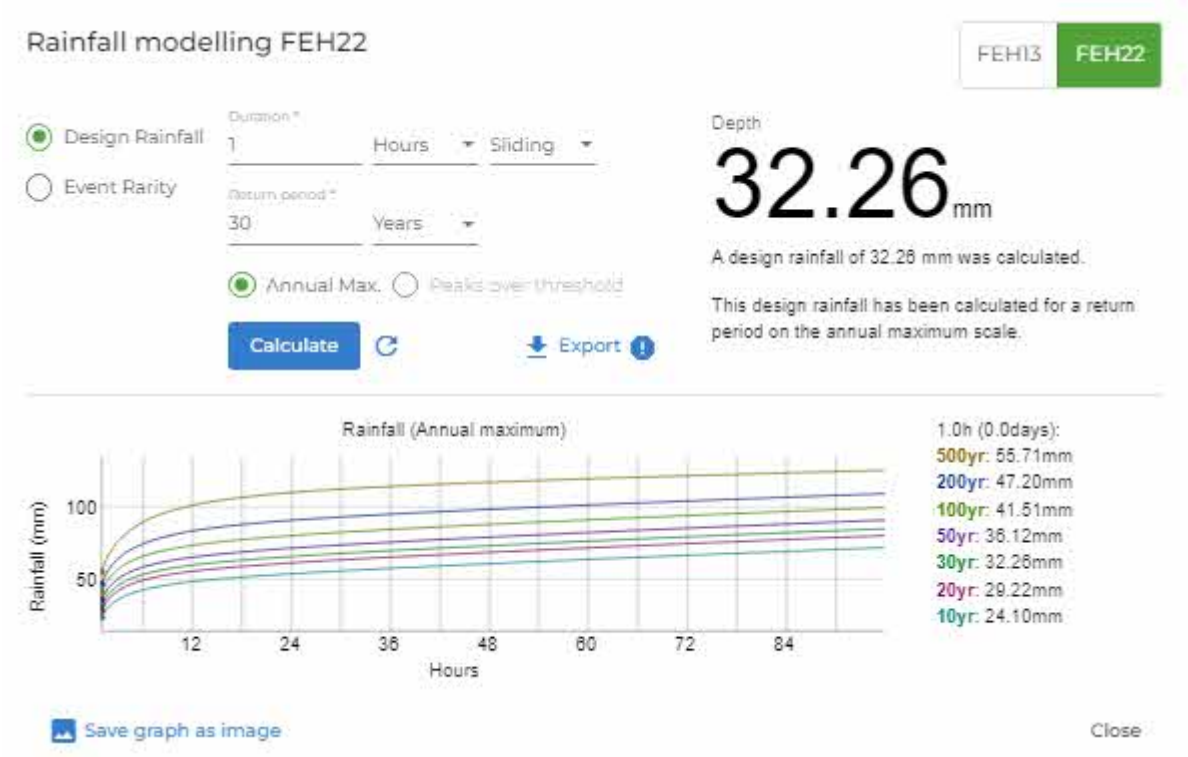
1in1 year



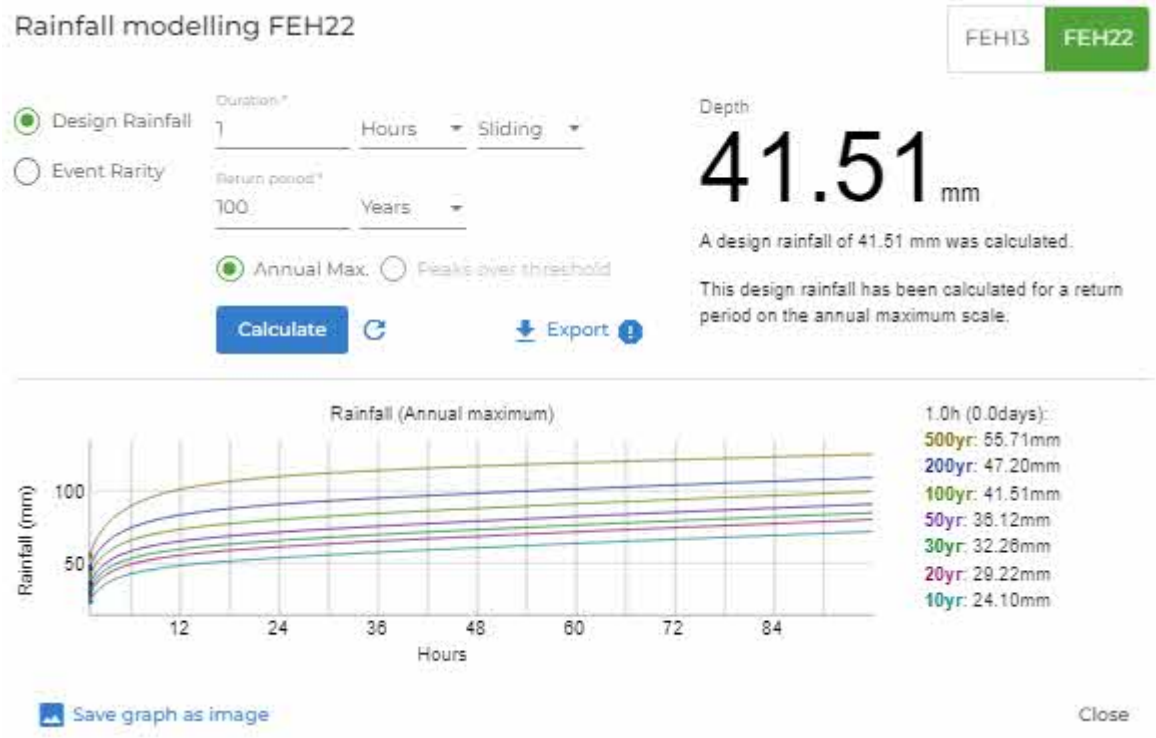
Qbar



1in30 year



1in100 year



APPENDIX G
SURFACE WATER DRAINAGE STRATEGY

CIVIL / STRUCTURAL DESIGN RISK MANAGEMENT

Abnormal or unusual residual risks associated with the design outcomes shown on this drawing are:–

RSK LDE LTD has followed its Design Risk Management process for Hazard Elimination and Risk reduction in developing the designs shown on this drawing.
Abnormal or unusual residual risks may be shown above where it is considered that such risk may not normally be expected by competent persons engaged on work of this nature or type.

Notes:

1. This drawing is to be read in conjunction with all relevant Architects and engineering drawings.
2. This drawing has been prepared only for planning purposes, no liability is accepted by LDE for any use of this drawing other than for the purpose which it was originally prepared.
3. Base layout taken from Aspect Consultants Hard Landscaping Plan drawing number 901 dated 17/10/2023.

