

PROPOSED RESIDENTIAL DEVELOPMENT at MILLFIELD NURSERIES, SPALDING COMMON



DRAINAGE STATEMENT FOR JoJoS BEHEER BV c/o RDC Ltd

HALL
-infrastructure-
DESIGN

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Contents

Drainage Statement

Document 1	Drawing No AS2129/1 rev B – Topographical Survey.
Document 2	Drawing No 1608/01 – Schematic Concept Drainage Plan.
Document 3	HR Wallingford green field runoff calculations.
Document 4	Microdrainage proposed surface water calculations.
Document 5	extract from Ground Investigation Report C13746 Ground Engineering Ltd – March 2016.
Document 6	Welland & Deepings IDB record plans.

Drainage Statement for Proposed Housing Development at Millfield Nurseries, Spalding Common.

Hall Infrastructure Design Ltd have been engaged by JoJos Beheer b.v. c/o Robert Doughty Consultancy Ltd to prepare a drainage statement for a proposed residential development at the above site. A proposed site layout drawing, reference 1201-01-MP01, produced by Robert Doughty Consultancy Ltd has been provided to Hall Infrastructure Design Ltd from which to produce this statement. A topographical survey drawing, reference AS2129/1, produced by Axis Surveys Ltd, has also been provided. This drawing has been amended by Hall Infrastructure Design Ltd to clearly show existing buildings and hardstandings on the site.

This application is for outline planning permission.

This statement details the existing site conditions pre development and the discharges post development and assumes that the development land is uncontaminated and inert.

1. Topography and Site Layout.

The development site is a brown field site situated at land to the east of Spalding Common and west of Cradge Bank in Spalding Common, as shown on the topographical survey drawing AS2129/1 rev B (**doc 1**). The site, which is irregular in shape is accessed from Spalding Common with an approximate frontage width of 74m increasing to approximately 300m, average depth of 202m and a site area of 4.604 Ha. The existing impermeable area is 2.861 Ha (62%). The site currently discharges surface water at an unrestricted rate through a number of 100mm dia and 150mm dia pipes to an existing riparian drain which in turn is connected to the River Welland Soke Dyke by a 300mm dia culvert beneath Cradge Bank, all as shown on the topographical survey drawing AS2129/1 rev B (**doc 1**).

The proposal includes for the construction of a network of adopted roads and footpaths serving one hundred and thirty three detached, semi detached and terraced dwellings. The proposed impermeable area has been calculated based on the roof areas of proposed dwellings (0.843 Ha – 18%), the adopted access road and footpaths (0.440 Ha – 10%), domestic curtilage private access roads and courtyards (0.195 Ha – 4%) and domestic curtilage driveways (0.389 Ha – 8%) totalling 1.867 Ha which represents 41% (including an allowance for development creep) of the total site area as shown on the schematic concept drainage plan drawing no 1608/01 (**doc 2**). It is proposed that roof areas will discharge to adjacent domestic curtilage driveways and / or domestic curtilage private access roads and courtyards will in turn will discharge to a network of under-drained roadside swales connected to an on-line storage / balancing pond through to the agreed outfall point.

2. Existing green field conditions.

Existing green field runoff values, calculated in accordance with the H R Wallingford greenfield runoff estimation for sites (**doc 3**) in accordance with DEFRA / Environment Agency Report SC030219 rev E and Interim National Procedure Principle 17, confirm that the impermeable area (1.867 Ha) of the site generates a 1 year run off value of 5.00 l/s, 30 year of 6.42 l/s and 100 year of 9.33 l/s. The client has confirmed that they have permission to discharge at a maximum rate of 10.00 l/s to the existing River Welland Soke Dyke on the east side of Cradge Bank. This is shown on the Welland & Deepings IDB asset plan (**doc 6**).

Assuming only 50% of the existing greenhouses discharge to the existing riparian drain through the network of existing 100mm and 150mm outlets, based on 50mm / hr rainfall, these would generate existing flows in the region of 145 l/s.

3. Infiltration Testing.

The client has commissioned a ground investigation report from Ground Engineering Ltd, ref C13746 March 2016. An extract from this report (**doc 5**) confirms that soakaways are not practicable on this site due to negligible / nil infiltration rates and high water table.

4. The Design – Surface Water.

In accordance with the House of Commons Written Statement (HCWS161 – 18th December 2014) there is an

expectation for SuDS to be incorporated in all residential developments of 10 houses or more (major developments) unless demonstrated to be inappropriate.

Furthermore, in accordance with recognised guidance, Part H of the Building Regulations 2010 and National Planning Policy Framework 2012, there is a hierarchy of where surface water should discharge. This hierarchy should be followed where practicable, and is as follows:

- 1) Infiltration
- 2) Watercourse
- 3) Public sewer

Any proposed surface water drainage system will need to be designed to account for the effects of climate change over the lifetime of the development. Based on the recommendations in Paragraph 13 - Table 5 of the Technical Guide to National Planning Policy Framework 2012 (NPPF-TG) the proposed drainage systems should be sized to allow for a 30% increase in rainfall intensity.

The 2014 DEFRA Draft National Standards and Specified Criteria for Sustainable Drainage states that:

'The drainage system must be designed and constructed so surface water discharged does not adversely impact the water quality of receiving water bodies, both during construction and when operational.'

Based on best practice and EA guidelines it is desirable to incorporate 1 no. water treatment stage within the drainage design for roof water runoff and 2 no. water treatment stages within the drainage design for vehicular surfaces where practicable and subject to the requirements of approving/adopting authorities. Therefore, the design of the drainage system should seek to ensure that all runoff complies with these requirements and SUDS features are incorporated into the drainage design to provide pollution reduction.

Lincolnshire County Council, the Lead Local Flood Authority (LLFA) in this area will be the approving body for this application.

Addressing each method in turn:

Infiltration

Grass areas and soft landscaping areas are proposed in the development totalling 2.737 Ha (59%), as shown on the schematic concept drainage plan, drawing no 1608/01 (**doc 2**).

There are no proposals for any other surface water to discharge to infiltration at this stage given the findings of the ground investigation report.

Watercourse

Watercourse can be used as the method of disposal of the surface water from the development.

Domestic curtilage roof areas totalling 0.843 Ha (18%), including an allowance for development creep, are proposed to discharge to the sub base reservoir layers of adjacent individual domestic curtilage permeable paved driveways, as shown on the schematic concept drainage plan drawing no 1608/01 (**doc 2**).

Permeable materials (e.g. permeable block paving) are proposed to the individual domestic curtilage driveways totalling 0.389 Ha (8%), with sub base reservoir layer connected to the adopted access road swale under-drain as shown on the schematic concept drainage plan drawing no 1608/01 (**doc 2**).

Permeable materials (e.g. permeable block paving) are proposed to the domestic curtilage private access road and courtyards totalling 0.195 Ha (4%), with sub base reservoir layer connected to the adopted access road swale under-drain as shown on the schematic concept drainage plan drawing no 1608/01 (**doc 2**).

