motion

EA/NRW Historic Flood Map (1:10,000)

General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point
- Map ID

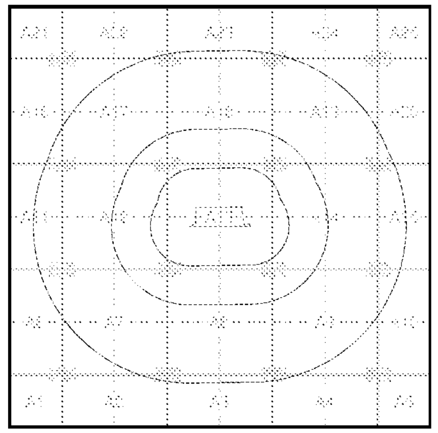
Historic Flood Events Data

- Channel Capacity Exceeded (no raised defences)
- Channel Capacity Exceeded /Surface Water
- Groundwater/High Water Table
- Local Drainage/Surface Water
- Mechanical Failure
- Obstruction/Blockage - Bridge
- Obstruction/Blockage - Channel
- Historical Flood Liabilities
- Obstruction/Blockage - Culvert
- Obstruction/Blockage - Debris Screen
- Operational Failure/ Breach of Defence
- Other
- Overtopping of Defences
- Surface Water
- Unknown

Contours (height in metres)

- Standard Contour
- Master Contour
- Spot Height
- Mean Low Water
- Mean High Water

EA/NRW Historic Flood Map - Slice A



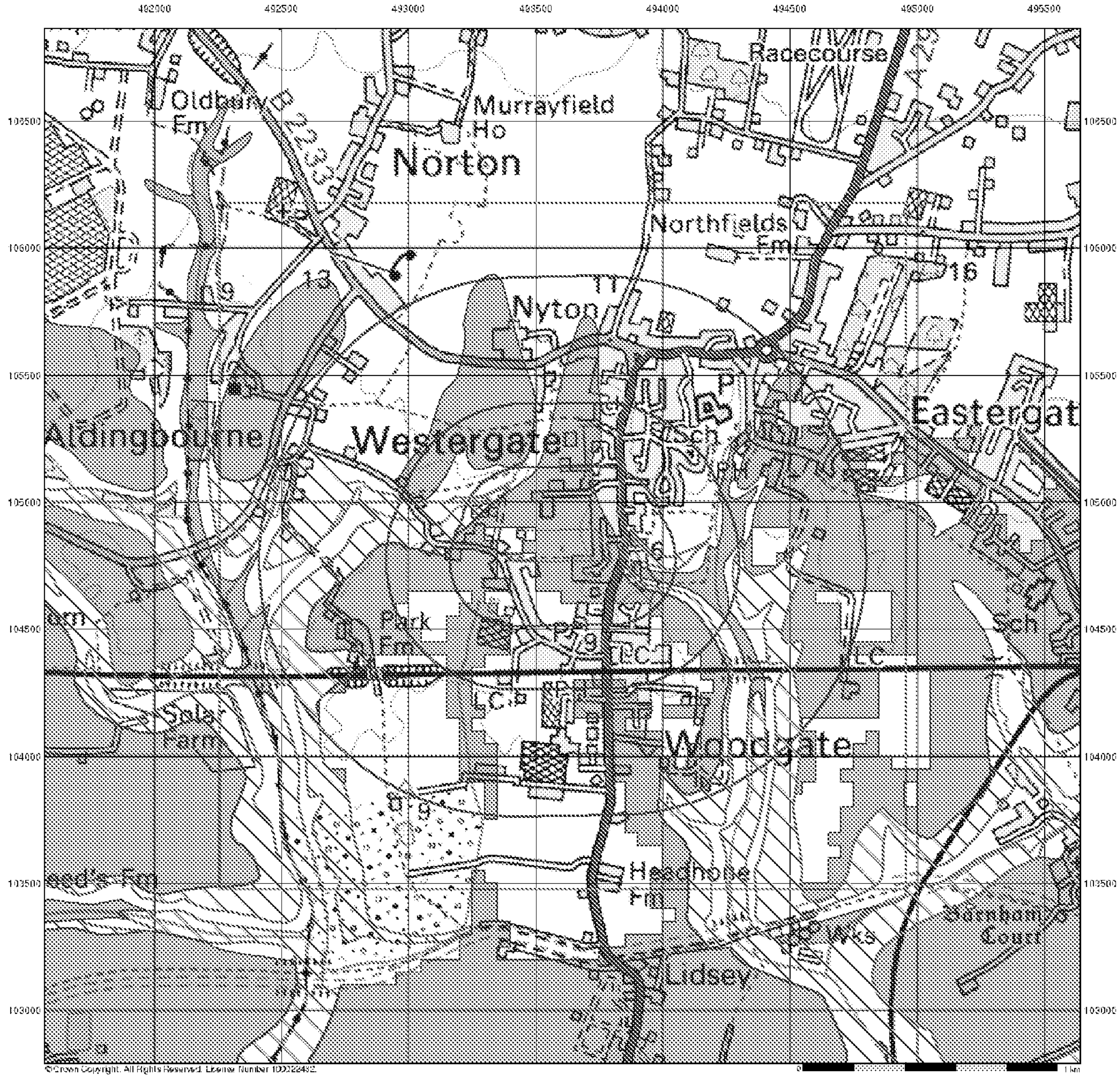
Order Details

Order Number:	298113894_1_1
Customer Ref:	1glwes AL
National Grid Reference:	493600, 104820
Slice:	A
Site Area (Ha):	3.82
Search Buffer (m):	1000

Site Details

Site at 493600, 104800

Landmark INFORMATION GROUP
Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk



motion

BGS Flood Data (1:50,000)

General

Specified Site
Specified Buffer(s)
Bearing Reference Point
Slice
Map ID

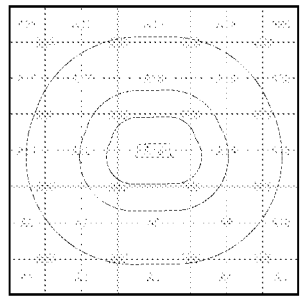
BGS Geological Indicators of Flooding

Coastal

Inland

Bodies of Water

BGS Flood Data Map - Slice A



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Order Details

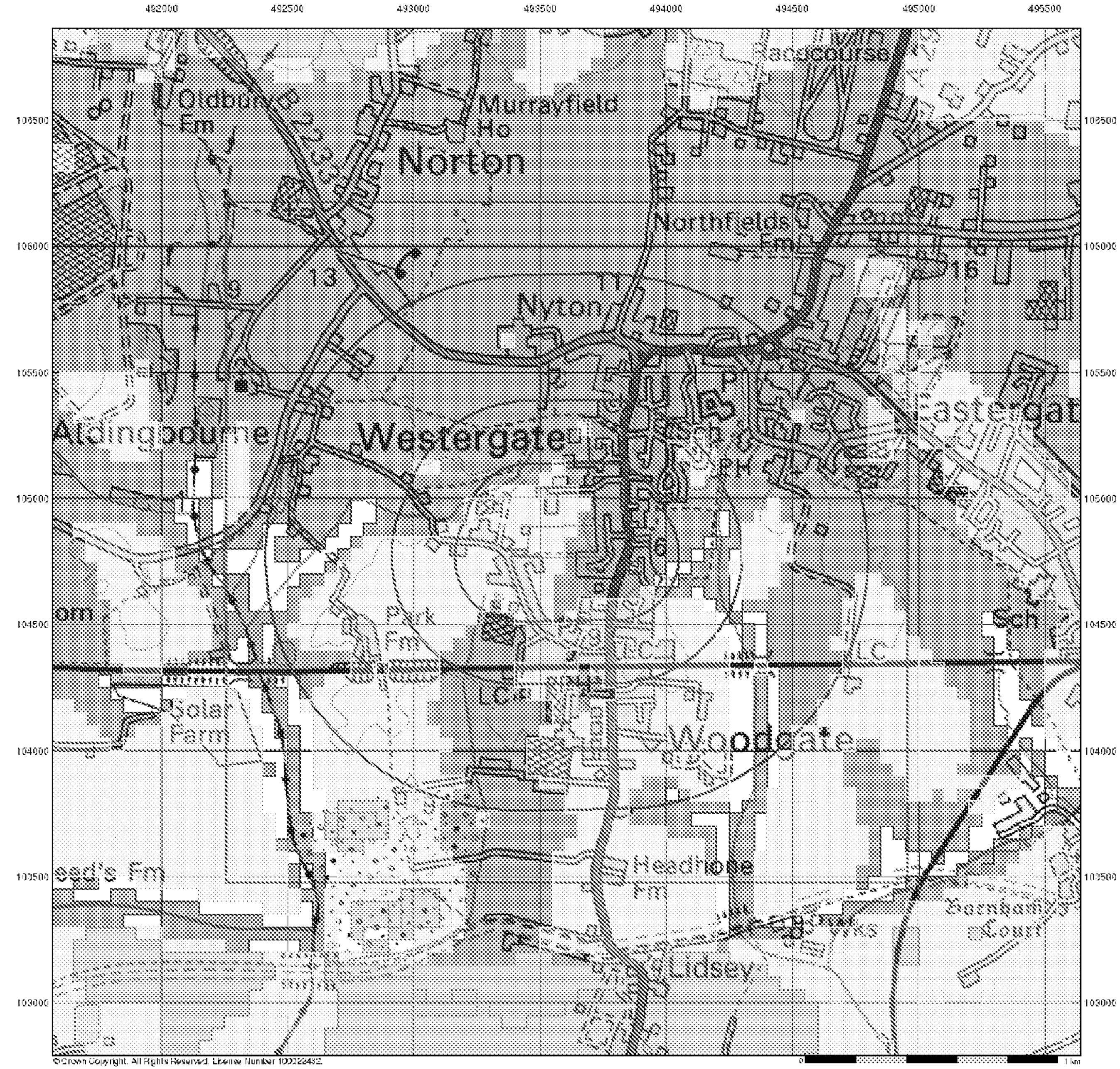
Order Number:	298113894_1_1
Customer Ref:	1glwes AL
National Grid Reference:	493600, 104820
Slice:	A
Site Area (Ha):	3.82
Search Buffer (m):	1000

Site Details

Site at 493600, 104800

Landmark INFORMATION GROUP

Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk



motion

BGS Flood Data (1:50,000)

General

Specified Site
Specified Buffer(s)
Bearing Reference Point
Slice
Map ID

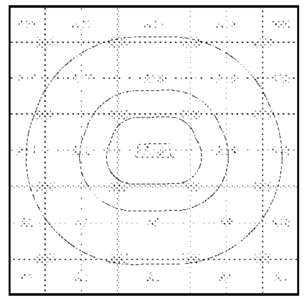
BGS Groundwater Flooding Susceptibility

Potential for Groundwater Flooding to Occur at Surface

Potential for Groundwater Flooding of Property Situated Below Ground Level

Limited Potential for Groundwater Flooding to Occur

BGS Flood Data Map - Slice A



Order Details

Order Number: 298113894_1_1
Customer Ref: 1glwes AL
National Grid Reference: 493600, 104820
Slice: A
Site Area (Ha): 3.82
Search Buffer (m): 1000

Site Details

Site at 493600, 104800

Landmark INFORMATION GROUP
Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk

motion

GeoSmart Information Groundwater Flood Map (1:50,000)

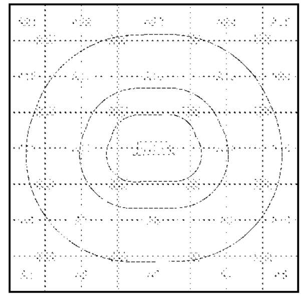
General

Specified Site | Specified Buffer(s) | Bearing Reference Point | Slice

GeoSmart Information Groundwater Flooding Risk

- High Risk
- Moderate Risk
- Low Risk
- Negligible Risk

GeoSmart Information Groundwater Flood Map - Slice A



N

Order Details

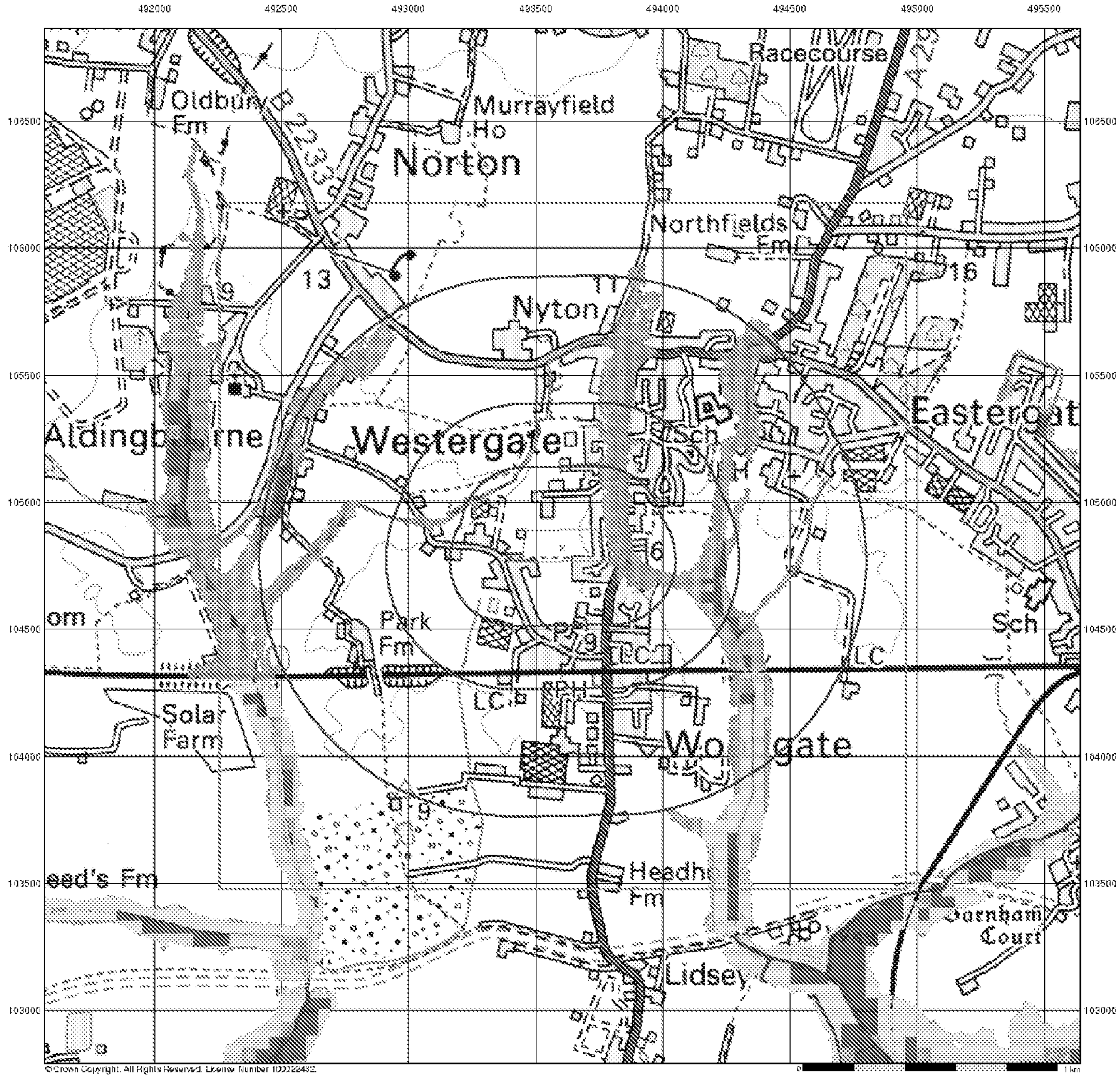
Order Number:	298113894_1_1
Customer Ref:	1glwes AL
National Grid Reference:	493600, 104820
Slice:	A
Site Area (Ha):	3.82
Search Buffer (m):	1000

Site Details

Site at 493600, 104800

Landmark INFORMATION GROUP

Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk



motion

EA/NRW RoFRS Data (1:50,000)

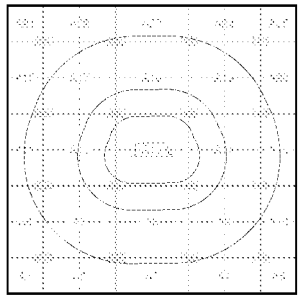
General

Specified Site · Specified Buffer(s) · Bearing Reference Point · Slice · Map ID

Risk of Flooding from Rivers and Sea (RoFRS)

- High Risk
- Medium Risk
- Low Risk
- Very Low Risk

EA/NRW RoFRS Data Map - Slice A



Order Details

Order Number:	298113894_1_1
Customer Ref:	1glwes AL
National Grid Reference:	493600, 104820
Slice:	A
Site Area (Ha):	3.82
Search Buffer (m):	1000

Site Details

Site at 493600, 104800

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Appendix M

UKSuDS Greenfield Runoff Calculator

Print | Close Report

HR Wallingford

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Phil Allen
Site name:	Meadow Way
Site location:	Westergate

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013) , the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Site Details

Latitude:	50.83531° N
Longitude:	0.67236° W
Reference:	2913145086
Date:	Aug 10 2022 14:39

Runoff estimation approach IH124

Site characteristics

Total site area (ha): 1.5

Methodology

Q_{BAR} estimation method:	Calculate from SPR and SAAR
SPR estimation method:	Calculate from SOIL type

Soil characteristics	Default	Edited
SOIL type:	2	2
HOST class:	N/A	N/A
SPR/SPRHOST:	0.3	0.3

Hydrological characteristics	Default	Edited
SAAR (mm):	749	749
Hydrological region:	7	7
Growth curve factor 1 year:	0.85	0.85
Growth curve factor 30 years:	2.3	2.3
Growth curve factor 100 years:	3.19	3.19
Growth curve factor 200 years:	3.74	3.74

Notes

(1) Is Q_{BAR} < 2.0 l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is SPR/SPRHOST ≤ 0.3?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates	Default	Edited
Q_{BAR} (l/s):	2.96	2.96
1 in 1 year (l/s):	2.52	2.52
1 in 30 years (l/s):	6.81	6.81
1 in 100 year (l/s):	9.44	9.44
1 in 200 years (l/s):	11.07	11.07

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Appendix N

Proposed Drainage Strategy Plan

Notes

1. All levels and dimensions are to be checked on site before any work commences. All dimensions are in metres unless stated otherwise.
2. Any discrepancies shall be reported to the engineer immediately, so that clarification can be sought prior to the commencement of works.
3. This drawing shall be read in conjunction with all other relevant engineering details, drawings and specification.
4. The exact location of all private rainwater pipes & internal foul soil pipes are to be confirmed with the architect details prior to works commencing.
5. The contractor is to keep a record of any variations made on site, including the relocation of sewers or drains, for their "as built" drawings to be prepared upon project completion.
6. All works to the adopted system are to be carried out in accordance with Sewers for Adoption, 7th Edition.
7. All works to the private drainage system to be in accordance with the Building Regulations Approved Document Part "H" 2015 edition.
8. 350mm min cover to be provided for private pipes laid in soft/paved areas. 900mm min cover to be provided for private pipes laid beneath roads/driveways unless not practicable. Where unachievable, shallow private drains may require protection using concrete surround or paving slabs bridging the trench, subject to the NHBC inspector's requirements.
9. All pipes shall be laid soffit to soffit with outgoing pipes unless otherwise stated.
10. Manholes situated within areas accessible to motor vehicles are to be fitted with suitable strength covers and frames. Please refer to the manhole schedule for guidance on this.

Legend

- New Surface Water Gravity Pipe
- New Foul Water Gravity Pipe
- New Surface Water Linear Drainage
- New Flow Control Structure [Ø1200mm Chamber]
- New SW Inspection Chamber [Ø1200mm]
- New SW Inspection Chamber [Ø450mm]
- New FW Inspection Chamber [Ø1200mm]
- New Inlet Headwall / Outfall Headwall
- Polystorm Linflex Filter Pipe
- Permeable Paviours
- Geocellular Attenuation Tank

Revision Notes:		Drn	Chk	App	Date
B	Final Issue	PA	RW	NJ	16/11/2022
A	First Issue	PA	RW	NJ	02/11/2022

Drawing Status:

DRAFT
NOT FOR CONSTRUCTION

motion

84 North Street
Guildford
Surrey
GU1 4AU
01483 531300

9 Greyfriars Road
Reading
Berkshire
RG1 1NU
0118 206 2930

Golden Cross House
8 Duncannon Street
London
WC2N 4JF
020 7031 8141

www.motion.co.uk

Client: gleeson land — Promoting Land. Unlocking Value.

Project: Land West of Meadow Way

Title: Drainage Strategy

Scale: 1:500 | Size: A1 | Project No: 1glwes/2204050

Drawing: 2204050-0500-01 | Revision: B

Notes

1. All levels and dimensions are to be checked on site before any work commences. All dimensions are in metres unless stated otherwise.
2. Any discrepancies shall be reported to the engineer immediately, so that clarification can be sought prior to the commencement of works.
3. This drawing shall be read in conjunction with all other relevant engineering details, drawings and specification.
4. The exact location of all private rainwater pipes & internal foul soil pipes are to be confirmed with the architect details prior to works commencing.
5. The contractor is to keep a record of any variations made on site, including the relocation of sewers or drains, for their "as built" drawings to be prepared upon project completion.
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- New Surface Water Linear Drainage
- New Flow Control Structure [Ø1200mm Chamber]
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- New SW Inspection Chamber [Ø450mm]
- New FW Inspection Chamber [Ø1200mm]
- New Inlet Headwall / Outfall Headwall
- Polystorm Linflex Filter Pipe
- Permeable Paviours
- Geocellular Attenuation Tank

Rev	Revision Notes	Drn	Chk	App	Date
B	Final Issue	PA	RW	NJ	14/11/2022
A	First Issue	PA	RW	NJ	02/11/2022

Drawing Status:

DRAFT
NOT FOR CONSTRUCTION

motion

84 North Street
Guildford
Surrey
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9 Greyfriars Road
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8 Duncannon Street
London
WC2N 4JF
020 7031 8141

www.motion.co.uk

Client: gleeson land — Promoting Land. Unlocking Value.

Project: Land West of Meadow Way

Title: Drainage Strategy

Scale: 1:500 | Size: A1 | Project No: 1glwes/2204050

Drawing: 2204050-0500-02 | Revision: B

Appendix O

MicroDrainage Network Model Calculation

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	19.600	Add Flow / Climate Change (%)	0
Ratio R	0.333	Minimum Backdrop Height (m)	0.500
Maximum Rainfall (mm/hr)	150	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	0.350
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Storm at outfall 17 (pipe 1.011)

Time (mins)	**Area (ha)**	**Time (mins)**	**Area (ha)**	**Time (mins)**	**Area (ha)**
0-4	0.170	4-8	1.089	8-12	0.182

Total Area Contributing (ha) = 1.441

Total Pipe Volume (m³) = 63.995

Time Area Diagram at outfall 32 (pipe 11.001)

Time (mins)	**Area (ha)**	**Time (mins)**	**Area (ha)**
0-4	0.091	4-8	0.003

Total Area Contributing (ha) = 0.094

Total Pipe Volume (m³) = 0.090

Network Design Table for Storm

- Indicates pipe length does not match coordinates
« - Indicates pipe capacity < flow

PN	**Length (m)**	**Fall (m)**	**Slope (1:X)**	**I.Area (ha)**	**T.E. (mins)**	**Base Flow (l/s)**	**k (mm)**	**HYD SECT**	**DIA (mm)**	**Section Type**	**Auto Design**

Network Results Table

Network Design Table for Storm

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	3.815	0.055	69.4	0.000	5.00	0.0	0.600	o	100	Pipe/Conduit	
1.001	12.957	0.056	231.4	0.099	0.00	0.0	0.600	o	225	Pipe/Conduit	
2.000	3.223	0.105	30.7	0.000	5.00	0.0	0.600	o	100	Pipe/Conduit	
2.001	15.852	0.056	283.1	0.122	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.002	53.014	0.089	596.7	0.066	0.00	0.0	0.600	o	450	Pipe/Conduit	
1.003	35.124	0.351	100.0	0.089	0.00	0.0	0.600	o	450	Pipe/Conduit	
3.000	3.067	0.031	100.0	0.007	5.00	0.0	0.600	o	100	Pipe/Conduit	
3.001	8.000#	0.080	100.0	0.055	0.00	0.0	0.600	o	150	Pipe/Conduit	
3.002	5.000#	0.050	100.0	0.006	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.004	20.011	0.200	100.0	0.069	0.00	0.0	0.600	o	450	Pipe/Conduit	
4.000	11.097	0.448	24.8	0.006	5.00	0.0	0.600	o	100	Pipe/Conduit	
5.000	5.531	0.095	58.2	0.000	5.00	0.0	0.600	o	100	Pipe/Conduit	
5.001	10.968	0.110	100.0	0.153	0.00	0.0	0.600	o	150	Pipe/Conduit	
5.002	10.774	0.108	100.0	0.026	0.00	0.0	0.600	o	150	Pipe/Conduit	
4.001	8.338	0.104	80.0	0.018	0.00	0.0	0.600	o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	143.89	5.07	10.150	0.000	0.0	0.0	0.0	0.93	7.3	0.0
1.001	141.48	5.32	9.920	0.099	0.0	0.0	0.0	0.86	34.6«	38.0
2.000	144.19	5.04	10.200	0.000	0.0	0.0	0.0	1.40	11.0	0.0
2.001	140.92	5.38	9.920	0.122	0.0	0.0	0.0	0.77	30.7«	46.6
1.002	131.86	6.45	9.639	0.287	0.0	0.0	0.0	0.83	131.2	102.6
1.003	129.68	6.74	9.550	0.377	0.0	0.0	0.0	2.03	323.4	132.3
3.000	143.91	5.07	9.611	0.007	0.0	0.0	0.0	0.77	6.0	2.9
3.001	142.63	5.20	9.580	0.063	0.0	0.0	0.0	1.00	17.8«	24.2
3.002	141.84	5.28	9.500	0.069	0.0	0.0	0.0	1.00	17.8«	26.5
1.004	128.47	6.90	9.199	0.514	0.0	0.0	0.0	2.03	323.4	179.0
4.000	143.40	5.12	9.850	0.006	0.0	0.0	0.0	1.56	12.2	2.3
5.000	143.67	5.09	9.770	0.000	0.0	0.0	0.0	1.01	7.9	0.0
5.001	141.93	5.27	9.650	0.153	0.0	0.0	0.0	1.00	17.8«	58.8
5.002	140.27	5.45	9.540	0.179	0.0	0.0	0.0	1.00	17.8«	67.9
4.001	139.41	5.55	9.357	0.203	0.0	0.0	0.0	1.46	58.2«	76.7

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
4.002	10.000#	0.100	100.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.005	29.611	0.148	200.0	0.022	0.00	0.0	0.600	o	525	Pipe/Conduit	
6.000	2.380	0.024	100.0	0.000	5.00	0.0	0.600	o	100	Pipe/Conduit	
6.001	8.000#	1.547	5.2	0.040	0.00	0.0	0.600	o	100	Pipe/Conduit	
1.006	25.680	0.128	200.0	0.069	0.00	0.0	0.600	o	525	Pipe/Conduit	
7.000	5.285	0.090	58.7	0.000	5.00	0.0	0.600	o	100	Pipe/Conduit	
7.001	7.620	0.051	149.4	0.067	0.00	0.0	0.600	o	100	Pipe/Conduit	
1.007	38.077	0.190	200.0	0.025	0.00	0.0	0.600	o	525	Pipe/Conduit	
8.000	2.055	0.230	8.9	0.000	5.00	0.0	0.600	o	100	Pipe/Conduit	
8.001	5.000#	0.063	80.0	0.051	0.00	0.0	0.600	o	100	Pipe/Conduit	
1.008	44.835	0.224	200.0	0.055	0.00	0.0	0.600	o	525	Pipe/Conduit	
1.009	33.815	0.511	66.2	0.078	0.00	0.0	0.600	o	600	Pipe/Conduit	
9.000	4.588	0.074	61.6	0.000	5.00	0.0	0.600	o	100	Pipe/Conduit	
9.001	3.000#	0.580	5.2	0.105	0.00	0.0	0.600	o	150	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
4.002	137.94	5.71	9.253	0.203	0.0	0.0	0.0	1.00	17.8«	76.7
1.005	126.27	7.22	8.999	0.739	0.0	0.0	0.0	1.58	342.1	252.8
6.000	144.06	5.05	9.554	0.000	0.0	0.0	0.0	0.77	6.0	0.0
6.001	143.68	5.09	9.530	0.040	0.0	0.0	0.0	3.42	26.9	15.6
1.006	124.43	7.49	8.851	0.848	0.0	0.0	0.0	1.58	342.1	285.9
7.000	143.71	5.09	9.410	0.000	0.0	0.0	0.0	1.01	7.9	0.0
7.001	141.77	5.29	9.320	0.067	0.0	0.0	0.0	0.63	4.9«	25.7
1.007	121.84	7.89	8.723	0.940	0.0	0.0	0.0	1.58	342.1	310.1
8.000	144.44	5.01	9.250	0.000	0.0	0.0	0.0	2.60	20.4	0.0
8.001	143.49	5.11	9.020	0.051	0.0	0.0	0.0	0.86	6.8«	19.9
1.008	118.97	8.36	8.532	1.046	0.0	0.0	0.0	1.58	342.1	336.9
1.009	117.87	8.55	8.233	1.123	0.0	0.0	0.0	3.00	847.3	358.6
9.000	143.80	5.08	9.850	0.000	0.0	0.0	0.0	0.98	7.7	0.0
9.001	143.69	5.09	9.700	0.105	0.0	0.0	0.0	4.46	78.8	41.0

