



Project Title

Report to Discharge Drainage Related Planning Condition

At

Proposed Bungalow

1 Dobfield Road

Rochdale

OL16 3AW

PG Consulting
108 Ack Lane West
Cheadle Hulme
Cheshire
SK8 7ES

Tel: 07710 758971

Mail: Paul@pgcl.co.uk

Paul Graveney Consulting Ltd Trading as PG Consulting
Company Registration 11238546

Document Management

Project No.: PGC 963
Project Name: Proposed Bungalow, Dobfield Road, Rochdale.
Report Title: Report to Discharge Drainage Related Planning Condition
Issue: 1
Status: Final
Prepared By: Paul Graveney BEng, CEng, MICE

Document Revision

Issue	Status	Author	Approved	Date
1	Final	Paul Graveney	Paul Graveney	02/07/24

Distribution

Issue	Organisation	Quantity
1	EKPS / PHD	1

This report is the property of Paul Graveney Consulting Ltd and is confidential to the client designated in the report. Whilst it may be shown to their professional advisers, the contents are not to be disclosed to, or made use of, by any third party, without our express written consent. Without such consent we can accept no responsibility to any third party.

Paul Graveney Consulting Ltd certify that they have carried out the work contained herein with due skill, care and diligence to their best belief and knowledge based on the time and information available.

This report is made on behalf of Paul Graveney Consulting Ltd. By receiving it and acting on it, the client – or any third party relying on it – accepts that no individual is personally liable in contract, tort or breach of statutory duty or otherwise (including negligence).

Paul Graveney Consulting Ltd

CONTENTS

1.0	Introduction	4
2.0	Drainage Strategy	5
2.1	Existing Drainage	5
2.2	Existing Runoff	5
2.3	Existing Geology	5
2.4	Hydrological Assessment	5
2.5	SuDS Hierarchal Approach	6
2.6	Surface Water Drainage Strategy	6
2.7	Foul Flows	6
2.8	Maintenance	7
3.0	Drainage Related Planning Condition and Responses	11
3.1	Planning Conditions	11

Appendix A: PG Consulting Drainage GA

Appendix B: Hydraulic Calculations

Appendix C: Infiltration Test Results

1.0 Introduction

- 1.1 In February 2024 a planning application was submitted to Rochdale Borough Council for the change of use of an existing single storey office building, into one bungalow including erection of front porch and alteration to and installation of additional windows and doors on front, side and rear elevations to an office building adjacent to 1 Dobfield Road, Rochdale, OL16 3AW,
- 1.2 Planning approval, Ref: 23/01383/FUL was granted in June 2024 that included a planning condition relating to the drainage of the development.
- 1.3 This report has been prepared to remove this condition; Number 5.

2.0 Drainage Strategy

2.1 Existing Drainage

- 2.1.1 A review of the United Utilities adopted sewer records has identified no public sewers passing through the site.
- 2.1.2 Some 200m to the north east of the site beyond the River Beal and within 3rd party open fields is a 675mm diameter combined sewer flowing north.
- 2.1.3 No surface water sewers are located in close proximity.
- 2.1.3 The current site is unmade with no positive drainage.

2.2 Existing Runoff

- 2.2.1 The site area is currently unmade and so is considered to be greenfield for drainage purposes. As the area is so small a suitable Greenfield rate cannot be achieved.

2.3 Existing Geology

- 2.3.1 A detailed Phase 2 site investigation has been completed within the Phase 2 boundary. This identified topsoil to circa 0.5m over Glaciofluvial Sheet Deposits comprising a gravelly, fine to coarse Sand to a depth of 5m BGL.
- 2.3.2 3 No. Site-specific BRE compliant soil percolation test pits were excavated at the site to a maximum depth of 1.5m BGL. A minimum infiltration of rate of 3.45×10^{-5} m/s was determined and will be used in the design as the lowest rate obtained.

2.4 Hydrological Assessment

- 2.4.1 The closest identified watercourses in close proximity are the River Beal located 160m to the east of the proposed site flowing in a northerly direction.

2.5 SuDS Hierarchal Approach

- 2.5.1 Based on the existing drainage configuration, plus an assessment of the local site conditions, the SuDS hierarchal approach for discharge of surface water at the development site is considered in detail below:

Method	Suitability	Suitability for Development
Infiltration to Ground	Yes	The site investigation works have proved that the underlying sand will be suitable for infiltration.
Connection to Watercourse	No	No watercourse in close proximity.
Connection to Surface Water Sewer	No	No surface water sewer in close proximity
Connection to Combined Water Sewer	No	No combined water sewer in close proximity

Figure 1: SuDS Hierarchal Approach

2.6 Surface Water Drainage Strategy

- 2.6.1 The general principle of the surface water drainage strategy for the new property is to collect the runoff from the roof and direct it to a number of RWPs. These will then drop down to a new private surface water network that flows in a southerly direction and outfalls into a new geocellular infiltration tank within the rear garden to allow the water to infiltrate to the underlying sands.
- 2.6.2 A hydraulic model has been built and simulated within the Causeway Flow design software. This confirms that no flooding will occur up to the extreme 100 year + 45% CC storm event. The drainage GA can be found in Appendix A with the calculations in Appendix B.

2.7 Foul Flows

- 2.7.1 Foul flows generated by the new property will outfall to a new sewage treatment plant and then into a drainage field to allow the water to permeate into the underlying sands.