Permeable materials (e.g. permeable block paving) are proposed to the adopted shared surface road totalling 0.092 Ha (2%) with sub base reservoir layer under-drained and connected to an on-line storage / attenuation pond as shown on the schematic concept drainage plan drawing no 1608/01 (**doc 2**).

Traditional materials (tarmac) are proposed to the adopted access roads / footpaths totalling 0.348 Ha (8%) with an under-drained swale conveying runoff to an on-line storage / attenuation pond as shown on the schematic concept drainage plan drawing no 1608/01 (**doc 2**).

Anglian Water Services Ltd's October 2013 requirements with regard to surface water storage are that the preferred method should be an adoptable on-line system with an adopted or Management Company Ltd maintained off-line storage pond being acceptable.

Conflicting with this preference – the SUDS Lead Local Flood Authority (LLFA) which, at the time of the development's anticipated construction date, is Lincolnshire County Council, have confirmed at the Lincolnshire LLFA Consultants & Developers Seminar (April 2015) that their preference is for under-drained swales to be used for conveyance of surface water to an on-line storage pond.

The suggested locations of proposed under-drained swales and the balancing pond are shown on the schematic concept drainage plan 1608/01 (**doc 2**). These together with the use of permeable materials within domestic curtilage provides source control (quality) and storage volume (quantity) together with amenity and biodiversity SUDS.

Surface water from the adoptable road (0.348 Ha) (which will comprise one footway to the high side and a single cross-fall carriageway) will shed directly into a 300mm deep adjacent under-drained swale to the low side, providing highway water with an initial treatment stage, with domestic curtilage roof areas (0.843 Ha), individual domestic curtilage permeable paved driveways (0.389 Ha), domestic curtilage private access roads and courtyards (0.195 Ha) and permeable paved adopted access road (0.092 Ha) being collected along the way, connected in to the perforated under-drain pipework. Typical construction details for the source control outlets from domestic roof water to permeable paved individual driveway and under-drained conveyance swale are shown on the schematic concept drainage plan drawing no 1608/01 (**doc 2**).

Roof water will be collected in underground pipes, where required, within domestic curtilage with silt traps incorporated prior to connecting to adjacent permeable paved individual driveways wherever practicable by way of proprietary diffusers which in turn are connected to the under-drained swale. Where roof water downpipes are located either over or immediately adjacent to permeable paved individual driveways these will surface discharge to the permeable paving with proprietary rainwater shoes with no underground pipework being required. This provides an "on-plot" source control treatment stage for all domestic curtilage runoff prior to entering the adoptable system. An on-line surface water detention and attenuation balancing pond provides additional storage and a second treatment stage at the flow control location. The pond will be wet (maximum 600mm depth) under normal conditions (unless infiltration results in the water level further reducing) with a normal water area of 663m², normal water level of 1.125m ODN and 1:3 side slope batters, as shown on the schematic concept drainage plan 1608/01 (**doc 2**). A Hydrobrake Optimum flow control device together with a higher level small diameter orifice plate attenuate flows down to the permitted discharge rates for 1 year, 30 year and up to the 1:100 year plus 30% climate change standard to permitted discharge rates. Flows in excess of these figures are stored in the on-line detention and attenuation balancing pond where they are stored for a period of time before draining back down again to normal water level.

The final outfall from the development is proposed at invert level (1.066m ODN) which is the invert level of an existing 300mm diameter culvert pipe connecting to the existing River Welland Soke Dyke as shown on the schematic concept drainage plan 1608/01 (**doc 2**). This existing culvert pipe is 500mm above the invert level of the Soke Dyke. The invert level of the development discharge at the balancing pond is proposed at 1.125m ODN.

The normal water level in the balancing pond being set at 1.125m ODN is at least 1.425m below the carriageway level of Cradge Bank (2.550m ODN) thereby enabling a maximum 1.101m of storage depth and 0.324m freeboard.

Microdrainage calculations, using FEH rainfall data, have been prepared to demonstrate that the surface water design operates satisfactorily for the given return periods whilst keeping discharges lower than or equal to existing

green field values. (**doc 4**) confirms the Microdrainage calculations with 1 year outflow restricted to 4.3 l/s with the water level in the balancing pond raising by 356mm to a level of 1.481m ODN, 30 year outflow restricted to 6.3 l/s with the water level in the balancing pond raising by 806mm to a level of 1.931m ODN and 100 year plus 30% climate change outflow restricted to 10.0 l/s with the water level in the balancing pond raising by 1101mm to a level of 2.226m ODN. Top of bank of the surface water balancing pond and lower plateau of the public open space area will be set at 2.525m ODN with the lower plateau area being set at 1.925m ODN therefore providing an additional 299mm freeboard above the 100 year plus 30% climate change level.

In order to comply with Planning Practise Guidance which refers to NPPF-TG (paragraph 9) and to demonstrate how the surface water sewer system can be monitored and maintained to ensure it will continue to function correctly for the lifetime of the development and prevent any increase in flood risk on or off site it is anticipated that the surface water system including the under-drain to the swales to its point of attenuated discharge to the existing outfall culvert pipe will be included in a section 104 adoption agreement with Anglian Water Services Ltd. It is anticipated that the grassed surface part of the swales will be included in a section 38 adoption agreement with Lincolnshire County Council. It is anticipated that the balancing ponds will be included in the Public Open Space area and will be adopted by a Management Company Ltd.

Public Sewer

There are no proposals for any surface water to discharge to public sewer at this stage.

5. Flood Risk.

Flood risk does not form any part of this drainage statement as this is being dealt with by R M Associates.

6. Finished Floor Levels.

Finished floor levels do not form any part of this drainage statement as this is being dealt with by R M Associates, however it is understood that finished floor levels will be raised to a minimum 1.0m above existing average ground level. The average existing ground level has been evaluated for the purposes of this drainage statement as 2.4m ODN therefore a minimum finished floor level of 3.4m ODN has been applied from which to work out the schematic concept drainage design plan drawing no 1608/01 (**doc 2**).

7. The Design – Foul Water.

Foul water drainage does not form part of this drainage statement as this is being dealt with by others, however it is understood that the client will obtain a pre-planning report from Anglian Water Services Ltd in which the foul water servicing of the site will be addressed.

8. Conclusion.

With the information provided to date it has been demonstrated that the proposed development site can easily comply with the set discharge requirements. Sustainable Urban Drainage Systems can be incorporated within the design (permeable pavements, under-drained swales etc) with final attenuation for the infrastructure being in an on-line storage / balancing pond. The use of water butts and other rainwater harvesting techniques could be considered at the detailed design stage and these would provide additional storage over and above that demonstrated in this statement.

The set discharge requirements of Welland & Deepings IDB represent a significant betterment to the existing network post-development than what exists pre-development.

All elements of the surface water drainage system can be demonstrated to comply with paragraph 9 of NPPF-TG.

