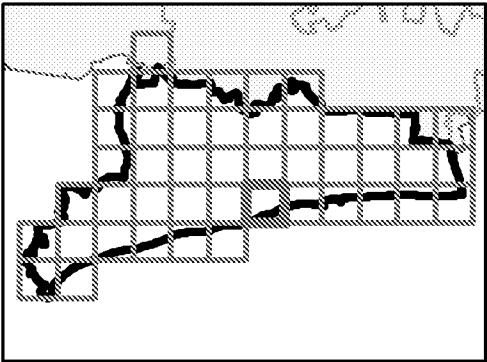




Notes

- one 1 Comprised of land having a less than 1 in 1 000 annual probability of river or sea flooding in any year.
- one Comprised of land having between a 1 in 100 and 1 in 1 000 annual probability of river flooding or 1 in 100 and 1 in 1 000 annual probability of sea flooding in any year.
- one a his one comprises land assessed as having a greater than 1in 100 annual probability of river flooding or a greater than 1 in 100 annual probability of flooding from sea in any year.
- one b his one comprises land where water has to flow or be stored in times of flood the functional floodplain. he SFR identified this Flood one as land which would flood with an annual probability of 1 in 10 years where detailed modelling exists. n the absence of detailed hydraulic model information a precautionary approach has been adopted with the assumption that the extent of Flood one b would be a ust to Flood one a. f development a shown to be in Flood one a further work should be undertaken as part of a detailed site specific

Key Plan



Legend

Run District SFR boundary

Flood one b

Flood one a

Flood one

00.1250.250.5

km

REF	Date	Comments
A	one 010	
B		
C		

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R	D	S	R	C	C	C
E	E	1	S	F	R	
F		D		E	D	C
				E	S	

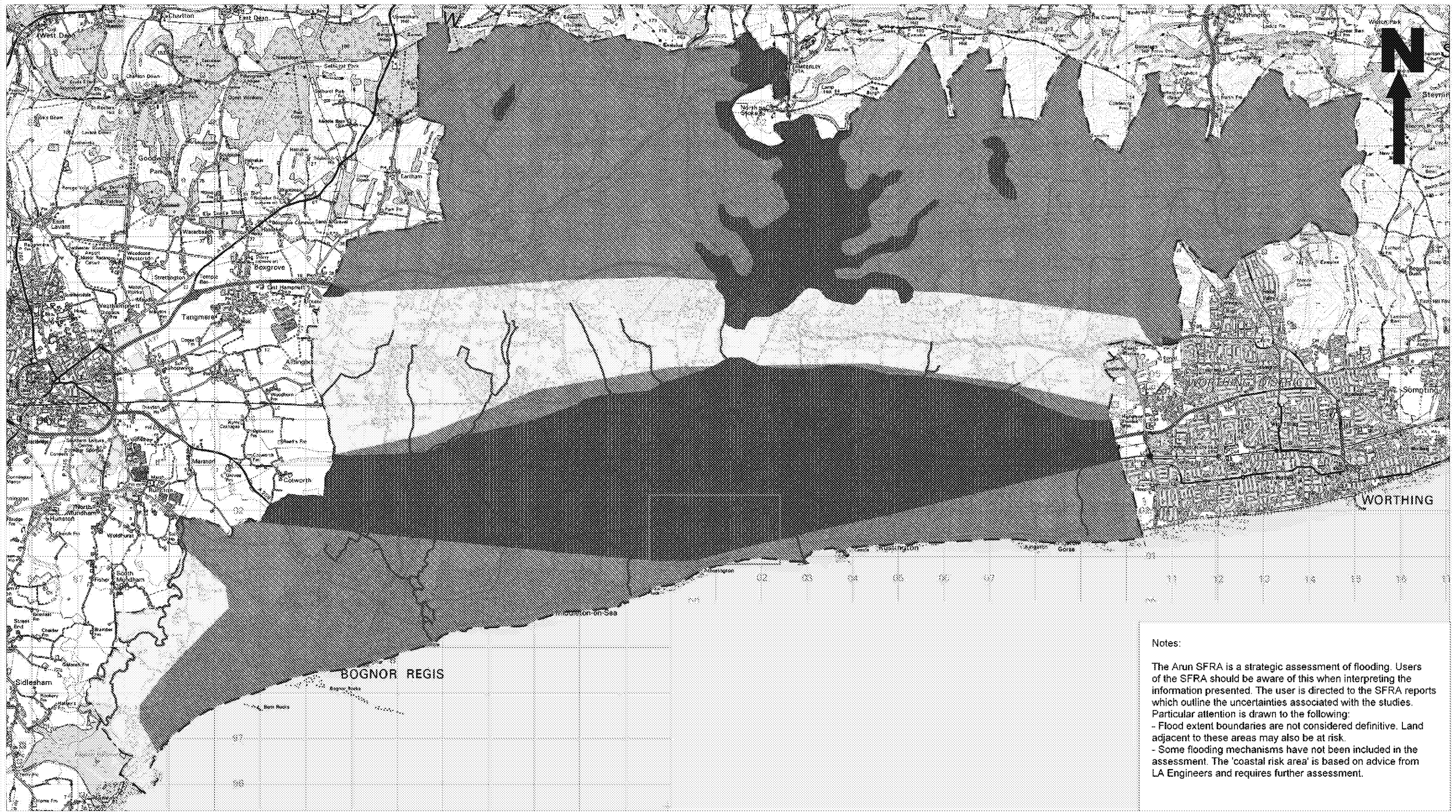
Sheet 6 1 of 8 index number DC 1

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Appendix E - Risk of Groundwater Flooding Maps



Notes:

The Arun SFRA is a strategic assessment of flooding. Users of the SFRA should be aware of this when interpreting the information presented. The user is directed to the SFRA reports which outline the uncertainties associated with the studies. Particular attention is drawn to the following:

- Flood extent boundaries are not considered definitive. Land adjacent to these areas may also be at risk.
- Some flooding mechanisms have not been included in the assessment. The 'coastal risk area' is based on advice from LA Engineers and requires further assessment.