2.8 Maintenance

2.8.1 This section is intended to give an overview of the operation and maintenance for the drainage features included with the drainage strategy and in relation to typical details. Where proprietary products are specified, the manufacturer's instructions and recommendations should be followed in priority to this document unless specifically noted otherwise due to project constraints. The recommended operations and frequencies are typical only and should be more frequent initially to ensure that there are no unforeseen issues with the operation and then adjusted to suit the site requirements.

2.8.2 There are three types of maintenance activities associated with surface water drainage systems. The SuDS Manual, CIRIA C753, defines these as:

- Regular Maintenance – *'basic tasks undertaken on a frequent and predictable schedule' including vegetation management, litter and debris removal, and inspections.'*
- Occasional Maintenance – *'tasks that are likely to be required periodically, but on a much less frequent and predictable basis than the routine tasks (sediment removal is an example).'*
- Remedial Maintenance – *'intermittent tasks that may be required to rectify faults associated with the system, although the likelihood of faults can be minimised by good design. 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.'*

2.8.3 Specific maintenance needs should be monitored, and maintenance schedules adjusted to suit the location and condition of the drainage feature in question.

2.8.4 Piped Networks, Inspection, Manhole and Catchpit Chambers

The appropriate health and safety equipment must be used when accessing manholes. Confined space certificates must be held by any personnel entering a manhole and the appropriate permits should be obtained where required.

Pipes are proprietary products, and the materials can vary across the site and as such where used the manufacture's recommendations should be followed.

Pipes are intended to be the main conveyance across the development and where oversized they form the attenuation volume required by the limitation of the discharge rate. They are intended to be dry except for during rainfall events. These have been designed to be self-cleaning where possible for smaller diameter pipes, and for larger diameters the risk is reduced due to the overall pipe size.

Access for maintenance is provided through access chambers and manholes.

Regular inspection and maintenance are important to identify areas which may have been obstructed / clogged and may not be drainage correctly thus exposing the development to a greater level of flood risk.

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Inspect and identify any features that are not operating correctly. If required, take remedial action	Monthly for three months, then six monthly
	Debris removal from catchment surface / gratings (where may cause risks to performance)	Monthly (and after large storms)
	Remove sediment from trapped sumps, manholes and catchpits.	Annually or as required
Remedial Maintenance	Repair / rehabilitation of gratings, inlets and outlets	As required
Monitoring	Inspect / check all gratings, trapped sumps, manholes and catchpits to ensure that they are in good condition and operating as designed	Annually and after large storm events
Structure Rehabilitation / Repair	Regular Maintenance and Monitoring to identify if repair and / or replacement of features or pipework is required.	As required

Figure 2: Operation and Maintenance Requirements of Piped Networks and Inspection Chambers

2.8.5 Attenuation Storage

Geocellular tanks are modular storage systems made with plastic units. These units can be assembled to achieved re required volume and usually on multiple layers. Generally, the units have 95% of voids content and are used to create an efficient below ground structure to store surface water.

The geocellular units and geotextile are proprietary products and therefore manufacturer's recommendations should also be taken into consideration.

Access for maintenance should be provided by an access shaft located on the tank and from the manhole chambers downstream of the tank.

Regular inspection and maintenance are important for the effective operation of attenuation tanks as designed. As the feature is buried, a regular inspection regime is very important to ensure the correction functionality of the surface water drainage network.

Maintenance Schedule	Required Action	Frequency
Regular Maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action.	Monthly for 3 months, then annually.
	Remove debris from the catchment surface (where it may cause risks to performance).	Monthly.
	For systems where rainfall infiltrates into the tank from above, check surface of filter for blockages by sediment, algae or other matter; remove and replace surface infiltration medium as required.	Annually.
	Remove sediments from pre-treatment structures and/or internal forebays.	Annually, or as required.
Occasional Maintenance	Remove sediment from pre-treatment structures and/or internal forebays	Annually, or as required
	Inspect/check all inlets, outlets, vents and overflows to ensure that they are in good condition and operating as designed.	Annually
Remedial Actions	Survey inside of tank for sediment build-up and remove if necessary.	Every 5 years or as required.

Figure 3: Operation and Maintenance Requirements for Attenuation Crates

2.8.6 Permeable Paving

Permeable paving provides a surface suitable for vehicular traffic, while allowing rainwater to infiltrate through the surface and into the underlying structural layers. The surface itself is impervious to water, but the blocks are laid to provide void space through the surface to the sub-base. The water is temporarily stored within this sub-base before controlled discharge downstream.

Permeable surfaces, together with their associated substructures, are an efficient means of managing surface water runoff close to its source – intercepting runoff, reducing the volume and frequency of runoff, and providing a treatment medium. Treatment processes that occur within the surface structure, sub-base and geotextile layers include filtration, absorption, biodegradation and sedimentation.

Permeable paving should be inspected regularly, preferably during and after heavy rainfall to check effective operation and identify areas of ponding. Permeable paving needs to be regularly cleaned of silt and other sediments to preserve their infiltration capacity. Evidence suggests that sweeping once per year should be sufficient to maintain an acceptable infiltration rate on most developments.

Maintenance Schedule	Required Action	Frequency
Regular Maintenance	Brushing and vacuuming (standard cosmetic sweep over whole surface)	Once a year, or when required during autumn leaf fall
	Inspect infiltration surfaces for ponding, compaction, silt accumulation, record areas where water is ponding for > 48hours	Every 3 months, 48 hours after large storms.
Occasional Maintenance	Stabilise and mow contributing and adjacent areas	As required
	Manage other weeds and vegetation and remove nuisance plants	Once a year, or when required
Remedial Actions	Repair erosion of any adjacent soft landscaping adjacent to the paving	As required
	Remedial work to any depressions, rutting and cracked or broken blocks.	As required
	Rehabilitation of surface and upper substructure by remedial sweeping	As required
	Remove and dispose of oils or petrol residues using safe standard practices	As required

Figure 4: Operation and Maintenance Requirements for Permeable Paving

3.0 Drainage Related Planning Condition and Responses

3.1 Planning Conditions

- 3.1.1 The detailed planning condition is listed below in *italics* with the PG Consulting response in Blue beneath.