Key

- Catchpit Manhole with Orifice Plate
- Silt Trap 450mm Inspection Chamber
- Hydrobrake Vortext Flow Control Chamber
- Surface Water Carrier Drain Pipe
- Perforated Pipe
- Permeable Block Pavement (Non Infiltration) with Impermeable Geomembrane
- Porous Asphalt (Non Infiltration) with Impermeable Geomembrane
- Rainwater Gardens
- Rainwater Down Pipe
- Rodding Eye
- Existing Drainage Ditch
- +50.00 Indicative Level
- FFL 53.900 Indicative Finish Floor Level

Rev.	Date	Amendment	Drawn	Chkd.	Appd.
P01	08.11.23	Preliminary issue.	SH	AS	RD

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Web: www.rsk.co.uk

Client
BURSTON RIDGE FARM DEVELOPMENT LTD

Project Title
BURSTON RIDGE FARM, WINGRAVE

Status
PRELIMINARY

Drawing Title
PROPOSED SURFACE WATER DRAINAGE STRATEGY

Drawn	Date	Checked	Date	Approved	Date
SH	08.11.23	AS	08.11.23	RD	08.11.23

Scale	Orig Size	Dimensions
1:200	A0	m

Project No.: 890701
Drawing File: 890701-RSK-ZZ-XX-DR-C-0003-Proposed Surface Water Drainage Strategy.dwg

Drawing No.: 890701 | RSK | ZZ | XX | DR | C | 0003 | Rev. P01

Project	Orig.	Vol./Sys.	Lev./Loc.	Type	Role	Draw. No.	

Scale 1:200
0 2 4 6 8 10m

APPENDIX H
SURFACE WATER DESIGN CALCULATIONS (RESIDENTIAL DEVELOPMENT AND TRACK ROAD)

Design Setţ ngs

Rainfall Methodology	FEH-22	Maximum Time of Concentraɵon (mins)	30.00	Preferred Cover Depth (m)	1.200
Return Period (years)	2	Maximum Rainfall (mm/hr)	999.0	Include Intermediate Ground	✓
Addiɵonal Flow (%)	0	Minimum Velocity (m/s)	1.00	Enforce best pracɵce design rules	✓
CV	0.750	Connecɵon Type	Level Soĸ ts		
Time of Entry (mins)	5.00	Minimum Backdrop Height (m)	5.000		

Nodes

Name	Area (ha)	Cover Level (m)	Diameter (mm)	Easɵng (m)	Northing (m)	Depth (m)
1		53.840	450	341.626	1047.222	1.200
2	0.045	53.620	1200	387.828	1049.885	1.220
4	0.041	53.850	1200	380.030	1052.776	1.410
5	0.017	53.630	450	378.516	1020.398	0.795
6		53.630	450	377.138	1038.571	0.920
Swale	0.010	53.500		394.610	1043.601	0.700
7		53.410	450	410.890	1022.598	0.990
3 FC	0.020	53.410	1200	406.239	1045.727	1.110
ounɲall		53.410		421.955	1059.216	1.210

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	1	2	46.279	0.600	52.640	52.400	0.240	192.8	225	5.82	47.8
2.000	4	2	8.317	0.600	52.440	52.400	0.040	207.9	225	5.15	50.9
3.000	5	6	18.225	0.600	52.835	52.710	0.125	145.8	150	5.37	49.9
3.001	6	2	15.565	0.600	52.710	52.400	0.310	50.2	150	5.55	49.1
1.001	2	3 FC	18.875	0.600	52.400	52.300	0.100	188.7	225	6.15	46.5
4.000	Swale	3 FC	11.822	0.600	52.800	52.500	0.300	39.4	150	5.12	51.0
5.000	7	3 FC	23.592	0.600	52.420	52.300	0.120	196.6	225	5.42	49.7
1.002	3 FC	ounɲall	20.711	0.600	52.300	52.200	0.100	207.1	225	6.54	45.1

Name	US Node	DS Node	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)
1.000	1	2	0.938	37.3	0.0	0.975	0.995	0.000
2.000	4	2	0.903	35.9	5.7	1.185	0.995	0.041
3.000	5	6	0.830	14.7	2.3	0.645	0.770	0.017
3.001	6	2	1.423	25.1	2.3	0.770	1.070	0.017
1.001	2	3 FC	0.948	37.7	13.0	0.995	0.885	0.103
4.000	Swale	3 FC	1.608	28.4	1.4	0.550	0.760	0.010
5.000	7	3 FC	0.929	36.9	0.0	0.765	0.885	0.000
1.002	3 FC	ounɲall	0.905	36.0	16.3	0.885	0.985	0.133

Simulaɵon Seɬ ngs

Rainfall Methodology	FEH-22	Analysis Speed	Normal	Addiɵonal Storage (m³/ha)	0.0	30 year (l/s)	1.4
Summer CV	0.750	Skip Steady State	x	Check Discharge Rate(s)	✓	100 year (l/s)	1.8
Winter CV	0.840	Drain Down Time (mins)	1440	1 year (l/s)	0.5	Check Discharge Volume	x

Storm Duraɵons

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

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

Pre-development Discharge Rate

Site Makeup	Greenȷ eld	Soil Index	4	Growth Factor 30 year	2.40	Q 1 year (l/s)	0.5
Greenȷ eld Method	IH124	SPR	0.47	Growth Factor 100 year	3.19	Q 30 year (l/s)	1.4
Posiɵvely Drained Area (ha)	0.130	Region	6	BeΣ erment (%)	0	Q 100 year (l/s)	1.8
SAAR (mm)	640	Growth Factor 1 year	0.85	QBar	0.6		

Node 2 Carpark Storage Structure

Base Inf Coeĸ cient (m/hr)	0.00000	Porosity	0.30	Width (m)	5.300	Depth (m)	0.600
Side Inf Coeĸ cient (m/hr)	0.00000	Invert Level (m)	52.820	Length (m)	48.000	Inf Depth (m)	
Safety Factor	2.0	Time to half empty (mins)	512	Slope (1:X)	160.0		

Node 4 Carpark Storage Structure

Base Inf Coeĸ cient (m/hr)	0.00000	Porosity	0.30	Width (m)	16.000	Depth (m)	0.500
Side Inf Coeĸ cient (m/hr)	0.00000	Invert Level (m)	53.150	Length (m)	14.000	Inf Depth (m)	
Safety Factor	2.0	Time to half empty (mins)	102	Slope (1:X)	112.0		

Node 3 FC Carpark Storage Structure

Base Inf Coeĸ cient (m/hr)	0.00000	Porosity	0.30	Width (m)	4.900	Depth (m)	0.600
Side Inf Coeĸ cient (m/hr)	0.00000	Invert Level (m)	52.610	Length (m)	40.000	Inf Depth (m)	
Safety Factor	2.0	Time to half empty (mins)	1035	Slope (1:X)	115.0		

Node Swale Depth/Area Storage Structure

Base Inf Coeĸ cient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	52.800
Side Inf Coeĸ cient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	705