Arun District Council SFRA

Map G1 - Indicative Risk of Groundwater Flooding



CAPITA SYMONDS

Legend

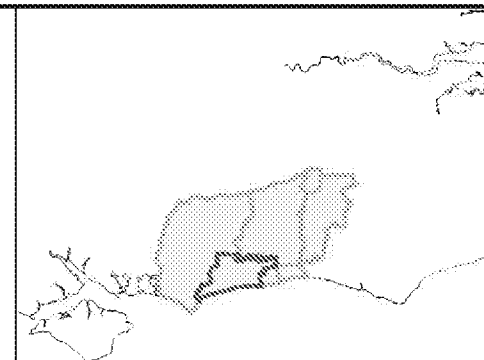
Arun District Boundary

Main River

Groundwater Emergence Zones

Groundwater Flood Risk

High
 Medium



0 2 4
Kilometres

Scale at A3: 1:80,000

Date: 31/01/2008

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Map_G1.wor



The Areas Susceptible to Groundwater Flooding (ASGVWF) is a strategic scale map showing groundwater flood areas on a 1km square grid. The data was produced to annotate indicative Flood Risk Areas for Preliminary Flood Risk Assessment (PFRA) studies and allow the Lead Local Flood Authorities (LLFAs) to determine whether there may be a risk of flooding from groundwater.

This data shows the proportion of each firm grid square where geological and hydrogeological conditions show that groundwater might emerge. It does not show the likelihood of groundwater flooding occurring. It does not take account of the chance of flooding from groundwater rebound. This dataset covers a large area of land, and only isolated locations within the overall susceptible area are actually likely to suffer the consequences of groundwater flooding.

The ASGWVF data should be used only in combination with other information, for example local data or historic data. It should not be used as sole evidence for any specific flood risk management, land use planning or other decisions at any scale. However, the data can help to identify areas for assessment at a local scale where finer resolution datasets exist.

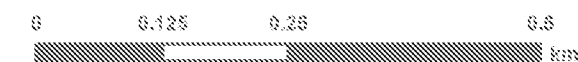
Arvin District SFRA boundary

 < 25%

 >= 25% < 50%

 >= 50% < 75%

 >= 75%



REF	Date	Comments
A	June 2018	.
B		
C		

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ARUN DISTRICT COUNCIL
LEVEL 1 SFRA: APPENDIX F
AREAS SUSCEPTIBLE TO GROUNDWATER

Sheet No: 14 of 48 Index Number: A/C 14

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Appendix F - Historic Incidents of Flooding From Sewers



Notes:

The Arun SFRA is a strategic assessment of flooding. Users of the SFRA should be aware of this when interpreting the information presented. The user is directed to the SFRA reports which outline the uncertainties associated with the studies. Particular attention is drawn to the following:

- Flood extent boundaries are not considered definitive. Land adjacent to these areas may also be at risk.
- Some flooding mechanisms have not been included in the assessment. The 'coastal risk area' is based on advice from LA Engineers and requires further assessment.

Arun District Council SFRA

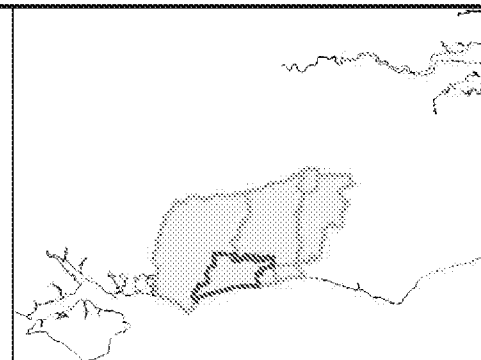
Map S - Historic Incidents of Flooding from Sewers



