



GEMMA DESIGN

Knowles & Son

**Residential development at 1A
Upper Redlands Road, Reading**

**Surface Water Drainage Design,
Management & Maintenance
Plan**

February 2017

Gemma Design Ltd
Lea View House, Two Rivers Estate,
Station Lane, Witney,
Oxon, OX28 4LD
Tel: 01993 705 522
Fax: 01993 779 220
E-mail: info@gemma-design.co.uk
website: www.gemma-design.co.uk

Document Ref: 4265-GDL-RP-C-001
(Rev A)

Surface Water Drainage Design, Management & Maintenance Plan

FOR

Knowles & Son

Gemma Design Ltd have prepared this report in accordance with the instruction of Knowles & Son ("The Client").

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Prepared by:	Pavlos Iordanidis MEng		Date:	09/02/2017
Checked by:	S Watts BEng (Hons)		Date:	09/02/2017
Approved by:	S Watts BEng (Hons)		Date:	09/02/2017

Issue

Date	Sheet No	Sets	Recipient
08/02/2017	Formal Issue	1	Knowles & Son
09/02/2017	Second Formal Issue	1	Knowles & Son

Amendments

Date	Sheet No	Sets	Recipient
09/02/2017	Footpath construction amended	Rev A	Knowles & Son

Contents

- 1.0 Introduction
- 2.0 Surface Water Drainage Proposals
- 3.0 Maintenance of the Surface Water Drainage System

1.0 Introduction

- 1.1 This report provides details of the surface water drainage proposals for a residential development at 1A Upper Redlands Road, Reading, comprising of 6 semi-detached and 4 terraced houses. The report has been prepared to address *planning condition No. 12*.
- 1.2 In particular, the report provides details about the method proposed to manage the surface run-off from site, the proposed design principles and details of the maintenance regime for managing the drainage system in perpetuity.
- 1.3 The report should be read in conjunction with the drawings listed below:

Proposed Drainage Design – 4265-GDL-XX-D-DR-C-003_P1

Private drainage construction details (Sheet 1) – 4265-GDL-XX-D-DR-C-010_P1

Private drainage construction details (Sheet 2) – 4265-GDL-XX-D-DR-C-011_P1

Private road construction details (Sheet 2) – 4265-GDL-XX-D-DR-C-012_P1

2.0 Surface Water Drainage Proposals

- 2.1 It is proposed to manage the surface run-off from the development by providing an attenuated connection to the adoptable surface water sewer in Upper Redlands Road to the north of the site. Geocellular crates will be used to attenuate the surface-run off from the proposed hardstandings and buildings on the development. The rate of discharge will be controlled by a hydrobrake. Consideration was given to the use of soakage systems; however, as there is no soakage available on the site, due to the clayey ground conditions, this option is not suitable.
- 2.2 Catchpits will be provided upstream of the cellular storage to intercept any silt and debris in the surface run-off and prevent it from entering the cellular storage units.
- 2.3 The cellular storage has been designed in accordance with current best practice to accommodate a 1 in 100 year storm event, including a 30% allowance for climate change. Copies of the hydraulic design (Micro Drainage) calculations are enclosed in Appendix B.
- 2.4 The rate of discharge will be limited to a maximum of 5l/s using a hydrobrake, which is the practical minimum flow rate to avoid potential blockages in the flow control device.
- 2.5 It is also proposed to use porous asphalt surfacing to form a new footpath, to the front of the houses, south of the development, to manage the surface run-off from this area and to provide an appropriate surface in the tree root protection zone.
- 2.6 Porous asphalt allows rainwater to percolate through the surface and to be stored in the underlying layers (granular sub-base), but at the same time provides a suitable surface for pedestrians.

- 2.7 Full details of the surface water drainage design proposals are enclosed in Appendix A.

3.0 Maintenance of Surface Water Drainage System

- 3.1 Regular inspections and maintenance of the surface water drainage system is essential to ensure the effective operation of the drainage system.
- 3.2 A management company will be responsible for maintaining the drainage system on behalf of Reading University.
- 3.3 Outlined below are details of the proposed maintenance regime, which is in accordance with the guidance provided in the SUDS manual, CIRIA publication C753.

Attenuation System

- 3.4 Catchpits will be provided to intercept silt and debris in the surface water and to prevent it from entering the cellular storage system. The catchpits should initially be inspected on a monthly basis and then on an annual basis and any build-up of detritus or silt should be removed.
- 3.5 Roof gutters and downpipe filters should be cleaned on a regular basis to prevent leaves and other detritus from entering the drainage system. The use of leaf guards are recommended.
- 3.6 If, in the unlikely event, the tank fails due to excessive silting it will need to be removed, cleaned and re-laid.
- 3.7 A summary of the maintenance requirements are provided in the schedule below:

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action	Monthly for 3 months, 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 blockage by sediment, algae or other matter; remove and replace surface infiltration medium as necessary.	Annually
	Remove sediment from pre-treatment structures and/or internal forebays	Annually, or as required
Remedial actions	Repair/rehabilitate inlets, outlet, overflows and vents	As required
Monitoring	Inspect/check all inlets, outlets, vents and overflows to ensure that they are in good condition and operating as designed	Annually
	Survey inside of tank for sediment build-up and remove if necessary	Every 5 years or as required

Porous asphalt surfacing

- 3.8 Porous asphalt surfaces benefit from extremely low maintenance. The surface should be inspected, preferably during and after heavy rainfall, to check for effective operation and identify any areas of surface ponding.
- 3.9 Regular sweeping and washing is often the only maintenance necessary. Leaves, tree flowers, pine needles and other detritus should not be allowed to remain on the surface for any length of time. If this happens they rapidly rot down forming a drainage-inhibiting 'skin' within the surface, and providing a growing medium for algae, moss and weeds which may allow moisture to be held within the surface, which may cause issues during cold / freezing conditions due to expansion / contraction. Periodic cleaning by hosing down or light power washing and copious amounts of water with a stiff brush should be all that is necessary to remove pollution and surface debris.
- 3.10 Washing can be carried out using a portable pressure washer (up to 150 bar rating) to remove dirt, grime and moss providing care is taken not to damage the surface with excessive pressure. For more extensive washing we would recommend contracting a specialist contractor.
- 3.11 Snow and ice are not harmful and can be permitted to melt through. The removal of ice or frost from the surface can be achieved by the application of environmentally-benign deicers and salt. Snow ploughing is acceptable but should be done carefully (i.e. set the blade slightly higher than usual). Do not use road grit, as this will clog the permeable surface and the grit will break down the porous topping. The area can also be treated with deicing treatments prior to a cold snap to prevent freezing occurring in the first place. When the weather has returned to normal, (non freezing conditions) please wash the area through with water to remove the salt from the surface.

Hydrobrake Flow Control Device

- 3.12 Only minimal maintenance is required for the flow control device. If a blockage occurs then it is most likely to be at the intake, therefore it is recommended that the unit be inspected monthly for the first three months and thereafter on a six monthly basis with the unit being hosed down as necessary and any build-up of detritus or silt should be also removed. For further details of the maintenance requirements refer to the manufacturers guidelines.