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	20.6	0.0	0.700	48.0	0.0

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)	Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
2 year 15 minute summer	100.637	28.477	30 year 60 minute summer	122.058	32.256
2 year 15 minute winter	70.623	28.477	30 year 60 minute winter	81.093	32.256
2 year 30 minute summer	65.026	18.400	30 year 120 minute summer	77.374	20.448
2 year 30 minute winter	45.632	18.400	30 year 120 minute winter	51.405	20.448
2 year 60 minute summer	42.832	11.319	30 year 180 minute summer	59.499	15.311
2 year 60 minute winter	28.457	11.319	30 year 180 minute winter	38.676	15.311
2 year 120 minute summer	31.846	8.416	30 year 240 minute summer	46.681	12.336
2 year 120 minute winter	21.158	8.416	30 year 240 minute winter	31.014	12.336
2 year 180 minute summer	26.160	6.732	30 year 360 minute summer	34.786	8.952
2 year 180 minute winter	17.005	6.732	30 year 360 minute winter	22.612	8.952
2 year 240 minute summer	21.315	5.633	30 year 480 minute summer	26.748	7.069
2 year 240 minute winter	14.161	5.633	30 year 480 minute winter	17.771	7.069
2 year 360 minute summer	16.567	4.263	30 year 600 minute summer	21.438	5.864
2 year 360 minute winter	10.769	4.263	30 year 600 minute winter	14.648	5.864
2 year 480 minute summer	13.026	3.442	30 year 720 minute summer	18.743	5.023
2 year 480 minute winter	8.654	3.442	30 year 720 minute winter	12.596	5.023
2 year 600 minute summer	10.597	2.898	30 year 960 minute summer	14.895	3.922
2 year 600 minute winter	7.240	2.898	30 year 960 minute winter	9.867	3.922
2 year 720 minute summer	9.367	2.511	30 year 1440 minute summer	10.311	2.764
2 year 720 minute winter	6.295	2.511	30 year 1440 minute winter	6.930	2.764
2 year 960 minute summer	7.567	1.992	100 year +40% CC 15 minute summer	498.787	141.140
2 year 960 minute winter	5.012	1.992	100 year +40% CC 15 minute winter	350.026	141.140
2 year 1440 minute summer	5.365	1.438	100 year +40% CC 30 minute summer	328.590	92.980
2 year 1440 minute winter	3.605	1.438	100 year +40% CC 30 minute winter	230.589	92.980
30 year 15 minute summer	282.311	79.884	100 year +40% CC 60 minute summer	219.887	58.110
30 year 15 minute winter	198.113	79.884	100 year +40% CC 60 minute winter	146.088	58.110
30 year 30 minute summer	183.688	51.977	100 year +40% CC 120 minute summer	136.033	35.949
30 year 30 minute winter	128.904	51.977	100 year +40% CC 120 minute winter	90.377	35.949

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)	Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
100 year +40% CC 180 minute summer	103.683	26.681	100 year +40% CC 600 minute summer	36.933	10.102
100 year +40% CC 180 minute winter	67.397	26.681	100 year +40% CC 600 minute winter	25.235	10.102
100 year +40% CC 240 minute summer	80.995	21.405	100 year +40% CC 720 minute summer	32.247	8.642
100 year +40% CC 240 minute winter	53.811	21.405	100 year +40% CC 720 minute winter	21.672	8.642
100 year +40% CC 360 minute summer	60.131	15.474	100 year +40% CC 960 minute summer	25.560	6.730
100 year +40% CC 360 minute winter	39.087	15.474	100 year +40% CC 960 minute winter	16.931	6.730
100 year +40% CC 480 minute summer	46.150	12.196	100 year +40% CC 1440 minute summer	17.610	4.720
100 year +40% CC 480 minute winter	30.661	12.196	100 year +40% CC 1440 minute winter	11.835	4.720

Results for 2 year Critical Storm Duration. Lowest mass balance: 99.22%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
180 minute winter	1	128	52.938	0.298	1.2	0.0474	0.0000	SURCHARGED
180 minute winter	2	128	52.938	0.538	3.5	2.3868	0.0000	SURCHARGED
15 minute winter	4	13	53.170	0.730	5.3	0.9370	0.0000	SURCHARGED
180 minute winter	5	128	52.938	0.103	0.7	0.0164	0.0000	OK
180 minute winter	6	128	52.938	0.228	0.8	0.0363	0.0000	SURCHARGED
240 minute winter	Swale	232	52.877	0.077	0.5	1.6983	0.0000	OK
240 minute winter	7	232	52.877	0.457	0.6	0.0726	0.0000	SURCHARGED
240 minute winter	3 FC	232	52.877	0.577	2.7	6.6828	0.0000	SURCHARGED
15 minute summer	outfall	1	52.200	0.000	0.9	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)
180 minute winter	1	1.000	2	-1.2	-0.046	-0.033	1.8406
180 minute winter	2	Orifice	3 FC	1.8			
15 minute winter	4	Orifice	2	2.8			
180 minute winter	5	3.000	6	0.7	0.469	0.048	0.2780
180 minute winter	6	3.001	2	0.6	0.072	0.023	0.2740
240 minute winter	Swale	Orifice	3 FC	0.3			
240 minute winter	7	5.000	3 FC	-0.6	-0.018	-0.015	0.9383
240 minute winter	3 FC	Hydro-Brake®	outfall	0.9			

Results for 30 year Critical Storm Duration. Lowest mass balance: 99.22%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
180 minute winter	1	172	53.154	0.514	1.0	0.0818	0.0000	SURCHARGED
180 minute winter	2	172	53.154	0.754	7.2	14.9217	0.0000	SURCHARGED
30 minute winter	4	29	53.280	0.840	11.4	5.4792	0.0000	SURCHARGED
180 minute winter	5	176	53.154	0.319	1.5	0.0508	0.0000	SURCHARGED
180 minute winter	6	176	53.154	0.444	1.4	0.0706	0.0000	SURCHARGED
360 minute winter	Swale	376	53.068	0.268	0.9	6.9295	0.0000	SURCHARGED
360 minute winter	7	376	53.068	0.648	0.3	0.1031	0.0000	SURCHARGED
360 minute winter	3 FC	376	53.068	0.768	3.1	17.5926	0.0000	SURCHARGED
15 minute summer	outfall	1	52.200	0.000	0.9	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)
180 minute winter	1	1.000	2	-1.0	-0.032	-0.028	1.8406
180 minute winter	2	Orifice	3 FC	2.3			
30 minute winter	4	Orifice	2	2.8			
180 minute winter	5	3.000	6	1.4	0.444	0.097	0.3208
180 minute winter	6	3.001	2	1.4	0.078	0.054	0.2740
360 minute winter	Swale	Orifice	3 FC	0.3			
360 minute winter	7	5.000	3 FC	-0.3	0.012	-0.008	0.9383
360 minute winter	3 FC	Hydro-Brake®	outfall	0.9			

Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 99.22%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
240 minute winter	1	232	53.339	0.699	0.8	0.1112	0.0000	SURCHARGED
240 minute winter	2	232	53.339	0.939	9.2	29.2670	0.0000	FLOOD RISK
120 minute winter	4	114	53.407	0.967	8.6	14.2024	0.0000	SURCHARGED
240 minute winter	5	232	53.340	0.505	2.1	0.0802	0.0000	FLOOD RISK
240 minute winter	6	232	53.339	0.629	2.0	0.1001	0.0000	FLOOD RISK
600 minute winter	Swale	585	53.280	0.480	0.9	14.3848	0.0000	FLOOD RISK
600 minute winter	7	585	53.280	0.860	0.1	0.1367	0.0000	FLOOD RISK
600 minute winter	3 FC	585	53.280	0.980	3.2	26.2036	0.0000	FLOOD RISK
15 minute summer	outfall	1	52.200	0.000	0.9	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)
240 minute winter	1	1.000	2	-0.8	-0.032	-0.020	1.8406
240 minute winter	2	Orifice	3 FC	2.5			
120 minute winter	4	Orifice	2	2.2			
240 minute winter	5	3.000	6	2.0	0.416	0.137	0.3208
240 minute winter	6	3.001	2	1.9	0.110	0.077	0.2740
600 minute winter	Swale	Orifice	3 FC	0.2			
600 minute winter	7	5.000	3 FC	0.2	-0.007	0.006	0.9383
600 minute winter	3 FC	Hydro-Brake®	outfall	1.0			