Condition 5

Prior to the commencement of development, details of a sustainable surface water drainage scheme shall be submitted to and approved in writing by the Local Planning Authority. The drainage scheme shall include:

Construction details for permeable paving including kerbing and cross-section of open graded sub-base for the parking area, so that rainwater does not flow across the public footpath from the parking area of the development.

Prior to occupation/ use of the proposed development, the drainage scheme shall be completed in accordance with the approved details and retained thereafter for the lifetime of the development.

As described in the report, the SuDS hierarchal approach incorporating geocellular infiltration tank and outfall to the underlying sands has been incorporated. The parking bays are to be constructed in permeable surfacing.

The proposed drainage layout is designed in line with Non-Statutory Technical Standards for Sustainable Drainage Systems (March 2015), with connection to the underlying sands.

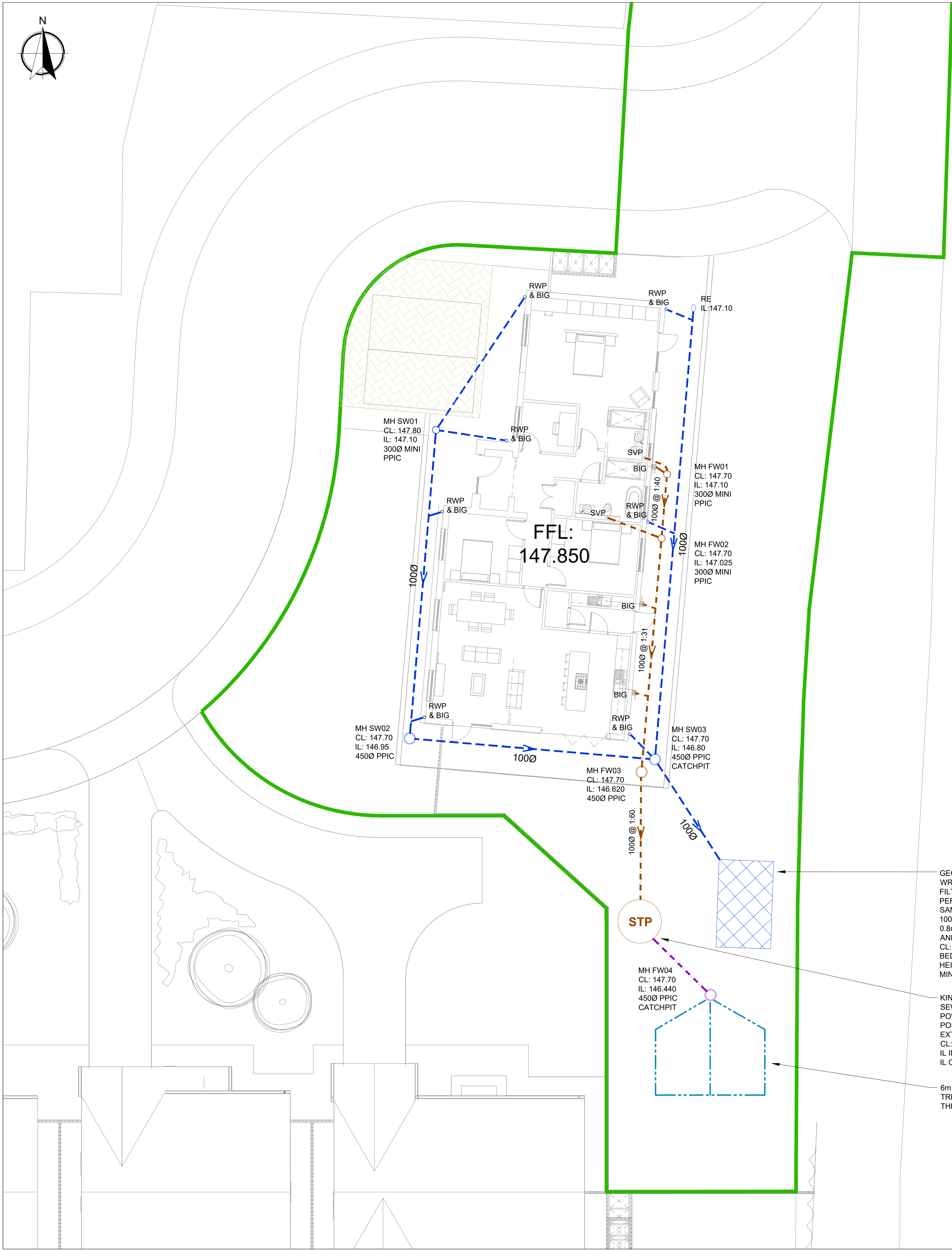
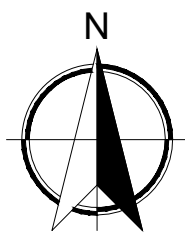
Management and maintenance details have been provided in Section 2.8.

Refer to the drainage GA in Appendix A and the hydraulic calculations in Appendix B. This confirms no flooding for the 100 year + 45% climate change event.

Build up detail for the permeable surfacing is shown on the GA drawing in Appendix A.