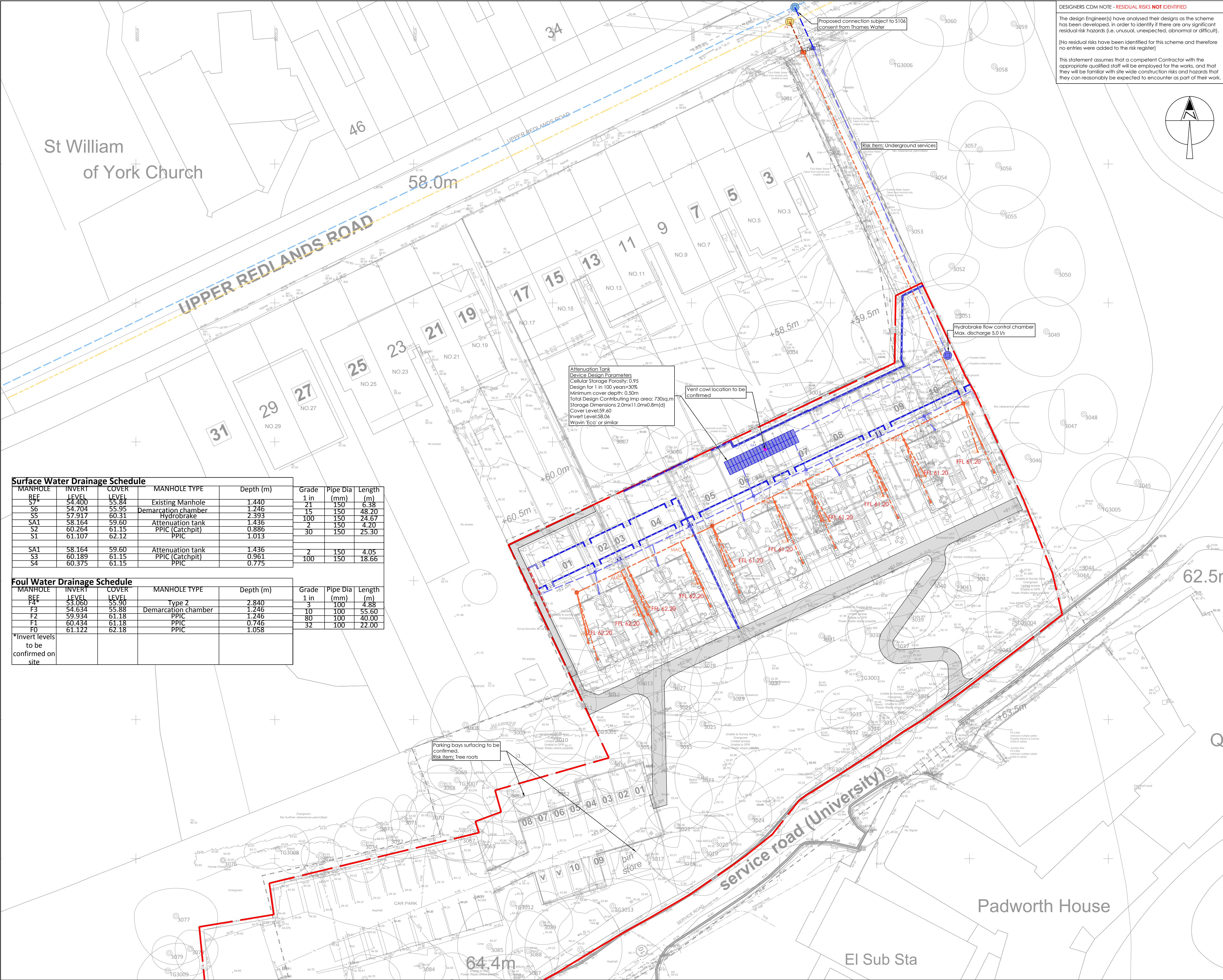
Appendix A – Drawings

Proposed Drainage Design – 4265-GDL-XX-D-DR-C-003_P2

Private drainage construction details (Sheet 1) – 4265-GDL-XX-D-DR-C-010_P1

Private drainage construction details (Sheet 2) – 4265-GDL-XX-D-DR-C-011_P1

Private road construction details (Sheet 2) – 4265-GDL-XX-D-DR-C-012_P2



Surface Water Drainage Schedule

MANHOLE	INVERT LEVEL	COVER LEVEL	MANHOLE TYPE	Depth (m)	Grade 1 in	Pipe Dia (mm)	Length (m)
REF	54.400	55.84	Existing Manhole	1.440	21	150	6.38
S6	54.704	55.95	Demarcation chamber	1.246	15	150	48.20
S5	57.917	60.31	Hydrobrake	2.393	100	150	24.67
SA1	58.164	59.60	Attenuation tank	1.436	2	150	4.20
S2	60.264	61.15	PPIC (Catchpit)	0.886	30	150	25.30
S1	61.107	62.12	PPIC	1.013			
SA1	58.164	59.60	Attenuation tank	1.436	2	150	4.05
S3	60.189	61.15	PPIC (Catchpit)	0.961	100	150	18.66
S4	60.375	61.15	PPIC	0.775			

Foul Water Drainage Schedule

MANHOLE	INVERT LEVEL	COVER LEVEL	MANHOLE TYPE	Depth (m)	Grade 1 in	Pipe Dia (mm)	Length (m)
F4*	53.060	55.90	Type 2	2.840	3	100	4.88
F3	54.634	55.88	Demarcation chamber	1.246	10	100	55.60
F2	59.934	61.18	PPIC	1.246	80	100	40.00
F1	60.434	61.18	PPIC	0.746	32	100	22.00
F0	61.122	62.18	PPIC	1.058			
*Invert levels to be confirmed on site							

DESIGNERS CDM NOTE - RESIDUAL RISKS NOT IDENTIFIED

The design Engineer(s) have analysed their designs as the scheme has been developed. In order to identify if there are any significant residual risk hazards (i.e. unusual, unexpected, abnormal or difficult). [No residual risks have been identified for this scheme and therefore no entries were added to the risk register]

This statement assumes that a competent Contractor with the appropriate qualified staff will be employed for the works, and that they will be familiar with site wide construction risks and hazards that they can reasonably be expected to encounter as part of their work.

DESIGNERS CDM NOTE

THERE ARE NO SUBSTANTIAL RESIDUAL RISK ITEMS IDENTIFIED

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KEY

- Foul drain (private/non adoptable)
- Surface water drain (private/non-adoptable)
- Foul sewer (Adoptable)
- Surface water drain (Adoptable)
- Highway Drain (Adoptable)
- Existing Private Foul drain
- Existing Private Surface water drain
- Existing Adoptable Foul sewer
- Existing Adoptable Surface water sewer
- Existing Adoptable Combined water sewer

- SW** **FW** **CHAMBER DETAILS**
- Depth - 0.6m or less Mini access chamber MAC (300mmØ)
 - Depth - 0.45m to 1.25m PPIC (475mmØ)
 - Depth - 0.45m to 1.25m 600x450 P.C.C. units/brick (preferred type for trafficked areas)
 - Adoptable demarcation manhole within 1m of boundary 600mm x 450mm (size to be confirmed by adoption authority) PCC or brick construction NOT plastic.
 - Manhole
 - Depth - 1.25 to 1.5m (1050mmØ P.C.C. ring)
 - Depth - 1.55 to 3.0m (1200mmØ P.C.C. ring)

- RE Surface water rodding eye
- F1 Manhole number
- Entrance into building
- Soil Vent Pipe/Soil Stack
- Rain water down pipe (roddable access)
- YG Yard gully (225mmØ trapped)
- Road gully (trapped) C250 hinged cover & frame
- Floor Gully
- Linear Drainage channel
- Crate storage (Refer to drawing for sizes)

FFLXXX.XX Finished floor level

Retaining Wall

Site Boundary

Porous asphalt footpath construction

Vent cowl

It is strongly recommended that where possible all drainage runs are laid commencing from the outfalls, especially where the outfall depth is shallow.