CAPITA SYMONDS

Legend

- Arun District Boundary
- Historic Incidents of Sewer Flooding



0 2 4
Kilometres

Scale at A3: 1:80,000

Date: 31/01/2008

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Map_S wor



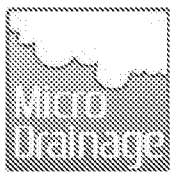
Appendix G - Microdrainage Calculations

Infrastruct CS Ltd		Page 1
The Stables High Cogges, Witney Oxfordshire	Greenfield Runoff Baird's Care Home Littlehampton	
Date 10/04/2018 File 2868 GREENFIELD.SRCX	Designed by MBD Checked by TST	
Micro Drainage		Source Control 2017.1.2
<u>ICP SUDS Mean Annual Flood</u> Input Return Period (years) 100 Soil 0.400 Area (ha) 0.840 Urban 0.000 SAAR (mm) 719 Region Number Region 6 Results 1/s QBAR Rural 2.9 QBAR Urban 2.9 Q100 years 9.4 Q1 year 2.5 Q30 years 6.7 Q100 years 9.4		
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Infrastruct CS Ltd					Page 1	
The Stables High Cogges, Witney Oxfordshire			Attenuation Tank Baird's Care Home Littlehampton			
Date 10/04/2018 File 2868 Attenuation			Designed by MBD Checked by TST			
Micro Drainage			Source Control 2017.1.2			
Summary of Results for 100 year Return Period (+40%)						
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status	
15 min Summer	4.439	0.339	5.0	89.6	O K	
30 min Summer	4.548	0.448	5.0	118.4	O K	
60 min Summer	4.656	0.556	5.0	146.7	O K	
120 min Summer	4.746	0.646	5.0	170.5	O K	
180 min Summer	4.778	0.678	5.0	179.1	O K	
240 min Summer	4.786	0.686	5.0	181.0	O K	
360 min Summer	4.776	0.676	5.0	178.6	O K	
480 min Summer	4.763	0.663	5.0	174.9	O K	
600 min Summer	4.746	0.646	5.0	170.5	O K	
720 min Summer	4.728	0.628	5.0	165.8	O K	
960 min Summer	4.690	0.590	5.0	155.8	O K	
1440 min Summer	4.614	0.514	5.0	135.7	O K	
2160 min Summer	4.508	0.408	5.0	107.6	O K	
2880 min Summer	4.416	0.316	5.0	83.3	O K	
4320 min Summer	4.282	0.182	5.0	47.9	O K	
5760 min Summer	4.210	0.110	5.0	29.2	O K	
7200 min Summer	4.190	0.090	4.5	23.9	O K	
8640 min Summer	4.179	0.079	4.0	20.9	O K	
10080 min Summer	4.170	0.070	3.5	18.6	O K	
15 min Winter	4.482	0.382	5.0	100.8	O K	
30 min Winter	4.605	0.505	5.0	133.3	O K	
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)		
15 min Summer	124.633	0.0	93.3	18		
30 min Summer	83.789	0.0	125.6	33		
60 min Summer	53.779	0.0	161.2	62		
120 min Summer	33.337	0.0	199.9	122		
180 min Summer	24.832	0.0	223.4	182		
240 min Summer	20.006	0.0	239.9	240		
360 min Summer	14.706	0.0	264.6	308		
480 min Summer	11.818	0.0	283.5	370		
600 min Summer	9.966	0.0	298.8	434		
720 min Summer	8.665	0.0	311.8	500		
960 min Summer	6.943	0.0	333.1	636		
1440 min Summer	5.071	0.0	365.0	908		
2160 min Summer	3.696	0.0	399.1	1296		
2880 min Summer	2.949	0.0	424.6	1672		
4320 min Summer	2.142	0.0	462.5	2336		
5760 min Summer	1.705	0.0	490.8	2992		
7200 min Summer	1.427	0.0	513.6	3672		
8640 min Summer	1.235	0.0	533.4	4408		
10080 min Summer	1.093	0.0	550.9	5136		
15 min Winter	124.633	0.0	104.6	18		
30 min Winter	83.789	0.0	140.6	33		
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Infrastruct CS Ltd				Page 2	
The Stables High Cogges, Witney Oxfordshire		Attenuation Tank Baird's Care Home Littlehampton			
Date 10/04/2018 File 2868 Attenuation		Designed by MBD Checked by TST			
Micro Drainage		Source Control 2017.1.2			
<u>Summary of Results for 100 year Return Period (+40%)</u>					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	4.729	0.629	5.0	165.9	○ K
120 min Winter	4.837	0.737	5.0	194.5	○ K
180 min Winter	4.880	0.780	5.0	205.9	○ K
240 min Winter	4.895	0.795	5.0	209.8	○ K
360 min Winter	4.891	0.791	5.0	208.8	○ K
480 min Winter	4.868	0.768	5.0	202.9	○ K
600 min Winter	4.847	0.747	5.0	197.2	○ K
720 min Winter	4.822	0.722	5.0	190.5	○ K
960 min Winter	4.765	0.665	5.0	175.6	○ K
1440 min Winter	4.648	0.548	5.0	144.6	○ K
2160 min Winter	4.484	0.384	5.0	101.3	○ K
2880 min Winter	4.348	0.248	5.0	65.5	○ K
4320 min Winter	4.199	0.099	5.0	26.2	○ K
5760 min Winter	4.180	0.080	4.0	21.0	○ K
7200 min Winter	4.167	0.067	3.3	17.7	○ K
8640 min Winter	4.158	0.058	2.9	15.3	○ K
10080 min Winter	4.152	0.052	2.6	13.6	○ K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
60 min Winter	53.779	0.0	180.6	62	
120 min Winter	33.337	0.0	223.9	120	
180 min Winter	24.832	0.0	250.2	178	
240 min Winter	20.886	0.0	268.7	234	
360 min Winter	14.706	0.0	296.3	342	
480 min Winter	11.818	0.0	317.5	398	
600 min Winter	9.966	0.0	334.7	466	
720 min Winter	8.665	0.0	349.3	542	
960 min Winter	6.943	0.0	373.1	694	
1440 min Winter	5.071	0.0	408.8	982	
2160 min Winter	3.696	0.0	447.0	1384	
2880 min Winter	2.949	0.0	475.5	1732	
4320 min Winter	2.142	0.0	518.0	2248	
5760 min Winter	1.705	0.0	549.7	2944	
7200 min Winter	1.427	0.0	575.2	3680	
8640 min Winter	1.235	0.0	597.4	4400	
10080 min Winter	1.093	0.0	617.0	5136	
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Infrastruct CS Ltd		Page 3																																				