Appendix A – PG Consulting Drawing

PGC 963-DR-C-001: Drainage GA



GEOCELLULAR INFILTRATION TANK
WRAPPED IN NON-WOVEN GEOTEXTILE
FILTER WRAP TO ALLOW WATER TO
PERMEATE INTO UNDERLYING GRAVELLY
SAND. SIZED AT 8m³ FOR THE EXTREME
100YR + 45% CC STORM EVENT (4m x 2.5m x
0.8m). AN INFILTRATION RATE OF 3.45x10-5m/s
AND FACTOR OF SAFETY OF 5.
CL: 14.700
BED LEVEL: 146.400
HEIGHT: 0.8m
MIN DEPTH OF COVER: 0.5m

KINGSPAN KLARGESTER BA BIODISC
SEWAGE TREATMENT PLANT WITH
POWER SUPPLY AND VENTED. FINAL
POSITION TO BE AGREED ON SITE.
EXTENDED ACCESS DEPTH REQUIRED
CL: 147.700
IL IN: 146.520
IL OUT: 146.470

6m x 3m DRAINAGE FIELD TO ALLOW
TREATED FOUL WATER TO DRAIN INTO
THE UNDERLYING GRAVELLY SAND

DRAINAGE NOTES

1. THE CONTRACTOR IS RESPONSIBLE FOR THE CONFIRMATION OF ALL POSITIONS AND LEVELS OF EXISTING DRAINS, SEWERS AND MANHOLES PRIOR TO THE COMMENCEMENT OF THE PROPOSED WORKS AND ANY DISCREPANCIES REPORTED IMMEDIATELY TO PGC.
2. ALL PRIVATE DRAINAGE WITHIN THE SITE IS TO COMPLY WITH THE REQUIREMENTS OF BS EN 752 AND BUILDING REGULATIONS PART H.
3. NO DEVIATION FROM THE CONTENT OF THIS DRAWING IS ALLOWED WITHOUT PERMISSION OF PGC.
4. FOR DETAILS OF WORKMANSHIP AND MATERIALS REFER TO THE SPECIFICATION, BUILDING REGULATIONS AND BRITISH STANDARDS CURRENT AT THE TIME OF THE WORK.
5. ADEQUATE PROTECTION IS TO BE PROVIDED TO MAINTAIN INTEGRITY OF THE EXISTING SERVICES AND PROPOSED WORKS DURING CONSTRUCTION.
6. COVER LEVELS ARE PROVISIONAL AND THE FINAL LEVEL SHOULD BE ADJUSTED AND SET TO SUIT THE PROPOSED FINISHED LEVELS AS CONFIRMED BY THE ARCHITECT.
7. CONCRETE SURROUND IS TO BE PROVIDED TO ALL DRAINS WITH A COVER OF LESS THAN 1.2m OF THE FINISHED GROUND LEVEL IN HIGHWAY AREAS OR WITHIN 0.6m IF WITHIN LANDSCAPED AREAS. AN EXPANSION JOINT IS TO BE PROVIDED AT EACH AND EVERY PIPE JOINT.
8. ANY GRADIENTS OF DRAINS INDICATED ARE INDICATIVE ONLY AND THE CONTRACTOR SHALL INSTALL THE DRAINS TO THE SPECIFIED LEVELS SHOWN FOR EACH MANHOLE (U.O.N), CATCHPIT INVERT LEVELS ARE FOR THE OUTGOING PIPE WITH THE SUMP LEVEL SPECIFIED SEPARATELY.
9. ALL PIPEWORK WITHIN MANHOLES ARE TO BE LAID SOFFIT TO SOFFIT (U.O.N), ALL CHAMBER INVERT LEVELS ARE FOR THE OUTGOING PIPE LEVELS. BACKDROP PIPEWORK SHALL BE CONNECTED AT SOFFIT TO SOFFIT WITH THE RODDING ACCESS LEVEL SPECIFIED.
10. ALL INVERT LEVELS PROVIDED FOR 475mm PPIC CHAMBER ARE TO THE LOWEST PIPE WITHIN THE BENCHING ARRANGEMENT.
11. MANHOLE COVERS AND FRAMES ARE TO BE IN ACCORDANCE WITH BS EN 124 AND THE FOLLOWING:
 - VEHICULAR AREAS: CLASS D400 (E600 IN SERVICE YARD LOCATIONS), DOUBLE TRIANGULAR, 150mm DEEP DUCTILE IRON COVER AND FRAME WITH THREE POINT COVER SEATING, (NON-ROCK DESIGN) BADGED FW OR SW FOR FOUL OR SURFACE WATER DRAINAGE.
 - PEDESTRIAN AREAS: CLASS B125, 100mm DEEP, BADGED FW OR SW FOR FOUL OR SURFACE WATER DRAINAGE.
 - IF COVERS ARE REQUIRED TO BE RECESSED A HOWE GREEN 1050 HEAVY DUTY, STAINLESS STEEL EDGE, EXTERNAL USE, 100mm RECESS OR SIMILAR APPROVED SHALL BE USED.
12. REFER TO ARCHITECT'S DRAWING FOR RWP'S/WPC'S POP UP SIZES. ALL REST BENDS ARE ASSUMED TO BE 1000, SET 600mm BELOW SSL, UNLESS OTHER SPECIFIED. THE CONTRACTOR SHALL ALLOW FOR SUITABLE VIKING JOHNSON ADAPTORS/COUPLINGS FOR JOINTING THE DIFFERENT PIPE MATERIALS/PIPE SIZES.
13. ALL BRICKWORK IN CONNECTION WITH DRAINAGE IS BE SOLID ENGINEERING BRICK CLASS B TO BS 3921.
14. ALL INSITU CONCRETE TO BE GEN3 UNLESS SPECIFIED OTHERWISE.
15. DRAINAGE CHANNELS ARE TO BE ACO MD SYSTEM C/W 'HEELGUARD' GRATES OR 'BRICKSLOT' TO LANDSCAPE ARCHITECT APPROVAL.
16. ALL PRECAST CONCRETE PIPES, CHAMBER PRODUCTS AND ROAD GULLIES SHALL BE TO BS 5911 AND BE KITEMARKED.
17. VITRIFIED CLAY PIPES TO CONFORM TO BS EN 295 MANUFACTURER: HEPWORTH SUPERSLEEVE:
 - 100/150mmØ -40 kN/m
 - 225mmØ -45 kN/m
 - 300mmØ -72 kN/mAND BE SUPPLIED WITH EPDM SEALING RINGS AS STANDARD.
18. PLASTIC PIPEWORK IS ACCEPTABLE AND SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE MANUFACTURERS RECOMMENDATIONS
19. UPON COMPLETION OF THE WORKS, ALL THE DRAINS SHALL BE CLEANED BY JETTING, REMOVING ALL DEBRIS FROM SITE. NO DEBRIS SHALL BE PERMITTED TO ENTER THE EXISTING DRAINAGE SYSTEM.
20. UPON COMPLETION OF THE WORKS THE CONTRACTOR SHALL SURVEY THE WORKS AND PROVIDE A SUITABLY 'MARKED-UP' DRAWINGS FOR 'RECORD' PURPOSES'.