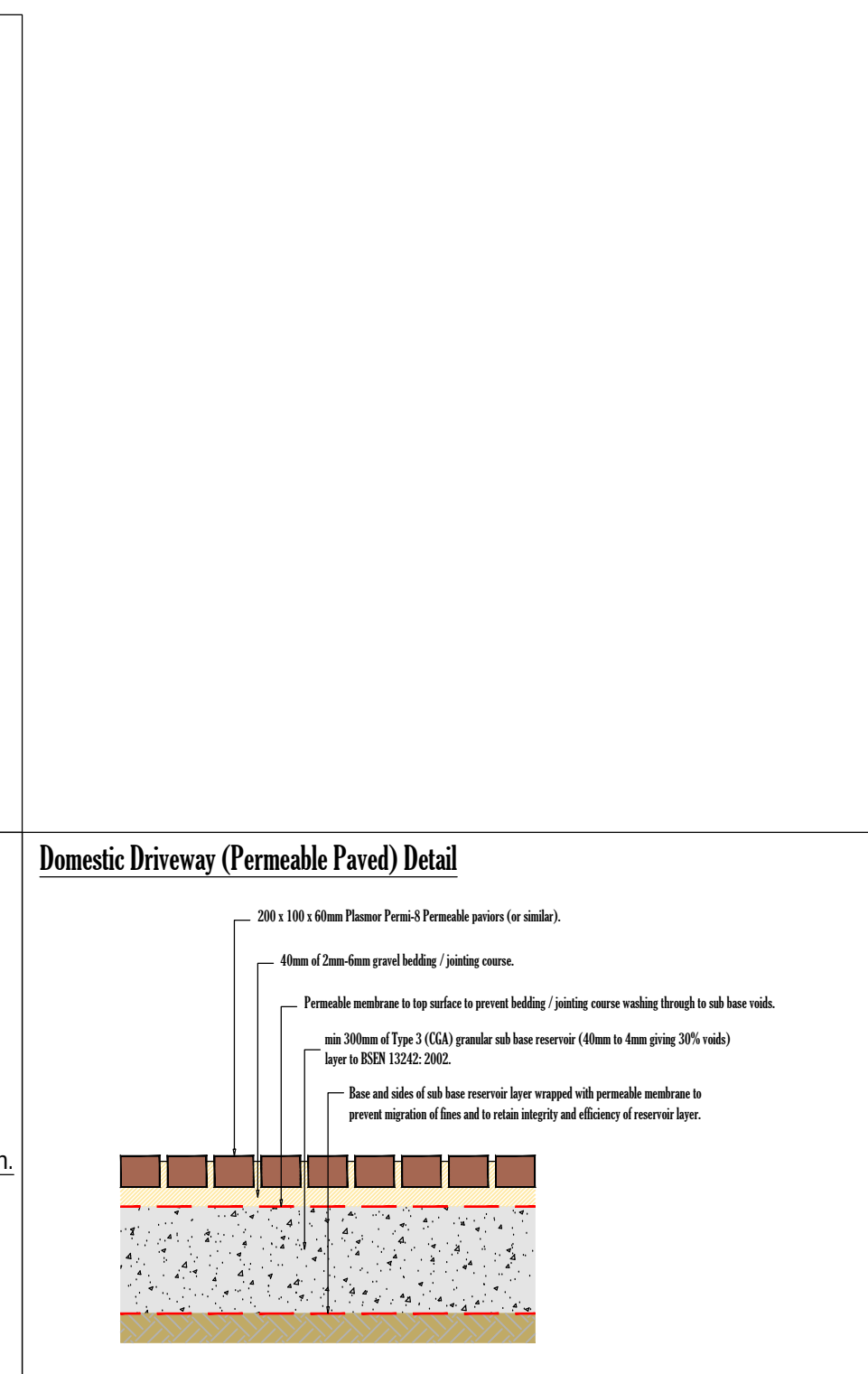
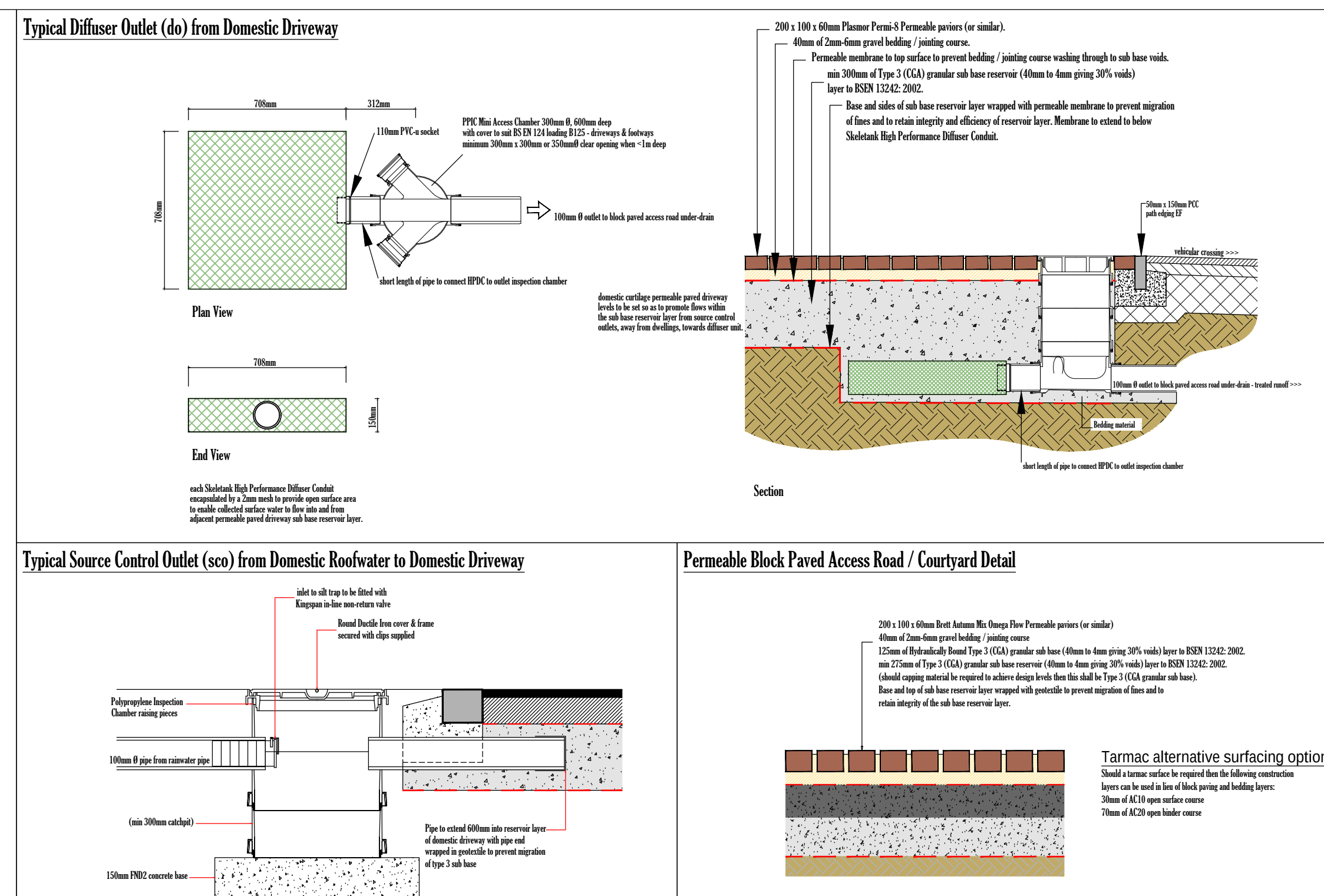
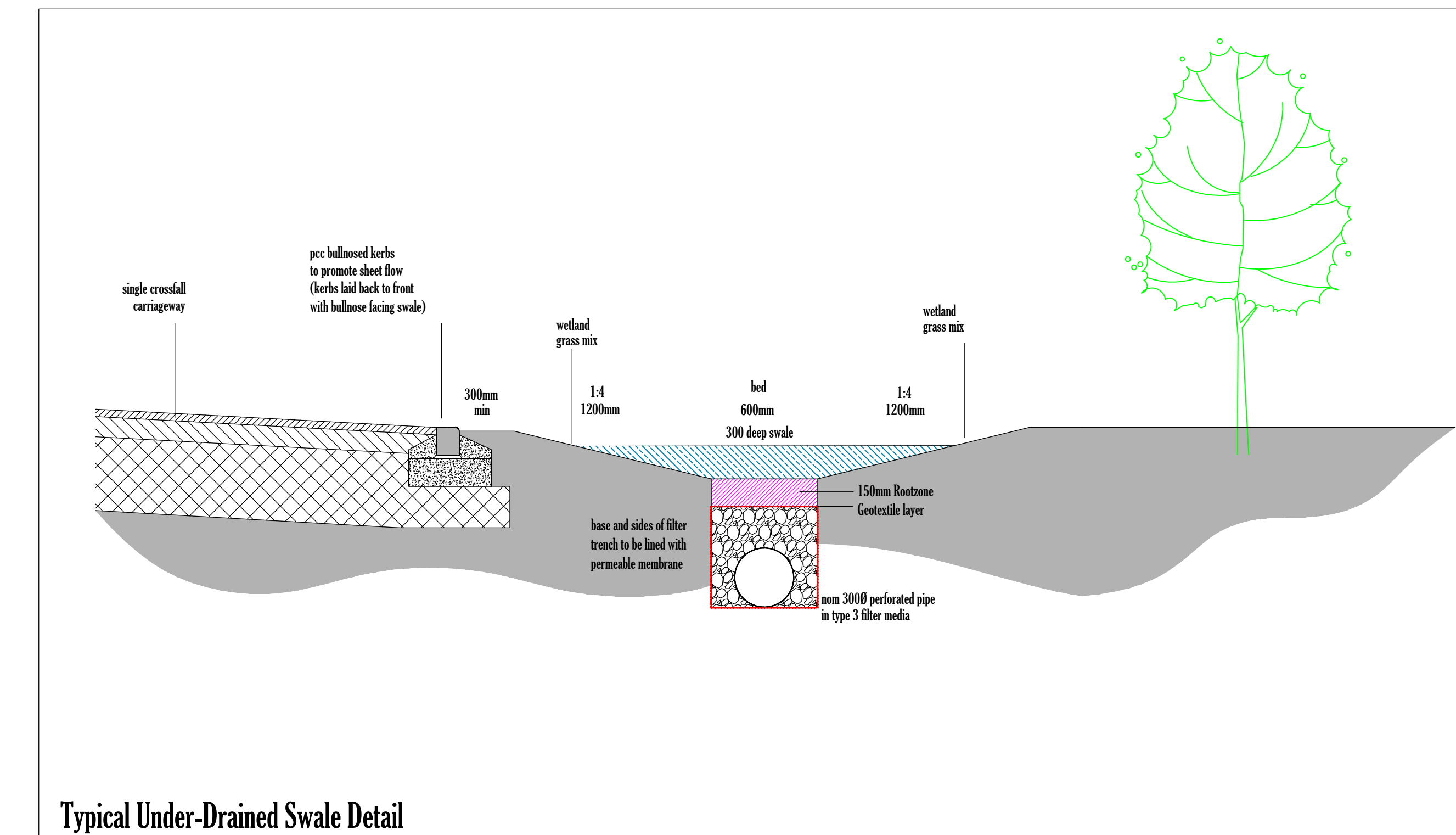
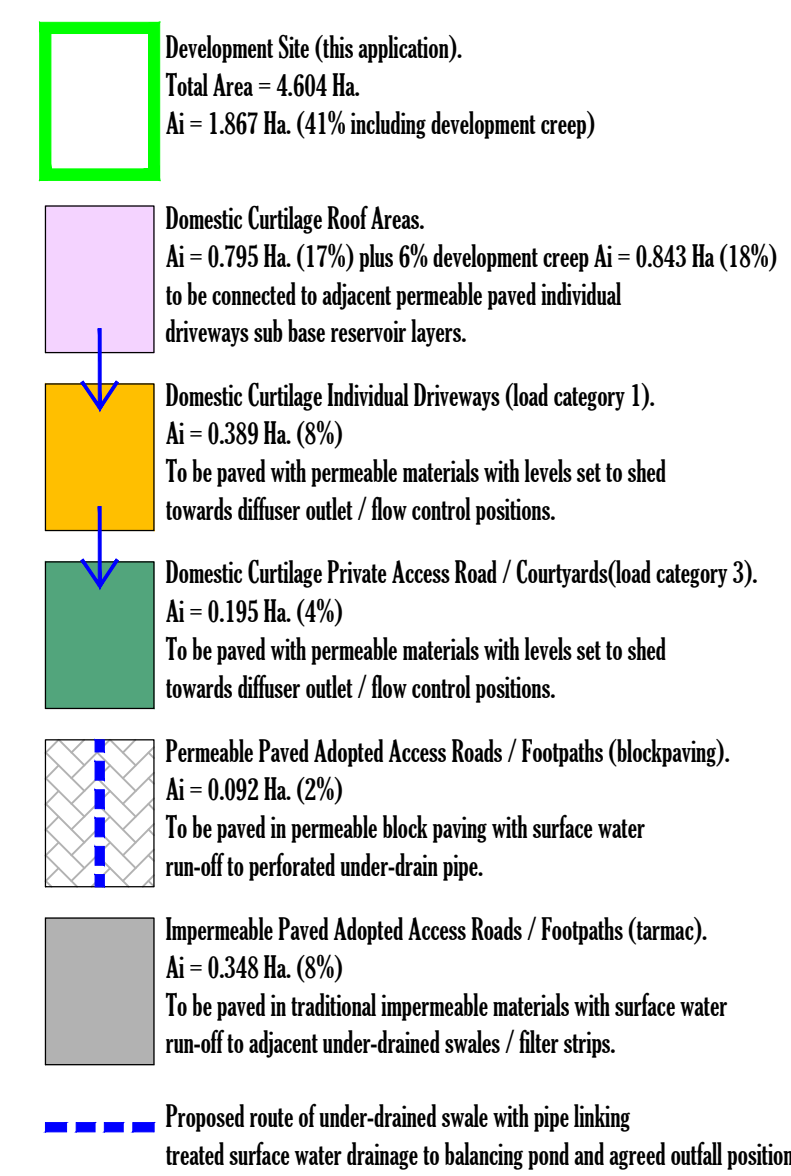
This statement contains schematic concept drainage proposals. The detailed road and sewer design for the entire development would proceed following outline planning approval.