The Stables High Cogges, Witney Oxfordshire	Attenuation Tank Baird's Care Home Littlehampton																																					
Date 10/04/2018 File 2868 Attenuation	Designed by MBD Checked by TST																																					
Micro Drainage		Source Control 2017.1.2																																				
<u>Rainfall Details</u> <table> <tr> <td>Rainfall Model</td> <td>FSR</td> <td>Winter Storms</td> <td>Yes</td> </tr> <tr> <td>Return Period (years)</td> <td>100</td> <td>Cv (Summer)</td> <td>0.750</td> </tr> <tr> <td>Region</td> <td>England and Wales</td> <td>Cv (Winter)</td> <td>0.840</td> </tr> <tr> <td>M5-60 (mm)</td> <td>19.000</td> <td>Shortest Storm (mins)</td> <td>15</td> </tr> <tr> <td>Ratio R</td> <td>0.350</td> <td>Longest Storm (mins)</td> <td>10080</td> </tr> <tr> <td>Summer Storms</td> <td>Yes</td> <td>Climate Change %</td> <td>+40</td> </tr> </table> <u>Time Area Diagram</u> Total Area (ha) 0.400 <table> <tr> <th>Time (mins)</th> <th>Area</th> </tr> <tr> <th>From:</th> <th>To: (ha)</th> </tr> <tr> <td>0</td> <td>4 0.400</td> </tr> </table> <u>Time Area Diagram</u> Total Area (ha) 0.000 <table> <tr> <th>Time (mins)</th> <th>Area</th> </tr> <tr> <th>From:</th> <th>To: (ha)</th> </tr> <tr> <td>0</td> <td>4 0.000</td> </tr> </table>			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)	19.000	Shortest Storm (mins)	15	Ratio R	0.350	Longest Storm (mins)	10080	Summer Storms	Yes	Climate Change %	+40	Time (mins)	Area	From:	To: (ha)	0	4 0.400	Time (mins)	Area	From:	To: (ha)	0	4 0.000
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<u>Model Details</u> Storage is Online Cover Level (m) 5.500 <u>Tank or Pond Structure</u> Invert Level (m) 4.100 <table border="1"> <thead> <tr> <th>Depth (m)</th> <th>Area (m²)</th> <th>Depth (m)</th> <th>Area (m²)</th> <th>Depth (m)</th> <th>Area (m²)</th> </tr> </thead> <tbody> <tr> <td>0.000</td> <td>264.0</td> <td>0.800</td> <td>264.0</td> <td>0.801</td> <td>0.0</td> </tr> </tbody> </table> <u>Pump Outflow Control</u> Invert Level (m) 4.100 <table border="1"> <thead> <tr> <th>Depth (m)</th> <th>Flow (l/s)</th> <th>Depth (m)</th> <th>Flow (l/s)</th> <th>Depth (m)</th> <th>Flow (l/s)</th> <th>Depth (m)</th> <th>Flow (l/s)</th> </tr> </thead> <tbody> <tr><td>0.100</td><td>5.0000</td><td>0.900</td><td>5.0000</td><td>1.700</td><td>0.0000</td><td>2.500</td><td>0.0000</td></tr> <tr><td>0.200</td><td>5.0000</td><td>1.000</td><td>5.0000</td><td>1.800</td><td>0.0000</td><td>2.600</td><td>0.0000</td></tr> <tr><td>0.300</td><td>5.0000</td><td>1.100</td><td>5.0000</td><td>1.900</td><td>0.0000</td><td>2.700</td><td>0.0000</td></tr> <tr><td>0.400</td><td>5.0000</td><td>1.200</td><td>5.0000</td><td>2.000</td><td>0.0000</td><td>2.800</td><td>0.0000</td></tr> <tr><td>0.500</td><td>5.0000</td><td>1.300</td><td>0.0000</td><td>2.100</td><td>0.0000</td><td>2.900</td><td>0.0000</td></tr> <tr><td>0.600</td><td>5.0000</td><td>1.400</td><td>0.0000</td><td>2.200</td><td>0.0000</td><td>3.000</td><td>0.0000</td></tr> <tr><td>0.700</td><td>5.0000</td><td>1.500</td><td>0.0000</td><td>2.300</td><td>0.0000</td><td></td><td></td></tr> <tr><td>0.800</td><td>5.0000</td><td>1.600</td><td>0.0000</td><td>2.400</td><td>0.0000</td><td></td><td></td></tr> </tbody> </table>			Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	0.000	264.0	0.800	264.0	0.801	0.0	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	0.100	5.0000	0.900	5.0000	1.700	0.0000	2.500	0.0000	0.200	5.0000	1.000	5.0000	1.800	0.0000	2.600	0.0000	0.300	5.0000	1.100	5.0000	1.900	0.0000	2.700	0.0000	0.400	5.0000	1.200	5.0000	2.000	0.0000	2.800	0.0000	0.500	5.0000	1.300	0.0000	2.100	0.0000	2.900	0.0000	0.600	5.0000	1.400	0.0000	2.200	0.0000	3.000	0.0000	0.700	5.0000	1.500	0.0000	2.300	0.0000			0.800	5.0000	1.600	0.0000	2.400	0.0000		
Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)																																																																																	
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0.100	5.0000	0.900	5.0000	1.700	0.0000	2.500	0.0000																																																																															
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0.400	5.0000	1.200	5.0000	2.000	0.0000	2.800	0.0000																																																																															
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0.600	5.0000	1.400	0.0000	2.200	0.0000	3.000	0.0000																																																																															
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0.800	5.0000	1.600	0.0000	2.400	0.0000																																																																																	
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Appendix H - Proposed Drainage Strategy