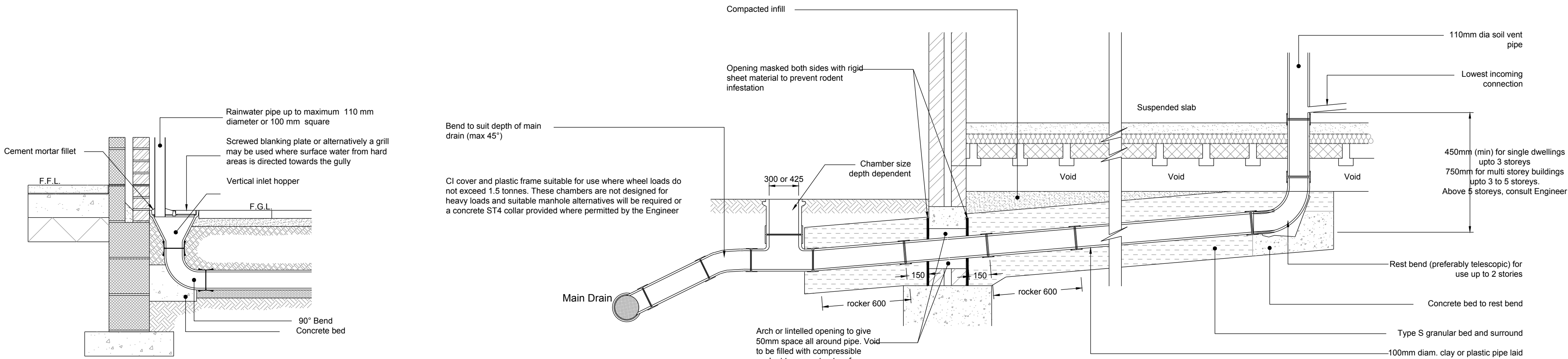
P2	Footpath surfacing construction amended	09/02/17	PI
P1	Preliminary Issue	03/02/17	PI
REV	REVISION DETAILS	DATE	DRAWN BY
CLIENT	KNOWLES	ORIGINATOR	GEMMA DESIGN
PROJECT	1A Upper Redlands Road Reading	TITLE	Proposed Drainage Layout
SCALE	1:250 @A1	PI	SW
PROJECT	4265	ORIGINATOR	GDL
ZONE	XX	LEVEL	D
TYPE	DR	ROLE	C
DOC NO	003	STATUS:	S3
JOB NO.	4265	PURPOSE OF ISSUE	FOR COMMENT
REVISION:	P2		

NON ADOPTABLE DRAINAGE NOTES

- Generally non-adoptable drainage shall comply with the DLR Building Regulations approved document H (April 2002)
- Any changes made from the drainage design shown on this drawing shall be reported to the Engineer.
 - The Contractor must confirm the invert levels and positions of all outfalls/connections to existing drainage prior to commencing work on-site.
 - Non-adoptable chambers shall be :-

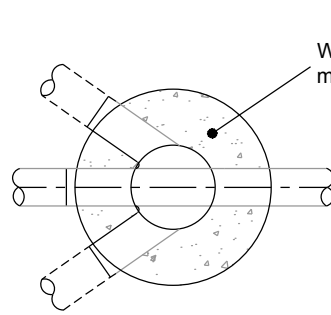
depth to invert	chamber size and type
0.325m to 0.6m	shallow access chamber 300mmØ
0.4m to 1.25m	Inspection chamber 475mm Ø (polyprop) 600mmx450mm Brick/P.C.C. units
1.35 to 1.5	Manhole 1050mmØ P.C.C. ring 1200mmx750mm Brick/P.C.C. units
1.50 to 3.0	Manhole 1200mm Ø P.C.C. ring (ring diameter increased if sewer dia greater than 475mm Ø)
 - All manholes shall have a flexible joint within 150mm of the face of the structure and a "rocker pipe" which should not exceed 600mm in length.
 - Non-adoptable drainage to be either :-
concrete to BS 5911:Part 100 and 110
vitrified clayware to BS EN 295
Grey iron to BS437
UPVC to BS EN 1401
PP to BS EN 1852
Structure wall to BS EN 13476
Confirm plastic pipes acceptable to Client.
 - For private drains, pipes with less than 0.9m cover beneath carriageways & hardstanding or 600mm in other areas shall have 100mm thick concrete slab with mesh reinforcement and 150mm bearing each side of the trench. Where the depth of cover at any location is less than 450mm it is recommended that a concrete surround with flexible joints is provided.
 - Trenches within 1m of load bearing walls should be filled with concrete at least to the underside of the foundation. Where the distance is more than 1m from the foundations the concrete should be taken at least up to a 45degree line from the bottom of the foundations. Alternatively, the foundations could be taken to a deeper level to avoid undermining by the drainage trench (check with the Engineer where this is required).
 - Pipe bed and surround to be Type S granular unless otherwise noted in item 7.
 - Drains passing through walls or foundations should have either an arched or lintelled opening to give 50mm clearance around the pipe. The opening shall be masked both sides with a rigid non perishable material, or alternatively a short length of pipe may be built in solid if it is connected within 150mm to rocker pipes (max 600mm long) with flexible joints.
 - Drains under buildings should be surrounded by at least 100mm of granular or other flexible filling.
 - Unless otherwise stated all non-adoptable drainage shall be 100mmØ (see drainage schedules).
 - Road gully connections to be 150mmØ.
Yard gully connections 100mmØ.
 - New connections to existing public sewers should be carried out as required and under the supervision of the Water Authority The appropriate sewer connection notice should be applied for where appropriate.
 - Covers shall be to B.S. EN 124:1994 Class A15 access covers and gratings capable of withstanding a 1.5 T load. For use in areas where only pedestrians have access. Class B125 access covers and frames capable of withstanding a 12.5T load. For use in car parks and pedestrian areas where occasional vehicular access is likely. Class C250 access covers and frames capable of withstanding a 25T load. For use in areas where not extending more than 500mm from kerb face into the carriageway Class D400 access covers and gratings capable of withstanding a 40T load. For use in areas where cars and lorries have access including carriageways, hard shoulders and pedestrian areas.

Cover and frames to be increased to 150 deep when located within the following areas:
 - Trunk roads and dual carriageways
 - All other A roads
 - Bus Routes
 - All other roads except residential cul-de-sacs
 - It is recommended that where possible the Contractor should ensure that all drainage is commenced at the outfall and laid into the site and not vice versa, especially where the outfall depth is shallow.
 - Shallow pipelines may need to be protected when laid at an early stage of a contract and are subject to construction traffic loadings.
 - In buildings up to 3 storeys the rest bend at the base of the soil stack should be 450mm below the invert of the lowest incoming drain. In buildings over 3 storeys this should be increased to 750mm. In buildings over 5 storeys the ground floor drainage connections should have their own connections to the external drain.