Detailed design does not form any part of the current design remit.

G.W.Hall 16.05.16

Document 1

Document 2



Document 3

Site name: Millfield Nurseries

Site location: Spalding Common

Site coordinates

Latitude: 52.76338° N

Longitude: 0.1708° W

Reference: gcruhj78unfm / 4.6

Date: 12 May 2016

This is an estimation of the greenfield runoff rate limits that are needed to meet normal best practice criteria in line with Environment Agency guidance "Preliminary rainfall runoff management for developments", W5-074/A/TR1/1 rev. E (2012) and the CIRIA SUDS Manual (2007). It is not to be used for detailed design of drainage systems. It is recommended that every drainage scheme uses hydraulic modelling software to finalise volume requirements and design details before drawings are produced.

Site characteristics

Total site area	4.6	ha
Significant public open space	2.73	ha
Area positively drained	1.87	ha

Methodology

Greenfield runoff method	IH124
Qbar estimation method	Calculate from SPR and SAAR
SPR estimation method	Calculate from SOIL type
SOIL type	2
HOST class	N/A
SPR	0.30

Hydrological characteristics

	Default	Edited	
SAAR	559	559	mm
M5-60 Rainfall Depth	20	20	mm
'r' Ratio M5-60/M5-2 day	0.4	0.4	
FEH/FSR conversion factor	0.79	0.79	
Hydrological region	5	5	
Growth curve factor: 1 year	0.87	0.87	
Growth curve factor: 10 year	1.65	1.65	
Growth curve factor: 30 year	2.45	2.45	
Growth curve factor: 100 year	3.56	3.56	

Greenfield runoff rates

	Default	Edited	
Qbar	2.62	2.62	l/s
1 in 1 year	5.00	5.00	l/s
1 in 30 years	6.42	6.42	l/s
1 in 100 years	9.33	9.33	l/s

Please note that a minimum flow of 5 l/s applies to any site

Document 4

Hall Infrastructure Design Ltd		Page 1
9 St Mary's Park Louth Lincolnshire LN11 0EF	Millfield Nurseries Spalding Common JoJos Beheer bv	
Date 16.05.16 File scheme 1.MDX	Designed by GWH Checked by GWH	
Causeway	Network 2016.1	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FEH Rainfall Model	
Return Period (years)	1
Site Location GB 523550 320200 TF 23550 20200	
C (1km)	-0.022
D1 (1km)	0.292
D2 (1km)	0.301
D3 (1km)	0.224
E (1km)	0.313
F (1km)	2.487
Maximum Rainfall (mm/hr)	0
Maximum Time of Concentration (mins)	30
Foul Sewage (l/s/ha)	0.000
Volumetric Runoff Coeff.	0.750
Add Flow / Climate Change (%)	0
Minimum Backdrop Height (m)	0.010
Maximum Backdrop Height (m)	1.500
Min Design Depth for Optimisation (m)	1.200
Min Vel for Auto Design only (m/s)	1.00
Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.257	4-8	0.917	8-12	0.561	12-16	0.132

Total Area Contributing (ha) = 1.867

Total Pipe Volume (m³) = 44.037

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	105.000	0.358	293.3	0.323	8.00	0.0	0.600	o	300	Pipe/Conduit	
2.000	69.000	0.240	287.5	0.213	8.00	0.0	0.600	o	300	Pipe/Conduit	
3.000	72.000	0.240	300.0	0.222	8.00	0.0	0.600	o	300	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	0.00	9.92	1.900	0.323	0.0	0.0	0.0	0.91	64.5	0.0
2.000	0.00	9.25	2.165	0.213	0.0	0.0	0.0	0.92	65.2	0.0
3.000	0.00	9.33	2.165	0.222	0.0	0.0	0.0	0.90	63.8	0.0

Hall Infrastructure Design Ltd		Page 2
9 St Mary's Park Louth Lincolnshire LN11 0EF	Millfield Nurseries Spalding Common JoJos Beheer bv	
Date 16.05.16	Designed by GWH	
File scheme 1.MDX	Checked by GWH	
Causeway	Network 2016.1	

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
2.001	115.000	0.383	300.0	0.354	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.001	63.000	0.210	300.0	0.194	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.002	62.000	0.207	300.0	0.191	0.00	0.0	0.600	o	300	Pipe/Conduit	
4.000	80.000	0.267	299.6	0.370	8.00	0.0	0.600	o	300	Pipe/Conduit	
4.001	40.000	0.133	300.8	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.003	17.000	0.059	288.1	0.000	0.00	0.0	0.600	o	300	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)
2.001	0.00	11.45	1.925	0.789	0.0	0.0	0.0	0.90	63.8	0.0
1.001	0.00	12.62	1.542	1.306	0.0	0.0	0.0	0.90	63.8	0.0
1.002	0.00	13.76	1.332	1.497	0.0	0.0	0.0	0.90	63.8	0.0
4.000	0.00	9.48	1.525	0.370	0.0	0.0	0.0	0.90	63.8	0.0
4.001	0.00	10.22	1.258	0.370	0.0	0.0	0.0	0.90	63.7	0.0
1.003	0.00	14.07	1.125	1.867	0.0	0.0	0.0	0.92	65.1	0.0

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)
1.003	existing culvert	2.600	1.066	0.000	0	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	1.000
Hot Start (mins)	0	Inlet Coefficient	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 Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 5 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FEH	E (1km)	0.313
Return Period (years)	1	F (1km)	2.487
Site Location GB 523550 320200 TF 23550 20200		Summer Storms	Yes
C (1km)	-0.022	Winter Storms	No
D1 (1km)	0.292	Cv (Summer)	0.750
D2 (1km)	0.301	Cv (Winter)	0.840
D3 (1km)	0.224	Storm Duration (mins)	30

Hall Infrastructure Design Ltd		Page 3
9 St Mary's Park Louth Lincolnshire LN11 0EF	Millfield Nurseries Spalding Common JoJos Beheer bv	
Date 16.05.16 File scheme 1.MDX	Designed by GWH Checked by GWH	
Causeway	Network 2016.1	