GENERAL NOTES

1. DRAWINGS ARE TO BE READ IN CONJUNCTION WITH ALL RELEVANT SPECIFICATIONS, ENGINEERS, ARCHITECTS & SERVICES DRAWINGS, INCLUDING APPROVED BUILDERS WORK DRAWINGS. CONTRACTOR TO NOTIFY ENGINEER OF DISCREPANCIES BETWEEN STRUCTURAL DRAWINGS AND SPECIFICATIONS OR OTHER DRAWINGS.
2. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.
3. DETAILS OF EXISTING SEWERS SHALL BE CONFIRMED BY THE CONTRACTOR ON SITE PRIOR TO THE COMMENCEMENT OF WORKS. ANY DISCREPANCIES ARE TO BE REPORTED TO THE ENGINEER IMMEDIATELY. THE CONTRACTOR SHOULD CHECK THE LEVELS OF ALL NEW OUT FALLS IN RELATION TO EXISTING SEWERS PRIOR TO ANY CONSTRUCTION TO ENSURE THE PROPOSED DESIGN CAN BE ACHIEVED.
4. DO NOT SCALE FROM THIS DRAWN, WORK TO DIMENSIONS OR COORDINATES PROVIDED. ALL LEVELS ARE IN MILLIMETRES, UNLESS OTHERWISE NOTED. ANY AMBIGUITIES, OMISSIONS AND ERRORS ON DRAWINGS SHALL BE BROUGHT TO THE ATTENTION OF THE ENGINEER IMMEDIATELY.

KEY

- PROPOSED FOUL WATER DRAINAGE
- PROPOSED SURFACE WATER DRAINAGE
- PROPOSED TREATED FOUL WATER DRAINAGE
- PROPOSED PERMEABLE SURFACING
 - 60mm BLOCK PAVING
 - 50mm 5-20mm GRIT STONE BEDDING COURSE
 - GEOTEXTILE MEMBRANE
 - 200mm TYPE 3 NO FINES SUB BASE
 - GEOTEXTILE MEMBRANE
- SITE BOUNDARY
- RWP RAINWATER PIPE
- SVP SOIL VENT PIPE
- BIG BACK INLET GULLY
- RE RODDING EYE

NOTE ALL RWP AND SVP
LOCATIONS TO BE
CONFIRMED BY OTHERS

ALL PIPEWORK TO BE 1000
UNLESS NOTED
OTHERWISE

ALL COVER AND FRAMES
IN FEATURE PAVING TO BE
RECESSED

FFL AND ALL LEVELS AND
FALLS TO DRIVEWAYS TO
BE CONFIRMED BY OTHERS

P1	02.07.24	PG	PG	PRELIMINARY ISSUE
REV	DATE	DRAWN	REV'D ENG.	NOTES
CLIENT				
PIC DOBFIELD LTD				
PROJECT				
DOBFIELD ROAD, ROCHDALE				
DRAWING TITLE				
PROPOSED BUNGALOW DRAINAGE GA				
DRAWING STATUS				
INFORMATION				
SCALE	1:100	DRAWN BY	PG	ENGINEER
			PG	PG
DRAWING No				SHEET
PGC963-DR-C-020				A1
REVISION				P1
PGConsulting Civil & Infrastructure Engineers				106 Ack Lane West, Cheadle Hulme, Cheshire, SK8 7ES Tel: 07710 758971 Email: paul@pgcd.co.uk

Appendix B – Hydraulic Calculations

Design Settings

Rainfall Methodology	FSR	Maximum Time of Concentration (mins)	30.00
Return Period (years)	10	Maximum Rainfall (mm/hr)	50.0
Additional Flow (%)	0	Minimum Velocity (m/s)	1.00
FSR Region	England and Wales	Connection Type	Level Soffits
M5-60 (mm)	20.000	Minimum Backdrop Height (m)	0.200
Ratio-R	0.400	Preferred Cover Depth (m)	1.200
CV	0.750	Include Intermediate Ground	✓
Time of Entry (mins)	4.00	Enforce best practice design rules	✓