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Design Settings

Rainfall Methodology	FEH-22	Maximum Time of Concentration (mins)	30.00	Preferred Cover Depth (m)	1.200
Return Period (years)	2	Maximum Rainfall (mm/hr)	50.0	Include Intermediate Ground	✓
Additional Flow (%)	0	Minimum Velocity (m/s)	1.00	Enforce best practice design rules	✓
CV	0.750	Connection Type	Level Soffits		
Time of Entry (mins)	5.00	Minimum Backdrop Height (m)	5.000		

Nodes

Name	Area (ha)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
1	0.026	52.377	1200	418.145	1011.391	1.352
2	0.025	47.774	1200	507.559	1001.138	1.249
3	0.027	43.156	1200	596.898	990.247	1.131
4	0.025	39.929	1200	663.236	980.612	1.259
FC		39.320	1200	662.731	970.356	0.820
6		38.500		667.199	967.358	0.600

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	1	2	90.000	0.600	51.025	46.525	4.500	20.0	150	5.66	48.6
1.001	2	3	90.000	0.600	46.525	42.025	4.500	20.0	150	6.33	45.8
1.002	3	4	67.034	0.600	42.025	38.670	3.355	20.0	150	6.82	44.1
1.003	4	FC	10.268	0.600	38.670	38.500	0.170	60.4	150	6.95	43.6

Name	US Node	DS Node	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Pro Depth (mm)	Pro Velocity (m/s)
1.000	1	2	2.262	40.0	3.4	1.202	1.099	0.026	30	1.387
1.001	2	3	2.262	40.0	6.3	1.099	0.981	0.051	40	1.656
1.002	3	4	2.263	40.0	9.3	0.981	1.109	0.078	49	1.845
1.003	4	FC	1.296	22.9	12.2	1.109	0.670	0.103	78	1.315

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)
1.004	FC	6	5.381	0.600	38.500	37.900	0.600	9.0	150	6.98	43.5

Name	US Node	DS Node	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Pro Depth (mm)	Pro Velocity (m/s)
1.004	FC	6	3.385	59.8	12.1	0.670	0.450	0.103	46	2.671

Simulation Settings

Rainfall Methodology	FEH-22	Analysis Speed	Normal	Additional Storage (m³/ha)	0.0
Summer CV	0.750	Skip Steady State	✓	Check Discharge Rate(s)	x
Winter CV	0.840	Drain Down Time (mins)	1440	Check Discharge Volume	x

Storm Durations

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

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

Node 1 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Porosity	0.30	Width (m)	36.000	Depth (m)	0.500
Side Inf Coefficient (m/hr)	0.00000	Invert Level (m)	51.577	Length (m)	7.000	Inf Depth (m)	0.500
Safety Factor	2.0	Time to half empty (mins)	84	Slope (1:X)	35.0		

Node 2 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Porosity	0.30	Width (m)	90.000	Depth (m)	0.500
Side Inf Coefficient (m/hr)	0.00000	Invert Level (m)	46.974	Length (m)	2.750	Inf Depth (m)	
Safety Factor	2.0	Time to half empty (mins)	168	Slope (1:X)	20.0		

Node 3 Carpark Storage Structure

Base Inf Coeκ cient (m/hr)	0.00000	Porosity	0.30	Width (m)	90.000	Depth (m)	0.500
Side Inf Coeκ cient (m/hr)	0.00000	Invert Level (m)	42.356	Length (m)	2.000	Inf Depth (m)	
Safety Factor	2.0	Time to half empty (mins)	375	Slope (1:X)	200.0		

Node 4 Carpark Storage Structure

Base Inf Coeκ cient (m/hr)	0.00000	Porosity	0.30	Width (m)	79.000	Depth (m)	0.500
Side Inf Coeκ cient (m/hr)	0.00000	Invert Level (m)	39.129	Length (m)	3.200	Inf Depth (m)	
Safety Factor	2.0	Time to half empty (mins)	420	Slope (1:X)	20.0		

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)	Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
2 year 15 minute summer	100.637	28.477	2 year 960 minute summer	7.567	1.992
2 year 15 minute winter	70.623	28.477	2 year 960 minute winter	5.012	1.992
2 year 30 minute summer	65.026	18.400	2 year 1440 minute summer	5.365	1.438
2 year 30 minute winter	45.632	18.400	2 year 1440 minute winter	3.605	1.438
2 year 60 minute summer	42.832	11.319	30 year 15 minute summer	282.311	79.884
2 year 60 minute winter	28.457	11.319	30 year 15 minute winter	198.113	79.884
2 year 120 minute summer	31.846	8.416	30 year 30 minute summer	183.688	51.977
2 year 120 minute winter	21.158	8.416	30 year 30 minute winter	128.904	51.977
2 year 180 minute summer	26.160	6.732	30 year 60 minute summer	122.058	32.256
2 year 180 minute winter	17.005	6.732	30 year 60 minute winter	81.093	32.256
2 year 240 minute summer	21.315	5.633	30 year 120 minute summer	77.374	20.448
2 year 240 minute winter	14.161	5.633	30 year 120 minute winter	51.405	20.448
2 year 360 minute summer	16.567	4.263	30 year 180 minute summer	59.499	15.311
2 year 360 minute winter	10.769	4.263	30 year 180 minute winter	38.676	15.311
2 year 480 minute summer	13.026	3.442	30 year 240 minute summer	46.681	12.336
2 year 480 minute winter	8.654	3.442	30 year 240 minute winter	31.014	12.336
2 year 600 minute summer	10.597	2.898	30 year 360 minute summer	34.786	8.952
2 year 600 minute winter	7.240	2.898	30 year 360 minute winter	22.612	8.952
2 year 720 minute summer	9.367	2.511	30 year 480 minute summer	26.748	7.069
2 year 720 minute winter	6.295	2.511	30 year 480 minute winter	17.771	7.069