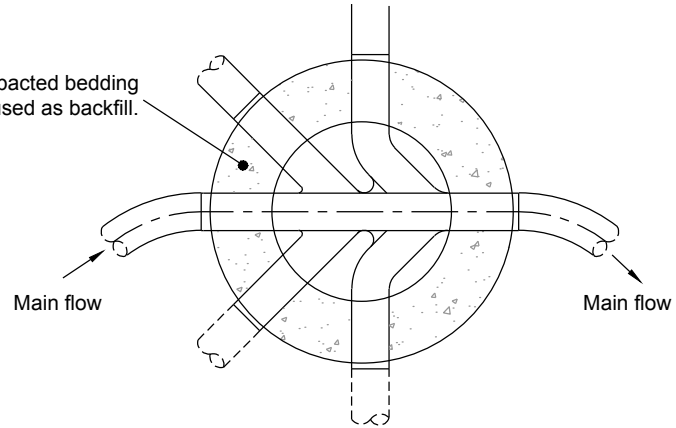


RAIN WATER PIPE WITH RODDING ACCESS

See pipeline building entry detail

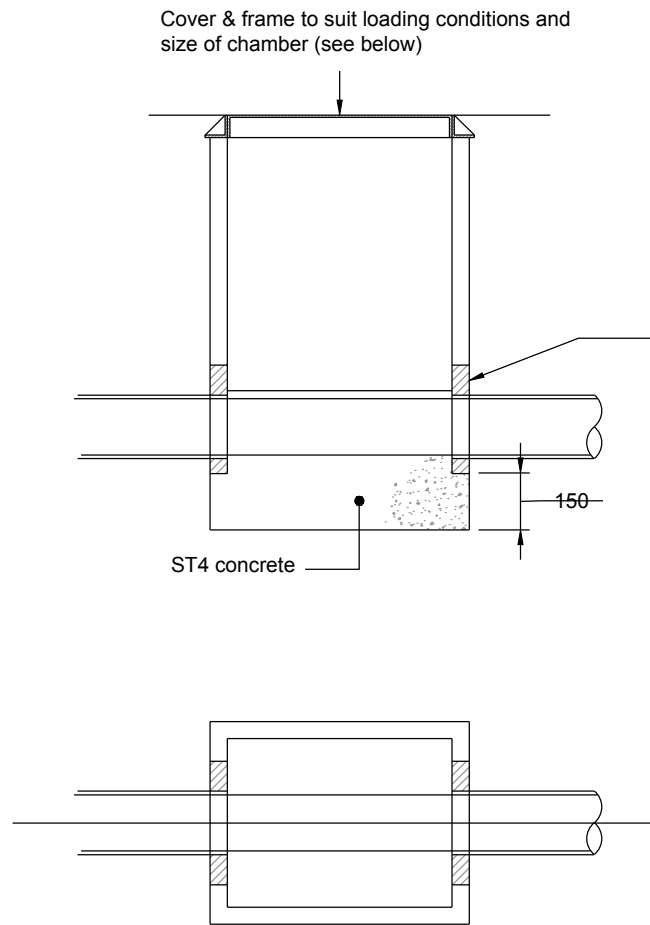


SHALLOW ACCESS CHAMBER

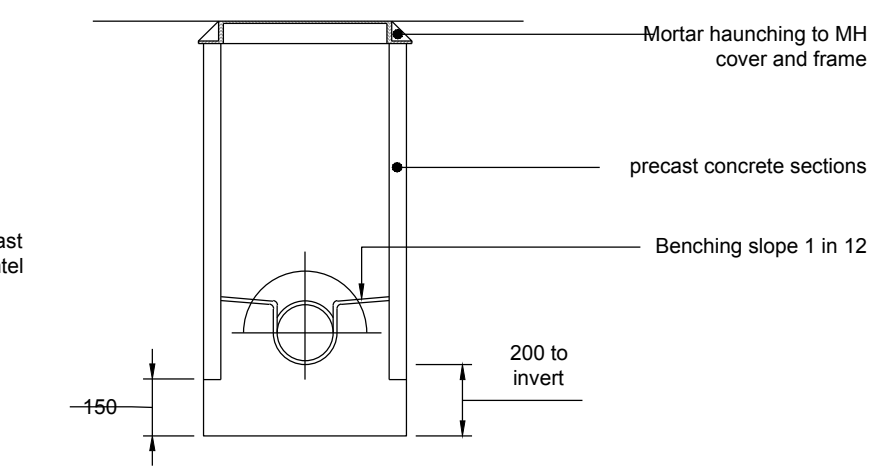


INSPECTION CHAMBER

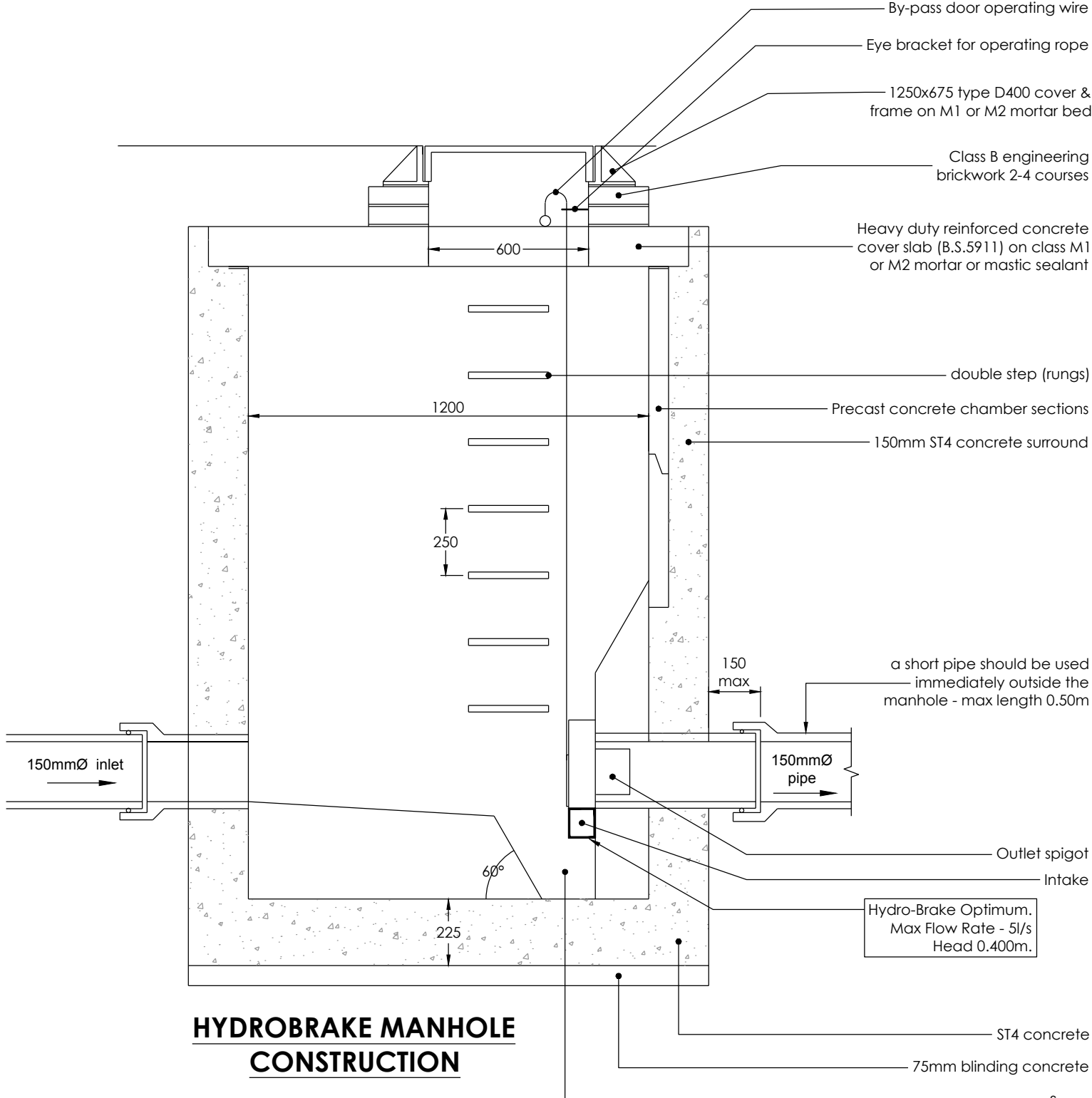
SOIL PIPE CONNECTION



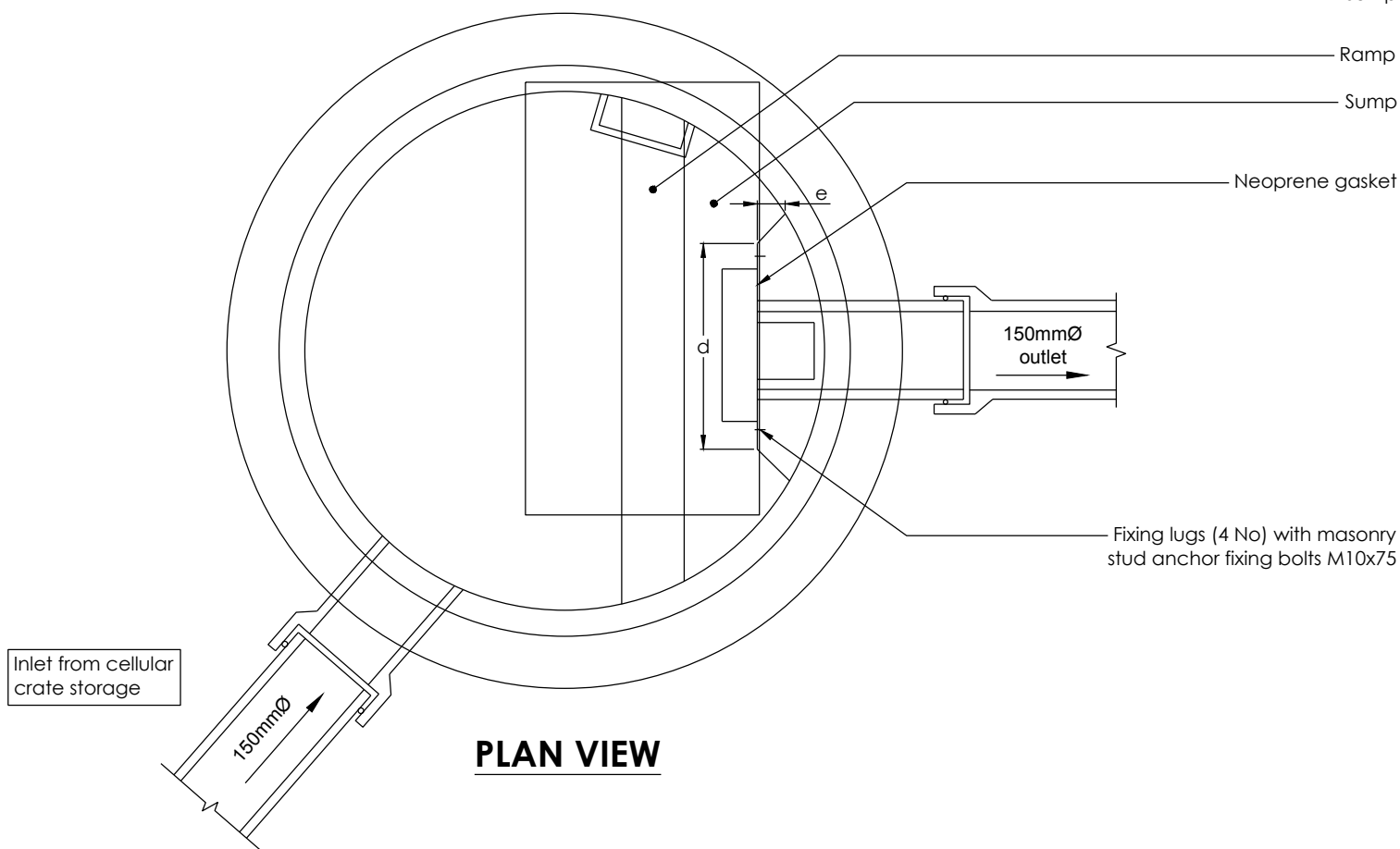
TYPICAL INSPECTION CHAMBER



TYPICAL SILT TRAP MANHOLE DETAIL



HYDROBRAKE MANHOLE CONSTRUCTION



PLAN VIEW

DESIGNERS CDM NOTE

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4. All manholes shall have a flexible joint within 150mm of the face of the structure and a "racker pipe" which should not exceed 600mm in length.

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7. Trenches within 1m of load bearing walls should be filled with concrete at least to the underside of the foundation. Where the distance is more than 1m from the foundations the concrete should be taken at least up to a 45degree line from the bottom of the foundations. Alternatively, the foundations could be taken to a deeper level to avoid undermining by the drainage trench (check with the Engineer where this is required).

8. Pipe bed and surround to be Type S granular unless otherwise noted in item 7.

9. Drains passing through walls or foundations should have either an arched or lintelled opening to give 50mm clearance around the pipe. The opening shall be masked both sides with a rigid non perishable material, or alternatively a short length of pipe may be built in solid if it is connected within 150mm to rocker pipes (max 600mm long) with flexible joints.