Online Controls for Storm

Complex Manhole: S9, DS/PN: 1.003, Volume (m³): 8.7

Hydro-Brake Optimum®

Unit Reference MD-SCU-0082-5500-0600-5500
Design Head (m) 0.600
Design Flow (l/s) 5.5
Flush-Flo™ Calculated
Objective Linear discharge profile
Application Surface
Sump Available Yes
Diameter (mm) 82
Invert Level (m) 1.125
Minimum Outlet Pipe Diameter (mm) 100
Suggested Manhole Diameter (mm) 1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.600	5.5	Kick-Flo®	0.123	2.7
Flush-Flo™	0.109	2.7	Mean Flow over Head Range	-	3.7

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)	Depth (m)	Flow (l/s)
0.100	2.7	0.800	6.3	2.000	9.7	4.000	13.5	7.000	17.6
0.200	3.3	1.000	7.0	2.200	10.1	4.500	14.3	7.500	18.3
0.300	4.0	1.200	7.6	2.400	10.6	5.000	15.0	8.000	18.9
0.400	4.6	1.400	8.2	2.600	11.0	5.500	15.7	8.500	19.5
0.500	5.1	1.600	8.7	3.000	11.8	6.000	16.4	9.000	20.0
0.600	5.5	1.800	9.2	3.500	12.6	6.500	17.0	9.500	20.6

Orifice

Diameter (m) 0.050 Discharge Coefficient 0.600 Invert Level (m) 1.925

Hall Infrastructure Design Ltd		Page 4
9 St Mary's Park Louth Lincolnshire LN11 0EF	Millfield Nurseries Spalding Common JoJos Beheer bv	
Date 16.05.16 File scheme 1.MDX	Designed by GWH Checked by GWH	
Causeway	Network 2016.1	

Storage Structures for Storm

Complex Manhole: S4, DS/PN: 2.001

Dry Swale

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	Trench Infiltration Side (m/hr)	0.00000
Infiltration Coefficient Side (m/hr)	0.00000	Trench Porosity	0.30
Safety Factor	2.0	Side Slope (1:X)	4.0
Porosity	1.00	Slope (1:X)	0.0
Invert Level (m)	2.225	Cap Volume Depth (m)	1.125
Trench Height (m)	0.825	Cap Infiltration Depth (m)	1.125
Trench Width (m)	0.6	Include Swale Volume	Yes
Trench Length (m)	56.0		

Dry Swale

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	Trench Infiltration Side (m/hr)	0.00000
Infiltration Coefficient Side (m/hr)	0.00000	Trench Porosity	0.30
Safety Factor	2.0	Side Slope (1:X)	4.0
Porosity	1.00	Slope (1:X)	0.0
Invert Level (m)	2.225	Cap Volume Depth (m)	1.125
Trench Height (m)	0.825	Cap Infiltration Depth (m)	1.125
Trench Width (m)	0.6	Include Swale Volume	Yes
Trench Length (m)	47.0		

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1000	Length (m)	270.0
Max Percolation (l/s)	375.0	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	3.000	Membrane Depth (mm)	100

Complex Manhole: S5, DS/PN: 1.001

Dry Swale

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	Trench Infiltration Side (m/hr)	0.00000
Infiltration Coefficient Side (m/hr)	0.00000	Trench Porosity	0.30
Safety Factor	2.0	Side Slope (1:X)	4.0
Porosity	1.00	Slope (1:X)	0.0
Invert Level (m)	1.842	Cap Volume Depth (m)	1.508
Trench Height (m)	1.208	Cap Infiltration Depth (m)	1.508
Trench Width (m)	0.6	Include Swale Volume	Yes
Trench Length (m)	74.0		

Hall Infrastructure Design Ltd		Page 5
9 St Mary's Park Louth Lincolnshire LN11 0EF	Millfield Nurseries Spalding Common JoJos Beheer bv	
Date 16.05.16 File scheme 1.MDX	Designed by GWH Checked by GWH	
Causeway	Network 2016.1	

Dry Swale

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	Trench Infiltration Side (m/hr)	0.00000
Infiltration Coefficient Side (m/hr)	0.00000	Trench Porosity	0.30
Safety Factor	2.0	Side Slope (1:X)	4.0
Porosity	1.00	Slope (1:X)	0.0
Invert Level (m)	1.842	Cap Volume Depth (m)	1.508
Trench Height (m)	1.208	Cap Infiltration Depth (m)	1.508
Trench Width (m)	0.6	Include Swale Volume	Yes
Trench Length (m)	90.0		

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1000	Length (m)	424.0
Max Percolation (l/s)	588.9	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	3.000	Membrane Depth (mm)	100

Complex Manhole: S6, DS/PN: 1.002

Dry Swale

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	Trench Infiltration Side (m/hr)	0.00000
Infiltration Coefficient Side (m/hr)	0.00000	Trench Porosity	0.30
Safety Factor	2.0	Side Slope (1:X)	4.0
Porosity	1.00	Slope (1:X)	0.0
Invert Level (m)	1.632	Cap Volume Depth (m)	1.718
Trench Height (m)	1.418	Cap Infiltration Depth (m)	1.718
Trench Width (m)	0.6	Include Swale Volume	Yes
Trench Length (m)	42.0		

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1000	Length (m)	242.0
Max Percolation (l/s)	336.1	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	3.000	Membrane Depth (mm)	100

Complex Manhole: S8, DS/PN: 4.001

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1000	Length (m)	148.0
Max Percolation (l/s)	205.6	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	2.650	Membrane Depth (mm)	200

Hall Infrastructure Design Ltd		Page 6
9 St Mary's Park Louth Lincolnshire LN11 0EF	Millfield Nurseries Spalding Common JoJos Beheer bv	
Date 16.05.16 File scheme 1.MDX	Designed by GWH Checked by GWH	
Causeway	Network 2016.1	

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1000	Length (m)	232.0
Max Percolation (l/s)	322.2	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	3.000	Membrane Depth (mm)	100

Tank or Pond Manhole: S9, DS/PN: 1.003

Invert Level (m) 1.125

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	663.0	0.600	860.0	1.200	2080.0	1.800	0.0	2.400	0.0
0.100	694.0	0.700	895.0	1.300	2080.0	1.900	0.0	2.500	0.0
0.200	726.0	0.800	2080.0	1.400	5250.0	2.000	0.0		
0.300	759.0	0.900	2080.0	1.500	5250.0	2.100	0.0		
0.400	792.0	1.000	2080.0	1.600	0.0	2.200	0.0		
0.500	826.0	1.100	2080.0	1.700	0.0	2.300	0.0		

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Document 5

GROUND ENGINEERING

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SITE INVESTIGATION REPORT

**MILLFIELD NURSERIES
SPALDING COMMON
SPALDING
LINCOLNSHIRE**

Report Reference C13746

On behalf of:-

**JoJos Beheer b.v.
c/o Robert Doughty Consultancy Limited
32 High Street
Helpringham
Sleaford
Lincolnshire
NG34 0RA**

March 2016

Sulphate Conditions

Sulphate analysis of selected samples of soil and groundwater yielded soluble sulphate concentrations within Design Sulphate Classes DS-1 and DS-2 of the BRE Special Digest 1, Table C1 (2005), presented in Appendix 3. The pH results of samples ranged between 7.2 and 8.7 indicating alkaline conditions. The characteristic soil pH was 7.5.