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)	Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
30 year 600 minute summer	21.438	5.864	100 year +40% CC 180 minute summer	103.683	26.681
30 year 600 minute winter	14.648	5.864	100 year +40% CC 180 minute winter	67.397	26.681
30 year 720 minute summer	18.743	5.023	100 year +40% CC 240 minute summer	80.995	21.405
30 year 720 minute winter	12.596	5.023	100 year +40% CC 240 minute winter	53.811	21.405
30 year 960 minute summer	14.895	3.922	100 year +40% CC 360 minute summer	60.131	15.474
30 year 960 minute winter	9.867	3.922	100 year +40% CC 360 minute winter	39.087	15.474
30 year 1440 minute summer	10.311	2.764	100 year +40% CC 480 minute summer	46.150	12.196
30 year 1440 minute winter	6.930	2.764	100 year +40% CC 480 minute winter	30.661	12.196
100 year +40% CC 15 minute summer	498.787	141.140	100 year +40% CC 600 minute summer	36.933	10.102
100 year +40% CC 15 minute winter	350.026	141.140	100 year +40% CC 600 minute winter	25.235	10.102
100 year +40% CC 30 minute summer	328.590	92.980	100 year +40% CC 720 minute summer	32.247	8.642
100 year +40% CC 30 minute winter	230.589	92.980	100 year +40% CC 720 minute winter	21.672	8.642
100 year +40% CC 60 minute summer	219.887	58.110	100 year +40% CC 960 minute summer	25.560	6.730
100 year +40% CC 60 minute winter	146.088	58.110	100 year +40% CC 960 minute winter	16.931	6.730
100 year +40% CC 120 minute summer	136.033	35.949	100 year +40% CC 1440 minute summer	17.610	4.720
100 year +40% CC 120 minute winter	90.377	35.949	100 year +40% CC 1440 minute winter	11.835	4.720

Results for 2 year Critical Storm Duration. Lowest mass balance: 97.85%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
30 minute winter	1	24	51.617	0.592	2.6	0.9693	0.0000	SURCHARGED
120 minute winter	2	96	47.059	0.534	2.1	2.5613	0.0000	SURCHARGED
240 minute winter	3	232	42.450	0.425	1.8	5.3105	0.0000	SURCHARGED
240 minute winter	4	236	39.232	0.562	1.6	3.1568	0.0000	SURCHARGED
240 minute winter	FC	252	38.736	0.236	0.9	0.2669	0.0000	SURCHARGED
15 minute summer	6	1	37.900	0.000	0.9	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)
30 minute winter	1	Orifice	2	1.0
120 minute winter	2	Orifice	3	0.9
240 minute winter	3	Orifice	4	0.8
240 minute winter	4	Orifice	FC	0.9
240 minute winter	FC	Hydro-Brake®	6	0.9

Results for 30 year Critical Storm Duration. Lowest mass balance: 97.85%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
60 minute winter	1	49	51.710	0.685	4.8	4.1188	0.0000	SURCHARGED
240 minute winter	2	228	47.156	0.631	2.8	9.1345	0.0000	SURCHARGED
600 minute winter	3	585	42.576	0.551	1.9	12.2519	0.0000	SURCHARGED
240 minute winter	4	572	39.353	0.683	2.7	11.6914	0.0000	SURCHARGED
240 minute winter	FC	580	38.984	0.484	1.0	0.5472	0.0000	SURCHARGED
15 minute summer	6	1	37.900	0.000	0.9	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)
60 minute winter	1	Orifice	2	1.1
240 minute winter	2	Orifice	3	1.0
600 minute winter	3	Orifice	4	1.0
240 minute winter	4	Orifice	FC	1.0
240 minute winter	FC	Hydro-Brake®	6	0.9

Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 97.85%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
120 minute winter	1	98	51.788	0.763	5.4	9.2543	0.0000	SURCHARGED
360 minute winter	2	360	47.269	0.744	3.4	17.6438	0.0000	SURCHARGED
600 minute winter	3	600	42.762	0.737	2.6	22.4955	0.0000	SURCHARGED
600 minute winter	4	1050	39.563	0.893	2.4	27.8947	0.0000	SURCHARGED
600 minute winter	FC	1050	39.110	0.610	0.9	0.6903	0.0000	FLOOD RISK
15 minute summer	6	1	37.900	0.000	0.9	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)
120 minute winter	1	Orifice	2	1.1
360 minute winter	2	Orifice	3	1.1
600 minute winter	3	Orifice	4	1.1
600 minute winter	4	Orifice	FC	0.9
600 minute winter	FC	Hydro-Brake®	6	0.9

APPENDIX I
SUDS MANAGEMENT STRATEGY

BURSTON RIDGE FARM DEVELOPMENT LTD

BURSTON RIDGE FARM, WINGRAVE

Sustainable Drainage System (SuDS) Maintenance Strategy

890701-R1(0)

7th November 2023

LDE
CIVILS | STRUCTURES | HYDROLOGY
an RSK company

RSK GENERAL NOTES

Project No.: 890701-R1(0)

Site: Burston Ridge Farm, Wingrave

Title: Sustainable Drainage System (SuDS) Maintenance Strategy

Client: Burston Ridge Farm Development Ltd

Date: 07th November.2023

Office: Coventry

Status: Final

Author	Suhasan Mahathevan	**Technical reviewer**	Assif Salim
Signature	[redacted]	Signature	[redacted]
Date:	08.11.2023	Date:	08.11.2023

Issue No	Version/Details	Date issued	Author	Reviewed by	Approved by
01	01	8.11.23	SM	TF	AS

CONTENTS

1 INTRODUCTION

This management strategy has been prepared by RSK Land and Development Engineering Ltd on behalf of Burston Ridge Farm Development Ltd, to satisfy planning conditions related to Burston Ridge Farm, Wingrave (The Development).

The SuDS considered for the purposes of this statement, include drainage features that will be employed to reduce and manage surface water runoff from the development to a design return period of 100 years plus climate change. This is required so that The Development will not increase the risk of flooding to the site and its environs. All drainage on site is taken to the water course. Such features include the following:

Permeable paving;

Swales;

Rain Garden.

This document outlines the long-term maintenance of the proposed surface water system and will refer to the following documents, some of which provide further detail on the maintenance operations required:

CIRIA Report C753, 'The SUDS Manual', 2015

CIRIA Report C625, 'Model Agreements for Sustainable Water Management Systems', 2004; and

Interpave, 'Permeable pavements: Guide to the Design, Construction and Maintenance of Concrete Block Permeable Pavements', ed. 4, 2006.

2 MAINTENANCE RESPONSIBILITIES

Responsibility for drainage within England and Wales rests with various bodies. For the Development, the drainage responsibilities will be divided between the following:

Private Landowner – each Householder will be responsible for the maintenance of drainage features within individual property curtilages.

Communal Areas - A Management company will be set up for the Development to maintain all permeable paving, swales, outfalls and any associated flow controls within communal areas.

3 MAINTENANCE REGIME

As the maintenance of the communal SUDS features will be carried out via a Management Company, the form of agreement should include the required maintenance listed below. Should the maintenance be transferred at a later date to a public body, then the model agreement SUDS MA1 should be used, details of which can be found in the CIRIA guidance C625.

The following section describes the required maintenance for each feature in turn. The SUDS maintenance requirements listed below should be reviewed after the first 5 years, with a view to agreeing a new regime for the ongoing maintenance.

Notwithstanding the routine inspections and maintenance requirements, after severe storm events all features shall be inspected to clear debris and repair damaged structures or features. Records of the maintenance carried out shall be prepared by the Management Company.