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
9.002	3.000#	0.360	8.3	0.033	0.00	0.0	0.600	o	150	Pipe/Conduit	🔓
9.003	39.283	0.588	66.8	0.078	0.00	0.0	0.600	o	150	Pipe/Conduit	🔒
1.010	10.134	0.032	316.9	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	🔒
10.000	9.788	0.098	100.0	0.000	5.00	0.0	0.600	o	100	Pipe/Conduit	🔓
10.001	11.535	0.144	80.0	0.000	0.00	0.0	0.600	o	100	Pipe/Conduit	🔒
1.011	41.371	0.040	1034.3	0.102	0.00	0.0	0.600	o	150	Pipe/Conduit	🔒
11.000	4.812	0.048	100.0	0.000	5.00	0.0	0.600	o	100	Pipe/Conduit	🔓
11.001	6.683	0.084	80.0	0.094	0.00	0.0	0.600	o	100	Pipe/Conduit	🔒

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
9.002	143.55	5.10	9.120	0.138	0.0	0.0	0.0	3.51	62.1	53.6
9.003	138.62	5.63	8.760	0.216	0.0	0.0	0.0	1.23	21.8«	81.0
1.010	117.17	8.67	7.722	1.339	0.0	0.0	0.0	1.36	385.2«	425.0
10.000	142.51	5.21	7.952	0.000	0.0	0.0	0.0	0.77	6.0	0.0
10.001	140.42	5.44	7.834	0.000	0.0	0.0	0.0	0.86	6.8	0.0
1.011	105.94	10.94	7.690	1.441	0.0	0.0	0.0	0.30	5.4«	425.0
11.000	143.54	5.10	7.998	0.000	0.0	0.0	0.0	0.77	6.0	0.0
11.001	142.30	5.23	7.700	0.094	0.0	0.0	0.0	0.86	6.8«	36.0

Area Summary for Storm

Pipe Number	**PIMP Type**	**PIMP Name**	**PIMP (%)**	**Gross Area (ha)**	**Imp. Area (ha)**	**Pipe Total (ha)**
1.000	-	-	100	0.000	0.000	0.000
1.001	User	-	100	0.016	0.016	0.016
	User	-	100	0.031	0.031	0.047
	User	-	100	0.035	0.035	0.082
	User	-	100	0.011	0.011	0.093
	User	-	100	0.006	0.006	0.099
2.000	-	-	100	0.000	0.000	0.000
2.001	User	-	100	0.020	0.020	0.020
	User	-	100	0.015	0.015	0.034
	User	-	100	0.041	0.041	0.075
	User	-	100	0.011	0.011	0.086
	User	-	100	0.002	0.002	0.089
	User	-	100	0.015	0.015	0.103
	User	-	100	0.002	0.002	0.106
	User	-	100	0.002	0.002	0.108
	User	-	100	0.007	0.007	0.115
	User	-	100	0.007	0.007	0.122
1.002	User	-	100	0.027	0.027	0.027
	User	-	100	0.010	0.010	0.037
	User	-	100	0.006	0.006	0.044
	User	-	100	0.018	0.018	0.062
	User	-	100	0.002	0.002	0.064
	User	-	100	0.002	0.002	0.066
1.003	User	-	100	0.013	0.013	0.013
	User	-	100	0.008	0.008	0.021
	User	-	100	0.008	0.008	0.028
	User	-	100	0.015	0.015	0.043
	User	-	100	0.005	0.005	0.048
	User	-	100	0.005	0.005	0.053
	User	-	100	0.004	0.004	0.057
	User	-	100	0.008	0.008	0.066
	User	-	100	0.002	0.002	0.067
	User	-	100	0.022	0.022	0.089
3.000	User	-	100	0.007	0.007	0.007
3.001	User	-	100	0.019	0.019	0.019
	User	-	100	0.007	0.007	0.026
	User	-	100	0.002	0.002	0.029
	User	-	100	0.002	0.002	0.031
	User	-	100	0.002	0.002	0.033
	User	-	100	0.002	0.002	0.035
	User	-	100	0.010	0.010	0.045
	User	-	100	0.010	0.010	0.055
3.002	User	-	100	0.006	0.006	0.006
1.004	User	-	100	0.021	0.021	0.021
	User	-	100	0.009	0.009	0.031
	User	-	100	0.008	0.008	0.038
	User	-	100	0.010	0.010	0.048
	User	-	100	0.004	0.004	0.053
	User	-	100	0.010	0.010	0.063
	User	-	100	0.006	0.006	0.069
4.000	User	-	100	0.006	0.006	0.006

Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
5.000	-	-	100	0.000	0.000	0.000
5.001	User	-	100	0.069	0.069	0.069
	User	-	100	0.020	0.020	0.089
	User	-	100	0.011	0.011	0.100
	User	-	100	0.053	0.053	0.153
5.002	User	-	100	0.010	0.010	0.010
	User	-	100	0.003	0.003	0.013
	User	-	100	0.003	0.003	0.016
	User	-	100	0.010	0.010	0.026
4.001	User	-	100	0.002	0.002	0.002
	User	-	100	0.007	0.007	0.009
	User	-	100	0.009	0.009	0.018
4.002	-	-	100	0.000	0.000	0.000
1.005	User	-	100	0.007	0.007	0.007
	User	-	100	0.002	0.002	0.009
	User	-	100	0.001	0.001	0.010
	User	-	100	0.012	0.012	0.022
6.000	-	-	100	0.000	0.000	0.000
6.001	User	-	100	0.021	0.021	0.021
	User	-	100	0.016	0.016	0.038
	User	-	100	0.003	0.003	0.040
1.006	User	-	100	0.016	0.016	0.016
	User	-	100	0.006	0.006	0.022
	User	-	100	0.006	0.006	0.028
	User	-	100	0.019	0.019	0.047
	User	-	100	0.022	0.022	0.069
7.000	-	-	100	0.000	0.000	0.000
7.001	User	-	100	0.035	0.035	0.035
	User	-	100	0.002	0.002	0.037
	User	-	100	0.006	0.006	0.043
	User	-	100	0.014	0.014	0.057
	User	-	100	0.010	0.010	0.067
1.007	User	-	100	0.014	0.014	0.014
	User	-	100	0.006	0.006	0.020
	User	-	100	0.005	0.005	0.025
8.000	-	-	100	0.000	0.000	0.000
8.001	User	-	100	0.022	0.022	0.022
	User	-	100	0.017	0.017	0.039
	User	-	100	0.001	0.001	0.040
	User	-	100	0.006	0.006	0.047
	User	-	100	0.003	0.003	0.050
	User	-	100	0.001	0.001	0.051
1.008	User	-	100	0.023	0.023	0.023
	User	-	100	0.007	0.007	0.030
	User	-	100	0.008	0.008	0.038
	User	-	100	0.002	0.002	0.039
	User	-	100	0.008	0.008	0.048
	User	-	100	0.003	0.003	0.050
	User	-	100	0.005	0.005	0.055
1.009	User	-	100	0.029	0.029	0.029
	User	-	100	0.016	0.016	0.045

Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
	User	-	100	0.009	0.009	0.054
	User	-	100	0.009	0.009	0.063
	User	-	100	0.015	0.015	0.078
9.000	-	-	100	0.000	0.000	0.000
9.001	User	-	100	0.047	0.047	0.047
	User	-	100	0.006	0.006	0.053
	User	-	100	0.003	0.003	0.056
	User	-	100	0.006	0.006	0.062
	User	-	100	0.006	0.006	0.068
	User	-	100	0.006	0.006	0.073
	User	-	100	0.010	0.010	0.083
	User	-	100	0.012	0.012	0.095
	User	-	100	0.008	0.008	0.103
	User	-	100	0.002	0.002	0.105
9.002	-	-	100	0.033	0.033	0.033
9.003	User	-	100	0.028	0.028	0.028
	User	-	100	0.037	0.037	0.065
	User	-	100	0.006	0.006	0.071
	User	-	100	0.002	0.002	0.073
	User	-	100	0.005	0.005	0.078
1.010	-	-	100	0.000	0.000	0.000
10.000	-	-	100	0.000	0.000	0.000
10.001	-	-	100	0.000	0.000	0.000
1.011	User	-	100	0.102	0.102	0.102
11.000	-	-	100	0.000	0.000	0.000
11.001	User	-	100	0.071	0.071	0.071
	User	-	100	0.023	0.023	0.094
				Total 1.535	Total 1.535	Total 1.535

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.011	17	8.680	7.650	0.000	1500	0

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
11.001	32	8.700	7.616	0.000	1200	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m^3/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	14
Number of Online Controls	12	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.600	Storm Duration (mins)	30
Ratio R	0.333		

Online Controls for Storm

Hydro-Brake® Optimum Manhole: 3, DS/PN: 1.002, Volume (m³): 2.3

Unit Reference	MD-SHE-0302-5200-0780-5200
Design Head (m)	0.780
Design Flow (l/s)	52.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	302
Invert Level (m)	9.639
Minimum Outlet Pipe Diameter (mm)	375
Suggested Manhole Diameter (mm)	1800

Control Points	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	0.780	52.0
Flush-Flo™	0.422	51.9
Kick-Flo®	0.656	47.8
Mean Flow over Head Range	-	39.6

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**
0.100	9.2	1.200	64.0	3.000	99.9	7.000	151.1
0.200	31.1	1.400	69.0	3.500	107.7	7.500	156.3
0.300	50.5	1.600	73.6	4.000	114.9	8.000	159.8
0.400	51.9	1.800	77.9	4.500	121.7	8.500	164.9
0.500	51.5	2.000	82.0	5.000	128.1	9.000	169.7
0.600	49.7	2.200	85.9	5.500	134.3	9.500	174.4
0.800	52.6	2.400	89.6	6.000	140.1		
1.000	58.6	2.600	93.2	6.500	145.7		

Hydro-Brake® Optimum Manhole: 20, DS/PN: 3.002, Volume (m³): 1.0

Unit Reference	MD-SHE-0049-1000-0800-1000
Design Head (m)	0.800
Design Flow (l/s)	1.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	49
Invert Level (m)	9.500
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Hydro-Brake® Optimum Manhole: 20, DS/PN: 3.002, Volume (m³): 1.0

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.800	1.0
Flush-Flo™	0.215	0.9
Kick-Flo®	0.437	0.8
Mean Flow over Head Range	-	0.8

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.8	1.200	1.2	3.000	1.8	7.000	2.7
0.200	0.9	1.400	1.3	3.500	1.9	7.500	2.8
0.300	0.9	1.600	1.4	4.000	2.1	8.000	2.9
0.400	0.8	1.800	1.4	4.500	2.2	8.500	2.9
0.500	0.8	2.000	1.5	5.000	2.3	9.000	3.0
0.600	0.9	2.200	1.6	5.500	2.4	9.500	3.1
0.800	1.0	2.400	1.6	6.000	2.5		
1.000	1.1	2.600	1.7	6.500	2.6		

Hydro-Brake® Optimum Manhole: 5, DS/PN: 5.001, Volume (m³): 0.7

Unit Reference	MD-SHE-0079-2300-0550-2300
Design Head (m)	0.550
Design Flow (l/s)	2.3
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	79
Invert Level (m)	9.650
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.550	2.3
Flush-Flo™	0.165	2.3
Kick-Flo®	0.376	1.9
Mean Flow over Head Range	-	2.0

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.2	0.300	2.2	0.500	2.2	0.800	2.7
0.200	2.3	0.400	2.0	0.600	2.4	1.000	3.0

Hydro-Brake® Optimum Manhole: 5, DS/PN: 5.001, Volume (m³): 0.7

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
1.200	3.3	2.400	4.5	5.000	6.4	8.000	8.1
1.400	3.5	2.600	4.7	5.500	6.7	8.500	8.3
1.600	3.8	3.000	5.0	6.000	7.0	9.000	8.5
1.800	4.0	3.500	5.4	6.500	7.3	9.500	8.8
2.000	4.2	4.000	5.8	7.000	7.5		
2.200	4.4	4.500	6.1	7.500	7.8		

Hydro-Brake® Optimum Manhole: 33, DS/PN: 4.002, Volume (m³): 1.4

Unit Reference	MD-SHE-0054-1200-0800-1200
Design Head (m)	0.800
Design Flow (l/s)	1.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	54
Invert Level (m)	9.253
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.800	1.2
Flush-Flo™	0.238	1.2
Kick-Flo®	0.482	1.0
Mean Flow over Head Range	-	1.0

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.0	1.200	1.4	3.000	2.2	7.000	3.2
0.200	1.2	1.400	1.5	3.500	2.3	7.500	3.3
0.300	1.2	1.600	1.6	4.000	2.5	8.000	3.4
0.400	1.1	1.800	1.7	4.500	2.6	8.500	3.5
0.500	1.0	2.000	1.8	5.000	2.8	9.000	3.6
0.600	1.1	2.200	1.9	5.500	2.9	9.500	3.7
0.800	1.2	2.400	2.0	6.000	3.0		
1.000	1.3	2.600	2.0	6.500	3.1		

Orifice Manhole: 24, DS/PN: 6.001, Volume (m³): 0.7

Diameter (m) 0.026 Discharge Coefficient 0.600 Invert Level (m) 9.530

Orifice Manhole: 22, DS/PN: 7.001, Volume (m³): 0.7

Diameter (m) 0.026 Discharge Coefficient 0.600 Invert Level (m) 9.320

Orifice Manhole: 26, DS/PN: 8.001, Volume (m³): 0.7

Diameter (m) 0.026 Discharge Coefficient 0.600 Invert Level (m) 9.020

Orifice Manhole: 14, DS/PN: 9.001, Volume (m³): 0.7

Diameter (m) 0.033 Discharge Coefficient 0.600 Invert Level (m) 9.700

Orifice Manhole: 26, DS/PN: 9.002, Volume (m³): 0.7

Diameter (m) 0.032 Discharge Coefficient 0.600 Invert Level (m) 9.120

Orifice Manhole: 17, DS/PN: 9.003, Volume (m³): 0.7

Diameter (m) 0.037 Discharge Coefficient 0.600 Invert Level (m) 8.760

Hydro-Brake® Optimum Manhole: 22, DS/PN: 1.011, Volume (m³): 4.3

Unit Reference	MD-SHE-0072-2300-1000-2300
Design Head (m)	1.000
Design Flow (l/s)	2.3
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	72
Invert Level (m)	7.690
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	1.000	2.3
Flush-Flo™	0.307	2.3
Kick-Flo®	0.625	1.9
Mean Flow over Head Range	-	2.0

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**
0.100	1.9	0.600	2.0	1.600	2.9	2.600	3.6
0.200	2.2	0.800	2.1	1.800	3.0	3.000	3.8
0.300	2.3	1.000	2.3	2.000	3.2	3.500	4.1
0.400	2.3	1.200	2.5	2.200	3.3	4.000	4.4
0.500	2.2	1.400	2.7	2.400	3.4	4.500	4.6

Hydro-Brake® Optimum Manhole: 22, DS/PN: 1.011, Volume (m³): 4.3

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
5.000	4.8	6.500	5.5	8.000	6.0	9.500	6.6
5.500	5.1	7.000	5.7	8.500	6.2		
6.000	5.3	7.500	5.9	9.000	6.4		

Hydro-Brake® Optimum Manhole: 31, DS/PN: 11.001, Volume (m³): 0.9

Unit Reference	MD-SHE-0042-7000-0700-7000
Design Head (m)	0.700
Design Flow (l/s)	0.7
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	42
Invert Level (m)	7.700
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.700	0.7
Flush-Flo™	0.185	0.6
Kick-Flo®	0.373	0.5
Mean Flow over Head Range	-	0.6

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.6	1.200	0.9	3.000	1.3	7.000	2.0
0.200	0.6	1.400	0.9	3.500	1.4	7.500	2.0
0.300	0.6	1.600	1.0	4.000	1.5	8.000	2.1
0.400	0.5	1.800	1.1	4.500	1.6	8.500	2.2
0.500	0.6	2.000	1.1	5.000	1.7	9.000	2.2
0.600	0.7	2.200	1.2	5.500	1.8	9.500	2.3
0.800	0.7	2.400	1.2	6.000	1.8		
1.000	0.8	2.600	1.3	6.500	1.9		

Storage Structures for Storm

Porous Car Park Manhole: 36, DS/PN: 1.001

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1000	Length (m)	32.0
Max Percolation (l/s)	44.4	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	9.920	Cap Volume Depth (m)	0.450

Porous Car Park Manhole: 38, DS/PN: 2.001

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1000	Length (m)	32.0
Max Percolation (l/s)	44.4	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	9.920	Cap Volume Depth (m)	0.450

Swale Manhole: 20, DS/PN: 3.002

Warning:- Volume should always be included unless the upstream pipe is being used for storage and/or as a carrier

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	34.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	3.0
Safety Factor	2.0	Slope (1:X)	0.0
Porosity	1.00	Cap Volume Depth (m)	0.700
Invert Level (m)	9.500	Cap Infiltration Depth (m)	0.700
Base Width (m)	0.8	Include Swale Volume	Yes

Porous Car Park Manhole: 5, DS/PN: 5.001

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	6.0
Membrane Percolation (mm/hr)	1000	Length (m)	115.0
Max Percolation (l/s)	191.7	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	9.650	Cap Volume Depth (m)	0.450

Swale Manhole: 33, DS/PN: 4.002

Warning:- Volume should always be included unless the upstream pipe is being used for storage and/or as a carrier

Infiltration Coefficient Base (m/hr)	0.00000	Base Width (m)	0.8
Infiltration Coefficient Side (m/hr)	0.00000	Length (m)	34.0
Safety Factor	2.0	Side Slope (1:X)	3.0
Porosity	1.00	Slope (1:X)	0.0
Invert Level (m)	9.253	Cap Volume Depth (m)	0.700

Swale Manhole: 33, DS/PN: 4.002

Cap Infiltration Depth (m) 0.700 Include Swale Volume Yes

Porous Car Park Manhole: 24, DS/PN: 6.001

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	10.0
Membrane Percolation (mm/hr)	1000	Length (m)	21.0
Max Percolation (l/s)	58.3	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	9.530	Cap Volume Depth (m)	0.450

Porous Car Park Manhole: 22, DS/PN: 7.001

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	10.0
Membrane Percolation (mm/hr)	1000	Length (m)	35.0
Max Percolation (l/s)	97.2	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	9.320	Cap Volume Depth (m)	0.450

Porous Car Park Manhole: 26, DS/PN: 8.001

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	10.0
Membrane Percolation (mm/hr)	1000	Length (m)	22.0
Max Percolation (l/s)	61.1	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	9.020	Cap Volume Depth (m)	0.450

Porous Car Park Manhole: 14, DS/PN: 9.001

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	6.0
Membrane Percolation (mm/hr)	1000	Length (m)	78.3
Max Percolation (l/s)	130.5	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	9.700	Cap Volume Depth (m)	0.450

Porous Car Park Manhole: 26, DS/PN: 9.002

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	6.0
Membrane Percolation (mm/hr)	1000	Length (m)	60.0
Max Percolation (l/s)	100.0	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	9.120	Cap Volume Depth (m)	0.450

Porous Car Park Manhole: 17, DS/PN: 9.003

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	6.0
Membrane Percolation (mm/hr)	1000	Length (m)	61.6
Max Percolation (l/s)	102.7	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	8.760	Cap Volume Depth (m)	0.450

Swale Manhole: 34, DS/PN: 10.001

Warning:- Volume should always be included unless the upstream pipe is being used for storage and/or as a carrier

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	60.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	3.0
Safety Factor	2.0	Slope (1:X)	0.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	7.702	Cap Infiltration Depth (m)	0.000
Base Width (m)	2.0	Include Swale Volume	Yes

Infiltration Basin Manhole: 22, DS/PN: 1.011

Invert Level (m)	7.690	Safety Factor	2.0
Infiltration Coefficient Base (m/hr)	0.00000	Porosity	1.00
Infiltration Coefficient Side (m/hr)	0.00000		

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	777.5	1.000	1102.3

Cellular Storage Manhole: 31, DS/PN: 11.001

Invert Level (m)	7.700	Safety Factor	2.0
Infiltration Coefficient Base (m/hr)	0.00000	Porosity	0.95
Infiltration Coefficient Side (m/hr)	0.00000		

Depth (m)	**Area (m²)**	**Inf. Area (m²)**	**Depth (m)**	**Area (m²)**	**Inf. Area (m²)**
0.000	182.0	182.0	0.401	0.0	203.6
0.400	182.0	203.6			

Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	14
Number of Online Controls	12	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.333
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	19.600	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0	DVD Status	ON
Analysis Timestep	Fine	Inertia Status	ON
DTS Status	OFF		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 40, 45

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	35	30 Winter	100	+45%	100/15 Summer				10.347
1.001	36	30 Winter	100	+45%	30/15 Winter				10.348
2.000	37	30 Winter	100	+45%	100/15 Winter				10.359
2.001	38	30 Winter	100	+45%	30/15 Summer				10.360
1.002	3	30 Winter	100	+45%	30/15 Summer				10.328
1.003	3	15 Winter	100	+45%					9.738
3.000	24	15 Winter	100	+45%	30/15 Summer				10.115
3.001	25	15 Winter	100	+45%	30/15 Summer				10.098
3.002	20	360 Winter	100	+45%	30/15 Summer				9.985
1.004	6	15 Winter	100	+45%					9.446
4.000	31	960 Winter	100	+45%	100/960 Winter				9.981
5.000	5	360 Winter	100	+45%	30/120 Winter				10.047
5.001	5	360 Winter	100	+45%	30/30 Winter				10.047
5.002	34	960 Winter	100	+45%	30/120 Summer				9.984
4.001	32	960 Winter	100	+45%	30/30 Summer				9.980
4.002	33	960 Winter	100	+45%	1/240 Summer				9.979
1.005	1	15 Winter	100	+45%					9.279
6.000	23	360 Winter	100	+45%	30/30 Summer				9.856
6.001	24	360 Winter	100	+45%	30/15 Winter				9.856
1.006	2	15 Winter	100	+45%					9.177
7.000	21	480 Winter	100	+45%	30/120 Summer				9.699
7.001	22	480 Winter	100	+45%	30/15 Winter				9.700

Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	35	0.097	0.000	0.08			0.5	FLOOD RISK	
1.001	36	0.203	0.000	0.86		14	25.2	FLOOD RISK	
2.000	37	0.059	0.000	0.05			0.4	FLOOD RISK	
2.001	38	0.215	0.000	0.95		14	25.9	FLOOD RISK	
1.002	3	0.238	0.000	0.43			51.9	FLOOD RISK	
1.003	3	-0.262	0.000	0.36			101.5	OK	
3.000	24	0.404	0.000	1.08			5.3	FLOOD RISK	
3.001	25	0.368	0.000	2.22			34.2	FLOOD RISK	
3.002	20	0.335	0.000	0.07		420	0.9	SURCHARGED	
1.004	6	-0.203	0.000	0.57			142.6	OK	
4.000	31	0.001	0.000	0.02			0.3	SURCHARGED	
5.000	5	0.177	0.000	0.00			0.0	FLOOD RISK	
5.001	5	0.247	0.000	0.14		774	2.3	FLOOD RISK	
5.002	34	0.294	0.000	0.21			3.3	SURCHARGED	
4.001	32	0.398	0.000	0.10			4.3	FLOOD RISK	
4.002	33	0.576	0.000	0.07		1600	1.2	FLOOD RISK	
1.005	1	-0.245	0.000	0.55			156.7	OK	
6.000	23	0.202	0.000	0.00			0.0	FLOOD RISK	
6.001	24	0.226	0.000	0.03		342	0.8	FLOOD RISK	
1.006	2	-0.199	0.000	0.70			192.0	OK	
7.000	21	0.189	0.000	0.00			0.0	FLOOD RISK	
7.001	22	0.280	0.000	0.19		520	0.9	FLOOD RISK	

Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
1.007	3	15 Winter	100	+45%				
8.000	25	480 Winter	100	+45%	100/120 Summer			
8.001	26	480 Winter	100	+45%	30/15 Summer			
1.008	1	15 Winter	100	+45%				
1.009	2	1440 Winter	100	+45%				
9.000	13	480 Winter	100	+45%	30/120 Winter			
9.001	14	480 Winter	100	+45%	30/30 Summer			
9.002	26	1440 Winter	100	+45%	30/120 Winter			
9.003	17	960 Winter	100	+45%	30/30 Winter			
1.010	3	1440 Winter	100	+45%	30/960 Summer			
10.000	36	1440 Winter	100	+45%	30/120 Summer			
10.001	34	1440 Winter	100	+45%	1/1440 Winter			
1.011	22	1440 Winter	100	+45%	1/240 Summer			
11.000	5	960 Winter	100	+45%				
11.001	31	960 Winter	100	+45%	30/15 Winter			

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
1.007	3	9.047	-0.201	0.000	0.69			203.2	OK
8.000	25	9.434	0.084	0.000	0.00			0.0	FLOOD RISK
8.001	26	9.434	0.314	0.000	0.15		408	0.9	FLOOD RISK
1.008	1	8.873	-0.184	0.000	0.73			221.4	OK
1.009	2	8.644	-0.189	0.000	0.04			26.4	OK
9.000	13	10.135	0.185	0.000	0.00			0.0	FLOOD RISK
9.001	14	10.135	0.285	0.000	0.03		512	1.5	FLOOD RISK
9.002	26	9.544	0.274	0.000	0.04		912	1.3	FLOOD RISK
9.003	17	9.224	0.314	0.000	0.09		1280	1.9	FLOOD RISK
1.010	3	8.644	0.322	0.000	0.12			27.5	FLOOD RISK
10.000	36	8.643	0.611	0.000	0.00			0.0	FLOOD RISK
10.001	34	8.643	0.709	0.000	0.10			0.6	FLOOD RISK
1.011	22	8.644	0.804	0.000	0.43			2.3	FLOOD RISK
11.000	5	8.094	-0.004	0.000	0.00			0.0	OK
11.001	31	8.094	0.294	0.000	0.10		1040	0.6	SURCHARGED

PN	US/MH Name	Level Exceeded
1.007	3	
8.000	25	
8.001	26	
1.008	1	
1.009	2	
9.000	13	
9.001	14	

Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Level Exceeded
9.002	26	
9.003	17	
1.010	3	
10.000	36	
10.001	34	
1.011	22	
11.000	5	
11.001	31	

Appendix P

Southern Water's Foul Sewage Modelling Criteria

Developer Services

Foul Sewerage Modelling Criteria:

Southern Water continues to review its modelling procedures and design standards. Our current update on the impact of a new development on the public sewer network is as below:

Item			
Development Size – Number of units	N		
Per Capita Flow -Litres/ head / day	G	125	(see note 4)
Infiltration – Percentage	I	10	(see note 5)
Occupancy – Persons/Dwelling	O	2.4	(see notes 6 & 7)
Dry Weather Flow multiplier (PF - Peaking Factor)		SD	PF
		30 to 240	2.5
(SD –Storm Duration– minutes)		240 to 480	2.0
		Above 480	1.4
Allowance for misconnected surface water		1.4 Square Metres per Dwelling (see note 8)	
Population – Number of people	P	N x O	

Hence: Design flow = (PF + 0.1) PG (foul flow element) plus the impact of 1.4 x **N** sq. m. (allowance for misconnected surface water)

Note that the above criteria applies subject to:

1) Only to the case of new domestic foul flow.

2) No proposed discharge of surface water into the foul sewer.

3) Southern Water supports the Hierarchy of H3 of Building Regulations with regards to the disposal of Surface Water.

4) Compliance with G2 of Building Regulations; that reasonable provision must be made by the installation of fittings and fixed appliances that use water efficiency for the prevention of undue consumption of water.

5) That upstream sewers are designed and constructed with materials and method fully compliant with Sewers for Adoption and Southern Water published addendum and corrigendum, in order to ensure that the infiltration of groundwater is minimised to the low rate of 10% of base flow.

Southern Water

6) That unless we are advised otherwise, we will assume the occupancy rate of 2.4 persons per property to be appropriate and in accordance with survey data that Southern Water has for development within its area.

7) Should the makeup of development be known and advised to Southern Water, with regards to the number of 1-bedroom, 2-bedroom units etc. then the modelling can be revised on the basis of:

- Number of bedrooms + 1, as the occupancy for each unit type.
- This level of information may not be available for initial Capacity Check assessments and in this case the default figure of 2.4 persons/dwelling is considered appropriate.

8) Should the density of the development be known, (where development density is calculated based on the number of expected new addresses divided by the area of the proposed site development) and advised to Southern Water, then the allowance for misconnected surface water can be adjusted to the following:

Development Density (Properties / 4Ha)	Misconnected surface water allowance m^2/property
<=100	2.1
120	1.6
140	1.1
180	0.6
>=200	0.3

Flats, housing association, and commercial property addresses will have no misconnected surface water allowance applied.

9) With regards to the allowance for misconnected surface water, reference is made to published guidance or studies including LASOO, CIRIA, DEFRA, and UKWIR.