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Depth (m)
SW01	0.008	4.00	147.800	300	0.700
SW02			147.700	450	0.750
RE01	0.008	4.00	147.700	100	0.600
SW03			147.700	450	0.900
SOAKAWAY			147.700	100	1.300
DUMMY			147.700	100	1.556

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	SW01	SW02	14.000	0.600	147.100	146.950	0.150	93.3	100	4.29	50.0
1.001	SW02	SW03	12.000	0.600	146.950	146.800	0.150	80.0	100	4.53	50.0
2.000	RE01	SW03	21.000	0.600	147.100	146.800	0.300	70.0	100	4.38	50.0
1.002	SW03	SOAKAWAY	8.000	0.600	146.800	146.700	0.100	80.0	100	4.68	50.0
1.003	SOAKAWAY	DUMMY	15.269	0.600	146.400	146.144	0.256	59.6	100	4.94	50.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
1.000	0.796	6.3	1.1	0.600	0.650	0.008	0.0	29	0.599
1.001	0.861	6.8	1.1	0.650	0.800	0.008	0.0	27	0.628
2.000	0.921	7.2	1.1	0.500	0.800	0.008	0.0	26	0.661
1.002	0.861	6.8	2.2	0.800	0.900	0.016	0.0	39	0.764
1.003	0.999	7.8	2.2	1.200	1.456	0.016	0.0	36	0.858

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.000	14.000	93.3	100	Circular	147.800	147.100	0.600	147.700	146.950	0.650
1.001	12.000	80.0	100	Circular	147.700	146.950	0.650	147.700	146.800	0.800
2.000	21.000	70.0	100	Circular	147.700	147.100	0.500	147.700	146.800	0.800
1.002	8.000	80.0	100	Circular	147.700	146.800	0.800	147.700	146.700	0.900

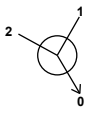
Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.000	SW01	300	Manhole	Adoptable	SW02	450	Manhole	Adoptable
1.001	SW02	450	Manhole	Adoptable	SW03	450	Manhole	Adoptable
2.000	RE01	100	Manhole	Adoptable	SW03	450	Manhole	Adoptable
1.002	SW03	450	Manhole	Adoptable	SOAKAWAY	100	Manhole	Adoptable

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.003	15.269	59.6	100	Circular	147.700	146.400	1.200	147.700	146.144	1.456

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.003	SOAKAWAY	100	Manhole	Adoptable	DUMMY	100	Manhole	Adoptable

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)	
SW01	66.249	70.424	147.800	0.700	300		0	1.000	147.100	100
SW02	50.588	42.644	147.700	0.750	450		1	1.000	146.950	100
							0	1.001	146.950	100
RE01	90.113	71.729	147.700	0.600	100		0	2.000	147.100	100
SW03	67.927	33.136	147.700	0.900	450		1	2.000	146.800	100
							2	1.001	146.800	100
							0	1.002	146.800	100
SOAKAWAY	76.316	18.966	147.700	1.300	100		1	1.002	146.700	100
							0	1.003	146.400	100
DUMMY	90.986	14.730	147.700	1.556	100		1	1.003	146.144	100

Simulation Settings

Rainfall Methodology	FSR	Analysis Speed	Normal
FSR Region	England and Wales	Skip Steady State	x
M5-60 (mm)	20.000	Drain Down Time (mins)	240
Ratio-R	0.400	Additional Storage (m³/ha)	20.0
Summer CV	0.750	Check Discharge Rate(s)	x
Winter CV	0.840	Check Discharge Volume	x

Storm Durations

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

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
1	0	0	0
30	0	0	0
100	45	0	0

Node SOAKAWAY Online Pump Control

Flap Valve	x	Design Depth (m)	1.200	Switch off depth (m)	0.100
Replaces Downstream Link	✓	Design Flow (l/s)	0.1		
Invert Level (m)	146.400	Switch on depth (m)	1.300		

Depth (m)	Flow (l/s)
1.300	0.100

Node SOAKAWAY Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.12400	Safety Factor	5.0	Invert Level (m)	146.400
Side Inf Coefficient (m/hr)	0.12400	Porosity	0.95	Time to half empty (mins)	

Depth (m)	Area (m ²)	Inf Area (m ²)	Depth (m)	Area (m ²)	Inf Area (m ²)	Depth (m)	Area (m ²)	Inf Area (m ²)
0.000	10.0	10.0	0.800	10.0	21.2	0.801	0.0	21.2