10. Drains under buildings should be surrounded by at least 100mm of granular or other flexible filling.

11. Unless otherwise stated all non-adoptable drainage shall be 100mmØ (see drainage schedules).

12. Road gully connections to be 150mmØ.
Yard gully connections 100mmØ.

13. New connections to existing public sewers should be carried out as required and under the supervision of the Water Authority. The appropriate sewer connection notice should be applied for where appropriate.

14. Covers shall be to B.S. EN 124:1994 Class A15 access covers and gratings capable of withstanding a 1.5 T load. For use in areas where only pedestrians have access. Class B125 access covers and frames capable of withstanding a 12.5T load. For use in car parks and pedestrian areas where occasional vehicular access is likely. Class C250 access covers and frames capable of withstanding a 25T load. For use in areas where not extending more than 500mm from kerb face into the carriageway Class D400 access covers and gratings capable of withstanding a 40T load. For use in areas where cars and lorries have access including carriageways, hard shoulders and pedestrian areas.

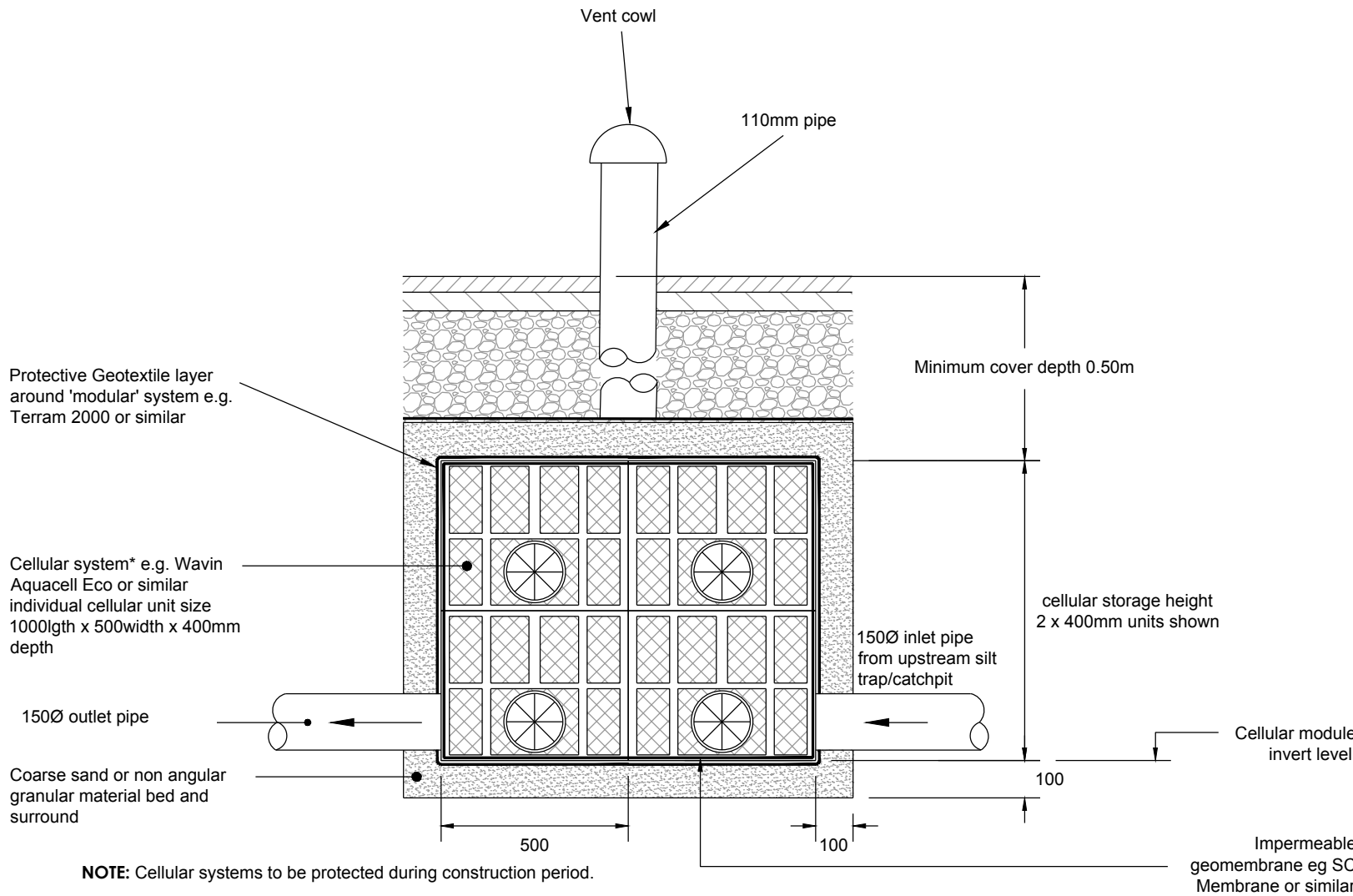
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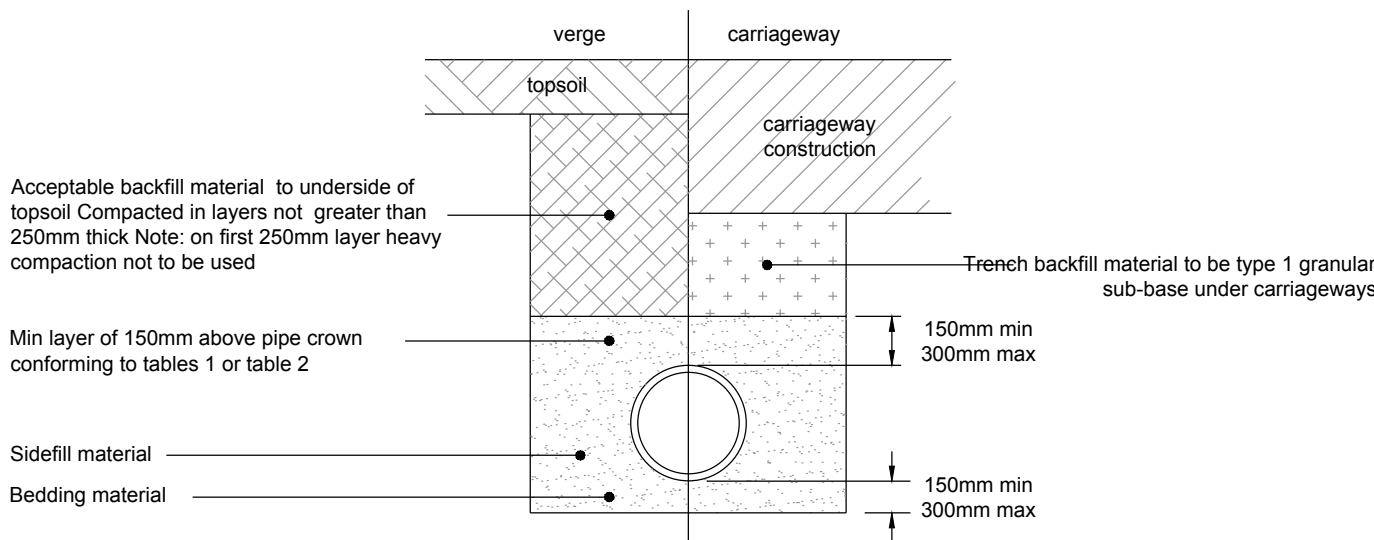
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17. In buildings up to 3 storeys the rest bend at the base of the soil stack should be 450mm below the invert of the lowest incoming drain. In buildings over 3 storeys this should be increased to 750mm. In buildings over 5 storeys the ground floor drainage connections should have their own connections to the external drain.