10) With regards to any proposed pumped flow rates.

- For the hydraulic design of pumping stations (and associated rising mains) we are guided by Sewers for Adoption and in the case of Edition 7, by clauses D4.6 and D5.3.1.
- This has a range of velocity of discharge in the rising main between 0.75 to 1.8 m/s, when the pump is operating. Our preference would be for a higher velocity than the minimum.
- If however the discharge is by gravity, then we would seek flows within the pipe capacity and self cleansing range.

motion

Appendix Q

MicroDrainage Network Model Calculation + 10% for Urban Creep

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	19.600	Add Flow / Climate Change (%)	0
Ratio R	0.333	Minimum Backdrop Height (m)	0.500
Maximum Rainfall (mm/hr)	150	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	0.350
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Storm at outfall 17 (pipe 1.011)

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.170	4-8	1.089	8-12	0.182

Total Area Contributing (ha) = 1.441

Total Pipe Volume (m³) = 63.995

Time Area Diagram at outfall 32 (pipe 11.001)

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.091	4-8	0.003

Total Area Contributing (ha) = 0.094

Total Pipe Volume (m³) = 0.090

Network Design Table for Storm

\# - Indicates pipe length does not match coordinates
« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design

Network Results Table

Network Design Table for Storm

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	3.815	0.055	69.4	0.000	5.00	0.0	0.600	o	100	Pipe/Conduit	
1.001	12.957	0.056	231.4	0.099	0.00	0.0	0.600	o	225	Pipe/Conduit	
2.000	3.223	0.105	30.7	0.000	5.00	0.0	0.600	o	100	Pipe/Conduit	
2.001	15.852	0.056	283.1	0.122	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.002	53.014	0.089	596.7	0.066	0.00	0.0	0.600	o	450	Pipe/Conduit	
1.003	35.124	0.351	100.0	0.089	0.00	0.0	0.600	o	450	Pipe/Conduit	
3.000	3.067	0.031	100.0	0.007	5.00	0.0	0.600	o	100	Pipe/Conduit	
3.001	8.000#	0.080	100.0	0.055	0.00	0.0	0.600	o	150	Pipe/Conduit	
3.002	5.000#	0.050	100.0	0.006	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.004	20.011	0.200	100.0	0.069	0.00	0.0	0.600	o	450	Pipe/Conduit	
4.000	11.097	0.448	24.8	0.006	5.00	0.0	0.600	o	100	Pipe/Conduit	
5.000	5.531	0.095	58.2	0.000	5.00	0.0	0.600	o	100	Pipe/Conduit	
5.001	10.968	0.110	100.0	0.153	0.00	0.0	0.600	o	150	Pipe/Conduit	
5.002	10.774	0.108	100.0	0.026	0.00	0.0	0.600	o	150	Pipe/Conduit	
4.001	8.338	0.104	80.0	0.018	0.00	0.0	0.600	o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	143.89	5.07	10.150	0.000	0.0	0.0	0.0	0.93	7.3	0.0
1.001	141.48	5.32	9.920	0.099	0.0	0.0	0.0	0.86	34.0«	38.0
2.000	144.19	5.04	10.200	0.000	0.0	0.0	0.0	1.40	11.0	0.0
2.001	140.92	5.38	9.920	0.122	0.0	0.0	0.0	0.77	30.7«	46.6
1.002	131.86	6.45	9.639	0.287	0.0	0.0	0.0	0.83	131.2	102.6
1.003	129.68	6.74	9.550	0.377	0.0	0.0	0.0	2.03	323.4	132.3
3.000	143.91	5.07	9.611	0.007	0.0	0.0	0.0	0.77	6.0	2.9
3.001	142.63	5.20	9.580	0.063	0.0	0.0	0.0	1.00	17.8«	24.2
3.002	141.84	5.28	9.500	0.069	0.0	0.0	0.0	1.00	17.8«	26.5
1.004	128.47	6.90	9.199	0.514	0.0	0.0	0.0	2.03	323.4	179.0
4.000	143.40	5.12	9.890	0.006	0.0	0.0	0.0	1.56	12.2	2.3
5.000	143.67	5.09	9.770	0.000	0.0	0.0	0.0	1.01	7.9	0.0
5.001	141.93	5.27	9.650	0.153	0.0	0.0	0.0	1.00	17.8«	58.8
5.002	140.27	5.45	9.540	0.179	0.0	0.0	0.0	1.00	17.8«	67.9
4.001	139.41	5.55	9.357	0.203	0.0	0.0	0.0	1.46	58.2«	76.7

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
4.002	10.000#	0.100	100.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.005	29.611	0.148	200.0	0.022	0.00	0.0	0.600	o	525	Pipe/Conduit	
6.000	2.380	0.024	100.0	0.000	5.00	0.0	0.600	o	100	Pipe/Conduit	
6.001	8.000#	1.547	5.2	0.040	0.00	0.0	0.600	o	100	Pipe/Conduit	
1.006	25.680	0.128	200.0	0.069	0.00	0.0	0.600	o	525	Pipe/Conduit	
7.000	5.285	0.090	58.7	0.000	5.00	0.0	0.600	o	100	Pipe/Conduit	
7.001	7.620	0.051	149.4	0.067	0.00	0.0	0.600	o	100	Pipe/Conduit	
1.007	38.077	0.190	200.0	0.025	0.00	0.0	0.600	o	525	Pipe/Conduit	
8.000	2.055	0.230	8.9	0.000	5.00	0.0	0.600	o	100	Pipe/Conduit	
8.001	5.000#	0.063	80.0	0.051	0.00	0.0	0.600	o	100	Pipe/Conduit	
1.008	44.835	0.224	200.0	0.055	0.00	0.0	0.600	o	525	Pipe/Conduit	
1.009	33.815	0.511	66.2	0.078	0.00	0.0	0.600	o	600	Pipe/Conduit	
9.000	4.588	0.074	61.6	0.000	5.00	0.0	0.600	o	100	Pipe/Conduit	
9.001	3.000#	0.580	5.2	0.105	0.00	0.0	0.600	o	150	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
4.002	137.94	5.71	9.253	0.203	0.0	0.0	0.0	1.00	17.8«	76.7
1.005	126.27	7.22	8.999	0.739	0.0	0.0	0.0	1.58	342.1	252.8
6.000	144.06	5.05	9.554	0.000	0.0	0.0	0.0	0.77	6.0	0.0
6.001	143.68	5.09	9.530	0.040	0.0	0.0	0.0	3.42	26.9	15.6
1.006	124.43	7.49	8.851	0.848	0.0	0.0	0.0	1.58	342.1	285.9
7.000	143.71	5.09	9.410	0.000	0.0	0.0	0.0	1.01	7.9	0.0
7.001	141.77	5.29	9.320	0.067	0.0	0.0	0.0	0.63	4.9«	25.7
1.007	121.84	7.89	8.723	0.940	0.0	0.0	0.0	1.58	342.1	310.1
8.000	144.44	5.01	9.250	0.000	0.0	0.0	0.0	2.60	20.4	0.0
8.001	143.49	5.11	9.020	0.051	0.0	0.0	0.0	0.86	6.8«	19.9
1.008	118.97	8.36	8.532	1.046	0.0	0.0	0.0	1.58	342.1	336.9
1.009	117.87	8.55	8.233	1.123	0.0	0.0	0.0	3.00	847.3	358.6
9.000	143.80	5.08	9.850	0.000	0.0	0.0	0.0	0.98	7.7	0.0
9.001	143.69	5.09	9.700	0.105	0.0	0.0	0.0	4.46	78.8	41.0

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
9.002	3.000#	0.360	8.3	0.033	0.00	0.0	0.600	o	150	Pipe/Conduit	
9.003	39.283	0.588	66.8	0.078	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.010	10.134	0.032	316.9	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	
10.000	9.788	0.098	100.0	0.000	5.00	0.0	0.600	o	100	Pipe/Conduit	
10.001	11.535	0.144	80.0	0.000	0.00	0.0	0.600	o	100	Pipe/Conduit	
1.011	41.371	0.040	1034.3	0.102	0.00	0.0	0.600	o	150	Pipe/Conduit	
11.000	4.812	0.048	100.0	0.000	5.00	0.0	0.600	o	100	Pipe/Conduit	
11.001	6.683	0.084	80.0	0.094	0.00	0.0	0.600	o	100	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
9.002	143.55	5.10	9.120	0.138	0.0	0.0	0.0	3.51	62.1	53.6
9.003	138.62	5.63	8.760	0.216	0.0	0.0	0.0	1.23	21.8«	81.0
1.010	117.17	8.67	7.722	1.339	0.0	0.0	0.0	1.36	385.2«	425.0
10.000	142.51	5.21	7.952	0.000	0.0	0.0	0.0	0.77	6.0	0.0
10.001	140.42	5.44	7.834	0.000	0.0	0.0	0.0	0.86	6.8	0.0
1.011	105.94	10.94	7.690	1.441	0.0	0.0	0.0	0.30	5.4«	425.0
11.000	143.54	5.10	7.998	0.000	0.0	0.0	0.0	0.77	6.0	0.0
11.001	142.30	5.23	7.700	0.094	0.0	0.0	0.0	0.86	6.8«	36.0

Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.000	0.000	0.000
1.001	User	-	100	0.016	0.016	0.016
	User	-	100	0.031	0.031	0.047
	User	-	100	0.035	0.035	0.082
	User	-	100	0.011	0.011	0.093
	User	-	100	0.006	0.006	0.099
2.000	-	-	100	0.000	0.000	0.000
2.001	User	-	100	0.020	0.020	0.020
	User	-	100	0.015	0.015	0.034
	User	-	100	0.041	0.041	0.075
	User	-	100	0.011	0.011	0.086
	User	-	100	0.002	0.002	0.089
	User	-	100	0.015	0.015	0.103
	User	-	100	0.002	0.002	0.106
	User	-	100	0.002	0.002	0.108
	User	-	100	0.007	0.007	0.115
	User	-	100	0.007	0.007	0.122
1.002	User	-	100	0.027	0.027	0.027
	User	-	100	0.010	0.010	0.037
	User	-	100	0.006	0.006	0.044
	User	-	100	0.018	0.018	0.062
	User	-	100	0.002	0.002	0.064
	User	-	100	0.002	0.002	0.066
1.003	User	-	100	0.013	0.013	0.013
	User	-	100	0.008	0.008	0.021
	User	-	100	0.008	0.008	0.028
	User	-	100	0.015	0.015	0.043
	User	-	100	0.005	0.005	0.048
	User	-	100	0.005	0.005	0.053
	User	-	100	0.004	0.004	0.057
	User	-	100	0.008	0.008	0.066
	User	-	100	0.002	0.002	0.067
	User	-	100	0.022	0.022	0.089
3.000	User	-	100	0.007	0.007	0.007
3.001	User	-	100	0.019	0.019	0.019
	User	-	100	0.007	0.007	0.026
	User	-	100	0.002	0.002	0.029
	User	-	100	0.002	0.002	0.031
	User	-	100	0.002	0.002	0.033
	User	-	100	0.002	0.002	0.035
	User	-	100	0.010	0.010	0.045
	User	-	100	0.010	0.010	0.055
3.002	User	-	100	0.006	0.006	0.006
1.004	User	-	100	0.021	0.021	0.021
	User	-	100	0.009	0.009	0.031
	User	-	100	0.008	0.008	0.038
	User	-	100	0.010	0.010	0.048
	User	-	100	0.004	0.004	0.053
	User	-	100	0.010	0.010	0.063
	User	-	100	0.006	0.006	0.069
4.000	User	-	100	0.006	0.006	0.006

Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
5.000	-	-	100	0.000	0.000	0.000
5.001	User	-	100	0.069	0.069	0.069
	User	-	100	0.020	0.020	0.089
	User	-	100	0.011	0.011	0.100
	User	-	100	0.053	0.053	0.153
5.002	User	-	100	0.010	0.010	0.010
	User	-	100	0.003	0.003	0.013
	User	-	100	0.003	0.003	0.016
	User	-	100	0.010	0.010	0.026
4.001	User	-	100	0.002	0.002	0.002
	User	-	100	0.007	0.007	0.009
	User	-	100	0.009	0.009	0.018
4.002	-	-	100	0.000	0.000	0.000
1.005	User	-	100	0.007	0.007	0.007
	User	-	100	0.002	0.002	0.009
	User	-	100	0.001	0.001	0.010
	User	-	100	0.012	0.012	0.022
6.000	-	-	100	0.000	0.000	0.000
6.001	User	-	100	0.021	0.021	0.021
	User	-	100	0.016	0.016	0.038
	User	-	100	0.003	0.003	0.040
1.006	User	-	100	0.016	0.016	0.016
	User	-	100	0.006	0.006	0.022
	User	-	100	0.006	0.006	0.028
	User	-	100	0.019	0.019	0.047
	User	-	100	0.022	0.022	0.069
7.000	-	-	100	0.000	0.000	0.000
7.001	User	-	100	0.035	0.035	0.035
	User	-	100	0.002	0.002	0.037
	User	-	100	0.006	0.006	0.043
	User	-	100	0.014	0.014	0.057
	User	-	100	0.010	0.010	0.067
1.007	User	-	100	0.014	0.014	0.014
	User	-	100	0.006	0.006	0.020
	User	-	100	0.005	0.005	0.025
8.000	-	-	100	0.000	0.000	0.000
8.001	User	-	100	0.022	0.022	0.022
	User	-	100	0.017	0.017	0.039
	User	-	100	0.001	0.001	0.040
	User	-	100	0.006	0.006	0.047
	User	-	100	0.003	0.003	0.050
	User	-	100	0.001	0.001	0.051
1.008	User	-	100	0.023	0.023	0.023
	User	-	100	0.007	0.007	0.030
	User	-	100	0.008	0.008	0.038
	User	-	100	0.002	0.002	0.039
	User	-	100	0.008	0.008	0.048
	User	-	100	0.003	0.003	0.050
	User	-	100	0.005	0.005	0.055
1.009	User	-	100	0.029	0.029	0.029
	User	-	100	0.016	0.016	0.045

Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
	User	-	100	0.009	0.009	0.054
	User	-	100	0.009	0.009	0.063
	User	-	100	0.015	0.015	0.078
9.000	-	-	100	0.000	0.000	0.000
9.001	User	-	100	0.047	0.047	0.047
	User	-	100	0.006	0.006	0.053
	User	-	100	0.003	0.003	0.056
	User	-	100	0.006	0.006	0.062
	User	-	100	0.006	0.006	0.068
	User	-	100	0.006	0.006	0.073
	User	-	100	0.010	0.010	0.083
	User	-	100	0.012	0.012	0.095
	User	-	100	0.008	0.008	0.103
	User	-	100	0.002	0.002	0.105
9.002	-	-	100	0.033	0.033	0.033
9.003	User	-	100	0.028	0.028	0.028
	User	-	100	0.037	0.037	0.065
	User	-	100	0.006	0.006	0.071
	User	-	100	0.002	0.002	0.073
	User	-	100	0.005	0.005	0.078
1.010	-	-	100	0.000	0.000	0.000
10.000	-	-	100	0.000	0.000	0.000
10.001	-	-	100	0.000	0.000	0.000
1.011	User	-	100	0.102	0.102	0.102
11.000	-	-	100	0.000	0.000	0.000
11.001	User	-	100	0.071	0.071	0.071
	User	-	100	0.023	0.023	0.094
				Total	Total	Total
				1.535	1.535	1.535

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.011	17	8.680	7.650	0.000	1500	0

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
11.001	32	8.700	7.616	0.000	1200	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	5.300
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	14
Number of Online Controls	12	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.600	Storm Duration (mins)	30
Ratio R	0.333		

Online Controls for Storm

Hydro-Brake® Optimum Manhole: 3, DS/PN: 1.002, Volume (m³): 2.3

Unit Reference	MD-SHE-0302-5200-0780-5200
Design Head (m)	0.780
Design Flow (l/s)	52.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	302
Invert Level (m)	9.639
Minimum Outlet Pipe Diameter (mm)	375
Suggested Manhole Diameter (mm)	1800

Control Points	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	0.780	52.0
Flush-Flo™	0.422	51.9
Kick-Flo®	0.656	47.8
Mean Flow over Head Range	-	39.6

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**
0.100	9.2	1.200	64.0	3.000	99.9	7.000	151.1
0.200	31.1	1.400	69.0	3.500	107.7	7.500	156.3
0.300	50.5	1.600	73.6	4.000	114.9	8.000	159.8
0.400	51.9	1.800	77.9	4.500	121.7	8.500	164.9
0.500	51.5	2.000	82.0	5.000	128.1	9.000	169.7
0.600	49.7	2.200	85.9	5.500	134.3	9.500	174.4
0.800	52.6	2.400	89.6	6.000	140.1		
1.000	58.6	2.600	93.2	6.500	145.7		

Hydro-Brake® Optimum Manhole: 20, DS/PN: 3.002, Volume (m³): 1.0

Unit Reference	MD-SHE-0049-1000-0800-1000
Design Head (m)	0.800
Design Flow (l/s)	1.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	49
Invert Level (m)	9.500
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Hydro-Brake® Optimum Manhole: 20, DS/PN: 3.002, Volume (m³): 1.0

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.800	1.0
Flush-Flo™	0.215	0.9
Kick-Flo®	0.437	0.8
Mean Flow over Head Range	-	0.8

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.8	1.200	1.2	3.000	1.8	7.000	2.7
0.200	0.9	1.400	1.3	3.500	1.9	7.500	2.8
0.300	0.9	1.600	1.4	4.000	2.1	8.000	2.9
0.400	0.8	1.800	1.4	4.500	2.2	8.500	2.9
0.500	0.8	2.000	1.5	5.000	2.3	9.000	3.0
0.600	0.9	2.200	1.6	5.500	2.4	9.500	3.1
0.800	1.0	2.400	1.6	6.000	2.5		
1.000	1.1	2.600	1.7	6.500	2.6		

Hydro-Brake® Optimum Manhole: 5, DS/PN: 5.001, Volume (m³): 0.7

Unit Reference	MD-SHE-0079-2300-0550-2300
Design Head (m)	0.550
Design Flow (l/s)	2.3
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	79
Invert Level (m)	9.650
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.550	2.3
Flush-Flo™	0.165	2.3
Kick-Flo®	0.376	1.9
Mean Flow over Head Range	-	2.0

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.2	0.300	2.2	0.500	2.2	0.800	2.7
0.200	2.3	0.400	2.0	0.600	2.4	1.000	3.0

Hydro-Brake® Optimum Manhole: 5, DS/PN: 5.001, Volume (m³): 0.7

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
1.200	3.3	2.400	4.5	5.000	6.4	8.000	8.1
1.400	3.5	2.600	4.7	5.500	6.7	8.500	8.3
1.600	3.8	3.000	5.0	6.000	7.0	9.000	8.5
1.800	4.0	3.500	5.4	6.500	7.3	9.500	8.8
2.000	4.2	4.000	5.8	7.000	7.5		
2.200	4.4	4.500	6.1	7.500	7.8		

Hydro-Brake® Optimum Manhole: 33, DS/PN: 4.002, Volume (m³): 1.4

Unit Reference	MD-SHE-0054-1200-0800-1200
Design Head (m)	0.800
Design Flow (l/s)	1.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	54
Invert Level (m)	9.253
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.800	1.2
Flush-Flo™	0.238	1.2
Kick-Flo®	0.482	1.0
Mean Flow over Head Range	-	1.0

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.0	1.200	1.4	3.000	2.2	7.000	3.2
0.200	1.2	1.400	1.5	3.500	2.3	7.500	3.3
0.300	1.2	1.600	1.6	4.000	2.5	8.000	3.4
0.400	1.1	1.800	1.7	4.500	2.6	8.500	3.5
0.500	1.0	2.000	1.8	5.000	2.8	9.000	3.6
0.600	1.1	2.200	1.9	5.500	2.9	9.500	3.7
0.800	1.2	2.400	2.0	6.000	3.0		
1.000	1.3	2.600	2.0	6.500	3.1		

Orifice Manhole: 24, DS/PN: 6.001, Volume (m³): 0.7

Diameter (m) 0.026 Discharge Coefficient 0.600 Invert Level (m) 9.530

Orifice Manhole: 22, DS/PN: 7.001, Volume (m³): 0.7

Diameter (m) 0.026 Discharge Coefficient 0.600 Invert Level (m) 9.320

Orifice Manhole: 26, DS/PN: 8.001, Volume (m³): 0.7

Diameter (m) 0.026 Discharge Coefficient 0.600 Invert Level (m) 9.020

Orifice Manhole: 14, DS/PN: 9.001, Volume (m³): 0.7

Diameter (m) 0.033 Discharge Coefficient 0.600 Invert Level (m) 9.700

Orifice Manhole: 26, DS/PN: 9.002, Volume (m³): 0.7

Diameter (m) 0.032 Discharge Coefficient 0.600 Invert Level (m) 9.120

Orifice Manhole: 17, DS/PN: 9.003, Volume (m³): 0.7

Diameter (m) 0.037 Discharge Coefficient 0.600 Invert Level (m) 8.760

Hydro-Brake® Optimum Manhole: 22, DS/PN: 1.011, Volume (m³): 4.3

Unit Reference	MD-SHE-0072-2300-1000-2300
Design Head (m)	1.000
Design Flow (l/s)	2.3
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	72
Invert Level (m)	7.690
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	1.000	2.3
Flush-Flo™	0.307	2.3
Kick-Flo®	0.625	1.9
Mean Flow over Head Range	-	2.0

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**
0.100	1.9	0.600	2.0	1.600	2.9	2.600	3.6
0.200	2.2	0.800	2.1	1.800	3.0	3.000	3.8
0.300	2.3	1.000	2.3	2.000	3.2	3.500	4.1
0.400	2.3	1.200	2.5	2.200	3.3	4.000	4.4
0.500	2.2	1.400	2.7	2.400	3.4	4.500	4.6

Hydro-Brake® Optimum Manhole: 22, DS/PN: 1.011, Volume (m³): 4.3

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
5.000	4.8	6.500	5.5	8.000	6.0	9.500	6.6
5.500	5.1	7.000	5.7	8.500	6.2		
6.000	5.3	7.500	5.9	9.000	6.4		

Hydro-Brake® Optimum Manhole: 31, DS/PN: 11.001, Volume (m³): 0.9

Unit Reference	MD-SHE-0042-7000-0700-7000
Design Head (m)	0.700
Design Flow (l/s)	0.7
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	42
Invert Level (m)	7.700
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.700	0.7
Flush-Flo™	0.185	0.6
Kick-Flo®	0.373	0.5
Mean Flow over Head Range	-	0.6

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.6	1.200	0.9	3.000	1.3	7.000	2.0
0.200	0.6	1.400	0.9	3.500	1.4	7.500	2.0
0.300	0.6	1.600	1.0	4.000	1.5	8.000	2.1
0.400	0.5	1.800	1.1	4.500	1.6	8.500	2.2
0.500	0.6	2.000	1.1	5.000	1.7	9.000	2.2
0.600	0.7	2.200	1.2	5.500	1.8	9.500	2.3
0.800	0.7	2.400	1.2	6.000	1.8		
1.000	0.8	2.600	1.3	6.500	1.9		

Storage Structures for Storm

Porous Car Park Manhole: 36, DS/PN: 1.001

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1000	Length (m)	32.0
Max Percolation (l/s)	44.4	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	9.920	Cap Volume Depth (m)	0.450

Porous Car Park Manhole: 38, DS/PN: 2.001

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1000	Length (m)	32.0
Max Percolation (l/s)	44.4	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	9.920	Cap Volume Depth (m)	0.450

Swale Manhole: 20, DS/PN: 3.002

Warning:- Volume should always be included unless the upstream pipe is being used for storage and/or as a carrier

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	34.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	3.0
Safety Factor	2.0	Slope (1:X)	0.0
Porosity	1.00	Cap Volume Depth (m)	0.700
Invert Level (m)	9.500	Cap Infiltration Depth (m)	0.700
Base Width (m)	0.8	Include Swale Volume	Yes

Porous Car Park Manhole: 5, DS/PN: 5.001

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	6.0
Membrane Percolation (mm/hr)	1000	Length (m)	115.0
Max Percolation (l/s)	191.7	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	9.650	Cap Volume Depth (m)	0.450

Swale Manhole: 33, DS/PN: 4.002

Warning:- Volume should always be included unless the upstream pipe is being used for storage and/or as a carrier

Infiltration Coefficient Base (m/hr)	0.00000	Base Width (m)	0.8
Infiltration Coefficient Side (m/hr)	0.00000	Length (m)	34.0
Safety Factor	2.0	Side Slope (1:X)	3.0
Porosity	1.00	Slope (1:X)	0.0
Invert Level (m)	9.253	Cap Volume Depth (m)	0.700

Swale Manhole: 33, DS/PN: 4.002

Cap Infiltration Depth (m) 0.700 Include Swale Volume Yes

Porous Car Park Manhole: 24, DS/PN: 6.001

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	10.0
Membrane Percolation (mm/hr)	1000	Length (m)	21.0
Max Percolation (l/s)	58.3	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	9.530	Cap Volume Depth (m)	0.450

Porous Car Park Manhole: 22, DS/PN: 7.001

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	10.0
Membrane Percolation (mm/hr)	1000	Length (m)	35.0
Max Percolation (l/s)	97.2	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	9.320	Cap Volume Depth (m)	0.450

Porous Car Park Manhole: 26, DS/PN: 8.001

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	10.0
Membrane Percolation (mm/hr)	1000	Length (m)	22.0
Max Percolation (l/s)	61.1	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	9.020	Cap Volume Depth (m)	0.450

Porous Car Park Manhole: 14, DS/PN: 9.001

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	6.0
Membrane Percolation (mm/hr)	1000	Length (m)	78.3
Max Percolation (l/s)	130.5	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	9.700	Cap Volume Depth (m)	0.450

Porous Car Park Manhole: 26, DS/PN: 9.002

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	6.0
Membrane Percolation (mm/hr)	1000	Length (m)	60.0
Max Percolation (l/s)	100.0	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	9.120	Cap Volume Depth (m)	0.450

Porous Car Park Manhole: 17, DS/PN: 9.003

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	6.0
Membrane Percolation (mm/hr)	1000	Length (m)	61.6
Max Percolation (l/s)	102.7	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	8.760	Cap Volume Depth (m)	0.450

Swale Manhole: 34, DS/PN: 10.001

Warning:- Volume should always be included unless the upstream pipe is being used for storage and/or as a carrier

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	60.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	3.0
Safety Factor	2.0	Slope (1:X)	0.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	7.702	Cap Infiltration Depth (m)	0.000
Base Width (m)	2.0	Include Swale Volume	Yes

Infiltration Basin Manhole: 22, DS/PN: 1.011

Invert Level (m)	7.690	Safety Factor	2.0
Infiltration Coefficient Base (m/hr)	0.00000	Porosity	1.00
Infiltration Coefficient Side (m/hr)	0.00000		

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	777.5	1.000	1102.3

Cellular Storage Manhole: 31, DS/PN: 11.001

Invert Level (m)	7.700	Safety Factor	2.0
Infiltration Coefficient Base (m/hr)	0.00000	Porosity	0.95
Infiltration Coefficient Side (m/hr)	0.00000		

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	182.0	182.0	0.401	0.0	203.6
0.400	182.0	203.6			

Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 5.300
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Storage Structures 14
Number of Online Controls 12 Number of Time/Area Diagrams 0
Number of Offline Controls 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.333
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 19.600 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status ON
Analysis Timestep Fine Inertia Status ON
DTS Status OFF

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 40, 45

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
1.000	35	30 Winter	100	+45%	100/15 Summer			
1.001	36	30 Winter	100	+45%	30/15 Summer	100/30 Winter		
2.000	37	30 Winter	100	+45%	100/15 Winter	100/30 Winter		
2.001	38	30 Winter	100	+45%	30/15 Summer	100/30 Winter		
1.002	3	30 Winter	100	+45%	30/15 Summer			
1.003	3	15 Winter	100	+45%				
3.000	24	15 Winter	100	+45%	30/15 Summer			
3.001	25	15 Winter	100	+45%	30/15 Summer			
3.002	20	360 Winter	100	+45%	30/15 Summer			
1.004	6	15 Winter	100	+45%				
4.000	31	960 Winter	100	+45%	100/960 Winter			
5.000	5	360 Winter	100	+45%	30/60 Winter			
5.001	5	360 Winter	100	+45%	30/30 Summer			
5.002	34	960 Winter	100	+45%	30/60 Winter			
4.001	32	960 Winter	100	+45%	30/30 Summer			
4.002	33	960 Winter	100	+45%	1/120 Winter			
1.005	1	15 Winter	100	+45%				
6.000	23	360 Winter	100	+45%	30/30 Summer			
6.001	24	360 Winter	100	+45%	30/15 Winter			
1.006	2	15 Winter	100	+45%				
7.000	21	480 Winter	100	+45%	30/60 Winter			
7.001	22	480 Winter	100	+45%	30/15 Winter			

Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
1.000	35	10.499	0.249	0.000	0.19			1.2	FLOOD RISK
1.001	36	10.500	0.355	0.008	0.86		15	25.3	FLOOD
2.000	37	10.500	0.200	0.006	0.13			1.1	FLOOD
2.001	38	10.500	0.355	0.129	1.01		15	27.4	FLOOD
1.002	3	10.465	0.375	0.000	0.43			51.9	FLOOD RISK
1.003	3	9.742	-0.258	0.000	0.37			104.6	OK
3.000	24	10.162	0.451	0.000	1.15			5.6	FLOOD RISK
3.001	25	10.142	0.412	0.000	2.32			35.8	FLOOD RISK
3.002	20	10.006	0.356	0.000	0.07		444	0.9	FLOOD RISK
1.004	6	9.452	-0.197	0.000	0.59			148.1	OK
4.000	31	10.024	0.044	0.000	0.02			0.3	SURCHARGED
5.000	5	10.075	0.205	0.000	0.00			0.0	FLOOD RISK
5.001	5	10.075	0.275	0.000	0.14		816	2.3	FLOOD RISK
5.002	34	10.027	0.337	0.000	0.21			3.4	FLOOD RISK
4.001	32	10.024	0.442	0.000	0.10			4.5	FLOOD RISK
4.002	33	10.022	0.619	0.000	0.07		1728	1.2	FLOOD RISK
1.005	1	9.286	-0.238	0.000	0.57			163.1	OK
6.000	23	9.876	0.222	0.000	0.00			0.0	FLOOD RISK
6.001	24	9.876	0.246	0.000	0.03		348	0.8	FLOOD RISK
1.006	2	9.188	-0.188	0.000	0.73			200.9	OK
7.000	21	9.722	0.212	0.000	0.00			0.0	FLOOD RISK
7.001	22	9.722	0.302	0.000	0.20		536	0.9	FLOOD RISK

PN	US/MH Name	Level Exceeded
1.000	35	
1.001	36	1
2.000	37	1
2.001	38	1
1.002	3	
1.003	3	
3.000	24	
3.001	25	
3.002	20	
1.004	6	
4.000	31	
5.000	5	
5.001	5	
5.002	34	
4.001	32	
4.002	33	
1.005	1	
6.000	23	
6.001	24	
1.006	2	

Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Level Exceeded
7.000	21	
7.001	22	

Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
1.007	3	15 Winter	100	+45%				
8.000	25	480 Winter	100	+45%	100/60 Winter			
8.001	26	480 Winter	100	+45%	30/15 Summer			
1.008	1	15 Winter	100	+45%				
1.009	2	1440 Winter	100	+45%				
9.000	13	480 Winter	100	+45%	30/120 Summer			
9.001	14	480 Winter	100	+45%	30/30 Summer	100/480 Winter		
9.002	26	1440 Winter	100	+45%	30/120 Summer			
9.003	17	960 Winter	100	+45%	30/30 Summer	100/960 Winter		
1.010	3	1440 Winter	100	+45%	30/480 Winter			
10.000	36	1440 Winter	100	+45%	30/60 Winter			
10.001	34	1440 Winter	100	+45%	1/960 Winter			
1.011	22	1440 Winter	100	+45%	1/120 Winter			
11.000	5	960 Winter	100	+45%	100/480 Winter			
11.001	31	960 Winter	100	+45%	30/15 Summer			

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
1.007	3	9.057	-0.190	0.000	0.72			212.4	OK
8.000	25	9.459	0.109	0.000	0.00			0.0	FLOOD RISK
8.001	26	9.459	0.339	0.000	0.16		416	0.9	FLOOD RISK
1.008	1	8.885	-0.172	0.000	0.77			232.1	OK
1.009	2	8.685	-0.148	0.000	0.04			27.7	OK
9.000	13	10.280	0.330	0.000	0.01			0.1	FLOOD RISK
9.001	14	10.280	0.430	0.259	0.04		536	1.7	FLOOD
9.002	26	9.684	0.414	0.000	0.04		1032	1.5	FLOOD RISK
9.003	17	9.340	0.430	0.083	0.10		1440	2.1	FLOOD
1.010	3	8.685	0.363	0.000	0.12			28.7	FLOOD RISK
10.000	36	8.684	0.652	0.000	0.00			0.0	FLOOD RISK
10.001	34	8.684	0.750	0.000	0.10			0.6	FLOOD RISK
1.011	22	8.685	0.845	0.000	0.43			2.3	FLOOD RISK
11.000	5	8.465	0.367	0.000	0.02			0.1	FLOOD RISK
11.001	31	8.465	0.665	0.000	0.12		1136	0.7	FLOOD RISK

PN	US/MH Name	Level Exceeded
1.007	3	
8.000	25	
8.001	26	
1.008	1	
1.009	2	
9.000	13	
9.001	14	1

Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Level Exceeded
9.002	26	
9.003	17	1
1.010	3	
10.000	36	
10.001	34	
1.011	22	
11.000	5	
11.001	31	

Appendix R

Exceedance Flow Plan

Notes

1. All levels and dimensions are to be checked on site before any work commences. All dimensions are in metres unless stated otherwise.
2. Any discrepancies shall be reported to the engineer immediately, so that clarification can be sought prior to the commencement of works.
3. This drawing shall be read in conjunction with all other relevant engineering details, drawings and specification.
4. The exact location of all private rainwater pipes & internal foul soil pipes are to be confirmed with the architect details prior to works commencing.
5. The contractor is to keep a record of any variations made on site, including the relocation of sewers or drains, for their "as built" drawings to be prepared upon project completion.
6. All works to the adopted system are to be carried out in accordance with Sewers for Adoption, 7th Edition.
7. All works to the private drainage system to be in accordance with the Building Regulations Approved Document Part "H" 2015 edition.
8. 350mm min cover to be provided for private pipes laid in soft/paved areas. 900mm min cover to be provided for private pipes laid beneath roads/driveways unless not practicable. Where unachievable, shallow private drains may require protection using concrete surround or paving slabs bridging the trench, subject to the NHBC inspector's requirements.
9. All pipes shall be laid soffit to soffit with outgoing pipes unless otherwise stated.
10. Manholes situated within areas accessible to motor vehicles are to be fitted with suitable strength covers and frames. Please refer to the manhole schedule for guidance on this.

Legend

- New Surface Water Gravity Pipe
- New Foul Water Gravity Pipe
- New Surface Water Linear Drainage
- New Flow Control Structure [Ø1200mm Chamber]
- New SW Inspection Chamber [Ø1200mm]
- New SW Inspection Chamber [Ø450mm]
- New FW Inspection Chamber [Ø1200mm]
- New Inlet Headwall / Outfall Headwall
- Polystorm Linflex Filter Pipe
- Permeable Paviours
- Geocellular Attenuation Tank

Revision	Notes	Drn	Chk	App	Date
A	First Issue	PA	RW	NJ	17/11/2022

Drawing Status:

DRAFT
NOT FOR CONSTRUCTION

motion

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www.motion.co.uk

Client: gleeson land — Promoting Land. Unlocking Value.

Project: Land West of Meadow Way

Title: Exceedance Plan

Scale: 1:500 | Size: A1 | Project No: 1glwes/2204050

Drawing: 2204050-0510-01 | Revision: A

Appendix S

Drainage Management and Maintenance Plan

Land to the Rear of Meadow Way, Westergate

Drainage Management & Maintenance Plan

For

Gleeson Land

motion

Document Control Sheet

Land to the Rear of Meadow Way, Westergate

Gleeson Land

This document has been issued and amended as follows:

Date	Issue	Prepared by	Approved by
10/10/2022	FINAL	Phil Allen MCIWEM C.WEM	Neil Jaques

Motion
84 North Street
[redacted]

Contents

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3.0 The Surface Water Drainage System 3
4.0 General Maintenance Principles 4
5.0 Inspection and Maintenance Frequency of Components 6

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1.0 Introduction

1.1 This document sets out the principles for the long-term management and maintenance of the proposed surface water drainage system on the residential development on the land to the west of Meadow Way, Westergate.

1.2 The purpose of this document is to ensure that the adopting site management company has a robust inspection and maintenance plan for the lifetime of the development. This ensures the optimum operation of the surface water drainage system and that it will be continually maintained in perpetuity. This will contribute to reducing the risk of surface water flooding both on- and off-site.

1.3 All those responsible for maintenance should follow relevant health and safety legislation for all activities listed within this report (including lone working, if relevant). Method statements and risk assessments should always be undertaken and made available, if requested.

1.4 This document has been produced by Motion on behalf of their client, Gleeson Land. This document describes the typical management and maintenance tasks that are known at the design stage (maintenance frequencies and typical tasks, for example). These have been drawn from industry guidance such as CIRIA C753 - The SuDS Manual – and manufacturer's own guidance.

1.5 Maintenance is considered as a construction activity under the CDM Regulations 2015. Under the CDM Regulations, it is a requirement that a competent person be appointed to carry out a required role. CDM defines a competent person as an individual with sufficient knowledge of the specific tasks to be undertaken, as well as sufficient experience and ability to carry out their duties in relation to the task in a way that secures health and safety on site.

1.6 In recognition of the requirements of the CDM Regulations 2015, this drainage management and maintenance plan expects that the maintenance work will be carried out by a competent person who must have prior knowledge of the drainage components and SuDS systems on site.

1.7 There are limitations on what this document can prescribe at this time. At this stage this document cannot name the specific individuals who will carry out the maintenance and what equipment is to be used. Related to this, this document is unable to provide method statements for exactly how maintenance practices will be carried out. These can only be determined at the time of the maintenance being carried out and the exact maintenance need. Therefore, this is to be the responsibility of the adopting site management company and/or the individuals carrying out the work. We urge those who are carrying out the maintenance to record this information and make it available to the Local Planning Authority (LPA), if required to do so. This drainage management and maintenance plan needs to be a living document that is owned and maintained by the adopting site management company and should be adhered to for the lifetime of the development.

2.0 Maintenance Categories

2.1 There are three categories of maintenance activities referred to in this report. These are:

Inspection and Monitoring

- Inspection and monitoring tasks should be carried out frequently, nominally once a month, and should include a visual inspection of all components including all inlets and outlets.

Regular Maintenance (Monthly)

- Regular maintenance consists of basic tasks done on a frequent and predictable schedule, including vegetation management and litter removal.

Seasonal Maintenance (Quarterly)

- Seasonal maintenance comprises tasks that are likely to be required periodically, but on a much less frequent and predictable basis than the routine tasks (leaf litter and sediment removal is an example).

Remedial Maintenance

- Remedial maintenance comprises of intermittent tasks that may be required to rectify faults associated with the system that have been identified through visual inspections. The likelihood of faults can be minimised by correct installation, regular inspection and timely maintenance. Where remedial work is found to be necessary, it is likely to be due to site-specific characteristics or unforeseen events and, as such, timings are difficult to predict.

3.0 The Surface Water Drainage System

3.1 The proposed surface water drainage system is made up of a number of components. These include:

- Permeable paving
- An infiltration basin
- Swales
- Catchpit manholes/silt traps
- Hydrobrakes/Flow Controls
- Manholes
- Pipes.

3.2 All components should be installed in accordance with the manufacturer's instructions and to the levels/arrangement as defined on the designer's drawings. Not doing so will invalidate any warranty provided by the manufacturer.

3.3 All maintenance and cleaning must be carried out in accordance with manufacturer's recommendations and by competent and suitably qualified staff, as defined in the CDM regulations 2015.

3.4 This document should be read in conjunction with the design drawings of the drainage system, so that the location and type of each feature can be recognised and understood.

3.5 Manufacturer's instructions are to be added to this document once specific products have been selected and installed as part of the detailed design. This document will subsequently form the basis for a drainage maintenance regime.

4.0 General Maintenance Principles

4.1 All surface water drainage systems, whether piped gravity systems, Sustainable Drainage Systems (SuDS), or flow control devices and pumps, require regular maintenance to keep them working at optimum efficiency and capacity. The maintenance of the surface water drainage system on land to the west of Meadow Way should be carried out alongside other regular maintenance tasks on site.

4.2 Timely and adequate maintenance will increase the lifespan of all the drainage components. Inadequate maintenance will do the reverse. Therefore, the projected lifespan and anticipated replacement date of each drainage component cannot be forecast at the time of this document being produced.

4.3 The site management company (or their agents) are responsible for the maintenance of the surface water drainage system for the lifetime of the development.

4.4 Construction activities can create and discharge significant quantities of sediment that will quickly clog the surface water drainage system. Therefore, construction-stage sediment removal is required immediately post-construction. The construction site manager should assess this and carry out cleaning as necessary.

4.5 Catchpit manholes/silt traps will be specified upstream of the permeable paved areas, as well as other locations on site. They will remove gross solids and the majority of silts. It is important that any debris build-up in the catchpit manholes/silt traps is removed at regular intervals. This will reduce the risk of the permeable paved areas becoming silted up. It will maintain the design capacity and function of this part of the drainage system.

4.6 Cleaning should also take place after large storms when there have been increased surface water flows and visible entrainment and deposition of debris.

4.7 An increased frequency of inspection and maintenance should be programmed into the autumn and winter months in acknowledgement that:

- Leaf fall from deciduous trees in autumn will result in an increased amount of leaf litter and an elevated blockage risk of drainage infrastructure.
- Increased rainfall during winter months will result in greater quantities of water moving through the drainage system and a greater input of silt and other debris.

4.8 Table 4.1, below, gives an overview of required maintenance tasks and the frequency with which they need to be undertaken. Section 5 – Inspection and Maintenance Frequency of Components – will assign typical maintenance frequencies and tasks to the specific components used within the surface water drainage system used on the land to the west of Meadow Way.

Table 4.1: Typical maintenance tasks and frequencies

Activity	Indicative Frequency	Typical Tasks
Inspection and Monitoring	Monthly	➢ Inspection of all inlets, outlets and control structures
Regular Maintenance	Monthly, for the lifetime of the development	➢ Litter picking and debris removal ➢ Weed removal and invasive plant control
Seasonal Maintenance	Quarterly, for the lifetime of the development	➢ Vegetation management around components ➢ Sweeping of pavement areas to remove surface silt ➢ Silt removal from system, including catchpits, cellular storage structures and control structures
Remedial maintenance	As required as a result of inspections, for the lifetime of the development.	➢ Inlet/outlet repairs ➢ Erosion repairs ➢ Reinstatement of edgings ➢ Reinstatement following pollution incidents ➢ Removal of silt build-up and leaf litter after storms ➢ Repair of vandalism ➢ Replacement of any blocked filter membranes/materials

5.0 Inspection and Maintenance Frequency of Components

5.1 Table 5.1 below lists each of the components used within the site's surface water drainage system. It suggests an indicative maintenance frequency for each component and ascribes typical maintenance tasks to them.

5.2 This list is not exhaustive, nor is it prescriptive. As mentioned in Section 3, additional, unscheduled maintenance may be required following adverse weather conditions or after autumn leaf falls. Additional maintenance tasks may be required to adequately clean and maintain individual components.

5.3 The list of components should be cross-referenced with the designer's drawings so that the location of each component can be identified.

5.4 It is the responsibility of the adopting site management company (or their agents) to ensure that all necessary maintenance activities are carried out in a timely manner and that the design performance of each drainage component is preserved.

5.5 If there is any uncertainty regarding the correct and safe methods of cleaning, or what equipment should be used, the manufacturer should be consulted.

Table 5.1: Maintenance Frequency and Task for Drainage Components

Activity	Indicative Frequency	Anticipated Tasks
Pipes	As required	➢ Identify any pipes that may not be operating properly and employ a competent, qualified contractor to inspect using CCTV. ➢ If the pipe is blocked with silt or debris, the pipe should be jetted clean from an upstream access point. All silt and debris should be captured and removed at a downstream access point. ➢ Inspect once clean. ➢ If any other defects are encountered (cracks, displaced joints, root ingress), appropriate solutions should be discussed with a competent and qualified contractor. These services are usually provided by the same companies that offer CCTV surveys and pipe jetting services.
Manholes	Annually and as required, for the lifetime of the development.	➢ Inspect/identify any damage or areas that are not operating correctly ➢ Remove silt, litter, leaves and other detritus. ➢ Inspect once clean.
Catchpit Manholes/Silt Traps	Annually and as required, for the lifetime of the development.	➢ Inspect/identify any damage or areas that are not operating correctly ➢ Remove silt, litter, leaves and other detritus. ➢ Inspect once clean.
Orifice Plates	Inspections at regular intervals (every 3 – 6 months).	➢ Orifice plates have no moving parts to fail and quality units are made of stainless steel to resist scour, degradation and chemical attack. ➢ The orifice plates in this scheme are to be downstream of the permeable paviours, so all contributing flows should be heavily filtered and free of any debris.

		- Debris and silt should be removed if present - Check wear on orifice to ensure no enlargement is taking place. - Any visible fixing bolts should be checked. - If there is a suspected blockage, the housing chamber can be inspected internally, the blockage cleared and the orifice returned to its working position.
Hydrobrake chambers	Every three months for the first year, then annually thereafter for the lifetime of the development.	- Contact manufacturer for instruction on approved and safe inspection and maintenance practices. - Inspect Hydrobrake and check functionality. Remove any detritus as required. - Inspect once clean.
Infiltration Basin	Monthly in Summer, as required in Winter	- Responsibility should be with landscape contractors. - Maintenance tasks are not that different from standard public open space. - Adequate access needs to be provided to the area. - Regular mowing should take place across maintenance access routes, amenity areas, across embankments and the main storage area. Remaining areas can remain as 'meadow'. Mowed grass lengths of 75 – 100mm are appropriate. - Grass clippings should be disposed of off-site. - Any dead growth should be cleared before the start of the growing season. - Any permanently wet areas with emergent aquatic vegetation should be managed as ponds or wetlands. - Remove any sediment build-up as required. - Check any inlets and outlets for blockages and clear as required. - Check any flow control devices, if present.
Swales	Monthly in Summer, as required in Winter	- Maintenance tasks for swales match those of infiltration basins, so please refer to the maintenance tasks, above.
Water Butts (not the responsibility of the adopting site management agency, but individual homeowners)	Annually in Autumn to Winter	- Remove falling leaves and seeds from guttering or those that have found their way into the water butt. - Water may stagnate slightly. If so, use a water butt cleaning disc into the tank. - In autumn and winter, drain water off every 10 days (or less) to make sure that water butts don't overflow and that water is kept moving. This will stop larvae and flies from using the water butt. - Use safe products such as vinegar to clean the outside of the tank and the inside of the lid and be careful not to contaminate water with chemicals.

		- At least once a year, completely empty the water butt and scrub it out with warm soapy water and then rinse thoroughly. This is best done at a time when the water butt is already nearly empty (end of summer) or when it can readily refill (winter).
Permeable paving	Once a year after autumn leaf fall, or reduced frequency as required, based on site-specific observations of clogging or manufacturer's recommendations.	- Agitate surface by means of mechanical sweeping or vacuuming to ensure no vegetation or moss is allowed to establish and grow in the joints. - Mechanical sweeping of paviours and refilling of joints with the correct aggregate need only be carried out at intervals of 5 years or so - Remove weeds from the surface through the application of glyphosate-based weed killers - Stabilise and mow contributing and adjacent areas. - Inspect once clean. - See Table 20.15 of CIRIA C753 for more information. - Permeable paving has a nominal 25-year lifespan, if correctly and regularly maintained. - When subjected to low level oil drips permeable paviours can continue to biodegrade hydrocarbons indefinitely. - Major oil spills have the potential to contaminate the surface and the underlying crushed stone. In the event of a major oil spill, the area of block paviours and crushed stone that is affected should be removed, cleaned and reinstalled.

5.6 Upon completion of maintenance activities, a record should be kept of the work carried out. This should be retained and an annual maintenance report should be compiled, which should include the following:

- Observations resulting from inspections
- Maintenance and operation activities undertaken during the year
- Recommendations for inspections and maintenance programmes for the following year

5.7 On the next page is a table with suggested information should be recorded and included with the maintenance plan. As mentioned in the introduction to this document, this should be a living document and regularly updated, as required and should be kept for the lifetime of the development.

5.8 The Local Planning Authority (Arun District Council) may request to check and sign off any maintenance activities. Therefore, it is the recommendation that the LPA is contacted prior to any scheduled routine maintenance. The table mentioned above and on the next page, as well as the annual maintenance report, should be offered to the LPA for their records and approval.

Date	Component requiring maintenance	Issues prompting maintenance	Scheduled maintenance (Y/N)	Maintenance carried out	Additional works required (Y/N). If yes, please detail	Next scheduled date of inspection and maintenance

Appendix B – Winter Ground Monitoring Results

Report Title:

Phase 2 Geo-Environmental Ground Investigation

Project Name:

Hook Lane, Westergate

Report Reference: **BRD3963-OR2-B**

Date: **June 2023**

BRD Environmental Ltd
Hawthorne Villa, 1 Old Parr Road,
Banbury, Oxfordshire, OX16 5HT
[redacted]

REPORT CONTROL SHEET

REPORT TITLE	**PHASE 2 GEO-ENVIRONMENTAL GROUND INVESTIGATION**
PROJECT	**HOOK LANE, WESTERGATE**
CLIENT	**GLEESON LAND**

REPORT REFERENCE	ISSUE DETAIL	DATE	PREPARED BY	CHECKED BY
BRD3963-OR2-A	First Issue - Interim issue whilst winter groundwater monitoring is ongoing.	31/10/2022	M Morgan & A Leon	B Devonshire
BRD3963-OR2-B	Updated following completion of groundwater monitoring programme.	12/06/2023	R Davies & A Leon	J Brockwell

BRD Environmental Limited

Geotechnical and Environmental Services

- Ground Investigation
- Japanese Knotweed Removal
- Soil, Water and Gas Testing
- Contamination Assessment
- Geotechnical Advice
- Remediation Solutions

Hawthorne Villa, 1 Old Parr Road, Banbury, Oxfordshire. OX16 5HT

[redacted]

REPORT LAYOUT

This report is divided into the following four sections: Summary Report, Technical Report, Supporting Information and Appendices.

SUMMARY REPORT
This expanded executive summary provides the main findings of the work undertaken in brief non-technical language. This section provides an overview of the key outcomes for the benefit of non-specialists and concludes with the main recommendations. This section should only be relied upon in the context of the whole report and the Technical Report should be referred to with respect to any design decisions.
TECHNICAL REPORT
The main report section is intended to provide the technical detail of the investigation and is intended to provide the level of information required by current guidance documents and practice. The Technical Report is written in a language that, in part, assumes knowledge of subject matter so that it can be written in as concise a form as possible. Its intended audience is peers, regulators and other professionals in related disciplines.

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SUPPORTING INFORMATION

This section of the report provides background details of a generic nature together with specific technical approaches adopted by BRD and details of the guidance documents that are commonly referenced in the report. The section also includes explanations of technical terms to assist non-specialist readers in understanding the Technical Report. It should be noted that not all the information within this section is necessarily applicable to this specific report.

APPENDICES

The final section of the report presents the factual data collected and employed as part of the investigation.

APPENDIX 1	**SITE PLANS**	
	Site Location Plan	Ref. BRD3963-OR1-A
	Revised Conceptual Site Model	Ref. BRD3963-OR6-A
	Proposed Development Layout	Richards Urban Design 'Illustrative Masterplan' drawing ref. 1318.02 dated 04.05.22.
	Exploratory Hole Location Plan	Ref. BRD3963-OD1-A
APPENDIX 2	**EXPLORATORY HOLE & MONITORING RECORDS**	
	Logs of trial pits.	Ref. TP01-TP09
	Photographic records of trial pits.	Ref. BRD3963-OP7-A
	Logs of boreholes.	Ref. WS01-WS05
	BRE365 soakage test records.	15 x A4 pages
	Groundwater monitoring records.	8 x A4 pages
APPENDIX 3	**LABORATORY TEST RESULTS**	
	DETS report 22-07925, 22-08576 & 22-08699	30 x A4 pages
	SPT report 41499_1 and 41499_2	20 x A4 pages

SUMMARY REPORT - GENERAL INFORMATION

SUBJECT	COMMENTS
CURRENT SITE CONDITION	The site currently comprises a rectangular agricultural field currently used for growing crops. There is an access track in the south western corner and in the south eastern corner, a residential property of No. 24 Meadow Way is also included within the site boundary as a potential future access route.
PROPOSED DEVELOPMENT	It is proposed that the site will be developed as a residential housing estate with around 87No. properties with driveways and private gardens as well as areas of open space. Pedestrian access will be gained from the current site access of Hook Lane and vehicular access will be via the location of No. 24 Meadow Way.
HISTORICAL SUMMARY	The site has remained as an agricultural field similar to the present day throughout its history. The surrounding area has gradually developed with a plant nursery including a large tank present to the north from the 1970s, a sewage pumping station constructed immediately to the east in the 1990s and surrounding housing constructed in the 1930s, 1970s and in the last decade.
PUBLISHED GEOLOGY	The site is shown to be underlain by superficial deposits comprising River Terrace Deposits (undifferentiated) formerly known as Aeolian Deposits ('Brickearth'). A nearby borehole to the north of the site also suggests the presence of Raised Beach Deposits beneath the site containing groundwater. The shallowest bedrock unit is shown to be the London Clay Formation. This was encountered from 6m depth within the borehole (to the north).
ACTUAL GROUND CONDITIONS	The investigation has proved an upper layer of River Terrace Deposits consistent with the material formerly known as 'Brickearth' consisting of sandy silty clays and in most instances this became gravelly toward the base. Beneath, soils considered to comprise Raised Beach Deposits were encountered and these typically consisted of loose to medium dense wet sands. The London Clay Formation was encountered at depths of over 3m in the eastern end of the site.
HYDROGEOLOGY	The site is situated upon superficial deposits designated a Secondary A Aquifer. The underlying bedrock geology is designated as Unproductive Strata. The site is not located within a groundwater Source Protection Zone.
HYDROLOGY	The closest surface water feature to the site are highlighted as the drainage ditches along the northern and eastern boundaries. These flow to a headwall at the south eastern corner of the field, which then presumably flows in a culvert where it meets another ditch present around 130m to the east and this flows into a stream flowing southwards at distance of 400m from the site. The site is not in an area indicated to be at risk of flooding.
PREVIOUS GROUND REPORTS	BRD is not aware of any previous ground investigations having been conducted at the site. However, BRD has undertaken geo-environmental desk study research and this has been reported separately.

SUMMARY REPORT - GEOTECHNICAL

SUBJECT	COMMENTS
EXCAVATIONS	It should be possible to forward excavations employing normal equipment. Specialist groundwater control, such as well pointing, will likely be required at this site for excavations below the water table. It is unlikely that requirements of the Party Wall Act will apply to the development.
SLOPE STABILITY	It is considered that slope stability is unlikely to be a concern at this site.
SUB-SURFACE CONCRETE	River Terrace Deposits/Raised Beach Deposits: Design Sulphate Class of DS-1 and Aggressive Chemical Environment for Concrete class of AC-1 applies.
SOAKAWAYS	The winter groundwater monitoring programme has shown that the water levels are seasonal and can be very shallow following sustained periods of wetter weather. As such it is considered that only shallow infiltration devices could be employed where ground levels are raised to create an artificial unsaturated zone.
PAVEMENT DESIGN	A preliminary design California Bearing Ratio (CBR) of 4% has been recommended.
FOUNDATIONS	
LIKELY FOUNDATION TYPE	The site is marginally suitable for shallow strip/trench fill footings to bear upon the River Terrace Deposits and/or the Raised Beach Deposits. Trench fill footings would be needed for plots located within the influence of zones of trees. Foundations would need to be reinforced where straddling changes in soil type. Excavations encountering groundwater seepages will become unstable and this will complicate the construction of the footings. This will be dependent upon actual groundwater levels present at the time of construction. As a consequence of this, it is recommended that construction of footings is avoided in sustained wet periods and during the winter months when groundwater can be expected to be at its shallowest.
VOLUME CHANGE POTENTIAL	River Terrace Deposits: Low i.e. minimal swelling or shrinking with moisture content changes. Raised Beach Deposits: Non-shrinkable soil type. Note that the London Clay is too deep to influence foundation depths due to tree influence.
ESTIMATED FOUNDATION DEPTHS	The minimum footing depth required is 0.75m, but 1.00m where required to allow for restricted new tree planting. Foundations should be designed to be as shallow as possible to minimise construction risks associated with shallow groundwater.
HEAVE PROTECTION	Will not be required.

SUMMARY REPORT – CONTAMINATION ISSUES

SUBJECT	COMMENTS
SOIL RISKS TO HUMAN HEALTH	No unacceptable contamination in respect of human health have been identified by this investigation.
LANDFILL GAS	No plausible sources of landfill gas have been identified.
RADON GAS	Radon gas protection measures are not required.
RISKS TO THE WATER ENVIRONMENT	No unacceptable contamination risks to water resources have been identified by this investigation.
RISKS TO BUILDING MATERIALS AND SERVICES	No unacceptable contamination risks to building materials and services have been identified by this investigation.
REMEDIATION	No remedial works are considered necessary to facilitate the development at this stage.
ASBESTOS	No asbestos has been detected in the soil samples tested. No suspected asbestos containing materials has been observed in the soils inspected.
WASTE SOIL DISPOSAL	The soils at the site should be classified as non-hazardous waste and characterised as inert waste for any landfill disposal purposes.