These results indicate an Aggressive Chemical Environment for Concrete (ACEC) Class of AC-2 for buried concrete. This ACEC Class should be considered when specifying a Design Chemical Class (DC Class) for buried concrete on this site, as detailed in the above cited BRE document.

Drainage

The soakaway tests (TP2A and TP3) gave soil infiltration rates (f) of 1.59×10^{-6} m/s and 9.81×10^{-7} m/s, for the silty sand Tidal Flat Deposit soils. The soil infiltration rate for TP1 was not determined as the water did not soakaway at all in the 240 minute test period. These results rate the Tidal Flat Deposit as having a 'poor' drainage potential according to BS8004:1986, and reflect the poor drainage properties of the Tidal Flat Deposit clays and silts.

Groundwater was locally met as seepages between 0.80m and 1.46m depth in the exploratory holes, within the superficial Tidal Flat Deposits. Soakaway drainage on this site may deteriorate over time as the chambers could become blocked with silt. Provision should be made for regular cleaning. There would be no advantage in excavating soakaway chambers below the groundwater level, which reduces the effective zone of soakaway strata.

Hardstanding

Made ground soils generally comprising brown/light brown, slightly clayey, slightly gravelly, sandy silt fill, varying to clayey/silty sand and gravel fill, or naturally deposited soft or firm, slightly sandy, silty clays or roddons of loose becoming very loose, brown and orange brown, silty fine grained sand, was encountered at sub-grade level across this site.

SOAKAWAY TEST RESULTS

BRE DIGEST 365 - SOIL INFILTRATION RATE

Project: Millfield Nurseries, Spalding Common
Client: JoJos Beheer b.v.

Project No: C13746
Sheet No: 1\1

Trial Pit: TP1
Depth: 1.40
Length: 1.30
Width: 0.48

FIRST FILLING

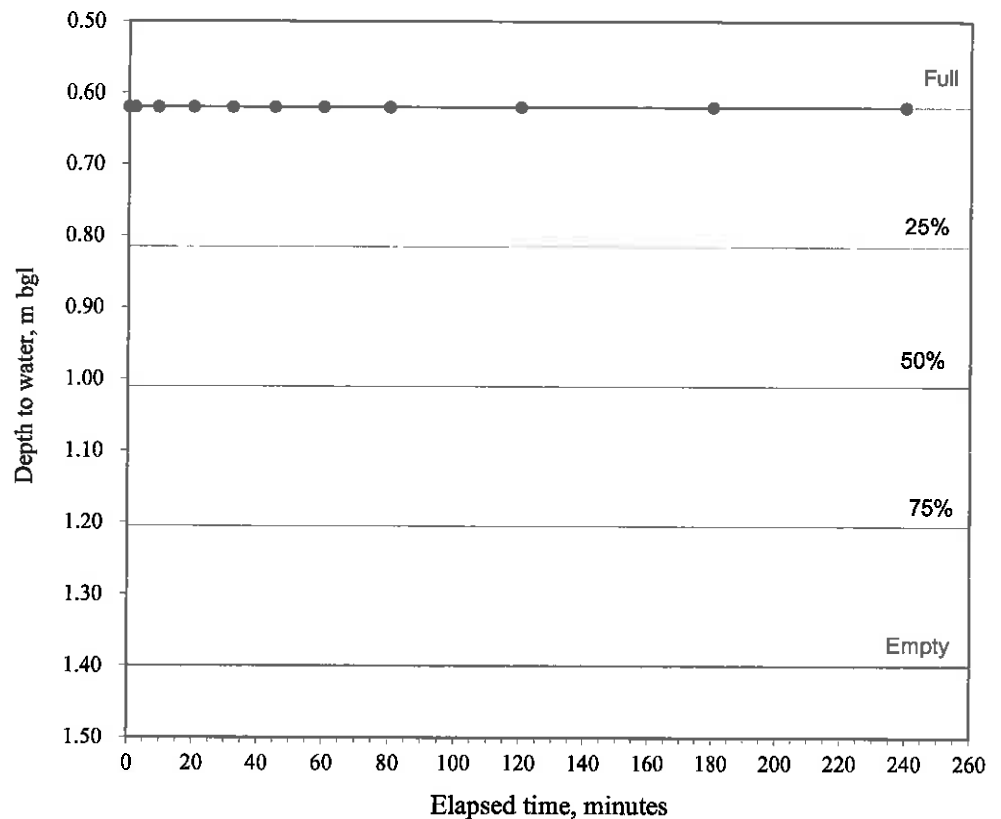
Description of Stratum under test:

Firm, brown/orange brown, sandy CLAY over
brown and grey, silty SAND

Depth to water prior to test: 1.40m
(below ground level)

Elapsed Time min	Depth to Water m
0	0.62
2	0.62
9	0.62
20	0.62
32	0.62
45	0.62
60	0.62
80	0.62
120	0.62
180	0.62
240	0.62

DEPTH TO WATER vs ELAPSED TIME



All dimensions given in metres

$$f = (V75-V25)/A50(T75-T25)$$

$$V75-V25 = 0.243$$

$$A50 = 2.012$$

$$T75-T25 =$$

Extrapolated Soil Infiltration Rate f = not determined

SOAKAWAY TEST RESULTS

BRE DIGEST 365 - SOIL INFILTRATION RATE

Project: Millfield Nurseries, Spalding Common
Client: JoJos Beheer b.v.