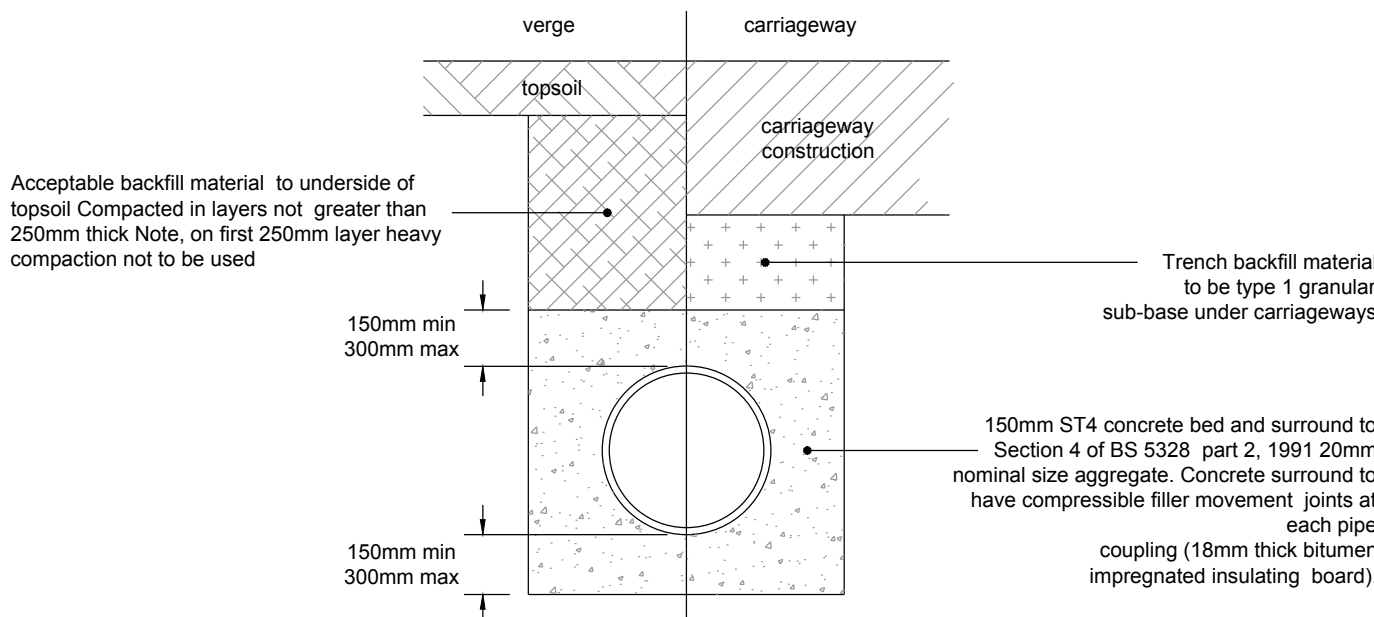


CELLULAR STORAGE (TYPICAL SECTION DETAIL)