SUMMARY REPORT – KEY RECOMMENDATIONS

RECOMMENDATIONS
A tree survey is required for detailed foundation design. This survey with topographic survey data should be undertaken prior to any site clearance to accurately record the location of any previously felled trees and existing trees both within the site and close to the site boundaries. The survey should record the trunk location, height and species of the trees. Once the development layout is confirmed, further geotechnical investigation should be undertaken in accordance with West Sussex County Council requirements in order to establish the design CBR along the line of the proposed roads to be adopted. Consideration should be given to further investigation employing static Cone Penetration Testing (CPT) targeting specific structures with high loads e.g. apartment blocks. Such testing may allow higher bearing capacities to be employed in the design of the targeted structures. In order to minimise construction difficulties, it is strongly recommended that excavations for foundations and deep drainage are only attempted in the drier summer/autumn months of May to September inclusive when the groundwater will be at its seasonal deepest. Additional contamination sampling will be required in the existing residential section of the site at No. 24 Meadow Way once the property has been vacated. This is to confirm a lack of any contamination risks in this part of the site. It is recommended that this report is submitted to the planning department of the Local Authority, the organisation undertaking the Building Control function and warranty providers to confirm that the investigation completed to date is satisfactory.

1. INTRODUCTION TO TECHNICAL REPORT

1.1. CONTRACT DETAILS

CLIENT	Gleeson Strategic Land Ltd trading as Gleeson Land.
SITE	Land situated off Hook Lane in the village of Westergate, West Sussex.
CLIENT'S ADVISORS	BRD Environmental Limited (BRD) has been commissioned directly by the Client.
REPORT CONTEXT	It is understood that the Client intends to market the site for residential redevelopment.
REPORT TYPE	Geo-environmental site investigation (i.e. combined geotechnical ground investigation and Phase 2 contamination assessment).
REPORT OBJECTIVES	The site has been the subject of a desk study referenced as follows: • 'Phase 1 Environmental Desk Study - Hook Lane, Westergate', BRD Environmental Ltd, report ref. BRD3963-OR1-A, dated July 2022. The purpose of the report is to present the findings of a ground investigation, and to present both geotechnical and contamination assessments of the ground conditions revealed.

1.2. SCOPE OF WORKS

The agreed scope of works was:

- Mobilisation to site and production of health and safety documentation.
- Delivery of 20mm granular material to site for backfilling the pits and supply of 75-100mm diameter perforated pipes for the inspection well in each soakage test pit.
- One day of windowless sampling using a percussive drilling rig to provide approximately 4-5No. boreholes to a nominal depth of 3m-5m, ground conditions permitting. Undertake Standard Penetration Tests (SPT) at 1m intervals. Installation of a 4m depth combined gas and groundwater monitoring well (nominal 50mm diameter) into 4No. boreholes. Installations will be finished with a flush fitting metal stopcock cover.
- One day of trial pitting using a mechanical excavator to provide approximately 8-9No. trial pits to a nominal depth of 3m, ground conditions permitting.
- Performance of soakage tests based upon BRE Digest 365 within 5No. of the trial pit locations. Supply of water to site via a 4WD water bowser unit on three consecutive days for the repeat filling of each test pit. A Geo-Environmental Technician will monitor the soakage tests.
- Removal of pipework at the end of the soakage tests and reinstatement of trial pit surfacing. The surplus soil from excavating the pits will be neatly stockpiled on site. The disposal of this soil has not been allowed for.
- All exploratory points will be logged and sampled in general accordance with BS5930:2015 by supervising Geo-Environmental Consultant.

- In-situ geotechnical testing of fine soils using a Hand Shear Vane and/or Pocket Penetrometer.

- Determination of the location of exploratory points by tape measurements or the use of a handheld recreational GPS unit.

- Geo-Environmental Technician to undertake 6No. groundwater monitoring visits over the winter period to determine resting groundwater levels, as well as to collect water samples for geotechnical analysis on the initial visit.

- Chemical testing of soil samples to confirm the soils are uncontaminated, to determine waste classification for muckaway and to meet the requirements for new water supply pipe specification. Budget based on the following testing schedule:

    - 8No. Metals Suite - As, Cd, Cr, CrVI, Hg, Pb, Se, Cu, Ni and Zn.
    - 8No. Inorganics Suite – water soluble sulphate, pH, organic matter.
    - 8No. Speciated Polycyclic Aromatic Hydrocarbons (PAH).
    - 3No. Banded aliphatic/aromatic Total Petroleum Hydrocarbons (TPH).
    - 3No. Benzene, Toluene, Ethylbenzene, Xylene (BTEX) and Methyl Tertiary Butyl Ether (MTBE) compounds.
    - 3No. Semi-Volatile Organic Compounds (SVOC) suite.
    - 3No. Organochlorine Pesticides suite.

- Chemical testing of 1No. soil sample for Waste Acceptance Criteria (WAC) to assist in establishing the waste classification of the soil for disposal purposes.

- Geotechnical testing as appropriate to the nature of the ground conditions encountered, but the budget is based on the following testing schedule:

    - 6No. Moisture content.
    - 6No. Plasticity indices.
    - 4No. Particle size distribution by wet sieve with 2No. by follow on hydrometer.
    - 8No. pH and water soluble sulphate analysis - soil.
    - 8No. Total sulphate and sulphur analysis - soil.
    - 4No. pH and sulphate analysis - water.

- Provision of a combined factual and interpretative investigation report. Factual findings to include all exploratory point records, monitoring and test results. Interpretative reporting to include a summary of information from desk study research, a Generic Quantitative Contamination Risk Assessment (GQRA), waste classification and a Geotechnical Assessment providing comments on pavement design, concrete classification, soakaway feasibility, foundation design recommendations.

Following the completion of the scheduled groundwater monitoring programme, a further 2No. visits were scheduled in to provide a better understanding of how the groundwater regime changed over the seasons.

1.3. REPORT LIMITATIONS

Any site boundary lines depicted on plans included within this report are approximate only and do not imply legal ownership of land. Any observations of tree species, asbestos containing materials within structures or invasive weeds, does not constitute a formal survey of such features. The identification of such features is therefore tentative only. In the case of Japanese Knotweed, BRD can undertake separate surveys for this plant undertaken by a Property Care Association qualified surveyor.

The report does not consider whether sensitive ecology or archaeology is present as these require consideration by professionals specialising in these matters. It should be recognised that the collection of desk study information may not be exhaustive and that other information pertinent to the site may be available.

The recommendations, interpretations and conclusions of this report are based solely on the ground conditions found at the exploratory holes. Due to the variability in the nature of ground, conditions between exploratory holes can only be interpreted and not defined. The description of the site and the ground conditions is accurate only for the dates of the field works. In particular, groundwater levels can vary due to seasonal and other effects.

The assessment and interpretation of contamination risks is based on the scope of works agreed with the Client together with the budgetary and programme constraints imposed. Further investigation, analysis and assessment of contamination may be required by regulators or other third parties with an interest in the site. An ecological risk assessment of contaminated soils is beyond the scope of this report. This report is concerned with assessing those contamination risks which apply to the future use of the site through the proposed development as part of the planning regime. The assessment does not consider the risk to current site users or continued future use of the site in its current state. If development of the site should occur that differs from that proposed, then the findings of the contamination assessment would need to be re-evaluated.

At the time of writing, detailed information on the proposed structure, such as detailed layout, loadings and serviceability limits, was not available. Accordingly, where geotechnical design advice is provided it is on the prescriptive basis allowed for by Eurocode 7: employing conventional and conservative design rules. The scope of this investigation excludes a formal slope stability study and any observations made regarding slopes are for information only.

2. SITE CHARACTERISTICS

2.1. SITE SETTING

SITE ADDRESS AND POST CODE	Land off Hook Lane, Westergate, West Sussex, PO20 3TF.
NATIONAL GRID REFERENCE	493600E, 104820N.

2.2. SITE DESCRIPTION

SUBJECT	COMMENTS
CURRENT SITE DESCRIPTION	The site currently comprises a rectangular agricultural field currently used for growing crops and covering an area of approximately 3.8 hectares. There is an access track in the south western corner and in the south eastern corner, a residential property of No. 24 Meadow Way is also included within the site boundary as a potential future access route.
SURROUNDING LAND USE	The site is set in a mixed agricultural and residential area.
PROPOSED DEVELOPMENT	It is proposed that the site will be developed as a residential housing estate with access via the current location of No. 24 Meadow Way in the south eastern corner.
HISTORICAL SUMMARY	The site has remained as an agricultural field similar to the present day throughout its history. The surrounding area has gradually developed with a plant nursery including a large tank present to the north from the 1970s, a sewage pumping station constructed immediately to the east in the 1990s and surrounding housing constructed in the 1930s, 1970s and in the last decade.
PUBLISHED GEOLOGY	The site is shown to be underlain by superficial deposits comprising River Terrace Deposits (undifferentiated) formerly known as Aeolian Deposits ('Brickearth'). A nearby borehole to the north of the site also suggests the presence of Raised Beach Deposits beneath the site containing groundwater. The shallowest bedrock unit is shown to be the London Clay Formation. This was encountered from 6m depth within the borehole (to the north).
RADON	Radon protection measures are not required.
HYDROGEOLOGY	The site is situated upon superficial deposits designated a Secondary A Aquifer. The underlying bedrock geology is designated as Unproductive Strata. The site is not located within a groundwater Source Protection Zone.

SUBJECT	COMMENTS
HYDROLOGY	The closest surface water feature to the site are highlighted as the drainage ditches along the northern and eastern boundaries. These flow to a headwall at the south eastern corner of the field, which then presumably flows in a culvert where it meets another ditch present around 130m to the east and this flows into a stream flowing southwards at distance of 400m from the site. The site is not in an area indicated to be at risk of flooding.

2.3. PREVIOUS INVESTIGATIONS

BRD is unaware of any previous ground investigations having been conducted at the site. However, the site has been the subject of geo-environmental desk study research by BRD and this has been reported separately in "Phase 1 Geo-Environmental Desk Study – Hook Lane, Westergate", BRD Environmental Ltd, ref. BRD3963-OR1-A, dated July 2022. This current report should be read in conjunction with the previous desk study report.

2.4. PRELIMINARY CONTAMINATION RISK ASSESSMENT

Minor potential contamination risks were identified from the site relating to residual pesticides from the agricultural land use as well as potential contamination from residential land use in the south eastern corner. Minor contamination risks to future residents have also been identified arising from off-site sources including the former nursery to the north (via fuel tanks) and possible sewage overflows from the adjacent pumping station to the west.

2.5. PRELIMINARY GEOTECHNICAL ASSESSMENT

Based on the desk study information alone, the anticipated ground conditions should be suitable for conventional strip foundations, albeit that if the superficial deposits are found to be variable then reinforced footings may be warranted. Coupled with this, there is the potential for seasonally shallow groundwater within these deposits.

Subject to groundwater levels and clay content of the upper soils, there is the potential that surface water disposal to soakaways could be feasible at the site.

3. GROUND INVESTIGATION

3.1. INVESTIGATION DESIGN

METHODOLOGY	A mixture of machine excavated trial pits and windowless sample boreholes were chosen as the most appropriate investigation technique. The trial pits expose more soil and allow a more detailed inspection of the ground conditions, as well as allowing soakage tests in accordance with BRE365 to be undertaken. The windowless sample boreholes allow in-situ strength data to be obtained as well as the installation of groundwater monitoring wells.	
DATES OF SITE WORKS	The main field works were undertaken on 20th September and 12th October 2022. Groundwater monitoring visits were undertaken on 17th October and 1st December 2022, 4th January, 8th February, 1st March, 5th April, 15th May and 8th June 2023.	
CONSTRAINTS TO EXPLORATORY HOLE LAYOUT	In order to comply with safety requirements, a 10m offset was applied to the overhead power lines running along the southern boundary and crossing the eastern end of the site. A sewer also runs along the southern boundary and was located within the same offset zone. Therefore, these areas were avoided but this did not significantly affect the overall spread of exploratory holes. Coupled with this, due to the occupied nature of the house at No. 24 Meadow Way, this section of the site could not be investigated at this time.	
EXPLORATORY HOLE SPACING	Approximately 50m-75m grid.	
LAYOUT RATIONALE	SOURCE / FEATURE	EXPLORATORY HOLE
CONTAMINATION SOURCES TARGETED	Potential contamination from agricultural land use.	WS01 to WS05. TP01 to TP09.
	Potential contamination from adjacent pumping station.	WS05.
	Potential contamination from off-site fuel tank in former nursery.	WS03.
	Potential contamination from residential land use in SE corner	Not targeted at this time as house is occupied.
GROUND FEATURES TARGETED	General site coverage.	WS01 to WS05. TP01 to TP09.
	Proposed attenuation basin in the north eastern corner of the site	TP01, WS02.

CONTAMINATION SAMPLING PLAN	Based on the proposed end use, the sampling and analysis plan is more positively biased towards near surface samples as these represent the soils most likely to be available to future site users. Some slightly deeper samples of subsoil have also been targeted to assess the risk to proposed buried infrastructure. In addition, some deeper samples were taken in areas where cross contamination / migration of groundwater contamination could have occurred.
ANALYSIS PLAN	Based on the site's history as agricultural fields, a general contamination suite of commonly occurring contaminants has been specified including a pesticide suite. In areas closer to the off-site sources of contamination some deeper samples have also been analysed for heavy metals and petroleum hydrocarbons to capture potential migratory pollutants.

3.2. BRD FIELDWORK

TRIAL PITS	
REFERENCES	TP01 to TP09.
DEPTH RANGE	From 1.50m to 3.40m.
EXCAVATOR	JCB 3CX style wheeled backactor.
BACKFILL	Soakage tests were completed in TP01 to TP05 and these pits were shallower (1.5m to 1.6m deep). The soakage pits were backfilled with 20mm gravel and a 90mm diameter observation well. The surface topsoil was reinstated and the pipes were removed following completion of the soakage tests. TP06 to TP09 were backfilled with arisings upon completion and compacted with rams of the excavator bucket.

WINDOWLESS SAMPLING BOREHOLES	
REFERENCES	WS01 to WS05.
DEPTH RANGE	From 4.60m to 5.45m.
RIG TYPE	Premier Drilling Rig.
INSTALLATION / BACKFILL	Borehole WS01 was backfilled with arisings only. Boreholes WS02 to WS05 had monitoring wells installed. These comprised 50mm nominal diameter standpipes fitted with a gas tap finished with a flush metal cover. The slotted response length of the well is shown on the individual logs. Bentonite seals are also indicated on the logs. The filter medium used was pea gravel.

MONITORING	
TYPE	Groundwater monitoring.
DATES	17th October and 1st December 2022, 4th January, 8th February, 1st March, 5th April, 15th May and 8th June 2023.
GROUNDWATER SAMPLING METHOD	Samples were retrieved using a sampling bailer during the first monitoring visit.

3.3. LABORATORY TESTING

GEOTECHNICAL TESTING	
The soil samples for geotechnical testing were forwarded to the laboratory of Soil Property Testing Ltd with pH and sulphate analysis undertaken at the laboratory of DETS Ltd. The geotechnical testing suite is detailed below. The UKAS accreditation of the individual test methods is shown on the laboratory test report included in the Appendices.	
TEST	NUMBER OF SAMPLES TESTED
Moisture content	8
Liquid and plastic limits	8
Particle size distribution by wet sieve	4
Particle size distribution by wet sieve and hydrometer	2
pH and Water soluble Sulphate	8
Total Sulphur and Sulphate	8

GROUNDWATER CHEMICAL TESTING	
The water samples for contamination and/or chemical geotechnical testing were forwarded to the laboratory of DETS Ltd and the testing suite is detailed below. The UKAS or MCERTS accreditation of the individual test methods is shown on the laboratory test report included in the Appendices.	
WATER TESTS	NUMBER OF SAMPLES TESTED
pH	3
Sulphate	3

SOIL CHEMICAL TESTING	
The soil samples for contamination and/or chemical geotechnical testing were forwarded to the laboratory of DETS Ltd and the testing suite is detailed below. The UKAS or MCERTS accreditation of the individual test methods is shown on the laboratory test report included in the Appendices.	
SOIL TESTS	**NUMBER OF SAMPLES TESTED**
Arsenic, Cadmium, Chromium, Chromium VI, Copper, Lead, Mercury, Nickel, Selenium, Zinc	8
Speciated Polycyclic Aromatic Hydrocarbons (PAH)	8
Total Petroleum Hydrocarbons (TPH) with full carbon banding and aliphatic/aromatic split	3
Benzene, Toluene, Ethylbenzene and Xylenes (BTEX) plus Methyl Tert Butyl Ether (MTBE)	3
Organic Matter	8
Semi-Volatile Organic Compounds (SVOCs)	3
Organochlorine Pesticides	3
Waste Acceptance Criteria (WAC) testing	1

4. GROUND CONDITIONS

4.1. OVERVIEW

The ground conditions encountered were broadly as anticipated from the published geology. This comprised an upper layer of River Terrace Deposits consistent with the material formerly known as 'Brickearth' consisting of silty sandy clays and in most instances this becoming gravelly toward the base. Beneath, soils considered to comprise Raised Beach Deposits were encountered and these typically consisted of loose to medium dense wet sands. The London Clay Formation was encountered at depths of over 3m in the eastern end of the site.

It is also noted that the strata appear to dip to the west with the River Terrace Deposits becoming thicker in this direction and the underlying Raised Beach Deposits and London Clay Formation becoming deeper.

Groundwater was encountered across the site at depths of between 2m and 3m during the excavation / drilling works.

Details of the various stratigraphic units are given in the following sections.

4.2. ARTIFICIAL GROUND

No buried structures, buried services or Made Ground were identified during the ground investigation.

4.3. TOPSOIL

Topsoil was encountered across the site extending to depths of between 0.20m and 0.30m. It was consistently described as 'brown, silty, slightly sandy clay with occasional rootlets'.

4.4. SUPERFICIAL DEPOSITS

4.4.1. River Terrace Deposits

The River Terrace Deposits primarily comprised soils formerly known as 'Brickearth' and consists of sandy silty clays. At the site these extended shallower in the eastern section (1.3m in TP01) and deeper towards the west (up to 2.5m in TP08 and TP09).

The upper clay strata were typically described as 'stiff orange brown to yellow brown sandy slightly gravelly CLAY. Gravel of fine angular flint'.

In most of the holes, towards the base of the River Terrace Deposits a very clayey gravel was encountered. This was between 0.3m and 0.9m thick and where thickest, in WS02 was described as 'medium dense brown very clayey GRAVEL of fine to medium angular flint'.

4.4.2. Raised Beach Deposits

The Raised Beach Deposits were encountered across the site directly beneath the River Terrace Deposits at depths in the range 1.3m to 2.5m and typically deeper towards the west.

The Raised Beach Deposits consisted primarily of a fine sand, but did encounter some gravel towards the base. The base of the strata was proven in the eastern section of the site at depths of between 3.3m to 3.8m, but in the western section extended beyond the base of the boreholes at 5.5m bgl.

The sand soils were typically described as 'wet loose or medium dense brown fine SAND'.

At the base of the sand, WS01, WS02 and WS03 in the eastern and central section of the site became dense and very gravelly with gravel consisting of fine to coarse, subrounded to angular flint and chalk'.

4.5. BEDROCK

4.5.1. London Clay Formation

The London Clay Formation was encountered at depths in the range 3.3m and 3.8m in WS01 and WS02 in the eastern section of the site. Elsewhere, the London Clay is likely to be present, but was beneath base of the boreholes at between >4.6m and >5.5m bgl.

The London Clay Formation soils were described as 'Firm grey silty CLAY'.

4.6. GEOTECHNICAL COMMENTS

The sandy Raised Beach Deposits were noted to be of loose consistency in some areas and when excavating the trial pits, were prone to collapse, most likely due to the groundwater.

4.7. CONTAMINATION OBSERVATIONS

No visual or olfactory evidence of contamination was noted during the forwarding of exploratory holes.

4.8. GROUNDWATER BEHAVIOUR

During the progressing of exploratory holes, the following general observations of groundwater behaviour were made.

In the trial pits, seepages of groundwater were recoded within the Raised Beach Deposits at depths in the range 2.0m to 3.0m bgl.

In the boreholes, water strikes were also recorded at depths in the range 2.0m to 3.0m bgl and it was noted that they were fairly slow inflows.

4.9. GROUNDWATER MONITORING

DATE	RESTING GROUNDWATER RANGE	COMMENTS
17/10/22	From 1.48m to 2.86m bgl.	Monitoring visit followed a period of mixed wet and dry weather after a very dry summer. The standing groundwater level was shallowest in borehole WS02, in the north eastern corner of the site, in the location close to the boundary ditch. In boreholes WS03 to WS05 in the central and western sections the groundwater was fairly consistent and ranged between 2.60m and 2.86m bgl.
01/12/22	From 0.23m to 1.02m bgl.	Monitoring visit followed a period of relatively wet weather. The groundwater levels had significantly increased since the previous monitoring visit with shallowest level recorded in borehole WS04, located in the north west of the site. The deepest groundwater level was

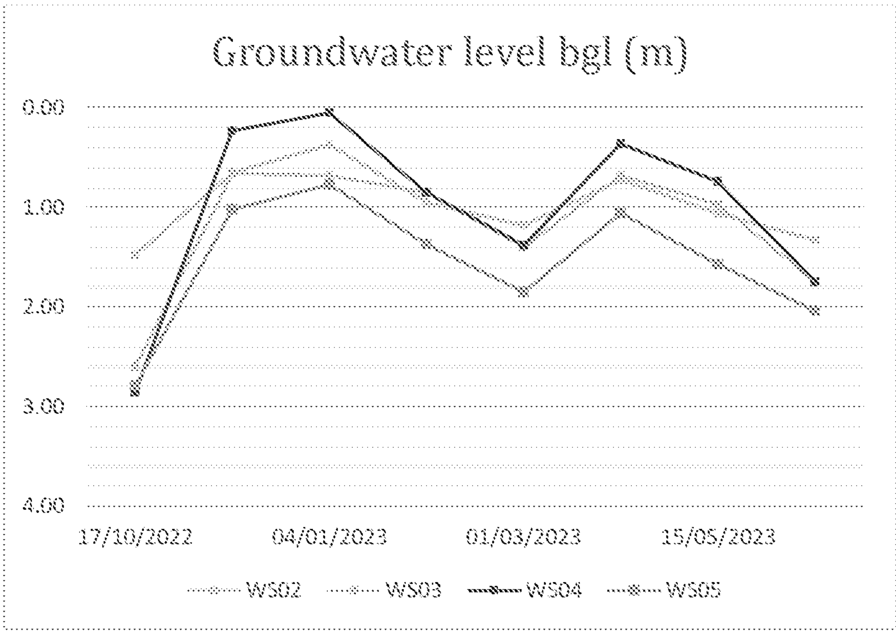
DATE	RESTING GROUNDWATER RANGE	COMMENTS
		recorded in borehole WS05, located in the south west of the site, albeit this was still around 1m bgl. The groundwater level variation was fairly consistent in all the boreholes.
04/01/23	From 0.05m to 0.77m bgl.	Monitoring visit followed a period of mixed wet and dry weather. Slightly shallower standing groundwater levels to the previous visit were typically recorded in most of the boreholes.
08/02/23	From 0.85m to 1.37m bgl.	Monitoring visit followed a period of more settled weather. The groundwater levels had decreased since the previous monitoring visit with shallowest levels at <1m bgl depth recorded in boreholes WS03 and WS04. As before, the deepest groundwater level was recorded in borehole WS05. The groundwater levels were fairly consistent across all the boreholes.
01/03/23	From 1.18m to 1.85m bgl.	Monitoring visit followed a period of dry weather. The groundwater levels had decreased since the previous monitoring visit with shallowest level recorded in borehole WS02. The deepest groundwater level was again recorded in borehole WS05. As before, the groundwater levels were fairly consistent across all the boreholes.
05/04/23	From 0.36m to 1.06m bgl.	Monitoring visit followed a period of relatively wet weather. As with the previous visits following wetter weather, the groundwater levels had risen since the previous monitoring visit with shallowest level recorded in borehole WS04 and the deepest level in borehole WS05. As before, the groundwater levels were fairly consistent across all the boreholes.
15/05/23	From 0.64m to 1.48m bgl.	Monitoring visit was undertaken during a period of drier weather but following a very wet April. Consequently, whilst levels had dropped across all the wells, the groundwater levels were still relatively shallow.
08/06/23	From 1.33m to 2.04m bgl.	Monitoring undertaken during a prolonged dry period since the previous visit, with hardly any rainfall recorded. The levels have dropped consistently across all the boreholes reflecting this drier spell.

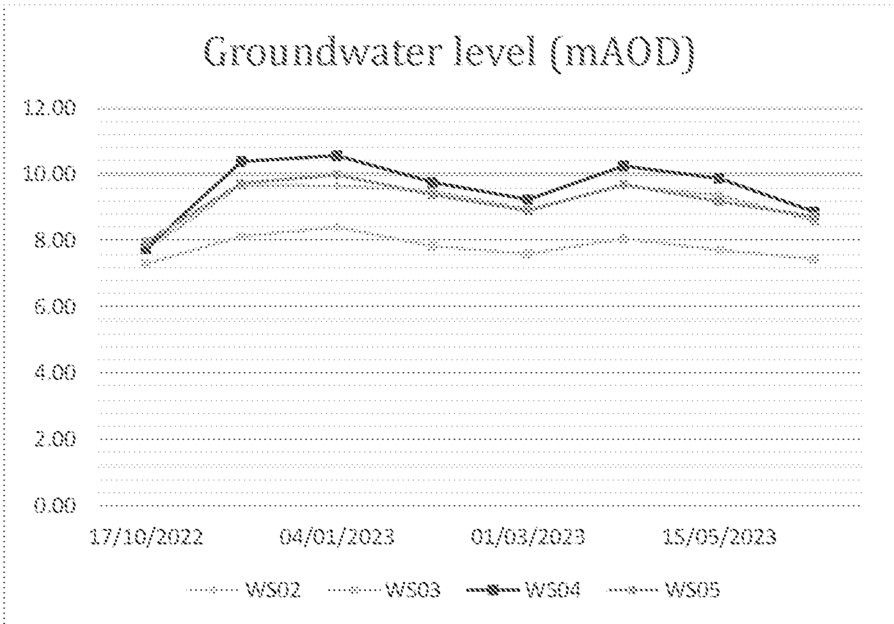
4.9.1. <u>Comments</u>

The initial monitoring visit was undertaken following an extremely dry summer and before the winter rains had begun, so consequently the deepest standing groundwater levels as part of the monitoring programme were recorded. However, monitoring through the wetter winter months has shown the resting groundwater levels to be much shallower. Four of the five winter monitoring visits have consistently recorded groundwater levels shallower than 1m bgl. Unsurprisingly the shallower groundwater levels did follow periods of more prolonged rainfall.

In contrast, the more recent monitoring in May and, in particular, June demonstrate that the groundwater levels do fall following periods of drier weather. Certainly, the overall monitoring programme shows the groundwater level changes across the site are subject to seasonal variation.

The two charts below show the groundwater levels on site compared to both the existing ground level and to Above Ordnance Datum (AOD). The level suggest a groundwater flow direction to the south east that fits with expectations from local topography and surface water courses.





5. GEOTECHNICAL PROPERTIES

5.1. COARSE SOIL PARAMETERS

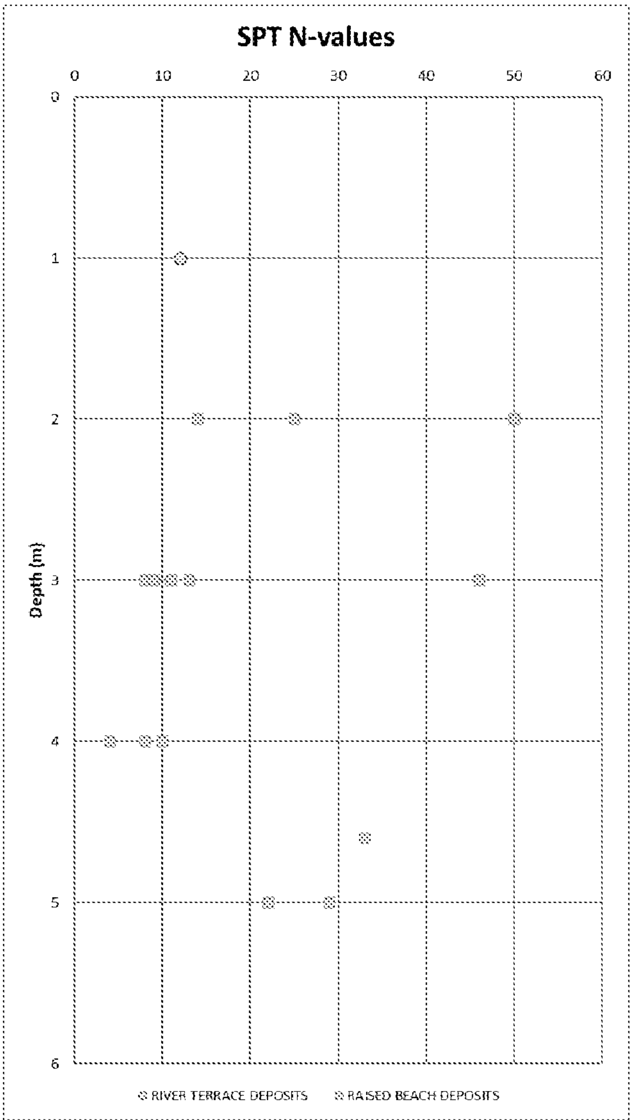
5.1.1. Standard Penetration Tests (SPTs)

A total of eighteen SPTs were carried out in the coarse soils of the River Terrace Deposits and the Raised Beach Deposits. Only two tests at 1m depth were undertaken in the coarse River Terrace Deposits with a same N-value of 12, which is indicative of medium dense deposits.