BURIED UTILITIES RISK NOTE

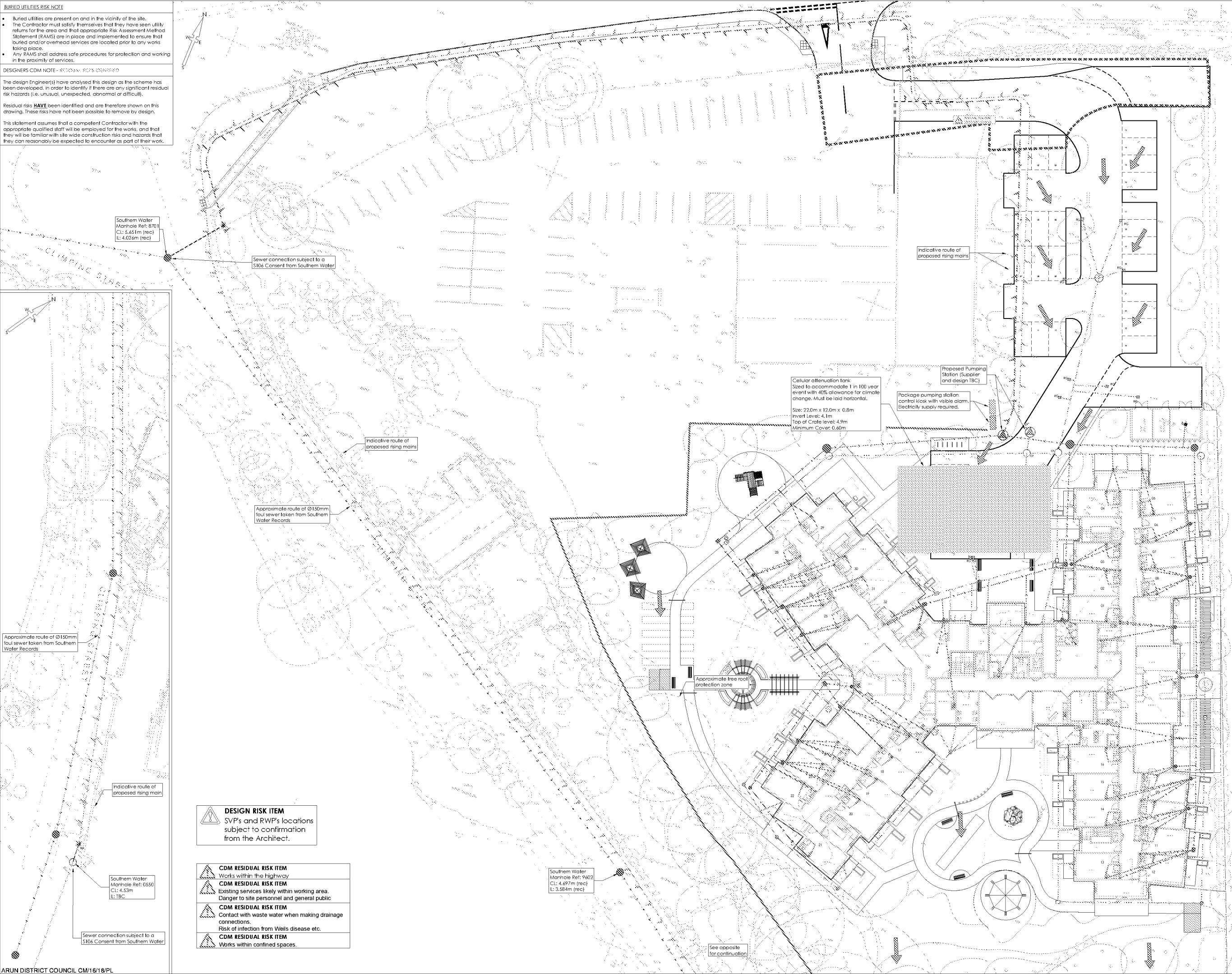
- Buried utilities are present on and in the vicinity of the site.
- The Contractor must satisfy themselves that they have seen utility returns for the area and that appropriate Risk Assessment Method Statement (RAMS) are in place and implemented to ensure that buried and/or overhead services are located prior to any works taking place.
- Any RAMS shall address safe procedures for protection and working in the proximity of services.

DESIGNERS CDM NOTE - RESIDUAL RISKS IDENTIFIED

The design Engineer(s) have analysed this design at the scheme has been developed, in order to identify if there are any significant residual risk hazards (i.e. unusual, unexpected, abnormal or difficult).

Residual risks **HAVE** been identified and are therefore shown on this drawing. These risks have not been possible to remove by design.

This statement assumes that a competent Contractor with the appropriate qualified staff will be employed for the work, 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.



Survey Company Info here
DRG NUMBER: DATE RECEIVED:

Architect Company Info here
DRG NUMBER: M/316-AP/003 May 2018 DATE RECEIVED: 08/05/18

NOTES

- All dimensions and levels are in metres unless otherwise noted
- This drawing is to be read in conjunction with the relevant Architect's/Engineers drawings, specifications and CDM documentation
- This drawings has been produced electronically and may have been photo reduced or enlarged when copied. Work to figured dimensions only (DO NOT SCALE). All dimensions to be checked on site. Any errors or omissions to be reported to the engineer immediately.
- This drawing contains coloured lines / information that may not be clear if reproduced in black and white.
- Digital copies of this plan can only be considered accurate if supplied directly by Infrastruct CS Ltd.

Construction Note

It is essential that new drainage associated with the development is laid from the outfall(s) into the site. This is essential to avoid unforeseen obstructions where encountered (such as services). If the drainage is laid from the site out to the outfall it can result in significant oblique works to relay and overcome such obstructions.

Location of Public Sewers have been taken from record drawings which should be fully substantiated by the contractor prior to commencing works on site

Drainage Key

Sewers

- Foul water drain (private/non adoptable)
- Surface water drain (private/non adoptable)
- Surface water sewer (Adoptable)
- Foul water sewer (Adoptable)
- Surface Water rising main
- Foul rising main
- Existing foul water sewer (Adopted)

Chamber Key

FW	SW	
		Mini access chamber (mac) - 300mmØ *
		Adaptable demarcation manhole within 1m of boundary *
		Manhole Depth 1.25 to 1.5m * Depth 1.55 to 3.0m *

* General note
(Refer to standard details & long sections for chamber sizes. Size may need to increase dependant on number of incoming pipes/size of incoming pipes)

	Surface water rodding eye
	Manhole reference number
	Rain water down pipe (roadable access)
	Silt Trap (ST) with removable silt bucket
	Soil vent pipe/soil stack
	Road gully (trapped) D400
	Linear drainage channel
	Cellular storage (refer to drawing for sizes)

Overland Flows Route

Water But

Tree root protection zone (RPZ)

P2	IJJ	TST	Layout and Drainage updated	11/05/18
P1	MBD	TST	Initial issue	11/04/18
REV	DRAWN	CHECK	REVISION COMMENTS	ISSUE DATE

DRAWING TITLE

Proposed Drainage Strategy

SHEET NO.