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)	Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
1 year 15 minute summer	109.521	30.991	30 year 180 minute winter	34.645	13.715
1 year 15 minute winter	76.857	30.991	30 year 240 minute summer	41.604	10.995
1 year 30 minute summer	71.439	20.215	30 year 240 minute winter	27.641	10.995
1 year 30 minute winter	50.133	20.215	30 year 360 minute summer	31.221	8.034
1 year 60 minute summer	48.435	12.800	30 year 360 minute winter	20.295	8.034
1 year 60 minute winter	32.179	12.800	30 year 480 minute summer	24.324	6.428
1 year 120 minute summer	30.053	7.942	30 year 480 minute winter	16.160	6.428
1 year 120 minute winter	19.966	7.942	30 year 600 minute summer	19.756	5.404
1 year 180 minute summer	23.233	5.979	30 year 600 minute winter	13.498	5.404
1 year 180 minute winter	15.102	5.979	30 year 720 minute summer	17.490	4.687
1 year 240 minute summer	18.475	4.882	30 year 720 minute winter	11.754	4.687
1 year 240 minute winter	12.274	4.882	30 year 960 minute summer	14.215	3.743
1 year 360 minute summer	14.169	3.646	30 year 960 minute winter	9.416	3.743
1 year 360 minute winter	9.210	3.646	30 year 1440 minute summer	10.161	2.723
1 year 480 minute summer	11.185	2.956	30 year 1440 minute winter	6.829	2.723
1 year 480 minute winter	7.431	2.956	100 year +45% CC 15 minute summer	505.670	143.087
1 year 600 minute summer	9.182	2.511	100 year +45% CC 15 minute winter	354.856	143.087
1 year 600 minute winter	6.274	2.511	100 year +45% CC 30 minute summer	332.000	93.944
1 year 720 minute summer	8.203	2.199	100 year +45% CC 30 minute winter	232.982	93.944
1 year 720 minute winter	5.513	2.199	100 year +45% CC 60 minute summer	222.268	58.739
1 year 960 minute summer	6.768	1.782	100 year +45% CC 60 minute winter	147.669	58.739
1 year 960 minute winter	4.483	1.782	100 year +45% CC 120 minute summer	134.215	35.469
1 year 1440 minute summer	4.949	1.326	100 year +45% CC 120 minute winter	89.169	35.469
1 year 1440 minute winter	3.326	1.326	100 year +45% CC 180 minute summer	101.219	26.047
30 year 15 minute summer	268.706	76.035	100 year +45% CC 180 minute winter	65.795	26.047
30 year 15 minute winter	188.566	76.035	100 year +45% CC 240 minute summer	78.690	20.795
30 year 30 minute summer	174.929	49.499	100 year +45% CC 240 minute winter	52.280	20.795
30 year 30 minute winter	122.757	49.499	100 year +45% CC 360 minute summer	58.701	15.106
30 year 60 minute summer	116.589	30.811	100 year +45% CC 360 minute winter	38.157	15.106
30 year 60 minute winter	77.459	30.811	100 year +45% CC 480 minute summer	45.550	12.038
30 year 120 minute summer	70.438	18.615	100 year +45% CC 480 minute winter	30.262	12.038
30 year 120 minute winter	46.797	18.615	100 year +45% CC 600 minute summer	36.875	10.086
30 year 180 minute summer	53.298	13.715	100 year +45% CC 600 minute winter	25.195	10.086

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)	Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
100 year +45% CC 720 minute summer	32.556	8.725	100 year +45% CC 960 minute winter	17.448	6.936
100 year +45% CC 720 minute winter	21.879	8.725	100 year +45% CC 1440 minute summer	18.700	5.012
100 year +45% CC 960 minute summer	26.340	6.936	100 year +45% CC 1440 minute winter	12.567	5.012

Results for 1 year Critical Storm Duration. Lowest mass balance: 94.69%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	SW01	10	147.131	0.031	1.2	0.0091	0.0000	OK
15 minute winter	SW02	10	146.978	0.028	1.2	0.0045	0.0000	OK
15 minute winter	RE01	10	147.128	0.028	1.2	0.0076	0.0000	OK
15 minute winter	SW03	11	146.842	0.042	2.4	0.0067	0.0000	OK
960 minute winter	SOAKAWAY	630	146.617	0.216	0.2	2.0582	0.0000	SURCHARGED
15 minute summer	DUMMY	1	146.144	0.000	0.0	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	SW01	1.000	SW02	1.2	0.630	0.192	0.0268	
15 minute winter	SW02	1.001	SW03	1.2	0.485	0.174	0.0293	
15 minute winter	RE01	2.000	SW03	1.2	0.524	0.165	0.0505	
15 minute winter	SW03	1.002	SOAKAWAY	2.3	0.760	0.341	0.0242	
960 minute winter	SOAKAWAY	Pump	DUMMY	0.0				0.0
960 minute winter	SOAKAWAY	Infiltration		0.1				

Results for 30 year Critical Storm Duration. Lowest mass balance: 94.69%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	SW01	10	147.150	0.050	2.9	0.0149	0.0000	OK
15 minute winter	SW02	10	146.996	0.046	2.9	0.0073	0.0000	OK
15 minute winter	RE01	10	147.144	0.044	2.9	0.0121	0.0000	OK
480 minute winter	SW03	448	146.923	0.123	0.6	0.0195	0.0000	SURCHARGED
480 minute winter	SOAKAWAY	448	146.923	0.523	0.6	4.9707	0.0000	SURCHARGED
15 minute summer	DUMMY	1	146.144	0.000	0.0	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	SW01	1.000	SW02	2.9	0.790	0.464	0.0515	
15 minute winter	SW02	1.001	SW03	2.9	0.589	0.427	0.0588	
15 minute winter	RE01	2.000	SW03	2.9	0.632	0.401	0.1012	
480 minute winter	SW03	1.002	SOAKAWAY	0.6	0.526	0.089	0.0626	
480 minute winter	SOAKAWAY	Pump	DUMMY	0.0				0.0
480 minute winter	SOAKAWAY	Infiltration		0.1				

Results for 100 year +45% CC Critical Storm Duration. Lowest mass balance: 94.69%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
960 minute winter	SW01	900	147.482	0.382	0.3	0.1141	0.0000	SURCHARGED
960 minute winter	SW02	900	147.482	0.531	0.3	0.0845	0.0000	FLOOD RISK
960 minute winter	RE01	900	147.482	0.382	0.3	0.1049	0.0000	FLOOD RISK
960 minute winter	SW03	900	147.481	0.681	0.6	0.1084	0.0000	FLOOD RISK
960 minute winter	SOAKAWAY	900	147.481	1.081	0.6	7.6134	0.0000	FLOOD RISK
15 minute summer	DUMMY	1	146.144	0.000	0.0	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
960 minute winter	SW01	1.000	SW02	0.3	0.419	0.048	0.1095	
960 minute winter	SW02	1.001	SW03	0.3	0.334	0.044	0.0939	
960 minute winter	RE01	2.000	SW03	0.3	0.342	0.041	0.1643	
960 minute winter	SW03	1.002	SOAKAWAY	0.6	0.468	0.089	0.0626	
960 minute winter	SOAKAWAY	Pump	DUMMY	0.0				0.0
960 minute winter	SOAKAWAY	Infiltration		0.1				