For the Raised Beach Deposits highly variable N-values were recorded due to the variable sand and gravel content of these soils together with the presence of the groundwater level. N-values range from 4 to >50 (refusal). A total of 3 tests, were finished at 50 blows, in boreholes WS03, WS04 and WS05 at depths of 4m and 5m bgl.

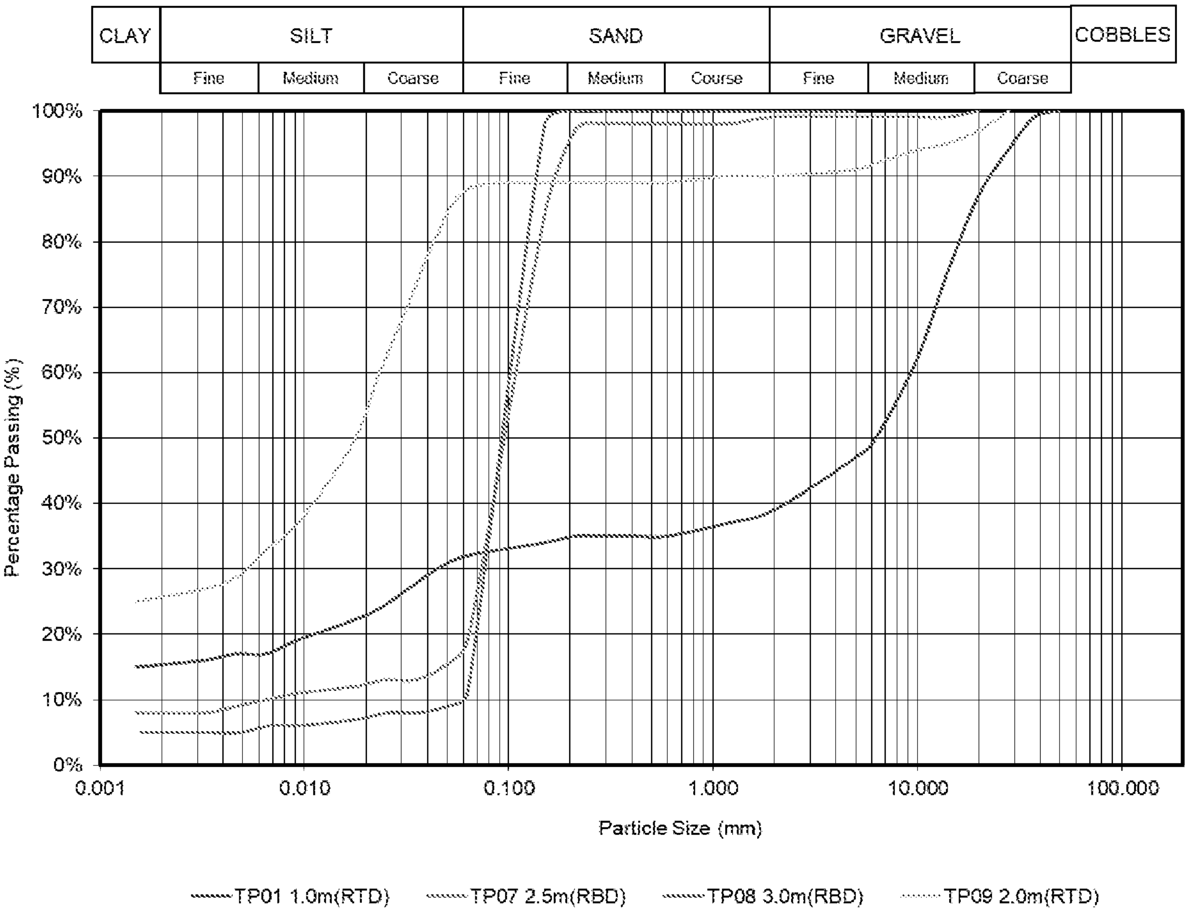
Typically, the lowest N-values, were recorded on encountering the groundwater level such as in boreholes WS03, WS04 and WS05 at 3m depth. Above and below the groundwater was struck N-values were typically indicative of medium dense sands becoming very dense with depth.

The graph below shows the SPT N-values recorded in the coarse River Terrace Deposits and the Raised Beach Deposits versus depth.



5.1.2. Particle Size Distribution (PSD)

Four samples, two of River Terrace Deposits (RTD) and two of the Raised Beach Deposits (RBD) were subject to particle size distribution determination. The two samples from the RTD revealed the soils to be highly variable, whereas the samples from RBD resulted with a very similar distribution as shown in the chart below.



The sample recorded from trial pit TP01 (RTD) at 1.0m depth, was classified as a slightly sandy, silty clayey gravel, however, based on its possible geotechnical behaviour it was considered as a slightly sandy, gravelly, silty clay. The gravel fraction was of 61%, the recorded sand fraction was only of 7%. The fines content was of 32% of which 15% was of clay fraction.

Sample from trial pit TP09 (RTD) recorded at 2.0m depth, was classified as a slightly gravelly, slightly sandy, clayey silt. The recorded gravel fraction was of 10% and the sand fraction of 2%. The fines content was of 88% of which 63% was of silty fraction and 25% of clay fraction.

Raised Beach Deposits samples recorded from trial pits TP07 and TP08 at 2.5m and 3.0m depth, respectively, recorded very similar distribution. These soils are classified as poorly graded, slightly gravelly, clayey, silty fine SAND. The gravel content was of 1% (TP07), the sand fraction was of 80% and 89%, of which, 78% and 89% was of fine sand fraction. The fines content was of 11% and 19%, of which 5% and 8% was of clay fraction.

5.2. FINE SOIL PARAMETERS

5.2.1. Index Property Testing

SOIL TYPE	River Terrace Deposits.
PLASTICITY INDEX (PI)	17% and 18% (Two samples: Low volume change potential). 20% (One sample: Medium volume change potential).
MODIFIED PI	10% and 13% (Two samples: Low volume change potential). 20% (One sample: Medium volume change potential).
COMMENTS	These deposits have been proved with variable plasticity indices as a consequence of the variable sand and gravel content. Some of the more granular layers would actually be considered as non-shrinkable as the fines content is below 35% as shown on one of the particle size distributions. Therefore, an average value of 16% is considered representative of the River Terrace Deposits.
NHBC CLASS	Low volume change potential.

SOIL TYPE	London Clay Formation.
PLASTICITY INDEX (PI)	48% and 51%.
MODIFIED PI	Not applicable – no oversize particles.
NHBC CLASS	High volume change potential.

5.2.2. Undrained Shear Strength

This section discusses all of the laboratory and in-situ tests that produce either direct or indirect measures of undrained shear strength.

5.2.2.1. Hand Shear Vane

SOIL TYPE	River Terrace Deposits.
CORRECTION FACTOR μ	μ=1.0
JUSTIFICATION	After Bjerrum 1972, employing average Plasticity Index.
DISCUSSION OF CORRECTED RESULTS	The recorded undrained shear strength near surface was of >145kPa which is indicative of very high strength soil type. However, these values are considered a consequence of the dry conditions recorded in the clayey River Terrace Deposits at shallow depths and should not be considered representative of these soils. At depth, an average value of 74kPa was recorded from trial pit TP08, indicating medium strength soil type which it is considered more representative of the River Terrace Deposits.

5.2.2.2. Hand Penetrometer

SOIL TYPE	River Terrace Deposits.
DISCUSSION OF CORRECTED RESULTS	The recorded undrained shear strength near surface was of >113kPa which is indicative of very high strength soil type. However, these values are considered a consequence of the dry conditions recorded in the clayey River Terrace Deposits at shallow depths and should not be considered representative of these soils.

SOIL TYPE	London Clay Formation.
DISCUSSION OF CORRECTED RESULTS	A single value of undrained shear strength was recorded in borehole WS02 at 3.9m depth. A value of 63kPa was recorded which is indicative of medium strength soil type.

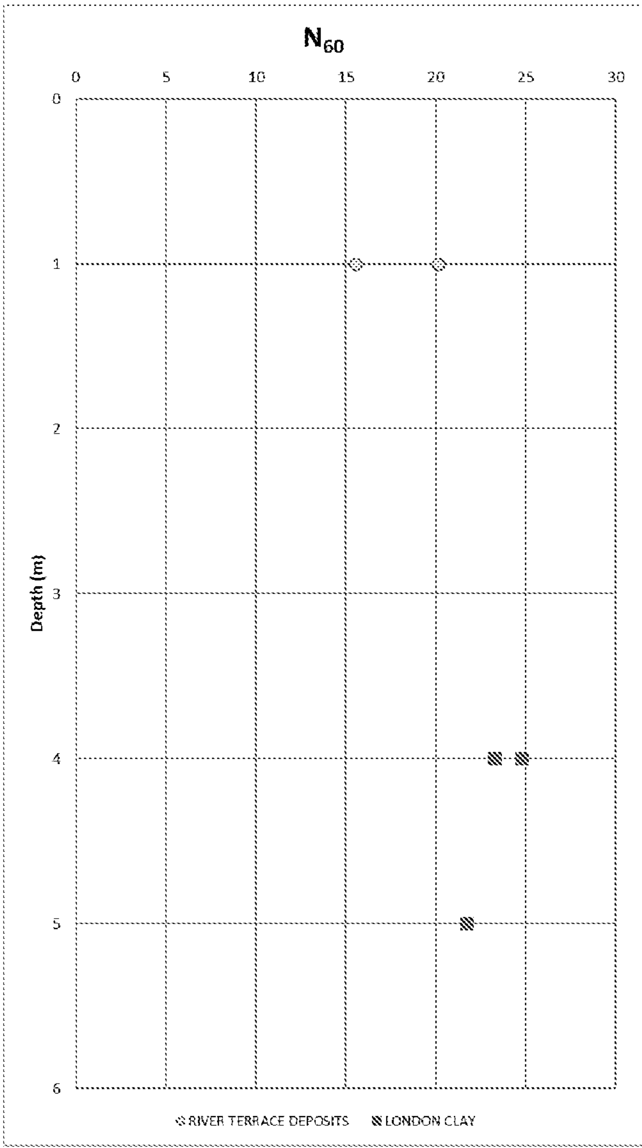
5.2.2.3. Standard Penetration Test Correlations

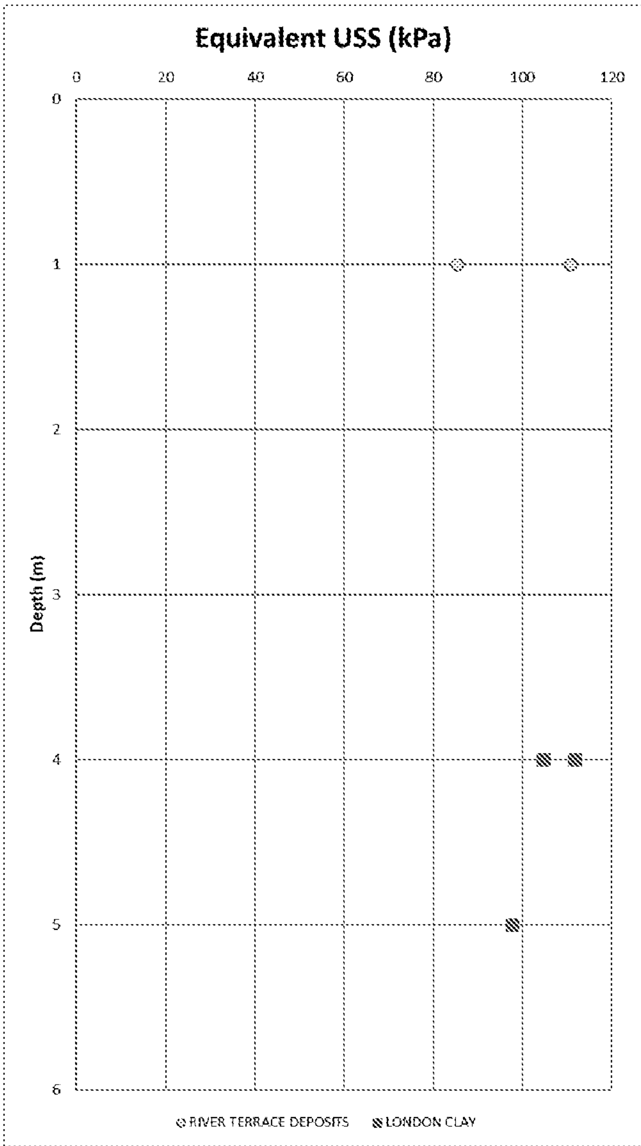
The SPT N-values recorded in the sandy clayey soils of the River Terrace Deposits and the clayey soils of the London Clay Formation have been corrected to N_{60}-values, and then correlated to an equivalent undrained shear strength (c_u) using the approach by Stroud (1985) based upon a relationship of $c_u=5.5N_{60}$, derived from an average PI of 16% for the River Terrace Deposits and a $c_u=4.5N_{60}$, derived from an average PI of 50% for the London Clay Formation.

The equivalent undrained shear strengths values for the River Terrace Deposits, recorded at 1m depth, range between 85kPa and 111kPa, averaging 102kPa. The interpretation of strength should be viewed as tentative only due to the varying granular content of the River Terrace Deposits.

The equivalent undrained shear strengths values for the London Clay Formation, recorded at 4m and 5m depths, range between 98kPa and 112kPa, averaging 105kPa.

The following charts show the distribution with depth of the N_{60}-values together with the derived equivalent undrained shear strength values obtained for the clayey soils of both the River Terrace Deposits and the London Clay Formation.





5.3. SULPHATE AND pH

	RIVER TERRACE DEPOSITS / RAISED BEACH DEPOSITS			
	Sulphate		pH	
Characteristic Value	71 mg/l		6.4 units	
Justification	Highest groundwater result.		Mean of lowest 20% results.	
	No. of tests	Results Range	No. of tests	Results Range
Soil	15	<10 – 23 mg/l	15	6.3 – 8.3 units
Groundwater	3	16 – 71 mg/l	3	6.7 – 7.4 units
Total Potential Sulphate	7	Not applicable as pyrite unlikely in the samples tested.		

	LONDON CLAY FORMATION			
	Sulphate		pH	
Characteristic Value	0.72%		8.0 units	
Justification	Based on Total Potential Sulphate.		Lowest measured value.	
	No. of tests	Results Range	No. of tests	Results Range
Soil	1	64 mg/l	1	8.0 units
Groundwater	-	N/A	-	N/A
Total Potential Sulphate	1	0.72% The sample tested is potentially pyritic.		

6. GEOTECHNICAL ASSESSMENT

6.1. INTRODUCTION

The following advice and recommendations are based on the construction of about 87No. low rise two to three storey residential properties across the entire site.. The proposed development layout plan is included in Appendix 1. From assessment of the nature of the ground conditions and the type of proposed structures, it is considered that the situation falls within EC7 Geotechnical Category 1.

Should the nature of the development be changed then the results of this investigation would need to be reviewed and reassessed.

6.2. EXCAVATIONS

STABILITY	Any excavation requiring man entry should be battered back to a safe angle, supported by an appropriate proprietary trench support system or adequately shored to provide safe working conditions. Shoring to any excavation requiring man entry must be designed by a suitably qualified and experienced engineer. Any support system will require regular inspection as detailed in published guidelines to ensure the excavation support is adequate and appropriate for the ground conditions present. Typically, for the River Terrace Deposits, it is anticipated that shallow narrow trench excavations will remain relatively stable and open for short periods, but minor spalling of side walls could still occur. However, in the Raised Beach Deposits and on encountering the groundwater level, trench excavations are likely to suffer side wall collapse. Likewise, excavations below the water table at these deposits are likely to result in excavation difficulties due to 'running sands' and appropriate groundwater control likely in the form of 'well pointing' will therefore be required. It is strongly recommended that excavations for foundations and deep drainage are only attempted in the drier summer/autumn months, from May to September inclusive, when the groundwater will typically be at its seasonal deepest in order to minimise construction difficulties.
EQUIPMENT	It should be possible to progress excavations with conventional equipment.
GROUNDWATER CONTROL	It is considered that construction without adequate groundwater control will be problematical and that pumping from sumps alone may not be sufficient. Consultation with groundwater control contractors is recommended as specialist measures such as 'well pointing' will likely be required. Any groundwater control system should be designed and operated to minimise the loss of fines from the soil matrix as this could adversely affect settlement. Groundwater levels at the time of construction will have a critical impact on the ease of which the structure can be built. The monitoring programme has shown that the groundwater levels become very shallow following periods of sustained wet weather. As a consequence of this, below ground works following or during periods of sustained wet weather will be more problematical. Where possible, it is recommended that below ground works preferably occur in the drier summer/autumn months when groundwater levels would typically be deeper.

6.3. SLOPE STABILITY

The site is relatively flat and no significant changes in level as part of the development are anticipated. It is therefore considered that slope stability is unlikely to be a significant concern at this site.

6.4. SUB-SURFACE CONCRETE

RIVER TERRACE DEPOSITS / RAISED BEACH DEPOSITS	
SITE / SOIL CATEGORY	Natural ground.
DESIGN SULPHATE CLASS	DS-1
GROUNDWATER REGIME	Mobile.
AGGRESSIVE CHEMICAL ENVIRONMENT FOR CONCRETE (ACEC) CLASS	AC-1

LONDON CLAY FORMATION	
SITE / SOIL CATEGORY	Natural ground containing pyrite.
DESIGN SULPHATE CLASS	DS-3 (DS-1 for piles)
GROUNDWATER REGIME	Static.
AGGRESSIVE CHEMICAL ENVIRONMENT FOR CONCRETE (ACEC) CLASS	AC-2s (AC-1s for piles)
COMMENTS	Concrete in pyritic ground that is initially low in soluble sulphate does not have to be designed to withstand a high potential sulphate class unless ground disturbance is such that pyrite may be oxidised. At this site it is only piles that could encountered the London clay and so a lower class could be employed. If a piled solution is employed, then further deep investigation would been required and this should include additional sulphate testing to confirm the classification for this soil type.

6.5. SOAKAWAYS

6.5.1. Soil Infiltration Rate

The records of the soakage tests are presented in the Appendices that includes the calculation of the soil infiltration rate. A summary of results are presented in the table below:

TRIAL PIT	SOIL INFILTRATION RATE		STRATUM TESTED
TP01	Test 1	1.01×10^{-5} m/s	0.25m - 0.60m: Slightly gravelly, silty CLAY. 0.60m - 1.30m: Slightly sandy, very clayey GRAVEL/ very gravelly CLAY. 1.30m - 1.50m: Clayey fine SAND.
	Test 2	1.03×10^{-5} m/s	
	Test 3	9.58×10^{-6} m/s	
TP02	Test 1	3.80×10^{-5} m/s	0.25m - 1.50m: Sandy CLAY.
	Test 2	2.88×10^{-5} m/s	
	Test 3	2.38×10^{-5} m/s	
TP03	Test 1	7.44×10^{-6} m/s	0.30m - 1.60m: Sandy, silty CLAY.
	Test 2	8.49×10^{-6} m/s	
	Test 3	7.35×10^{-6} m/s	
TP04	Test 1	8.15×10^{-6} m/s	0.25m - 1.60m: Sandy, silty CLAY.
	Test 2	1.15×10^{-5} m/s	
	Test 3	1.09×10^{-5} m/s	
TP05	Test 1	5.49×10^{-6} m/s	0.25m - 1.60m: Sandy CLAY.
	Test 2	4.81×10^{-6} m/s	
	Test 3	6.58×10^{-6} m/s	

6.5.2. Soakaway Design Advice

The results of soakage tests within the shallow River Terrace Deposits and the Raised Beach Deposits (in trial pit TP01), between approximately 1.5m and 1.6m depth, returned poor to moderate infiltration rates. This is to be anticipated given the variable content in sand and clayey soils in the River Terrace Deposits. The variable fines fraction in particular influence drainage characteristics of the soil.

Soakaway design will need to consider the variation of the groundwater table as during periods of elevated groundwater the ability of the soils underlying the site to receive additional water may be limited. To meet with the requirements of the Environment Agency, infiltration devices should not drain directly to groundwater. It should be ensured that an unsaturated zone in excess of a 1m thick is present between the base of the infiltration device and the seasonal high maximum groundwater level.

Based on the worst case winter monitoring visits, groundwater levels have been regularly recorded during periods of wetter weather at depths of less than 1m bgl across the site. Where development finished ground levels are being raised, there will be opportunity to employ shallow infiltration devices subject to careful design. The raising of ground levels will allow the creation of an artificial unsaturated zone in order to obtain the 1m offset required. It is likely that appropriate types of infiltration devices will be swales and permeable pavement designs.

Where levels are not being raised to allow the creation of an artificial unsaturated zone, then attenuated storage and control discharge into the local surface water network is likely alternative surface water drainage solution. Due to the shallow groundwater any such attenuation storage basins will need to be lined to prevent groundwater ingress.

6.6. PAVEMENT CONSTRUCTION

From consideration of the observed ground conditions and the plasticity of the near surface sandy clay soils of the River Terrace Deposits, it is recommended that a preliminary design California Bearing Ratio (CBR) of 4% is assumed. The cohesive deposits will be prone to rapid degradation during wet weather working and this should be avoided where possible.

The River Terrace Deposits are not considered to be a frost susceptible soil type (unlike the underlying Raised Beach deposits, but these are too deep to influence pavement design).

Once the development layout is confirmed, a further geotechnical investigation should be undertaken in order to establish the design CBR along the line of the proposed roads to be adopted in accordance with West Sussex County Council requirements.

All unsuitable soils, such as topsoil or desiccated soils, should be removed from beneath proposed paved areas. The exposed sub-grade formation should then be proof rolled to reveal any excessively soft or compressible zones and any such features identified also removed by excavation. Where unsuitable materials are removed, the resultant voids should be filled in layers with appropriately compacted suitable granular fill. To reduce the loss of granular construction materials into the sub-grade, consideration should be given to utilising a geotextile starter layer across the formation level.

6.7. PRELIMINARY FOUNDATION RECOMMENDATIONS

6.7.1. Introduction

Ground conditions have been proved consistent across the site. Typically, the River Terrace Deposits at shallow depths are recorded predominantly as clay soil type, but interbedded gravel/sand sequences have been observed in most of the exploratory works. Underneath, at depths between 1.3m and 2.5m the sandy deposits of the Raised Beach Deposits have been recorded deepening towards the west. The sandy soils have been recorded with a lower strength/density on encountering the groundwater level. The London Clay has been recorded at sufficient depth that it will not influence shallow foundation design.

It is considered that the site is suitable for shallow spread foundations, but groundwater will impact on when constructing such footings will be practicable. Within the zones of influence of the trees deepened trench fill foundations are considered appropriate, but piled foundations may need to be considered if such structures are to be constructed during periods of shallow groundwater.

For a limited number of plots, reinforced footings are likely to be required where different type of soils are found at formation level are present at foundation depth.

Around the groundwater level the Raised Beach Deposits typically exhibit an effective strength soil reduction and so some restrictions need to be considered in terms of bearing capacity. Consideration should be given to further investigation employing static Cone Penetration Testing (CPT) targeting specific structures with high loads e.g. apartment blocks. Such testing may allow higher bearing capacities to be employed in the design of the targeted structures.

Foundation construction in the winter months and sustained wet periods will need to be avoided to minimise construction difficulties. Consequently, and where possible, it is recommended that foundations are placed at the shallowest level as possible into the River Terrace Deposits. It is strongly recommended that foundation construction is only attempted in the drier summer/autumn months, from May to September inclusive, when the groundwater will typically be at its seasonal deepest.

6.7.2. Floor Slabs

In consideration of the near surface clay soils, fully suspended floor slabs designed and constructed in accordance with NHBC Standards are recommended at this development.

With reference to Section 2.2, the floor construction will not have to incorporate radon gas protection measures.

6.7.3. Traditional Footings

The site is marginally suitable for the adoption of shallow strip/trench fill footings. Foundations should be taken through made ground/topsoil to bear upon the River Terrace Deposits and/or the Raised Beach Deposits.

A reduced and conservative bearing value of 100kN/m^2 is considered appropriate for foundations up to 1m wide bearing upon the sands/gravel and sandy clay soils of the River Terrace Deposits and/or the Raised Beach Deposits. Immediate and long term settlement should be within tolerable limits and take place over several years.

Where different type of soils are found at foundation level, clayey gravel, clayey sand and sandy soils of the River Terrace Deposits and/or the Raised Beach Deposits it is recommended that nominal steel mesh reinforcement is included within the footing. This is to reduce the effects of differential settlement across the varying strata and distribute stresses more evenly.

Near surface the clayey soils of the River Terrace Deposits have been shown to have a low volume change potential when assessed against NHBC standards and therefore the minimum foundation depth required is 0.75m, but 1.00m where required to allow for restricted new tree planting. Under the NHBC Standards, foundation depths have to be increased if they are within the influence zone of felled trees, existing trees or proposed tree planting. It should be noted that where trees are in groups the resulting competition for resources can lead to deeper root systems than allowed for in the NHBC Standards. In any event, foundations should be taken below any roots encountered in foundation trench excavation. Where the required foundation depth varies around a structure, this can be accommodated by forming steps in the foundation as per NHBC Standards.

It should be noted that the Raised Beach Deposits is considered a non-shrinkable soil type as they are mainly sand and therefore the depth to reach these soils will be the maximum required foundation depth in regard of tree influence.

The excavator must be set up with care and operated correctly to ensure trench walls are vertical and base horizontal as any slight inclination will result in eccentric loading on trench fill footings.

A number of trees and tree stumps are located along the site boundaries. It will be necessary to remove all unwanted trees, stumps and root structures prior to commencing with the development. Any resultant void should be backfilled accordingly with respect to the preferred foundation design in the unlikely event that structures are to be placed in these locations.

Excavations encountering groundwater seepage or perched water at the site rapidly become unstable and this will complicate the construction of the footings. The ease of construction will be dependent upon actual groundwater levels present at the time of construction. As a consequence of this, it is recommended that construction of footings is avoided in sustained wet periods and during the winter months when groundwater can expected to be at its shallowest.

If problems are encountered then a 'dig and pour' approach may be required or in extreme cases a piled solution may need to be adopted. It is an inherent risk of 'dig and pour' that spoil disposal and concrete volumes could increase and professional supervision is also required. To minimise instability, the length of trench open at any one time can be reduced by adopting a two part solution. The first is a lower mass pour trench fill constructed using a semi-dry concrete that can be progressed segmentally around the plot. A thin reinforced strip footing can then be constructed upon the mass fill element once it has set.

An alternative to 'dig and pour' could be to employ specialist dewatering to allow the formation of footings. Such an approach would need good engineering control and reinforcement of the footing is advisable if this approach is taken.

During construction, any soft spots found at foundation formation level should be excavated and replaced with lean mix concrete. Foundation excavations should be kept dry and left open for the minimum amount of time possible. Where foundations cannot be completed immediately, a blinding layer of concrete should be placed.

6.8. RECOMMENDATIONS FOR FURTHER GEOTECHNICAL WORK

A tree survey is required for detailed foundation design. This survey with topographic survey data should be undertaken prior to any site clearance to accurately record the location of any previously felled trees and existing trees both within the site and close to the site boundaries. The survey should record the trunk location, height and species of the trees.

Once the development layout is confirmed, a further geotechnical investigation should be undertaken in accordance with West Sussex County Council requirements in order to establish the design CBR along the line of the proposed roads to be adopted.

Consideration should be given to further investigation employing static Cone Penetration Testing (CPT) targeting specific structures with high loads e.g. apartment blocks. Such testing may allow higher bearing capacities to be employed in the design of the targeted structures.

7. RISK ESTIMATION – SOILS

7.1. HUMAN HEALTH

The Generic Assessment Criteria (GAC) employed below are for residential land use as this is appropriate to the proposed form of development.