3.1 Manholes

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Remove cover and inspect, ensuring water is flowing freely and that the route for water is unobstructed. Remove debris and silt	Annually
Remedial actions	Repair physical damage if necessary.	As required

3.2 Below ground drainage pipes

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Inspect and identify any areas that are not operating correctly. If required take remedial action	Monthly for 3 Months and then Annually
	Remove debris from the catchment surface (where it may cause risks to performance)	Monthly
	Remove sediment from inlet structures (channels, rainwater pipes and inspection chambers).	Annually or as required
Remedial actions	Repair physical damage if necessary.	As required
Monitoring	Inspect all inlets, outlets and vents to ensure that they are in good condition and operating as designed.	Annually

Maintenance schedule	Required action	Typical frequency
	Survey inside of pipe runs for sediment build up and remove if necessary	Every 5 years or as required.

3.3 An example of operation and maintenance requirements for a proprietary flow control

Maintenance schedule	Required action	Typical frequency
Routine maintenance	Remove litter and debris and inspect for sediment, oil and grease accumulation	Six monthly
	Change the filter media	As recommended by manufacturer
	Remove sediment, oil, grease and floatables	As necessary – indicated by system inspections or immediately following significant spill
Remedial actions	Replace malfunctioning parts or structures	As required
Monitoring	Inspect for evidence of poor operation	Six monthly
	Inspect filter media and establish appropriate replacement frequencies	Six monthly
	Inspect sediment accumulation rates and establish appropriate removal frequencies	Monthly during first half year of operation, then every six months

3.4 Permeable Paving

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Brushing and vacuuming (standard cosmetic sweep over whole surface)	Once a year, after autumn leaf fall, or reduced frequency as required, based on site-specific observations of clogging or manufacturer's recommendations – pay particular attention to areas where water runs onto pervious surface from adjacent impermeable areas as this area is most likely to collect the most sediment
Occasional maintenance	Stabilise and mow contributing and adjacent areas	As required

Maintenance schedule	Required action	Typical frequency
	Removal of weeds or management using glyphospate applied directly into the weeds by an applicator rather than spraying	As required – once per year on less frequently used pavements
Remedial Actions	Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50mm of the level of the paving	As required
	Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or a hazard to users, and replace lost jointing material.	As required
	Rehabilitation of surface and upper substructure by remedial sweeping.	Every 10 to 15 years or as required (if infiltration performance is reduced due to significant clogging)
Monitoring	Initial inspection	Monthly for three months after installation
	Inspect for evidence of poor operation and/or weed growth – if required, take remedial action	Three monthly 48h after large storms in first six months
	Inspect silt accumulation rates and establish appropriate brushing frequencies	Annually

3.5 Swale

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Remove litter and debris	Monthly, or as required
	Cut grass- to retain grass height within specified design range	Monthly (during growing season), or as required
	Manage other vegetation and remove nuisance plants	Monthly at start, then as required
	Inspect inlets, outlets and overflows for blockages, and clear if required	Monthly
	Inspect infiltration surfaces for ponding, compaction, silt accumulation, record areas where water is ponding for >48 hours	Monthly or when required
	Inspect vegetation coverage	Monthly for 6 months, quarterly for 2 years, then half yearly
	Inspection inlets and facility surface for silt accumulation, establish appropriate silt removal frequencies	Half yearly
Occasional maintenance	Reseed areas of poor vegetation growth, alter plant types to better suit conditions, if required	As required or if bare soil is exposed over 10% or more of the swale treatment area
Remedial actions	Repair erosion or other damage by re-turfing or reseeding	As required

Maintenance schedule	Required action	Typical frequency
	Relevel uneven surfaces and reinstate design level	As required
	Scarify and spike topsoil layer to improve infiltration performance, break up silt deposits and prevent compaction of soil surface	As required
	Remove build up of sediment on upstream gravel trench, flow spreader or at top of filter strip	As required
	Remove and dispose of oils or petrol residues using safe standard practices	As required

3.6 Rain Gardens

Maintenance schedule	Required action	Typical frequency
Regular inspections	Inspect infiltration surfaces for silting and ponding, record de-watering time of the facility and assess standing water levels in underdrain (if appropriate) to determine if maintenance is necessary	Quarterly
	Check operation of underdrains by inspection of flows are rain	Annually
	Assess plants for disease infection, poor growth, invasive species etc and replace as necessary	Quarterly
	Inspect inlets and outlets for blockage	Quarterly
Regular maintenance	Remove litter and surface debris and weeds	Quarterly
	Replace any plants, to maintain planting density	As required
	Remove sediment, litter and debris build up from around inlets or from forebays	Quarterly to biannually
Occasional maintenance	Infill any holes or scour in the filter medium, improve erosion protection if required	As required
	Repair minor accumulations of silt by raking away surface mulch, scarifying surface of medium and replacing mulch	As required
Remedial actions	Remove and replace filter medium and vegetation above	As required but likely to be >20 years

APPENDIX A
INSPECTION CHECKLIST

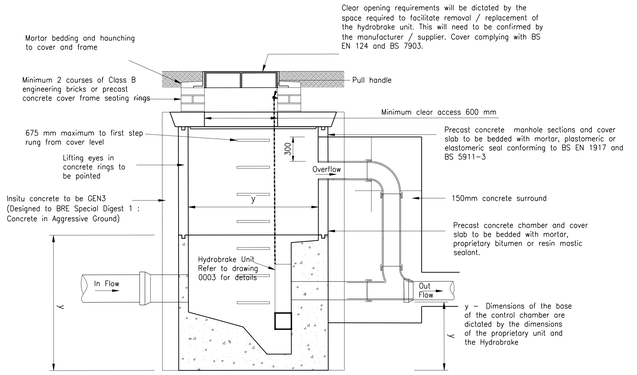
General information			
Site ID			
Site location and co-ordinates (GIS if appropriate)			
Elements forming the SuDS scheme		Approved drawing reference	
Inspection frequency		Approved specification reference	
Type of development		Specific purpose of any parts of the scheme (e.g. biodiversity, wildlife and visual aspects)	

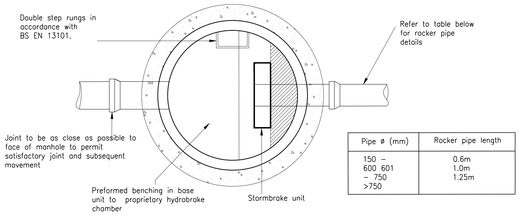
Inspection Date	Details	Y/N	Action required	Date completed	Details	Y/N	Action required	Date completed
General inspection items								
Is there any evidence of erosion, channelling, ponding (where not desirable) or other poor hydraulic performance?								
Is there any evidence of accidental spillages, oils, poor water quality, odours or nuisance insects?								
Have any health and safety risks been identified to either the public or maintenance operatives?								
Silt/Sediment accumulation								
Is there any sediment accumulation at inlets (or other defined accumulation zones such as the surface of filter drains or infiltration basins and within proprietary devices)? If yes, state depth (mm) and extent. Is removal required? If yes, state waste disposal requirements and confirm that all waste management requirements have been complied with (consult environmental regulator)								
Is surface clogging visible potentially problematic where water has to soak into the underlying								

Inspection Date	Details	Y/N	Action required	Date completed	Details	Y/N	Action required	Date completed
construction or ground (e.g. underdrained swale or infiltration basin)?								
Does permeable or porous surfacing require sweeping to remove silt?								
Is there evidence of litter accumulation in the system? If yes, is this a blockage risk?								
Is there any evidence of any other clogging or blockage of outlets or drainage paths?								
Is the vegetation condition satisfactory (density, weed growth, coverage etc)? (check against approved planting regime)								
Does any part of the system require weeding, pruning or mowing? (check against maintenance frequency state in approved design).								
Is there any evidence of invasive species becoming established? If yes, state action required								
Are any check dams or weirs in good condition?								
Is there any evidence of any accidental damage to the system (e.g. wheel ruts?)								