1/1

PROJECT

Bairds Care Home
Littlehampton
Sussex

CLIENT

SCALE @ A1

1:250

PROJECT NUMBER	STATUS	DATE
2868	S2	April 18

PROJECT	ORIGIN	PHASE	LEVEL	TYPE	ROLE	DWG NO	REVISION
BCH	ICS	01	XX	DR	C	003	P2

ENGINEER

MBD

DRAFT

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Appendix I - SuDS Management Plan

There are likely to be three categories of maintenance activities:

1. **Regular maintenance** (including inspections and monitoring).
2. **Occasional maintenance.**
3. **Remedial maintenance.**

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

Occasional maintenance comprises tasks that are likely to be required periodically, but on a much less frequent and predictable basis than the regular tasks (e.g. sediment removal or filter replacement). Table 1.1 summarises the likely maintenance activities required for each SuDS component and guidance on specific maintenance activities is given in the following sections.

Remedial maintenance describes the intermittent tasks that may be required to rectify faults associated with the system, although the likelihood of faults can be minimised by good design, construction and regular maintenance activities. Where remedial work is found to be necessary, it is likely to be due to site-specific characteristics or unforeseen events, and so timings are difficult to predict. Remedial maintenance can comprise activities such as:

- inlet/outlet repairs
- erosion repairs
- reinstatement or realignment of edgings, barriers, rip-rap or other erosion control
- infiltration surface rehabilitation
- replacement of blocked filter fabrics
- construction stage sediment removal (although this activity should have been undertaken before the start of the maintenance contract)
- system rehabilitation immediately following a pollution event.

It is important to note that these remedial activities will not be required for all systems, but for the purpose of estimating whole life maintenance costs, a contingency sum of 15-20% should be added to the annual regular and occasional maintenance costs to cover the risk of these activities being required.

O & M activity	SuDS component																	
	Pond/wetland	Detention basin	Infiltration basin	Silt traps and catchpits	Soakaway	Infiltration trench	Filter trench	Modular storage	Pervious pavement	green roofs	Filter strip	Sand filter	Pre-treatment systems	Perforated ring soakaways	Bio retention areas	Rain gardens	Oil interceptors	Flow control devices
Regular maintenance																		
Inspection	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Litter/debris removal	■	■	■	□	□	■	■	□	■	■	■	■	■	■	■	■	□	□
Grass cutting	■	■	■	□	□	■	■	□	□	■	■	□	□		■		□	□



Weed/invasive plant control	☐	☐	☐		☐	☐		☐	☐	☐	☐	☐	☐	☐	☐	☒		
Shrub management	☐	☐	☐					☐	☐	☐		☐		☐	☒			
Shoreline vegetation management	☒	☐										☐						
Aquatic vegetation management	☒	☐										☐						
Sediment management (*)	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒
Vegetation/plant replacement	☐	☐	☐						☐	☐		☐		☐	☐			
Vacumn sweeping and brushing									☒									
Structure rehabilitation/repair	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Infiltration surface reconditioning			☐		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐		

Table 1.1 Typical key SuDS components operation and maintenance activities

■ Will be required

□ May be required

* Sediment should be collected and managed in pre-treatment systems, upstream of the main device.

The maintenance regime of a site also needs to consider the response to extreme pollution events. A response action plan should be developed and communicated to all those involved in the operation of a site, so that if a spillage occurs it can be prevented from causing pollution to receiving waters. For full specifications, see individual chapters.



Inspections and reporting

Regular SuDS scheme inspections will:

- help determine optimum future maintenance activities
- confirm hydraulic, water quality, amenity and ecological performance
- allow identification of potential system failures, e.g. blockage, poor infiltration, poor water quality etc.

Inspections can generally be required at monthly site visits (e.g. for grass cutting) for little additional cost, and should, therefore, be subsumed into regular maintenance requirements. During the first year of operation, inspections should ideally be carried out after every significant storm event to ensure proper functioning, but in practice this may be difficult or impractical to arrange.

Typical routine inspection questions that will indicate when occasional or remedial maintenance activities are required, and/or when water quality requires investigation include:

- are inlets or outlets blocked?
- does any part of the system appear to be leaking (especially ponds and wetlands)?
- is the vegetation healthy?
- is there evidence of poor water quality (e.g. algae, oils, milky froth, odour, unusual colourings)?
- is there evidence of sediment build-up?
- is there evidence of ponding above an infiltration surface?
- is there any evidence of structural damage that requires repair?
- are there areas of erosion or channelling over vegetated surfaces?

Litter/debris removal

This is an integral part of SuDS maintenance and reduces the risks of inlet and outlet blockages, retains amenity value and minimises pollution risks. High litter removal frequencies may be required at high profile commercial/retail parks where aesthetics is a major driver.

Grass cutting

It is recommended that grass cutting be minimised around SuDS facilities, apart from swales and filter strips and structural embankments where a height of 100–150 mm is recommended to prevent the plants falling over, or "lodging", when water flows across the surface. In general, allowing grass to grow tends to enhance water quality performance. Short grass around a wet system such as pond or wetland provides an ideal habitat for nuisance species such as geese; allowing the grass to grow is an effective means of discouraging them. Grass around wet pond or wetland systems should not be cut to the edge of the permanent water.