Appendix C – Infiltration Test Results

SOAKAWAY TEST TO BRE 365

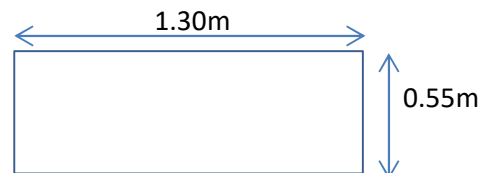
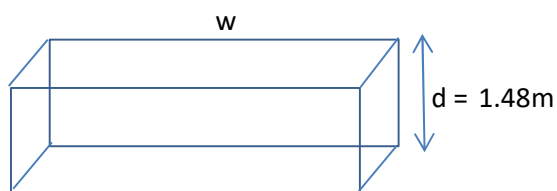
TP S1

$$\text{Soil infiltration rate } f = V_{p75-25} / A_{p50} \times t_{p75-25}$$

V_{p75-25} = the effective storage volume of water in the trial pit between 75% and 25% effective depth

A_{p50} = the internal surface area of the trial pit up to 50% effective depth and including the base area

t_{p75-25} = the time for the water level to fall from 75% to 25% effective depth (in seconds)



$$V_{p75-25} = w \times b \times d \times 0.5 = 0.53\text{m}^3$$

$$A_{p50} = (w \times b) + (w \times 0.5d \times 2) + (b \times 0.5d \times 2) = 3.45 \text{ m}^2$$

$$t_{p75-25} = 74 \text{ mins} = 4440 \text{ secs}$$

$$f = 3.45\text{E-}05 \text{ m/s}$$

Soakaway test carried out during a period of intermittent light and very heavy rainfall showers. Heavy rainfall overnight prior to test.

SOAKAWAY TEST TO BRE 365

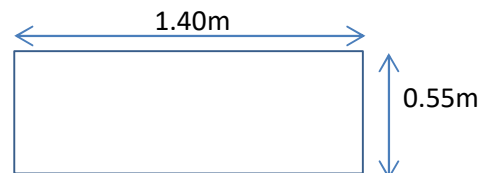
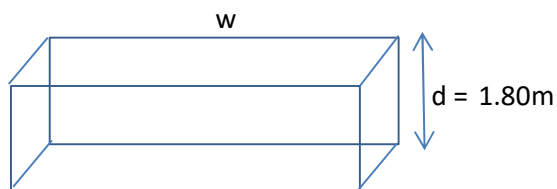
TP S2

$$\text{Soil infiltration rate } f = V_{p75-25} / A_{p50} \times t_{p75-25}$$

V_{p75-25} = the effective storage volume of water in the trial pit between 75% and 25% effective depth

A_{p50} = the internal surface area of the trial pit up to 50% effective depth and including the base area

t_{p75-25} = the time for the water level to fall from 75% to 25% effective depth (in seconds)



$$V_{p75-25} = w \times b \times d \times 0.5 = 0.69 \text{ m}^3$$

$$A_{p50} = (w \times b) + (w \times 0.5d \times 2) + (b \times 0.5d \times 2) = 4.28 \text{ m}^2$$

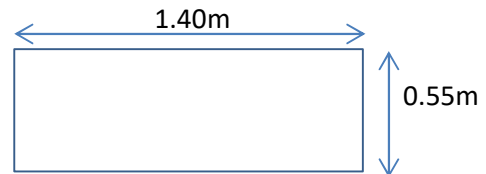
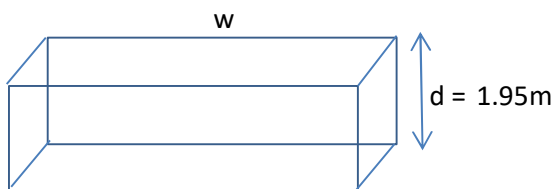
$$t_{p75-25} = 63 \text{ mins} = 3780 \text{ secs}$$

$$f = 4.28 \text{E-}05 \text{ m/s}$$

Soakaway test carried out during a period of intermittent light and very heavy rainfall showers. Heavy rainfall overnight prior to test.

SOAKAWAY TEST TO BRE 365

TP S3

Soil infiltration rate $f = V_{p75-25}/A_{p50} \times t_{p75-25}$ V_{p75-25} = the effective storage volume of water in the trial pit between 75% and 25% effective depth A_{p50} = the internal surface area of the trial pit up to 50% effective depth and including the base area t_{p75-25} = the time for the water level to fall from 75% to 25% effective depth (in seconds)

$$V_{p75-25} = w \times b \times d \times 0.5 = 0.75\text{m}^3$$

$$A_{p50} = (w \times b) + (w \times 0.5d \times 2) + (b \times 0.5d \times 2) = 4.57\text{ m}^2$$

$$t_{p75-25} = 49\text{ mins} = 2940\text{ secs}$$

$$f = 5.58\text{E-}05\text{ m/s}$$

Soakaway test carried out during a period of intermittent light and very heavy rainfall showers. Heavy rainfall overnight prior to test.