Inspection Date	Details	Y/N	Action required	Date completed	Details	Y/N	Action required	Date completed
Is there any evidence of cross connections or other unauthorised inflows?								
Is there any evidence of tampering with the flow control?								
Are there any other matters that could affect the performance of the system in relation to the design objectives for hydraulic, water quality, biodiversity and visual aspects?								
Other observations								
Information appended (e.g. photos)								
Continue as current Increase maintenance Decrease maintenance								
Proposed date for next inspection								

APPENDIX J
DRAINAGE CONSTRUCTION DETAILS

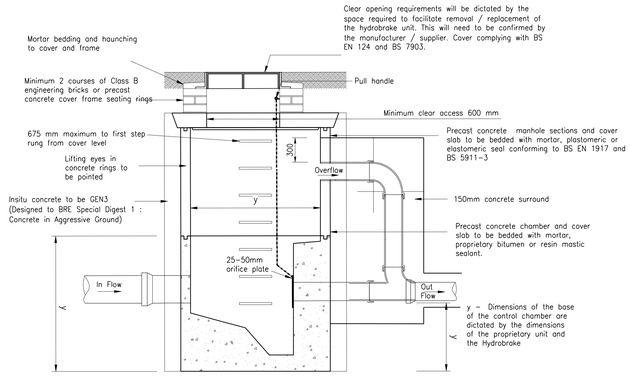


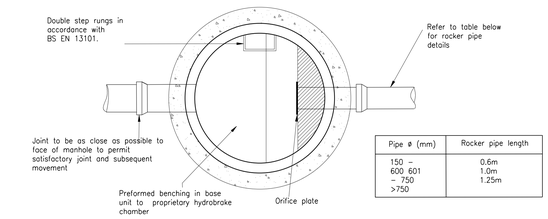


Pipe ø (mm)	Rocker pipe length
150 – 600 601 – 750 >750	0.6m 1.0m 1.25m

TYPICAL DETAIL TO UTILISE A PROPRIETARY BASE UNIT (WITH HYDROBRAKE PRE-INSTALLED)

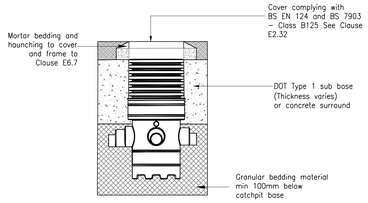
Hydrobrake Flow Control Chamber Detail



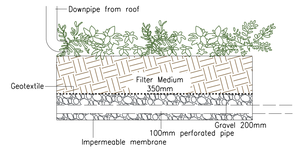


Pipe ø (mm)	Rocker pipe length
150 – 600 601 – 750 >750	0.6m 1.0m 1.25m

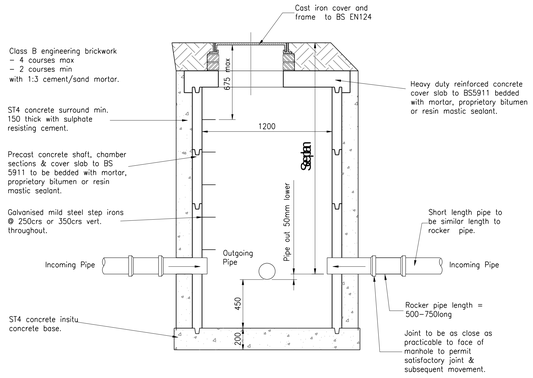
Orifice Flow Control Chamber Detail



450ø Catch Pit Inspection Chamber Typical Installation in Non Trafficked Areas
1:20



Ilustravlive Detail of SuDS Rain Garden
1:20



Catchpit Manhole Detail
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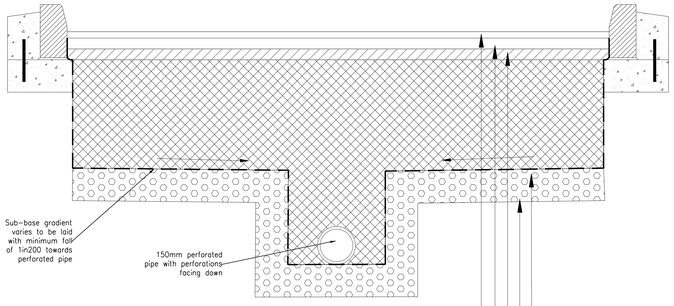
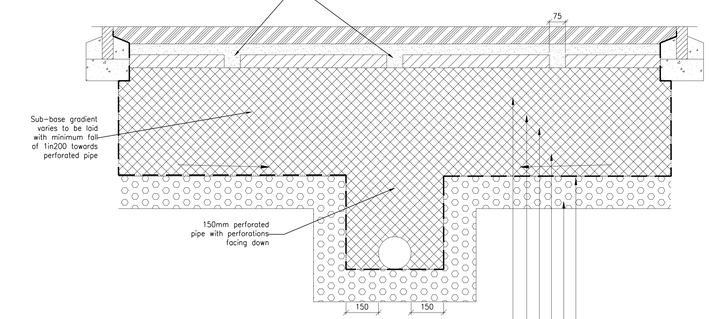
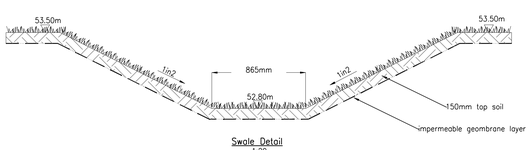


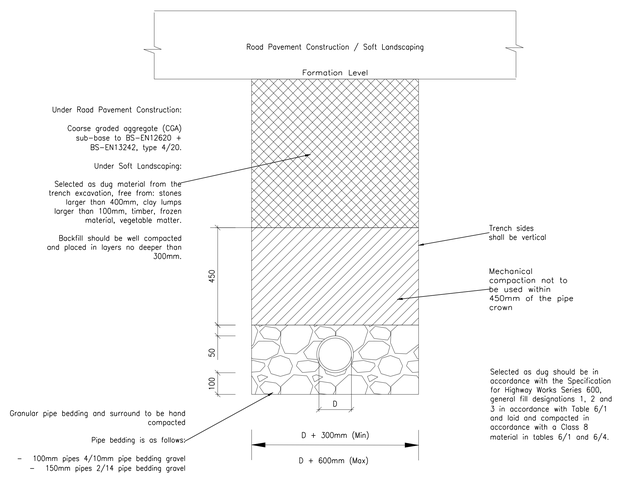
Permeable Asphalt Detail



Permeable Block Paving



Swale Detail
1:20



Class S Pipe Bedding Detail
1:10

CIVIL / STRUCTURAL DESIGN RISK MANAGEMENT

Abnormal or unusual residual risks associated with the design outcomes shown on this drawing are:–

RSK LDE LTD has followed its Design Risk Management process for Hazard Elimination and Risk reduction in developing the designs shown on this drawing.
Abnormal or unusual residual risks may be shown above where it is considered that such risk may not normally be expected by competent persons engaged on work of this nature or type.