Grass cutting is an activity undertaken primarily to enhance the perceived aesthetics of the facility. The frequency of cutting will tend to depend on surrounding land uses, and public requirements. Therefore, grass cutting should be done as infrequently as possible, recognising the aesthetic concerns of residents. However, grass around inlet and outlet infrastructure should be strimmed closely to reduce risks to system performance. If a manicured, parkland effect is required, then cutting will need to be undertaken more regularly than for meadow type grass areas, which aim to maximise habitat and biodiversity potential.

Weed/invasive plant control

Weeds are generally defined as vegetation types that are unwanted in a particular area.

For SuDS, weeds are often alien or invasive species, which do not enhance the technical performance or aesthetic value of the system, or non-native species and the spread of which is undesirable. In some places, weeding must be done by hand to prevent the destruction of surrounding vegetation (hand weeding should generally be required only during the first year, i.e. during plant establishment). However, over grassed surfaces, mowing can be an effective management measure. The use of herbicides and pesticides should be prohibited since they cause water quality deterioration. The use of fertilisers should also be limited or prohibited to minimise nutrient loadings which are damaging to water bodies.



Frequency of maintenance tasks

Landscape maintenance contract periods are usually of one or three years' duration.

The three-year period is increasingly common to ensure continuity and commitment to long-term landscape care. The frequency of regular landscape maintenance tasks in a contract period can range from daily to once in the contract period. In practice most site tasks are based on monthly or fortnightly site visits, except where grass or weed growth requires a higher frequency of work. In many cases a performance specification is used with terms such as "beds shall be maintained weed-free" or "grass shall be cut to a height of 50 mm with a minimum height of 25 mm and a maximum height of 100 mm" to obtain the required standards.

Frequency can be specified within the schedule to include irregular items such as "'meadow grass' - cut two times annually in July and September to a height of 50 mm, all arisings raked off and removed to wildlife features, compost facility or to tip", which provides flexibility for work that is not critical to the management of the site.

Maintenance tasks which suit a performance approach commonly include plant growth, grass cutting, pruning and tree maintenance. However, work tasks such as sweeping paths, regular litter collection and cleaning road surfaces will require work at an agreed frequency with more specific timings such as weekly, monthly or annually.

Where the frequency and timing of tasks is critical, a mixture of performance and frequency specification is necessary to provide effective maintenance.

SuDS maintenance generally tends towards a frequency requirement to ensure a predicable standard of care which can be recorded on site and which provides a reasonable basis for pricing work. A convenient frequency for many tasks is at a monthly inspection as this is the usual minimum site attendance required in a landscape specification. The monthly frequency should provide for an inspection of all SuDS features and checking all inlets and outlets.

Certain SuDS maintenance tasks however fall outside this monthly cycle and need to be accommodated in the contract. The two most obvious are:

- wetland vegetation maintenance
- silt management.

There are other tasks associated with ensuring the long-term performance of the systems that may be more difficult to predict and could even fall outside any contract period. It may therefore be more appropriate to review requirements for system rehabilitation at interim periods, when contracts are falling due for renewal.



OPERATION AND MAINTENANCE COSTS

Although the greatest part of the total cost for a scheme is usually the capital cost, SuDS schemes also require a finance stream to cover long-term operation and maintenance costs (as does a below-ground piped system). An estimate must be made regarding what these costs are likely to be, and funding requirements need to be agreed by the parties involved.

As many SuDS schemes utilise natural planting and are designed to support ecosystems and biodiversity, there needs to be a period of intensive maintenance of the emerging vegetation to ensure that it grows and provides the expected service. This will usually require specialist horticultural expertise and will incur costs beyond the construction phase. It is recommended that this is included in the construction contract and is the responsibility of the contractor (Chapter 29). Where the SuDS have more than one use, such as for recreation, there may also be a period of initial setting up and commissioning of the recreational area that will incur costs, although these costs would be expected to accrue to the operators of the recreational facilities rather than the developer. At the end of its design life, it is likely that a SuDS scheme would either be:

- a) fully rehabilitated, in which case the cost would be borne by the drainage owner or adoption body, or
- b) redeveloped, in which case the disposal and decommissioning costs would be accepted by the next developer.

The following table indicates possible annual maintenance cost ranges, based on a review of literature and some UK costs, undertaken in 2004 by HR Wallingford. This has been extended through additional literature reviews to cover additional SUDS components:

Option	Annual maintenance costs	Source
Green roofs	£2,500 per year for first 2 years for covered roof with sedum mat, £600 per year after. £1,250 per year for first 2 years for covered roof with biodiverse roof, £150 per year after.	Barnfield (2005) Barnfield (2005)
Simple rainwater harvesting (water butts)	Negligible	
Advanced rainwater harvesting	£250 per year per property for external maintenance contract	Rain Cycle
Permeable paving	£0.5 - £1 / m ³ of storage volume	HR Wallingford, 2004
Filter drain / perforated pipes	£0.2 - £1 / m ² of filter surface area	HR Wallingford, 2004
Swales	£0.1 / m ² of swale surface area £350 per year	HR Wallingford, 2004 Ellis, 2003