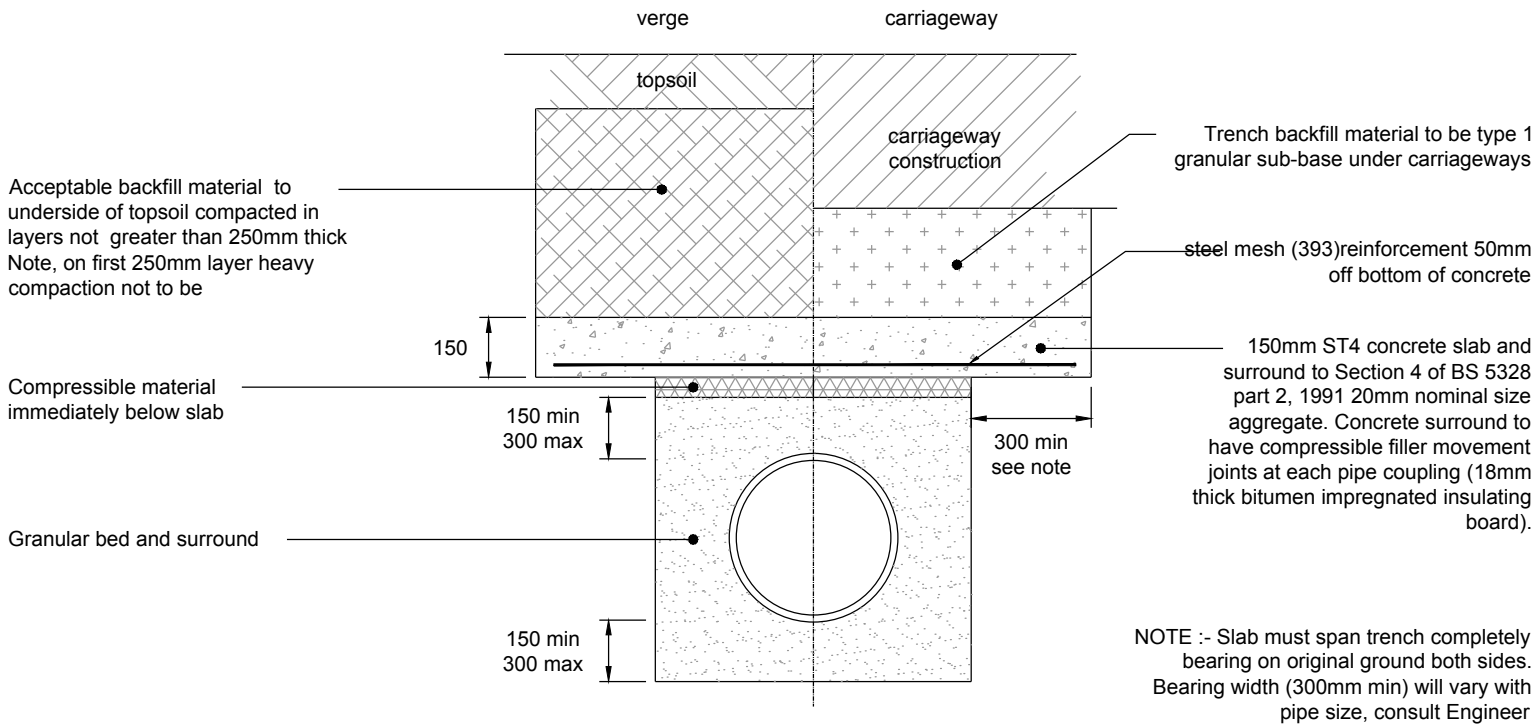
GRANULAR SURROUND BED TYPE S

To be used where cover to pipe soffit is greater than 1200mm in vehicular areas and greater than 900mm in non-trafficked areas (ie footpaths, verges, etc)



CONCRETE SURROUND BED TYPE Z

To be used where cover to pipe soffit is less than 1200mm in vehicular areas and 900mm in non-trafficked areas (ie footpaths, verges, etc)



CONCRETE SLAB PROTECTION

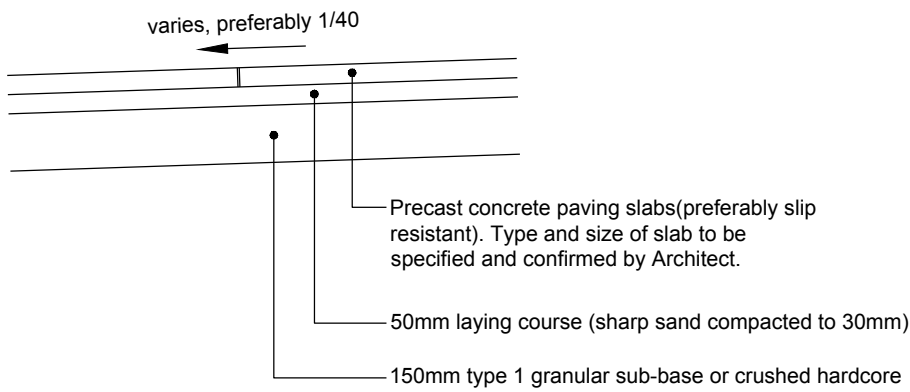
To be used where cover to pipe soffit is less than 1200mm in vehicular areas and 900mm in non-trafficked areas (ie footpaths, verges, etc)

DESIGNERS CDM NOTE

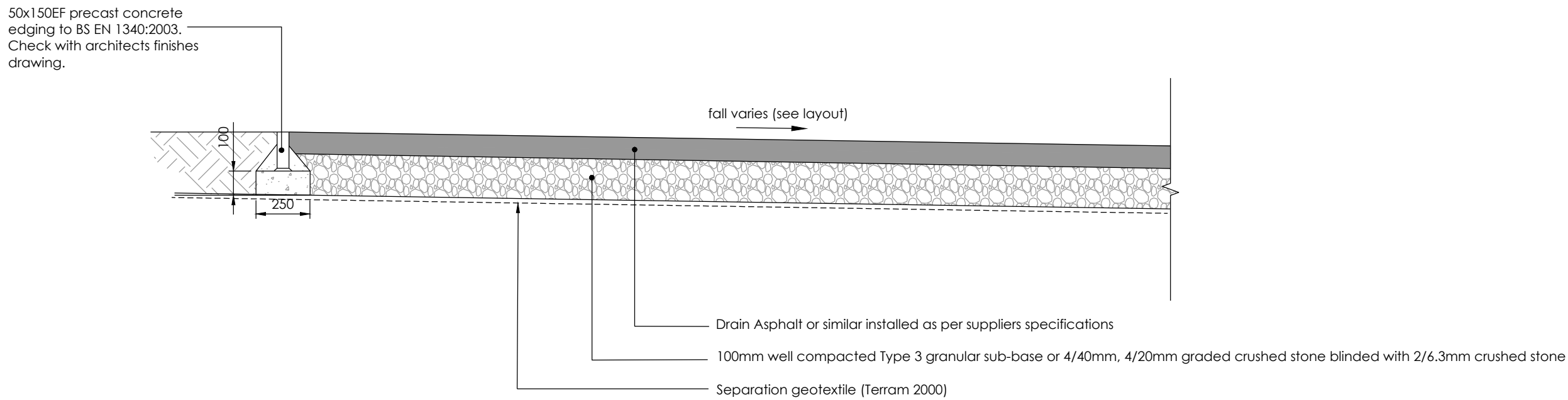
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SLABBED FOOTPATH DETAIL



POROUS ASPHALT FOOTPATH CONSTRUCTION DETAILS

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P2	Footpath construction detail amended			09/02/17	PI
P1	Preliminary Issue			03/02/17	PI
REV	REVISION DETAILS			DATE	DRAWN BY
CLIENT		ORIGINATOR			
					
PROJECT 1A Upper Redlands Road Reading		TITLE Private Road Construction Details			
SCALE N.T.S. @A1		DRAWN PI	CHECKED SW	APPROVED SW	
PROJECT 4265	ORIGINATOR GDL	ZONE XX	LEVEL HW	TYPE DR	DOC NO 012
JOB NO. 4265	PURPOSE OF ISSUE FOR COMMENT			STATUS: S3	REVISION: P2

Appendix B – Micro Drainage Calculations – Attenuation Tank

Gemma Design Ltd		Page 1
Lea View House Two Rivers Estate Station Lane Witney	1A Upper Redlands Reading	
Date 03/02/2017 File CELLULAR STORAGE.SRCX	Designed by PI Checked by SW	
Micro Drainage		Source Control 2016.1

Summary of Results for 100 year Return Period (+30%)

Half Drain Time : 30 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	-0.956	0.544	0.0	5.1	5.1	11.4	O K
30 min Summer	-0.882	0.618	0.0	5.3	5.3	12.9	O K
60 min Summer	-0.886	0.614	0.0	5.3	5.3	12.8	O K
120 min Summer	-0.962	0.538	0.0	5.1	5.1	11.2	O K
180 min Summer	-1.054	0.446	0.0	5.0	5.0	9.3	O K
240 min Summer	-1.144	0.356	0.0	5.0	5.0	7.4	O K
360 min Summer	-1.332	0.168	0.0	5.0	5.0	3.5	O K
480 min Summer	-1.448	0.052	0.0	5.0	5.0	1.1	O K
600 min Summer	-1.497	0.003	0.0	5.0	5.0	0.1	O K
720 min Summer	-1.500	0.000	0.0	4.4	4.4	0.0	O K
960 min Summer	-1.500	0.000	0.0	3.5	3.5	0.0	O K
1440 min Summer	-1.500	0.000	0.0	2.5	2.5	0.0	O K
2160 min Summer	-1.500	0.000	0.0	1.8	1.8	0.0	O K
2880 min Summer	-1.500	0.000	0.0	1.5	1.5	0.0	O K
4320 min Summer	-1.500	0.000	0.0	1.0	1.0	0.0	O K
5760 min Summer	-1.500	0.000	0.0	0.8	0.8	0.0	O K
7200 min Summer	-1.500	0.000	0.0	0.7	0.7	0.0	O K
8640 min Summer	-1.500	0.000	0.0	0.6	0.6	0.0	O K
10080 min Summer	-1.500	0.000	0.0	0.5	0.5	0.0	O K
15 min Winter	-0.869	0.631	0.0	5.4	5.4	13.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	119.869	0.0	16.3	17
30 min Summer	78.788	0.0	21.4	28
60 min Summer	49.388	0.0	26.8	46
120 min Summer	29.955	0.0	32.9	80
180 min Summer	22.080	0.0	36.4	114
240 min Summer	17.687	0.0	38.7	146
360 min Summer	12.839	0.0	42.3	206
480 min Summer	10.237	0.0	44.9	258
600 min Summer	8.581	0.0	47.0	308
720 min Summer	7.426	0.0	48.8	0
960 min Summer	5.907	0.0	51.7	0
1440 min Summer	4.271	0.0	56.1	0
2160 min Summer	3.084	0.0	60.8	0
2880 min Summer	2.445	0.0	64.3	0
4320 min Summer	1.760	0.0	69.4	0
5760 min Summer	1.393	0.0	73.2	0
7200 min Summer	1.161	0.0	76.3	0
8640 min Summer	1.000	0.0	78.9	0
10080 min Summer	0.882	0.0	81.1	0
15 min Winter	119.869	0.0	18.3	18