Project No: C13746
Sheet No: 1\1

Trial Pit: TP2A
Depth: 1.50
Length: 1.20
Width: 0.50

FIRST FILLING

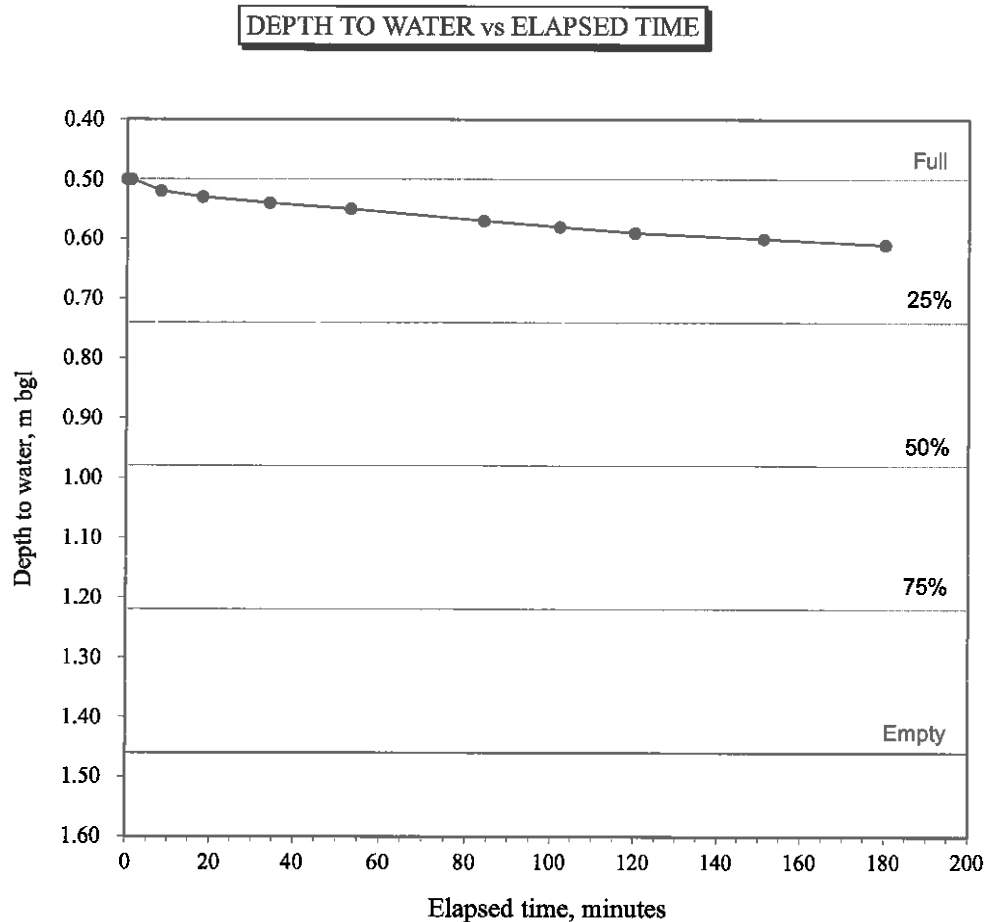
Description of Stratum under test:

Firm, brown, slightly gravelly, sandy SILT/CLAY over
brown/orange brown, silty/clayey SAND

Depth to water prior to test: 1.46m
(below ground level)

Elapsed Time min	Depth to Water m
0	0.50
1	0.50
8	0.52
18	0.53
34	0.54
53	0.55
84	0.57
102	0.58
120	0.59
151	0.60
180	0.61

All dimensions given in metres



$$f = \frac{(V_{75} - V_{25})}{A_{50}(T_{75} - T_{25})}$$

$V_{75} - V_{25} = 0.288$
 $A_{50} = 2.232$
 $T_{75} - T_{25} = 1355$ (extrapolated)

Extrapolated Soil Infiltration Rate $f = \underline{1.59E-06} \text{ m/s}$

SOAKAWAY TEST RESULTS

BRE DIGEST 365 - SOIL INFILTRATION RATE

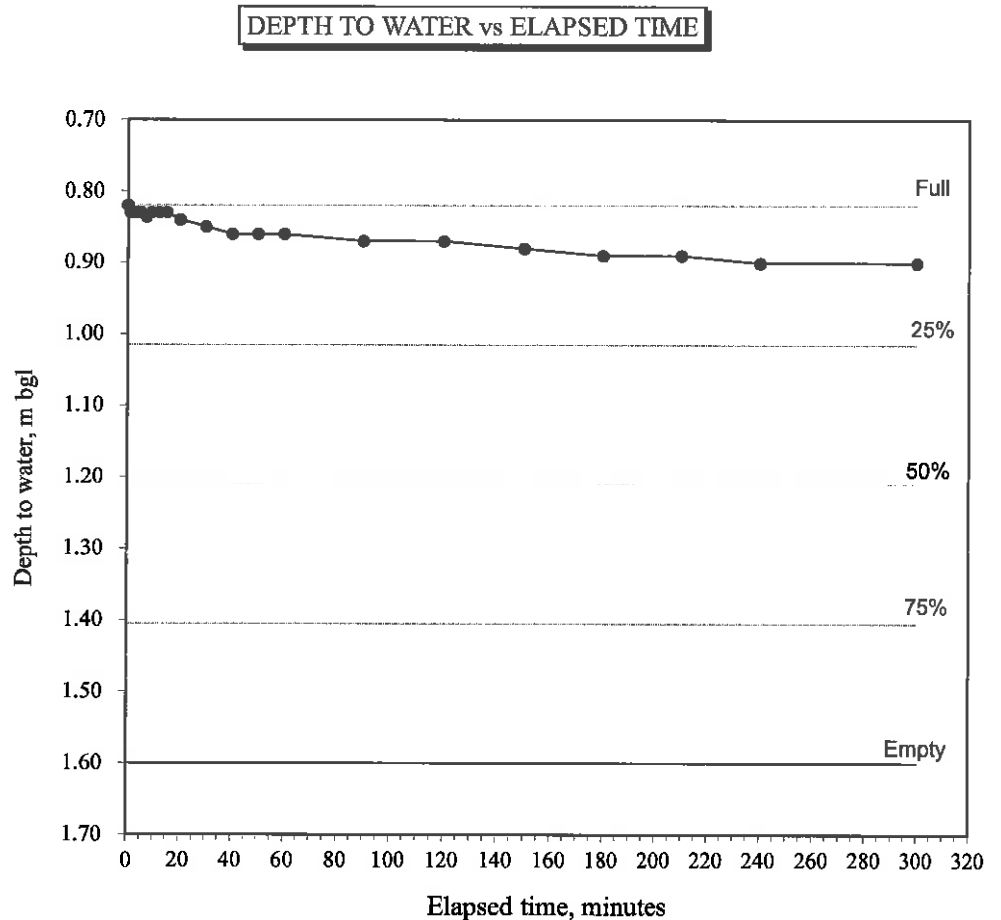
Project: Millfield Nurseries, Spalding Common
Client: JoJos Beheer b.v.

Project No: C13746
Sheet No: 1\1

Trial Pit: TP3 FIRST FILLING
Depth: 1.60
Length: 1.40
Width: 0.50

Description of Stratum under test: Firm, brown, sandy, silty CLAY over
light brown/orange brown, slightly clayey, silty SAND
Depth to water prior to test: 1.60m
(below ground level)

Elapsed Time min	Depth to Water m
0	0.82
1	0.83
3	0.83
5	0.83
7	0.84
9	0.83
12	0.83
15	0.83
20	0.84
30	0.85
40	0.86
50	0.86
60	0.86
90	0.87
120	0.87
150	0.88
180	0.89
210	0.89
240	0.90
300	0.90



All dimensions given in metres

$$f = \frac{(V75-V25)}{A50(T75-T25)}$$

$V75-V25 = 0.273$
 $A50 = 2.182$
 $T75-T25 = 2125$ (extrapolated)

Extrapolated Soil Infiltration Rate $f = \underline{9.81E-07} \text{ m/s}$

Document 6