CONTAMINANT	UNITS	NUMBER OF TESTS	MAXIMUM CONCENTRATION	GAC	NUMBER EXCEEDING GAC
Arsenic	mg/kg	8	14	37	0
Cadmium	mg/kg	8	0.3	22	0
Chromium (total)	mg/kg	8	26	910	0
Chromium (hexavalent)	mg/kg	8	<2	21	0
Copper	mg/kg	8	15	2,400	0
Lead	mg/kg	8	27	200	0
Mercury	mg/kg	8	<1	11	0
Nickel	mg/kg	8	25	180	0
Selenium	mg/kg	8	<3	250	0
Zinc	mg/kg	8	57	3,700	0
pH	Units	8	6.6-8.3	<5-10>	0
Naphthalene	mg/kg	8	<0.1	2.3	0
Acenaphthylene	mg/kg	8	<0.1	170	0
Acenaphthene	mg/kg	8	<0.1	210	0
Fluorene	mg/kg	8	<0.1	170	0
Phenanthrene	mg/kg	8	<0.1	95	0
Anthracene	mg/kg	8	<0.1	2,400	0
Fluoranthene	mg/kg	8	<0.1	280	0
Pyrene	mg/kg	8	<0.1	620	0
Benzo(a)anthracene	mg/kg	8	<0.1	7.2	0
Chrysene	mg/kg	8	<0.1	15	0
Benzo(b)fluoranthene	mg/kg	8	<0.1	2.6	0
Benzo(k)fluoranthene	mg/kg	8	<0.1	77	0
Benzo(a)pyrene	mg/kg	8	<0.1	2.2	0
Indeno(1,2,3-cd)pyrene	mg/kg	8	<0.1	27	0
Dibenzo(a,h)anthracene	mg/kg	8	<0.1	0.24	0
Benzo(ghi)perylene	mg/kg	8	<0.1	320	0
TPH Aliphatic C5-C6	mg/kg	3	<0.01	42	0
TPH Aliphatic C6-C8	mg/kg	3	<0.05	100	0
TPH Aliphatic C8-C10	mg/kg	3	<2	27	0
TPH Aliphatic C10-C12	mg/kg	3	<2	130	0
TPH Aliphatic C12-C16	mg/kg	3	<3	1,100	0
TPH Aliphatic C16-C35	mg/kg	3	<10	65,000	0
TPH Aliphatic C35-C44	mg/kg	3	<10	65,000	0

CONTAMINANT	UNITS	NUMBER OF TESTS	MAXIMUM CONCENTRATION	GAC	NUMBER EXCEEDING GAC
TPH Aromatic C5-C7	mg/kg	3	<0.01	70	0
TPH Aromatic C7-C8	mg/kg	3	<0.05	130	0
TPH Aromatic C8-C10	mg/kg	3	<2	34	0
TPH Aromatic C10-C12	mg/kg	3	<2	74	0
TPH Aromatic C12-C16	mg/kg	3	<2	140	0
TPH Aromatic C16-C21	mg/kg	3	<3	260	0
TPH Aromatic C21-C35	mg/kg	3	<10	1,100	0
TPH Aromatic C35-C44	mg/kg	3	<10	1,100	0
Benzene	mg/kg	3	<0.002	0.87	0
Toluene	mg/kg	3	<0.005	130	0
Ethylbenzene	mg/kg	3	<0.002	47	0
Xylene (total of all types)	mg/kg	3	<0.002	56	0
Methyl Tert Butyl Ether (MTBE)	mg/kg	3	<0.005	49	0
Semi-Volatile Organic Compounds (SVOCs)	mg/kg	3	<0.15	LOD*	0
Organochlorine Pesticides	mg/kg	3	<0.02	LOD*	0
Notes: *Limit of detection: Given the large amount of compounds in this group, coupled with the lack of GAC for certain compounds, any concentrations above the limit of detection will be highlighted in the first instance.					

None of the samples record any contaminants at concentrations exceeding their respective assessment criteria.

7.2. WATER ENVIRONMENT

It is not appropriate to consider human health assessment criteria for human health in relation to the risk to the water environment, but currently there are no generic soil assessment criteria in respect of the water environment. In the absence of any groundwater sampling data, the soil results are assessed on the basis of professional judgement.

The contaminant concentrations recorded in the soils at the site are not considered to be at such levels that they would present any significant risk to the underlying water environment.

7.3. BUILDING MATERIALS

CONTAMINANT	UNITS	NUMBER OF TESTS	MAXIMUM CONCENTRATION	GAC	NUMBER EXCEEDING GAC
pH	units	16	6.6-8.3	<5.5	0
Sulphate (w/s)	mg/l	16	64	500	0
Sum of SVOC + Aliphatic TPH >C5-C10 + Aromatic TPH >C5-C10 above detection limits	mg/kg	3	<2	2	0
Sum of Aliphatic TPH >C10-C21 + Aromatic TPH >C10-C21 above detection limits	mg/kg	3	<10	10	0
Sum of Aliphatic TPH >C21-C34 + Aromatic TPH >C10-C35 above detection limits	mg/kg	3	<10	500	0
Sum of BTEX + MTBE above detection limits	mg/kg	3	<0.005	0.1	0
Phenols	mg/kg	3	<0.1	2	0
Cresols and chlorinated phenols	mg/kg	3	<0.1	2	0
Naphthalene	mg/kg	8	<0.1	0.5	0
Benzo(a)pyrene	mg/kg	8	<0.1	0.5	0

None of the samples record any contaminants at concentrations exceeding their respective assessment criteria.

8. RISK EVALUATION

8.1. REVISED CONCEPTUAL MODEL

The revised conceptual site model plan is presented in the Appendices.

ADDITIONAL POLLUTANT LINKAGES	During the ground investigation, no additional sources of contamination were identified.
INVALID POLLUTANT LINKAGES	None of the previously identified potential pollutant linkages were found to be valid. The chemical testing has demonstrated a lack of any residual pesticides in the soil and there is no migratory contaminants from either the off site fuel tanks to the north or the sewage pumping station to the west.
LIMITATIONS AND UNCERTAINTIES	No exploratory holes were completed in the existing residential property at No. 24 Meadow Way in the south east corner which is currently proposed as the new development access route. This will need to be addressed at some point prior to development as there is a minor risk of contamination in this area. However, overall a sufficient spread of exploratory points was competed for contamination assessment purposes.

8.2. UPDATED CONTAMINATION RISK ASSESSMENT

The pollutant linkages identified in the revised conceptual site model will now be evaluated as to their severity:

SOURCES AND CONTAMINANTS	PATHWAYS (REFERENCE FROM MODEL)	RECEPTORS	POTENTIAL RISK
Agricultural fields	Direct contact Ingestion Inhalation Fruit / Vegetable uptake	Future residents	Negligible
Residential land use (SE corner)	Direct contact Ingestion Inhalation Fruit / Vegetable uptake (2)	Future residents	Low
	Direct contact	Building materials and services	Negligible

SOURCES AND CONTAMINANTS	PATHWAYS (REFERENCE FROM MODEL)	RECEPTORS	POTENTIAL RISK
Adjacent sewage pumping station	Spills onto site leading to: Direct contact Ingestion Inhalation Fruit / Vegetable uptake	Future residents	Negligible
Off site nursery and tank	Migration to site via groundwater leading to: Inhalation of vapours	Future residents	Negligible

The contamination risks that are presented to the various receptor groups are discussed further in the following sections:

RISK TO HUMAN HEALTH
No contamination risks have been identified in the main field section of the site during the ground investigation. The small residential section in the south east corner remains un-investigated and therefore a presumed low risk still exists in this section until proven otherwise.

RISK TO WATER ENVIRONMENT
No risks to the water environment have been identified by this ground investigation.

RISK TO BUILDING MATERIALS AND SERVICES
No risks to building materials and services have been identified by this ground investigation.

8.3. RISK MANAGEMENT

8.3.1. Introduction

A lack of soil contamination risks has been identified at the site by the ground investigation.

It is recommended that this report is submitted to the planning department of the Local Authority, the organisation undertaking the Building Control function and warranty providers to confirm that the investigation completed to date is satisfactory.

8.3.2. Further Contamination Assessment

In order to provide further confidence in the risk assessment and to address the limitations and uncertainties identified within the existing conceptual model it is recommended that the following additional investigation elements are completed for contamination assessment purposes:

- It is considered that further exploratory points are required in the vicinity of the existing residential property at No. 24 Meadow Way in order to confirm a lack of contamination in this area.

8.3.3. Outline Remediation Strategy

Due to the absence of contamination risks, no remediation is considered necessary.

8.4. WASTE SOIL DISPOSAL

Topsoil should be viewed as a resource rather than a waste. As the topsoil is suitable for residential garden use in terms contamination, the topsoil at the site should be stripped and the surplus reused on other developments. It should be noted that topsoil, even if uncontaminated, is unlikely to constitute 'inert waste' due to its high organic matter content.

It is considered that any natural sub-soils disposed of from the site would be classified as 'non-hazardous waste' and would be characterised for disposal to landfill as 'inert waste'. However, the chemical results should be forwarded to the proposed landfill site and the waste classification confirmed prior to disposing of any surplus soils. Waste Acceptance Criteria (WAC) testing of the soils will also be required where the soil is to be disposed of at a landfill permitted to accept inert waste. Such WAC testing has been completed and the results are in the Appendices which confirm the soil tested complies with the inert waste limits. The waste code from the European Waste Catalogue (EWC) 2002 for the soils would be 17 05 04 'Soil and Stones, not containing dangerous substances'.

9. HEALTH AND SAFETY FILE INFORMATION

9.1. INTRODUCTION

The aim of the following sections is to present pertinent Health and Safety information that has arisen from the current investigation/survey works discussed in this report. The aim is to identify health and safety controls that may be necessary during any subsequent maintenance, refurbishment, demolition or construction works. The information is not exhaustive and stems only from the aspects identified within the scope of the works undertaken by BRD.

Where BRD has been appointed as a Principal Contractor, then this information shall form the Health and Safety Files as required by the Construction Design and Management (CDM) Regulations 2015.

Reports are always forwarded to the Client and they shall be responsible for ensuring this safety information is disseminated to those who need it.

The works undertaken by BRD are detailed in the previous sections of this report.

9.2. HAZARDS

During the course of the BRD works the following noteworthy safety hazards have been identified:

9.2.1. Contamination

Although no contamination has been identified, as with any construction site, if any anomalous material is encountered during the redevelopment then expert environmental advice should be sought.

9.3. HAZARDOUS MATERIALS

BRD did not construct anything with hazardous materials.

Any soils to be imported to the site, in particular topsoil, should be tested to confirm their suitability in the development.

9.4. UTILITY SERVICES

No previously unidentified utility services were encountered during the BRD works.

The utility services plans held by the Client should be referred to.

REPORT SPECIFIC REFERENCES

- British Geological Survey sheet 317/332 “Chichester and Bognor” Solid and Drift edition (1:50,000) published 1996.
- ‘Phase 1 Environmental Desk Study – Hook Lane, Westergate’, BRD Environmental Ltd, report ref. BRD3963-OR1-A, dated July 2022.

SUPPORTING INFORMATION

GROUND INVESTIGATION

Exploratory holes are logged by an experienced Geo-Environmental Consultant in general accordance with 'Code of practice for site investigations' BS5930:2015, British Standards Institution, 2015. Soil samples for chemical and geotechnical analysis are taken from the exploratory holes at intervals dictated by the nature of the soils and the objectives of the investigation.

Where stated on the logs of inspection pits, trial pits or boreholes (where insitu testing has not been undertaken), the relative density of coarse (sand and gravel) soils is tentative only. Such assessments of density are on the basis of visual inspection only taking into consideration such factors as drilling rates, stability of pit side walls, appearance and behaviour under excavation.

Where Chalk strata is encountered it is logged and graded in general accordance with CIRIA guidance 'C574 - Engineering in Chalk'. It should be recognised that where percussive drilling methods are employed, the structure of the Chalk is destroyed and therefore the grading stated on such logs is either tentative or absent where it is not possible to assess the grade.

Hand Dug Inspection Pits

Hand tools are used to forward shallow inspection pits as a cost effective method of describing and sampling near surface soils. The technique is also used where exposure of existing footings is required. The depth reached by such techniques is a function of the nature of the ground and generally does not exceed 1.5m

Trial Pits

Mechanically excavated trial pits allow detailed inspection of near surface ground due to the large volume of soil exposed. A wheeled backhoe loader is the usual machine for digging trial pits that are typically 3 to 4.5m deep, 0.5m wide and 3m long.

Windowless Sampling Boreholes

This type of borehole is formed by a small tracked dynamic percussion drilling rig with samples retrieved in thin plastic liners within the narrow diameter steel sampling tubes. Borehole depths of up to 5m are typical, but in exceptional circumstances up to 15m depth can be achieved. This is the smallest type of rig that is capable of undertaking Standard Penetration Tests (SPTs).

Hand Held Window Sampling

Hand held window sampling is a useful method of drilling narrow diameter boreholes particularly where access is difficult. Hand held mechanical percussive hammers are used to drive the sampling tube into the ground. The soil samples are collected within the hollow metal sampling tubes and inspected via the open window along one side. Window sampling boreholes can be forwarded to depths of 3m to 6m depending upon ground conditions.

Cable Percussive Boreholes

This form of drilling involves repetitive dropping of a tube into the soil under its own weight from a tripod support. The sample is obtained from the clay cutter head in fine soils or a bailer for wet granular soils. As the borehole progresses SPTs can be undertaken and relatively undisturbed samples can be obtained. Typically these boreholes are 15 to 25m deep, but depths of double that can be achieved in soils, but only thin weak rock layers can be penetrated.

Rotary Boreholes

Where competent rock is required to be drilled then rotary drilling techniques are required. The drilling rigs can vary in size from small tracked units to larger units mounted on four wheel drive trucks. Rotary open hole drilling techniques break the rock into small fragments and so recovery of any samples is limited. In contrast, rotary coring retrieves excellent samples. Some rigs also allow windowless sampling to be undertaken through soil layers. There are no practical limits to the depths that this drilling method can achieve.

Dynamic Probing

Dynamic probing comprises a sectional rod with a sacrificial cone at the base of slightly larger diameter than the rod. The rod is driven into the ground by a constant mass falling through a set distance. The number of blows required to forward the rod per 100mm is then recorded and presented in a graph of N_{10} values. The standard applicable to dynamic probing is "BS EN ISO 22476-2:2005 Incorporating corrigendum no. 1, Geotechnical investigation and testing – Field testing – Part 2: Dynamic probing" BSi, February 2007.

Static Cone Penetration Tests

Cone Penetration Tests (CPT) consist of pushing a conical 60° cone into the ground at a constant rate and recording the force required to do this. Sensors in the cone record other information and this data can be correlated to a number of different geotechnical parameters.

Dynamic Penetrometer

The Transport Research Laboratory Dynamic Cone Penetrometer (TRL DCP) uses an 8 kg hammer dropping through a height of 575mm to drive a 60° cone of 20mm maximum diameter into the ground. The depth driven either per blow or per several blows is recorded. The strength of each of the soil layer encountered is then calculated by converting the penetration rate (mm per blow) into an approximate California Bearing Ratio (CBR) value employing the correlation proposed by TRL.

Gas Monitoring

Gas monitoring is undertaken with a portable gas monitor for oxygen, Methane, Carbon Dioxide, Hydrogen Sulphide and Carbon Monoxide together with recording of atmospheric pressure and any flow rate.

Vapour Monitoring

Headspace tests and monitoring for Volatile Organic Compounds (VOC) or Semi Volatile Organic Compounds (SVOC) is undertaken using a Photo Ionisation Detector (PID). The MiniRAE models used have a 10.6 eV lamp calibrated for isobutylene. The PID is useful tool to indicate the presence of a wide range of volatile compounds, but only provides semi-quantitative data as different compounds provide a different response and thus the reading is not a true reflection of the actual concentration present.

Low PID readings can be recorded in natural uncontaminated organic soils or even as a result of atmospheric pollution. It is generally accepted by consultants and regulators that recorded values in excess 50 parts per million (ppm) represents the presence of organic compound pollutants and in excess of 100 ppm such contamination may be significant.

The headspace test procedure involves the collection of a sample of suspected contaminated soils and placing within a sample bag. A tight seal to the bag is formed with a similar volume of air trapped to that of the soil and the sample is left for fifteen minutes to allow volatilisation of any contaminants. The bag is then pierced by, and sealed around, the sample probe of the PID and a reading taken.

Borehole well monitoring is undertaken by connecting the PID directly to the gas tap on the monitoring well installation.

Groundwater Level Monitoring

Groundwater levels are recorded with an electronic dip meter that has a detector end that is lowered into the borehole well. An audible signal is made when water is reached and the depth recorded from the graduated tape used to lower the detector. Where there is potential for a separate Light Non Aqueous Phase Liquid (LNAPL) to be present floating on the groundwater an oil/water interface meter is used in preference to a conventional dip meter so that any such floating product can be detected.

Geotechnical Sampling

BRD schedule a range of geotechnical testing as appropriate to the identified ground conditions, available budget and the proposed development. Different types of soil samples are obtained as appropriate to the ground conditions and planned testing.

SAMPLE TYPE	*SYMBOL USED ON LOGS*	*DESCRIPTION*
Disturbed	*D*	*Small disturbed soil samples of about 1 to 2 kg are collected in plastic bags.*
Bulk	*B*	*Large disturbed bulk samples up to about 20 to 30 kg are collected in plastic bags*
Undisturbed	*U*	*'Undisturbed' samples generally collected in plastic or metal tubes within cable percussive boreholes of 100mm diameter for samples of fine soils of firm to stiff consistency. Can also be representative of samples taken by cutting plastic sample liners from windowless sampling drilling methods. It is recognised that such samples do not generally meet Eurocode sample quality requirements for the tests commonly employed. However, given the wealth of experience with these sampling methods this continues to be common in United Kingdom practice particularly for less sensitive developments where more expensive sampling techniques are not economically justifiable.*
Undisturbed	*UT*	*A thin walled steel sampler developed by Archway Engineering called a UT100 in an attempt to gain better quality samples of soft to firm fine soils when using cable percussive drilling methods.*

Contamination Sampling

BRD schedule contamination testing as appropriate to the ground conditions, available budget, potential contaminants and the proposed development. Samples are collected in single use laboratory supplied containers.

Soil samples are retrieved in plastic containers and/or amber glass jars with a lined plastic cap. Contamination samples are indicated by a 'J' on exploratory hole logs.

Water samples are collected in plastic bottles and/or amber glass jars with a lined plastic cap then placed in cool boxes together with freezer packs. Water samples are indicated by a 'W' on exploratory hole records, but generally such samples are not tested as testing from dedicated monitoring wells is preferred for sample quality reasons.

Samples retrieved from the exploratory holes are dispatched to the laboratory by overnight courier. Where samples cannot be transported directly from site they are temporarily stored in the BRD dedicated sample storage facility which includes refrigeration where necessary. The individual accreditation of the test methods is detailed in the laboratory test report.

GEOTECHNICAL ASSESSMENT

Under Eurocode 7 (EC7) the following risk ranking is applied to geotechnical projects:

GEOTECHNICAL CATEGORY	*DESCRIPTION*
1	*Small and relatively simple structures for which it is possible to ensure that the fundamental requirements will be satisfied on the basis of experience and qualitative geotechnical investigations with negligible risk. For example, straightforward ground conditions, local experience, no excavation below the water table unless this will be straight forward.*
2	*Conventional types of structures and foundations. No difficult soil or loading conditions. Quantitative geotechnical data and laboratory testing. Routine procedures for field and laboratory testing. Conventional structures and no exceptional geotechnical risk. For example, spread, raft and piled foundations, retaining walls, bridge piers and abutments, embankments, ground anchors, tunnels and excavations.*
3	*Those structures not in Categories 1 and 2 such as very large or unusual structures, structures involving abnormal risks, or unusual or exceptionally difficult ground or loading conditions. Structures in highly seismic areas. Structures in areas of probable site instability or persistent ground movements that require separate investigation or special measures.*

GEOTECHNICAL PARAMETERS

Soakage Tests

Soakage tests comprise the filling of a test pit with water and recording the time taken for the water to drain away. The tests are undertaken in general accordance with 'Digest DG 365: Soakaway design' BRE, Revised 2016. The test pits are usually gravel filled for safety with a slotted vertical pipe through which water observations are made. Water is generally supplied by a tanker to allow fast filling of the pits with water. Compliant tests are filled and allowed to drain near empty three times.

Standard Penetration Tests

The standard penetration test (SPT) determines the resistance of soils at the base of a borehole to the dynamic penetration of a split barrel sampler and the recovering of disturbed samples for identification purposes. In gravelly soils and some soft rocks a solid cone is used in preference to the sampler.

The basis of the test consists in driving a sampler by dropping a hammer of 63.5 kg mass on from a height of 760 mm. The number of blows (N value) necessary to achieve a penetration of the sampler of 300 mm is recorded. The test is described in 'Geotechnical investigation and testing – Field testing – Part 3: Standard penetration test - BS EN ISO 22476-3:2005 Incorporating corrigendum no. 1', BSi, 2007.

The uncorrected N values of the SPT tests are recorded upon the borehole logs together with a record of blows for each 75mm test portion including the seating blows. Where the full test depth cannot be achieved due to refusal on hard stratum, the number of blows and the distance achieved is recorded and the N value given as >50. The abbreviation SPT(c) is used upon the logs indicates that the test was performed with a solid cone rather than a split spoon sampler.

It is necessary to apply a correction to the N values to account for the effects of energy delivery using the equation: $N_{60} = \frac{E_r}{60} N$ *where* E_r *is the energy ratio of the specific test equipment.*

In the case of tests in sand, for the effects of overburden and rod length the equation is modified to $N_{60} = \frac{E_r}{60}\ x\ \lambda\ x\ C_N\ x\ N$ *where* λ *is the correction factor for energy losses due to the rod length and* C_N *is the correction factor for vertical stress due to overburden of the soil.*

Sulphate

In order to compare the laboratory soil test results with 'Concrete in aggressive ground. BRE Special Digest 1: 2005' (BRE, 2005) laboratory results are converted to SO_4 *mg/l. Laboratory results expressed as* SO_3 *g/l and are multiplied by a factor of 1200 to express the results as* SO_4 *mg/l.*

Index Property Tests

In accordance with National House Building Council (NHBC) Standards Chapter 4.2 – Building near trees, the laboratory plasticity indexes are assessed against their volume change potential. The Modified Plasticity Index is defined as the Plasticity Index of the soil multiplied by the percentage of particles with a nominal diameter of less than 425µm. Whilst the NHBC Standards were developed for residential buildings, the advice is equally applicable to a large number of other types of low rise structures.

Hand Shear Vane

The undrained shear strength of the fine (i.e. clay) soils at the site can be established using hand shear vane apparatus. Usually three readings are taken at every depth tested and the uncorrected results recorded on the exploratory point log. Shear vane readings from depths below 1.2m depth in trial pits are from tests performed on excavated soil. In accordance with Eurocode 7 — Geotechnical design — Part 2: Ground investigation and testing EN 1997-2:2007 the results should be corrected. BRD employ only simple correction methods as the more complex correction methodologies imply undue accuracy to a test that has distinct disadvantages and limitations.

Pocket Penetrometers

The Pocket Penetrometer is a lightweight instrument for use by field personnel to check visual classification of soils. It is a simple test and there is inherent uncertainty related to the small volume of soil being tested and so the results should be used with appropriate caution. Pocket penetrometers are calibrated in terms of unconfined compressive strength and once converted to undrained shear strength (divide by two) the results are further reduced by a factor of 1.5 - 2.0 as the device tends to overestimate strengths.

Instrument Reading (uncompressive strength in kg/cm^2)	*Indicative Undrained Shear Strength (kN/m^2)*	*Indicative Consistency*	*Indicative strength*
1.0	*25 – 33*	*Soft*	*Low*
1.5	*38 – 50*	*Soft to firm*	*Low to medium*
2.0	*50 - 67*	*Firm*	*Medium*
2.5	*63 – 83*	*Firm to stiff*	*Medium to high*
3.5	*88 – 116*	*Stiff*	*High*
4.5	*113 – 150*	*Stiff to very stiff*	*High to very high*

CONTAMINATION ASSESSMENT METHODOLOGY

UK Policy

The UK Government's policy in relation to land affected by historic contamination is based on a 'suitable for use' approach. The approach recognises that the risks presented by any given level of contamination will vary greatly according to the use of the land and a wide range of other factors, such as the underlying geology of the site. Contamination risks therefore need to be assessed on a site-by-site basis. The 'suitable for use' approach limits requirements for remediation to the work necessary to prevent unacceptable risks to human health or the environment in relation to either the current use or future use of the land.

The three main drivers for contamination assessment and remediation are:

- *Voluntary action.*
- *Development as part of the planning regime.*
- *Regulatory action to mitigate unacceptable risks e.g. Part 2A of the Environmental Protection Act 1990.*

Pollutant Linkages

For a contamination risk to exist there must be a 'pollutant linkage' from the contaminant (source) via a pathway (the route from contaminant to receptor) to a receptor (the entity that could be harmed). The absence of a contaminant, pathway or receptor breaks the pollutant linkage and therefore no contamination risk exists.

Contamination is typically present at a site (in the ground and/or in the underlying groundwater) as a result of a historic or current industrial use, usually as a result of leaks, spills or disposal of residues, wastes and excess raw materials from the industrial processes. Contamination may also be present due to:

- *The deliberate application of chemicals e.g. the spraying of herbicide/pesticide.*
- *Migration of pollutants from adjacent land.*
- *Naturally occurring processes e.g. elevated concentrations of particular heavy metals associated with specific geological strata.*

Conceptual Site Model

The conceptual site model can be defined as a textual or graphical representation of the identified pollutant linkages for a given site. The model forms the basis for designing the investigation as the aim will be to target all of the potential pollutant linkages to determine, through the subsequent phases of risk assessment, whether or not they pose an actual risk.

It is important that the conceptual site model is updated with new information as the various investigation, risk assessment and remediation works are completed.

Technical Guidance

The technical and legal framework for contamination assessment is complex. The process adopted through this report for assessing contamination risks is in general accordance with the following guidance, as listed below:

- *'Investigation of Potentially Contaminated Sites - Code of Practice - BS 10175:2011+A2:2017', The British Standards Institution 2017.*
- *Land Contamination Risk Management, Environment Agency, 2021.*
- *'Guidance for the safe development of housing on land affected by contamination - R&D66: 2008', NHBC/Environment Agency, 2008.*

Risk Assessment Methodology

In line with the technical guidance, the contamination risk assessment follows a series of phased stages for each particular site:

PHASE	*DESCRIPTION*	*RISK ASSESSMENT STAGE*
PHASE1	*Generally limited to desk based research and a site walkover survey to develop an initial conceptual site model and identify what risks, if any, are likely to be presented by the site.*	***Hazard Identification and Assessment*** *A preliminary stage of risk assessment concerned with identifying and characterising the hazards that may be associated with a particular site and identifying potential pollutant linkages.*
PHASE 2	*This phase is concerned with establishing whether contamination is present, usually through intrusive ground investigation, and then evaluating the degree and magnitude of the associated risks.*	***Risk Estimation*** *A stage concerned with estimating the likelihood that receptors will suffer adverse effects if they come into contact with, or are otherwise affected by, a hazardous substance or agent under defined conditions.* ***Risk Evaluation*** *A stage of risk assessment concerned with evaluating the acceptability of estimated risks, taking into account the nature and scale of the risk estimates, any uncertainties associated with the assessment and the broad costs and benefits of taking action to mitigate risks.*
PHASE 3	*The appraisal and selection of remediation techniques, their implementation and verification.*	***Risk Management*** *The process whereby decisions are made to accept a known or assessed risk and/or the implementation of action to reduce the consequences or probabilities of occurrence.*

Risk Classification

The objective of risk assessment is to identify the nature and magnitude of the potential risks and should be based on a consideration of both:

- *The likelihood/probability of an event [taking into account both the presence of the hazard and receptor and the integrity of the pathway].*
- *The severity of the potential consequence [taking into account both the potential severity of the hazard and the sensitivity of the receptor].*

There is a need for a logical, transparent and repeatable system in defining the categories of severity of consequence and likelihood as well as for the risk itself and therefore the following risk rating matrix is employed:

		SEVERITY OF CONSEQUENCE			
		SEVERE	MEDIUM	MILD	MINOR
PROBABILITY	HIGH LIKELIHOOD	Very High Risk	High Risk	Moderate Risk	Moderate/Low Risk
	LIKELY	High Risk	Moderate Risk	Moderate/Low Risk	Low Risk
	LOW LIKELIHOOD	Moderate Risk	Moderate/Low Risk	Low Risk	Negligible Risk
	UNLIKELY	Moderate/Low Risk	Low Risk	Negligible Risk	Negligible Risk

These risk classifications are defined as follows:

- *Very High Risk - There is a high probability that severe harm could arise to a designated receptor from an identified hazard at the site without appropriate remediation action.*
- *High Risk - Harm is likely to arise to a designated receptor from an identified hazard at the site without appropriate remediation action.*
- *Moderate Risk - It is possible that without appropriate remediation action harm could arise to a designated receptor. It is relatively unlikely that any such harm would be severe, and if any harm were to occur it is more likely that such harm would be relatively mild.*
- *Low Risk - It is possible that harm could arise to a designated receptor from an identified hazard. It is likely that, at worst if any harm was realised any effects would be mild.*
- *Negligible Risk - The presence of an identified hazard does not give rise to the potential to cause harm to a designated receptor.*

This risk assessment matrix and classification system is based on guidance produced by Department for Environment, Food and Rural Affairs (Defra) and the Environment Agency in connection with contaminated land assessment.

RISK ESTIMATION - SOILS

Introduction to Soil Human Health Generic Assessment Criteria (GAC)

The Environment Agency (EA) and Department of Environment Food and Rural Affairs (DEFRA) had previously issued revised guidance following the consultation about the DEFRA publication "Assessing risks from land contamination – a proportionate approach. Soil Guideline Values: the Way Forward". This resulted in a revised version of the Contaminated Land Exposure Model (CLEA) model (version 1.06) and a few of the previously published Soil Guideline Values (SGVs) were revised.