Notes:

1. This drawing is to be read in conjunction with all relevant Architects and engineering drawings.
2. This drawing has been prepared only for planning purposes, no liability is accepted by LDE for any use of this drawing other than for the purpose which it was originally prepared.

Rev.	Date	Amendment	Drawn	Chkd.	Appd.
P01	08.11.23	Preliminary issue.	SM	AS	RD

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Client
BURSTON RIDGE FARM DEVELOPMENT LTD

Project Title
BURSTON RIDGE FARM, WINGRAVE

Status
PRELIMINARY

Drawing Title
PROPOSED SURFACE WATER DRAINAGE STRATEGY

Drawn	Date	Checked	Date	Approved	Date
SM	08.11.23	AS	08.11.23	RD	08.11.23

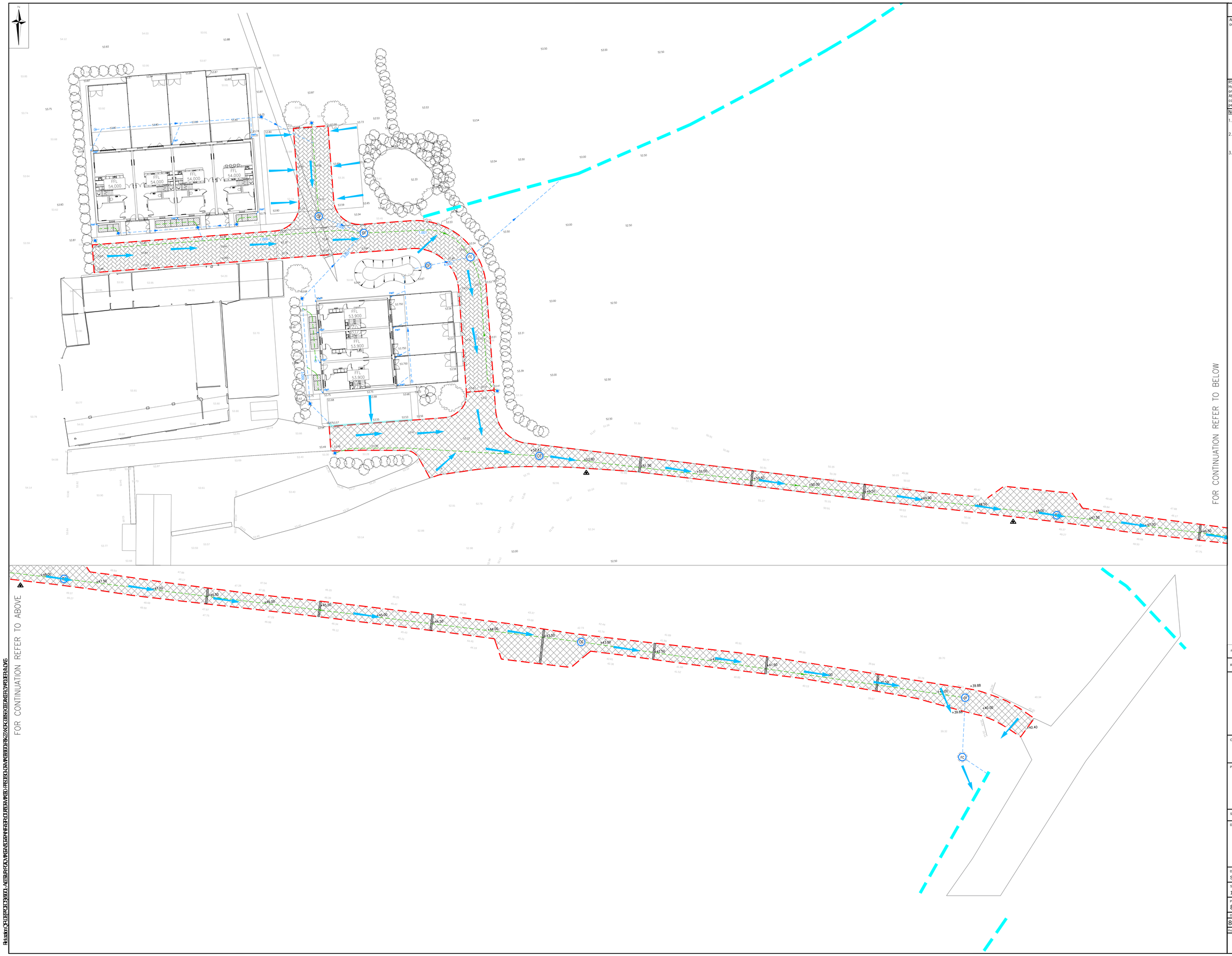
Scale	Orig Size	Dimensions
NTS	A0	m

Project No.: 890701
Drawing File: 890701-RSK-ZZ-XX-DR-C-0004- Drainage Construction Details.dwg

Drawing No.: 890701 | RSK | ZZ | XX | DR | C | 0003 | Rev. P01
(Project | Orig. | Vol./Sys. | Lev./Loc. | Type | Role | Draw. No.)

Scale 1:20
0 200 400 600 800 1000mm

APPENDIX K
EXCEEDANCE FLOW PLAN



CIVIL / STRUCTURAL DESIGN RISK MANAGEMENT

Abnormal or unusual residual risks associated with the design outcomes shown on this drawing are:–

RSK LDE LTD has followed its Design Risk Management process for Hazard Elimination and Risk reduction in developing the designs shown on this drawing.
Abnormal or unusual residual risks may be shown above where it is considered that such risk may not normally be expected by competent persons engaged on work of this nature or type.

Notes:

1. This drawing is to be read in conjunction with all relevant Architects and engineering drawings.
2. This drawing has been prepared only for planning purposes, no liability is accepted by LDE for any use of this drawing other than for the purpose which it was originally prepared.
3. Base layout taken from Aspect Consultants Hard Landscaping Plan drawing number 901 dated 17/10/2023.

Key

Overland Flow Route

Rev.	Date	Amendment	Drawn	Chkd.	Appd.
P01	08.11.23	Preliminary issue.	SM	AS	RD

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Client

BURSTON RIDGE FARM DEVELOPMENT LTD

Project Title

BURSTON RIDGE FARM, WINGRAVE

Status

PRELIMINARY

Drawing Title

EXCEEDANCE FLOW ROUTE PLAN

Drawn	Date	Checked	Date	Approved	Date
SM	08.11.23	AS	08.11.23	RD	08.11.23

Scale	Orig Size	Dimensions
1:200	A0	m

Project No.	Drawing File
890701	890701-RSK-ZZ-XX-DR-C-0005-Exceedance Flow Route Plan.dwg

Drawing No.							Rev.
890701	RSK	ZZ	XX	DR	C	0005	P01
Project	Orig.	Vol./Sys.	Lev./Loc.	Type	Role	Draw. No.	

Scale 1:200

0 2 4 6 8 10m