Gemma Design Ltd						Page 2	
Lea View House Two Rivers Estate Station Lane Witney				1A Upper Redlands Reading			
Date 03/02/2017				Designed by PI			
File CELLULAR STORAGE.SRCX				Checked by SW			
Micro Drainage				Source Control 2016.1			
<u>Summary of Results for 100 year Return Period (+30%)</u>							
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	-0.771	0.729	0.0	5.6	5.6	15.2	O K
60 min Winter	-0.785	0.715	0.0	5.6	5.6	14.9	O K
120 min Winter	-0.910	0.590	0.0	5.3	5.3	12.3	O K
180 min Winter	-1.052	0.448	0.0	5.0	5.0	9.4	O K
240 min Winter	-1.190	0.310	0.0	5.0	5.0	6.5	O K
360 min Winter	-1.461	0.039	0.0	5.0	5.0	0.8	O K
480 min Winter	-1.500	0.000	0.0	4.4	4.4	0.0	O K
600 min Winter	-1.500	0.000	0.0	3.7	3.7	0.0	O K
720 min Winter	-1.500	0.000	0.0	3.2	3.2	0.0	O K
960 min Winter	-1.500	0.000	0.0	2.5	2.5	0.0	O K
1440 min Winter	-1.500	0.000	0.0	1.8	1.8	0.0	O K
2160 min Winter	-1.500	0.000	0.0	1.3	1.3	0.0	O K
2880 min Winter	-1.500	0.000	0.0	1.1	1.1	0.0	O K
4320 min Winter	-1.500	0.000	0.0	0.8	0.8	0.0	O K
5760 min Winter	-1.500	0.000	0.0	0.6	0.6	0.0	O K
7200 min Winter	-1.500	0.000	0.0	0.5	0.5	0.0	O K
8640 min Winter	-1.500	0.000	0.0	0.4	0.4	0.0	O K
10080 min Winter	-1.500	0.000	0.0	0.4	0.4	0.0	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)			
30 min Winter	78.788	0.0	24.3	30			
60 min Winter	49.388	0.0	30.1	48			
120 min Winter	29.955	0.0	37.0	86			
180 min Winter	22.080	0.0	40.7	122			
240 min Winter	17.687	0.0	43.3	156			
360 min Winter	12.839	0.0	47.3	202			
480 min Winter	10.237	0.0	50.2	0			
600 min Winter	8.581	0.0	52.6	0			
720 min Winter	7.426	0.0	54.6	0			
960 min Winter	5.907	0.0	58.0	0			
1440 min Winter	4.271	0.0	62.9	0			
2160 min Winter	3.084	0.0	68.1	0			
2880 min Winter	2.445	0.0	72.0	0			
4320 min Winter	1.760	0.0	77.7	0			
5760 min Winter	1.393	0.0	82.0	0			
7200 min Winter	1.161	0.0	85.4	0			
8640 min Winter	1.000	0.0	88.3	0			
10080 min Winter	0.882	0.0	90.8	0			
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Gemma Design Ltd		Page 3
Lea View House Two Rivers Estate Station Lane Witney	1A Upper Redlands Reading	
Date 03/02/2017 File CELLULAR STORAGE.SRCX	Designed by PI Checked by SW	
Micro Drainage Source Control 2016.1		

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.800	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 0.073

Time (mins)	Area	Time (mins)	Area
From: To:	(ha)	From: To:	(ha)
0 4	0.052	4 8	0.021

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Gemma Design Ltd		Page 4
Lea View House Two Rivers Estate Station Lane Witney	1A Upper Redlands Reading	
Date 03/02/2017 File CELLULAR STORAGE.SRCX	Designed by PI Checked by SW	
Micro Drainage Source Control 2016.1		

Model Details

Storage is Online Cover Level (m) 0.000

Cellular Storage Structure

Invert Level (m) -1.500 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	22.0	22.0	0.801	0.0	37.0
0.800	22.0	37.0			

Hydro-Brake Optimum® Outflow Control

Unit Reference MD-SHE-0109-5000-0800-5000
Design Head (m) 0.800
Design Flow (l/s) 5.0
Flush-Flo™ Calculated
Objective Minimise upstream storage
Application Surface
Sump Available Yes
Diameter (mm) 109
Invert Level (m) -1.800
Minimum Outlet Pipe Diameter (mm) 150
Suggested Manhole Diameter (mm) 1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.800	5.0
Flush-Flo™	0.241	5.0
Kick-Flo®	0.537	4.2
Mean Flow over Head Range	-	4.3

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	3.7	1.200	6.0	3.000	9.3	7.000	13.9
0.200	5.0	1.400	6.5	3.500	10.0	7.500	14.4
0.300	5.0	1.600	6.9	4.000	10.6	8.000	14.8
0.400	4.8	1.800	7.3	4.500	11.3	8.500	15.2
0.500	4.5	2.000	7.7	5.000	11.8	9.000	15.7
0.600	4.4	2.200	8.0	5.500	12.4	9.500	16.1
0.800	5.0	2.400	8.4	6.000	12.9		
1.000	5.5	2.600	8.7	6.500	13.4		

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Gemma Design Ltd		Page 1
Lea View House Two Rivers Estate Station Lane Witney	1A Upper Redlands Reading	
Date 03/02/2017 File STORM DRAIN.MDX	Designed by PI Checked by SW	
Micro Drainage	Network 2016.1	

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 Coefficient 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 1
 Number of Online Controls 0 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 0.400
 Region England and Wales Cv (Summer) 0.750
 M5-60 (mm) 18.700 Cv (Winter) 0.840

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

Profile(s) Summer and Winter
 Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600,
 720, 960, 1440, 2160, 2880, 4320, 5760,
 7200, 8640, 10080
 Return Period(s) (years) 1, 30, 100
 Climate Change (%) 0, 0, 30

								Water
PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surge	First (Y) Flood	First (Z) Overflow	Level
							Act.	(m)
1.000	1	15 Winter	100	+30%				61.126
2.000	2	15 Winter	100	+30%				60.359
3.000	3	15 Winter	100	+30%				60.052
4.000	4	15 Winter	100	+30%				60.223
5.000	5	15 Winter	100	+30%				59.251
1.001	6	15 Winter	100	+30%	30/15 Winter			58.384
1.002	7	15 Winter	100	+30%				57.916

Surcharged Flooded				Pipe		Level	
PN	US/MH Name	Depth (m)	Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status
1.000	1	-0.112	0.000	0.15		11.3	OK
2.000	2	-0.123	0.000	0.08		7.5	OK
3.000	3	-0.119	0.000	0.09		7.5	OK
4.000	4	-0.113	0.000	0.13		7.5	OK
5.000	5	-0.117	0.000	0.11		5.4	OK
1.001	6	0.170	0.000	1.33		22.4	SURCHARGED
1.002	7	-0.072	0.000	0.54		22.4	OK