The main legislative driver for dealing with historical land affected by contamination is Part 2A of the Environmental Protection Act 1990. Revised Statutory Guidance to support Part 2A was published in April 2012. This Guidance introduced a new four-category system for classifying land under Part 2A for cases of a Significant Possibility of Significant Harm to human health,1 where Category 1 includes land where the level of risk is clearly unacceptable and Category 4 includes land where the level of risk posed is acceptably low. The impact assessment for the new Statutory Guidance stated "The new statutory guidance will bring about a situation where the current SGVs/GACs are replaced with more pragmatic (but still strongly precautionary) Category 4 screening levels (C4SLs) which will provide a higher simple test for deciding that land is suitable for use and definitely not contaminated land". The C4SLs are still derived using the CLEA model, but adopt a slightly different approach to toxicological assessment and exposure modelling.

In March 2014, the outcome of "SP1010 – Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination - Final Project Report" (CL:AIRE) was published. Due to slightly ambiguous wording within this report, Lord de Mauley, Parliamentary Under Secretary, DEFRA wrote to all local authorities on 3 September 2014 to confirm that the published C4SLs were final and that they can be used in risk assessment undertaken under the planning regime.

Whilst there are proposals for the industry to develop C4SLs for other contaminants, these have yet to produce any new values. BRD do not believe that C4SLs could be developed by a single organisation with sufficient confidence. BRD has therefore employed other, more conservative guidance based on the CLEA model (detailed below) within this assessment for compounds where C4SLs are not available. However, it should be noted that the results of this investigation may need to be reinterpreted as new C4SLs become available.

Due to the limited number of published C4SL values at this time, the Chartered Institute of Environmental health (CIEH) and Land Quality Management Ltd (LQM) have produced Generic Assessment Criteria (GAC) known as Suitable for Use Levels (S4ULs), for use in contaminated land human health risk assessment. These S4ULs (2014) have been derived for a large number of substances using the current CLEA model and are therefore consistent with current guidance. They also incorporate the revised exposure parameters as adopted by the C4SL programme, but have not adopted the revised toxicological approach adopted by the C4SLs and so remain a more conservative assessment criteria. The substances for which SGVs were previously published have also been revised as new S4ULs in light of the new exposure parameters proposed by the C4SL programme, and therefore effectively replace the existing SGVs.

In addition, in December 2009, other GAC for less common substances were produced by the Environmental Industries Commission (EIC), The Association of Geotechnical and Geoenvironmental Specialists (AGS) and Contaminated Land: Applications in Real Environments (CL:AIRE) using the CLEA model. These are referred to as the EIC/AGS/CLAIRE GAC.

In summary, C4SLs have been used where these are available. For those substances where C4SLs have yet to be issued, then the S4ULs have been adopted or in some cases, the EIC/AGS/CLAIRE GAC. All of the previously produced SGVs have now either been withdrawn, or superseded by the respective C4SLs or S4ULs.

The only exception to this approach is the PAH compound benzo(a)pyrene (BaP) where a C4SL guideline value has been produced, whereas BRD has adopted the S4UL value. The C4SL for BaP relates to its use as a surrogate marker compound representing all of the genotoxic PAH compounds as a mixture, rather than this individual compound. BRD has therefore adopted the compound specific S4UL value as the initial screening value, for consistency with the other PAH compounds before then employing the C4SL is necessary.

It should be noted that unless otherwise stated, all the assessment criteria adopted within this report have been derived based on a sandy loam soil at pH 7 and the values quoted are for a conservative soil organic matter content of 1% where applicable (i.e. organic contaminants).

Human Health - Soil Generic Assessment Criteria

The results of the soils analysis have been compared to generic assessment criteria for the default exposure scenarios comprising either residential land with plant uptake, residential land without plant uptake, or commercial/industrial land use. The criteria values selected are listed in the table below and full details on the source are referred to above. Where applicable, the results have also been assessed with reference to the required statistical tests presented within CL:AIRE Professional Guidance: "Comparing Soil Contamination Data with a Critical Concentration".

ANALYSIS	GENERIC ASSESSMENT CRITERIA (mg/kg unless stated)			SOURCE
	RESIDENTIAL WITH PLANT UPTAKE	RESIDENTIAL WITHOUT PLANT UPTAKE	COMMERCIAL / INDUSTRIAL	
Arsenic	37	40	640	C4SL
Cadmium	22	150	410	
Chromium (total)$	910	910	8,600	S4UL
Chromium VI	21	21	49	C4SL
Lead	200	310	2,330	
Mercury*	11	15	320	S4UL
Selenium	250	430	12,000	
Nickel	180	180	980	
Copper	2400	7,100	68,000	
Zinc	3,700	40,000	730,000	
pH	<5 - 10> units			Professional judgement
Naphthalene	2.3	2.3	190	S4UL
Acenaphthylene	170	2,900	83,000	
Acenaphthene	210	3,000	84,000	
Fluorene	170	2,800	63,000	
Phenanthrene	95	1,300	22,000	
Anthracene	2,400	31,000	520,000	
Fluoranthene	280	1,500	23,000	
Pyrene	620	3,700	54,000	
Benzo(a)anthracene	7.2	11	170	
Chrysene	15	30	350	
Benzo(b)fluoranthene	2.6	3.9	44	
Benzo(k)fluoranthene	77	110	1,200	
Benzo(a)pyrene	2.2	3.2	35	
Indeno(1,2,3-cd)pyrene	27	45	500	
Dibenzo(a,h)anthracene	0.24	0.31	3.5	S4UL
Benzo(ghi)perylene	320	360	3,900	
TPH Aliphatic C5-C6	42	42	3,200	
TPH Aliphatic C6-C8	100	100	7,800	
TPH Aliphatic C8-C10	27	27	2,000	
TPH Aliphatic C10-C12	130	130	9,700	
TPH Aliphatic C12-C16	1,100	1,100	59,000	
TPH Aliphatic C16-C35	65,000	65,000	1,600,000	
TPH Aliphatic C35-C44	65,000	65,000	1,600,000	

ANALYSIS	GENERIC ASSESSMENT CRITERIA (mg/kg unless stated)			SOURCE
	RESIDENTIAL WITH PLANT UPTAKE	RESIDENTIAL WITHOUT PLANT UPTAKE	COMMERCIAL / INDUSTRIAL	
TPH Aromatic C5-C7	70	370	26,000	
TPH Aromatic C7-C8	130	860	56,000	
TPH Aromatic C8-C10	34	47	3,500	
TPH Aromatic C10-C12	74	250	16,000	
TPH Aromatic C12-C16	140	1,800	36,000	
TPH Aromatic C16-C21	260	1,900	28,000	
TPH Aromatic C21-C35	1,100	1,900	28,000	
TPH Aromatic C35-C44	1,100	1,900	28,000	
Benzene	0.87	3.3	98	C4SL
Toluene	130	880	56,000	S4UL
Ethylbenzene	47	83	5,700	
Xylene^	56	79	5,900	
MTBE	49	73	7,900	EIC/AGS/CL:AIRE GAC

Notes:
** The S4UL for methyl mercury has been adopted as the worst case mercury compound as generally there is no desk study evidence to suggest the potential for elemental mercury on the majority of sites.*
^ The lowest S4UL of either p-xylene, o-xylene or m-xylene has been adopted for each land use as a conservative measure.
[$] S4UL for Chromium III adopted, as in the absence of Chromium VI it is likely that all of the chromium will be in this form as these are the two most common and stable forms of chromium in the soil environment.

Where no GAC is available, any concentrations exceeding the laboratory limit of detection are identified and discussed in more detail.

Water Environment - Soil Generic Assessment Criteria

There are no UK published Generic Assessment Criteria for soil test results in respect of the risk to the water environment and therefore risk estimation is on the basis of the professional judgement and experience of BRD to employ values that are a reasonable concentration above which concern for water resources is valid.

The Total PAH GAC employed is the sum of the 16No. priority PAH compounds regularly tested for in contaminated land analysis (i.e. US EPA 16PAHs). BRD employ a soil screening based upon the total PAH limit for 'inert waste' of 100mg/kg. The rationale is based on PAHs are recognised to be generally of low solubility and the risk to the water environment is correspondingly low.

In respect of Total Petroleum Hydrocarbons, BRD employ a value of 500 mg/kg as a screening value in comparison to the sum of the component aliphatic and aromatic TPH carbon bands. The employed soil screening value is based upon:

- *In common with some other consultants, the professional judgement and experience of BRD suggests that this value is a reasonable concentration above which concern for water resources is valid. The rationale is based on the fact that lower concentrations of fuel based contaminants are more likely to naturally degrade than migrate any great distance.*
- *BRD is aware of regional Environment Agency groundwater and contaminated land teams historically employing 500 mg/kg as a screening value for considering whether or not TPH could represent a risk to water resources.*
- *The value mirrors the mineral oil Waste Acceptance Criteria limits for what is considered 'inert waste'.*

Should elevated contaminants that pose a potential risk to the water environment be identified then site specific assessment criteria should be developed.

<u>Building Materials and Services – Soil Generic Assessment Criteria</u>

Some hydrocarbon compounds are known to both attack and permeate through certain plastic pipe materials, with the primary concern being the degradation and tainting of water supplies. The UK Water Industry Research (UKWIR) has therefore produced a document 'Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites' (ref. 10/WM/03/21) that specifies threshold criteria for the adoption of 'standard' polythene (PE) or PVC pipes, protective barrier pipe and ductile iron/steel/copper pipes.

The UKWIR threshold assessment criteria from Table 3.1 of this document for standard PE pipes have been employed. It should be noted that the approach taken by UKWIR is very conservative, and both the document and research are flawed. However, it is these values that are being using to specify water pipe materials and therefore it is appropriate to consider them.

The UKWIR guidance is particularly flawed in respect of the chemical analysis it expects as it seeks a limit of detection that is generally below limits that are reasonable or commonly employed in contaminated land assessment. The UKWIR seeks that where a substance is below the limit of detection it should be taken as being present at half this concentration. For the larger suite of chemicals where the limit is against a sum of compounds, this approach would mean that a sample of virgin sub-soil from a greenfield site with absolutely no contamination would actually fail the criteria for using standard PE pipes. To avoid this situation, BRD have adopted the approach of summing only those compounds detected above their respective limits of detection.

In terms of building materials, the primary concern is in respect of concrete as certain commonly occurring natural ground conditions can adversely impact on buried concrete as discussed in 'Special digest 1:2005 Concrete in aggressive ground', BRE, 2005.

ANALYSIS	*GENERIC ASSESSMENT CRITERIA*	*SOURCE*
pH	*<5.5*	*BRE Special Digest 1:2005*
Sulphate (w/s)	*500 mg/l*	*BRE Special Digest 1:2005*
Sum of any VOC above detection limits	*0.5 mg/kg*	*Relevant compounds adapted from UKWIR Table 3.1*
Sum of SVOC + Aliphatic TPH >C5-C10 + Aromatic TPH >C5-C10 above detection limits	*2 mg/kg*	
Sum of Aliphatic TPH >C10-C21 + Aromatic TPH >C10-C21 above detection limits	*10 mg/kg*	
Sum of Aliphatic TPH >C21-C34 + Aromatic TPH >C10-C35 above detection limits	*500 mg/kg*	
Sum of BTEX + MTBE above detection limits	*0.1 mg/kg*	
Phenols	*2 mg/kg*	
Cresols and chlorinated phenols	*2 mg/kg*	
Naphthalene	*0.5 mg/kg*	
Benzo(a)pyrene	*0.5 mg/kg*	

RISK ESTIMATION – GROUNDWATER

The initial assessment of the contamination risk to groundwater is by comparing dissolved groundwater concentrations with screening values (GAC) that are protective of groundwater resources.

The reference source for the target concentrations is generally the EA's Environmental Quality Standards (EQS) (accessed July 2018: http://evidence.environment-agency.gov.uk/ChemicalStandards/report.aspx?cid=17), the Water Supply (Water Quality) Regulations 2016 and the DW1/DW2 criteria from the Surface Water (Abstraction for drinking water)(classification) Regulations 1996. The target concentrations are outlined in the table below. The 'Petroleum Hydrocarbons in Groundwater: Guidance on assessing petroleum hydrocarbons using existing hydrogeological risk assessment methodologies'. CL:AIRE, 2017 has also been used as reference source for the values.

ANALYSIS	GENERIC ASSESSMENT CRITERIA (GAC)	SOURCE
Arsenic	50 µg/l	DW1 & EQS
Cadmium	5 µg/l	EQS
Chromium (total)	50 µg/l	DW2 & EQS
Copper	50 µg/l	DW1
Nickel	20 µg/l	EQS
Lead	50 µg/l	DW1
Mercury	1 µg/l	WSR
Selenium	10 µg/l	WSR
Zinc	5 mg/l	DW2
Cyanide	50 µg/l	WSR
pH	6 to 9 units	EQS
Benzene	10 µg/l	EQS
Toluene	74 µg/l	EQS
Ethylbenzene	300 µg/l	WHO guideline
Xylene	30 µg/l	EQS
Methyl tert-butyl ether (MTBE)	15 µg/l	Taste and odour threshold.
Naphthalene	2 µg/l	EQS
Benzo(a)pyrene	0.0017 µg/l	EQS - Less than Limit of Detection (LOD)
Total PAH	0.2 µg/l	DW1
TPH Aliphatic C5-C6	15,000 µg/l	World Health Organization (WHO) guide values for TPHCWG fractions in drinking water
TPH Aliphatic C6-C8	15,000 µg/l	
TPH Aliphatic C8-C10	300 µg/l	
TPH Aliphatic C10-C12	300 µg/l	
TPH Aliphatic C12-C16	300 µg/l	
TPH Aromatic C5-C7	10 µg/l	
TPH Aromatic C7-C8	700 µg/l	
TPH Aromatic C8-C10	300 µg/l	
TPH Aromatic C10-C12	90 µg/l	
TPH Aromatic C12-C16	90 µg/l	
TPH Aromatic C16-C21	90 µg/l	
TPH Aromatic C21-C35	90 µg/l	

There are no available generic assessment criteria for some of the analytical parameters which have been scheduled, for example hexavalent chromium, and some VOC compounds. These parameters will be assessed based on professional judgement should they exceed the limit of detection.

RISK ESTIMATION - GROUND GAS

<u>Introduction</u>

A variety of potentially hazardous gases occur in naturally in the ground environment. Microbial decay of organic matter under anaerobic conditions and geological processes can lead to the generation of Methane and Carbon Dioxide, but can also include traces gases such as Hydrogen sulphide and Carbon monoxide.

Methane is a colourless and odourless gas that has the hazardous properties of being flammable and, at certain air/Methane mixtures, explosive. Methane has a low toxicity, but can be a simple asphyxiant due to the displacement of oxygen.

Carbon Dioxide is a colourless, odourless and non-combustible gas that has the hazardous property of being a highly toxic chemical. At concentrations of 3% by volume, shortness of breath and headaches will occur becoming acute by 6%. At levels of above 10% by volume headache, visual distortion, tremors and rapid loss of consciousness occur. Concentrations of Carbon Dioxide above 22% by volume are likely to be fatal. The effects of Carbon Dioxide poisoning are made more severe if there is accompanying reduction in oxygen concentrations.

Hydrogen sulphide is a colourless and flammable gas that has an odour of rotten eggs. It is important to that the sense of smell is over powered at higher concentrations. The gas is toxic and can be an asphyxiant.

Carbon monoxide is a colourless, odourless and explosive gas in air mixtures that has the hazardous property of being a highly toxic chemical.

Radon is a naturally occurring colourless and odourless gas that is radioactive. It is formed by the radioactive decay of radium which in turn is derived from the radioactive decay of uranium, both of which are minerals that can be found in many soil types. Whilst it is recognised that the air inside every building contains radon, some buildings built in certain defined areas of the country might have unacceptably high concentrations and require special precautions to be taken. The maps contained within BRE211:2015 'Radon: guidance on protective measures for new buildings' identify areas where no radon protection measures are necessary or where higher concentrations are present that either basic or full radon protection measures are required to be fitted to all new buildings, extensions or refurbishments.

<u>Basis of Gas Assessment</u>

In order to classify the level of risk and need, if any, for gas protection measures at a site with the potential for a gas problem, consideration of each of the following is necessary:

- *The source of the gas.*
- *The generation potential of the gas.*
- *The location of the source and the geological setting.*
- *Boreholes flow rate and estimated surface emission rate.*
- *The nature of the proposed development.*
- *Confidence in the knowledge of the gas regime.*

The gas assessment is made with reference to 'C665 - Assessing risks posed by hazardous ground gases to buildings', Construction Industry Research and Information Association (CIRIA), 2007 and 'BS8485:2015 – Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings' BSi 2015.

<u>Gas Screening Value</u>

The methods within CIRIA C665 and BS8485 both use the gas concentrations together with the borehole flow rates to define a characteristic situation for a site based on the limiting borehole gas volume flow for Methane and Carbon Dioxide. This limiting borehole gas volume flow is called the Gas Screening Value (GSV) and is expressed below:

Gas Screening Value (l /hr) = borehole flow rate (l/hr) x gas concentration (fraction)

The calculation of GSV is completed for both Methane and Carbon Dioxide and then the 'worse case' maximum values are used in the assessment. The assessment is to determine the gas regime at the site is dependent upon the nature of the development.

<u>Characteristic Gas Situation</u>

The characteristic situation for many sites is determined from evaluation of the Gas Screening Value derived against the criteria in the following table.

Characteristic situation	Hazard potential	Gas Screening Value (CH4 or CO2 l/hr)	Additional factors
CS1	Very low risk	<0.07	Typically Methane ≤1% and/or Carbon Dioxide ≤5%. Otherwise consider an increase to characteristic situation 2.
CS2	Low risk	0.07 to <0.7	Borehole air flow rate not to exceed 70 l/hr. Otherwise consider an increase to characteristic situation 3.
CS3	Moderate risk	0.7 to <3.5	-
CS4	Moderate to high risk	3.5 to <15	-
CS5	High risk	15 to <70	-
CS6	Very high risk	>70	-

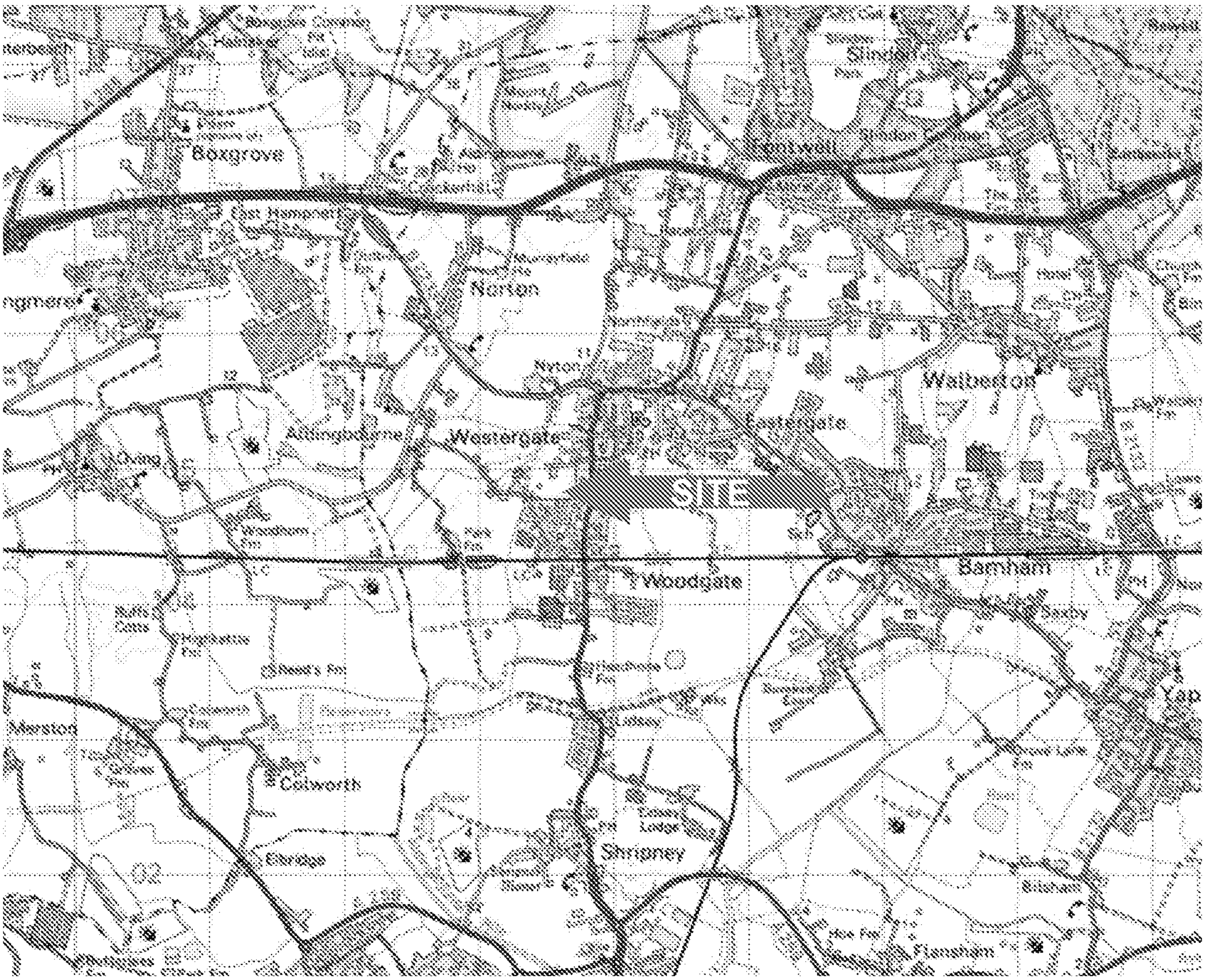
<u>Low rise housing with gardens – NHBC 'Traffic Lights'</u>

The NHBC model for low rise housing development considered a typical residential house with a ground floor area of 64m^2, suspended floor and ventilated sub-floor void of height 150mm. Where the proposed development of a site is consistent with this model, the NHBC traffic light situation of the site is determined from evaluation of the Gas Screening Value against the criteria in the following table.

Traffic Lights	Methane		Carbon Dioxide	
	Typical maximum concentrations (%)	Gas Screening Value (l/hr)	Typical maximum concentrations (%)	Gas Screening Value (l/hr)
Green	≤1	≤0.16	≤5	≤0.78
Amber 1	1> to ≤5	>0.16 to ≤0.63	>5 to ≤10	>0.78 to ≤1.56
Amber 2	5> to ≤20	>0.63 to ≤1.56	>10 to ≤30	>1.56 to ≤3.13
Red	>20	>1.56	>30	>3.13

APPENDIX 1

Site Location Plan



Not to scale.

Project Title: Hook Lane, Westergate
Client: Gleeson Land
BRD Reference: BRD3963-OP1-A
Date Issued: July 2022

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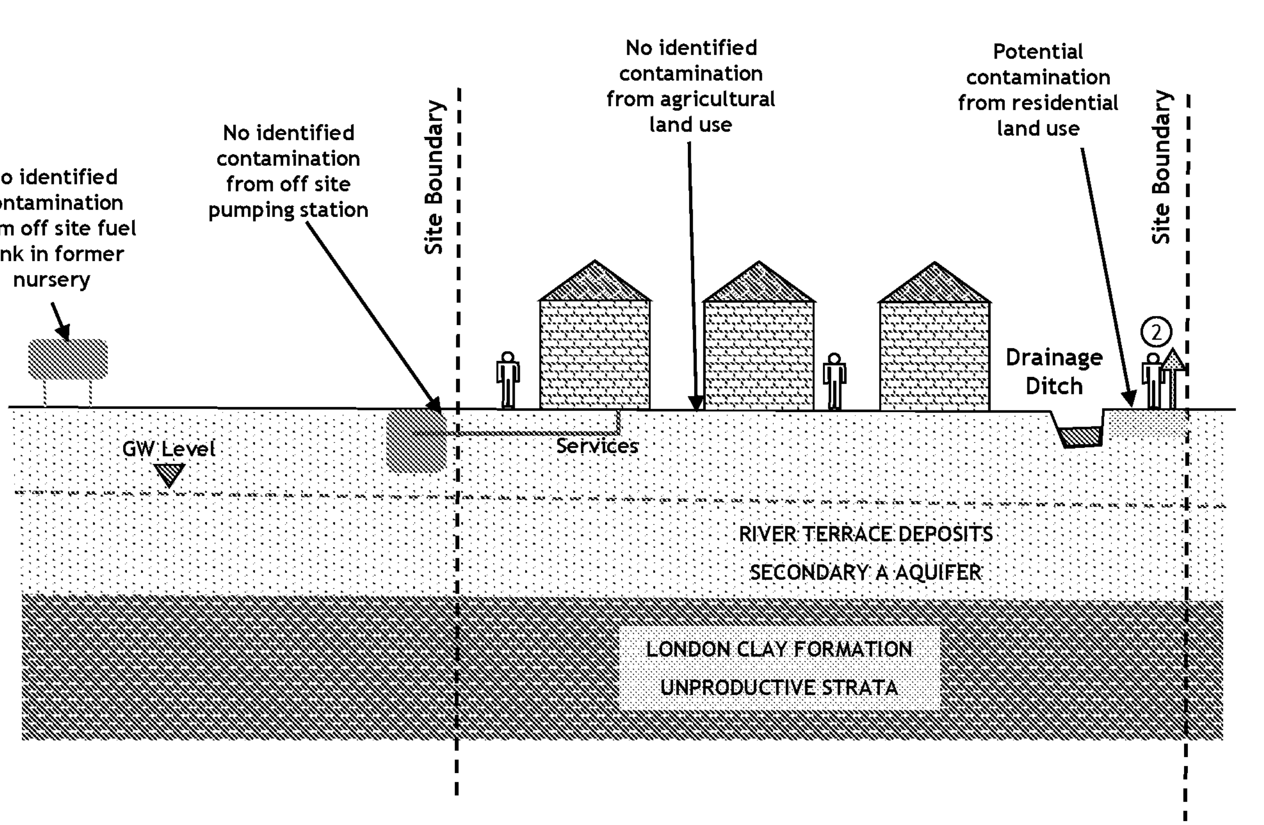
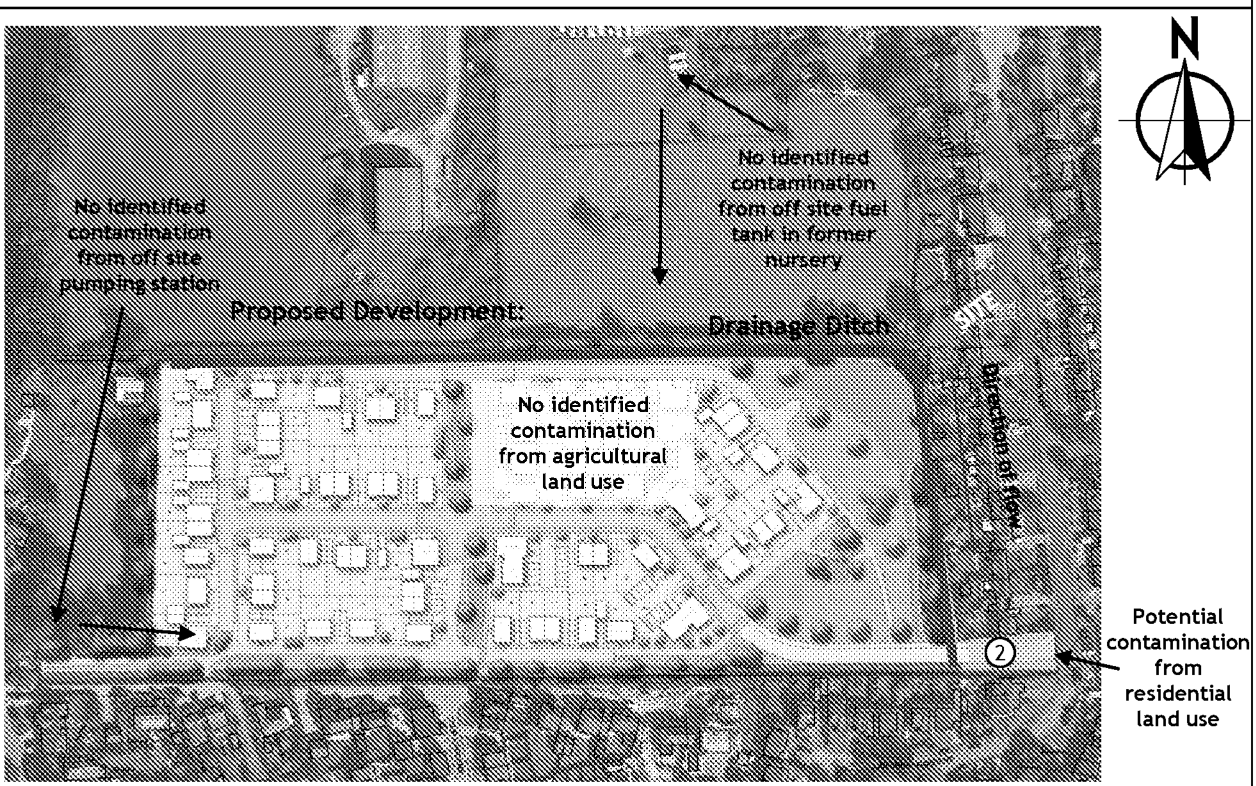
Revised Conceptual Model





Project Title: Hook Lane, Westergate
Client: Gleeson Land
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