Infiltration basin	£0.1 - £0.3 / m ² of detention basin area £0.25 - £1 / m ³ of detention volume	HR Wallingford, 2004
Soakaways	£0.1 / m ² of treated area	HR Wallingford, 2004
Infiltration trench	£0.2 - £1 / m ² of filter surface area	HR Wallingford, 2004
Filter strip	£0.1 / m ² of filter surface area	HR Wallingford, 2004
Constructed wetland	£0.1 / m ² of wetland surface area Annual maintenance of £200-250/yr. for first 5 years (declining to £80 -£100/yr. after 3 years).	HR Wallingford, 2004 Ellis, 2003
Retention (wet) pond	£0.5 - £1.5 / m ² of retention pond surface area £0.1 - £2 / m ³ of pond volume	HR Wallingford, 2004 HR Wallingford, 2004 Ellis, 2003
Detention basin	£0.1 - £0.3 / m ² of detention basin area £0.25 - £1 / m ³ of detention volume £250-£1000 per basin	HR Wallingford, 2004 HR Wallingford, 2004 Ellis, 2003

Indicative annual maintenance activities and unit costs for various SUDS features

Measure	Frequency	Rate and activity	Source
Advanced rainwater harvesting	5-7 years	£500 for pump replacement	Rain Cycle
Swale	3	£250 for removal of silt	SUDS Manual (C697)
	3	£250 for surface treatments to encourage infiltration	SUDS Manual (C697)
	25	£2,000 for replacement of topsoil and disposal of silts	SUDS Manual (C697)
Filter drain / filter strip	3	£250 for removal of silt	SUDS Manual (C697)
	3	£50 for limited weed control	SUDS Manual (C697)
	25	£1,000 for removal and cleaning of stone and the removal, disposal and replacement of geotextile.	SUDS Manual (C697)
Ponds and wetlands	3	£500 for partial silt removal and disposal to land	SUDS Manual (C697)



Indicative intermittent maintenance activities and unit rates for various SUDS features

DESIGN LIFE

The design life is typically defined as the minimum length of time that a scheme is required to perform its intended function. The design life for appraisals is typically taken to be 100 years, although alternative periods can be used. The design life is also an important consideration in whole life costing as component assets may have a shorter service life than the design life.

Design life for SUDS systems may be very long assuming appropriate construction and long-term maintenance is undertaken over the system life. There is a low risk of structural failure of SUDS components that can help to extend the structural design life.

Whilst this is the case, regular maintenance and inspections may be required to ensure that the SUDS components are delivering the required attenuation and water quality benefits. This requirement may limit the operational life of the assets or a component of a system that requires some level of intermittent maintenance or rehabilitation. This highlights the two elements of design life:

- Design life of the system as a whole.
- Component life of a system element, the failure of which may reduce the system's ability to achieve the stated function.

A review of available design lives for various SUDS measures are provided in the table below, based on a review of literature undertaken in 2004 as part of HR Wallingford's work for the DTI on whole life costing for SUDS components.



Option	Design life	Component life
Green roofs	Unlimited design life	N/A
Simple rainwater harvesting (water butts)	Unlimited design life	No reliable information
Advanced rainwater harvesting	Unlimited design life	No reliable information.
Permeable paving	Unlimited design life	20-25 years before replacement of filter material
Filter drain / perforated pipes	Unlimited design life	10 – 15 years before replacement of filter material
Swales	Unlimited design life	5 – 20 years before deep tilling required and replacement of infiltration surface
Infiltration basin	Unlimited design life	5 – 10 years before deep tilling required and replacement of infiltration surface
Soakaways	No available information	
Infiltration trench	Unlimited design life	10 – 15 years before replacement of filter material
Filter strip	Unlimited design life	20 – 50 years before replacement of the filter surface
Constructed wetland	20 – 50 years	sediment disposal after 10-15 years
Retention (wet) pond	20 – 50 years	
Detention basin	20 – 50 years	sediment disposal after 10-15 years

Design life estimates for SUDS measures

**Silt traps and catch pits***Description*

Silt traps and catch pits are circular or rectangular manholes and /or chambers with a sump in them to collect suspended solids. Some chambers have removeable silt buckets to assist with the removal of accumulated silt deposits. Catch pits are usually concrete ring or segment structures and silt traps preformed plastic chambers.

OPERATION AND MAINTENANCE REQUIREMENTS

Regular inspection and maintenance is required to ensure the effective long-term operation of below ground silt traps and catch pits systems. Maintenance responsibility for systems should be placed with a responsible organization. Maintenance requirements are described in the table below. Maintenance plans and schedules should be developed during the design phase. Specific maintenance needs of the system should be monitored, and maintenance schedules adjusted to suit requirements.

Regular maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action.	Monthly for 3 months, then six monthly
	Debris removal from catchment surface (where may cause risks to performance)	Monthly
	Inspection of silt traps and catch pits to assess silt accumulation	Monthly (and after large storms)
	Removal of accumulated silt from silt trap and catch pit sumps	Annually, or as required
Remedial actions	Repair/rehabilitation of inlets, outlet, overflows and vents	As required
Monitoring	Inspect/check all inlets, outlets, and overflows to ensure that they are in good condition and operating as designed	Annually and after large storms

Silt traps and catch pits – operation and maintenance requirements

**Geocellular/modular systems***Description*

Modular plastic geocellular systems with a high void ratio, that can be used to create a below ground infiltration (soakaway) or storage structure.

OPERATION AND MAINTENANCE REQUIREMENTS

Regular inspection and maintenance is required to ensure the effective long-term operation of below ground modular storage systems. Maintenance responsibility for systems should be placed with a responsible organization. Maintenance requirements for modular systems are described in the table below. Maintenance plans and schedules should be developed during the design phase. Specific maintenance needs of the system should be monitored, and maintenance schedules adjusted to suit requirements.

Modular systems – operation and maintenance requirements

Regular maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action.	Monthly for 3 months, then six monthly
	Debris removal from catchment surface (where may cause risks to performance)	Monthly
	Where rainfall infiltrates into blocks from above, check surface of filter for blockage by silt, algae or other matter. Remove and replace surface infiltration medium as necessary.	Monthly (and after large storms)
	Remove sediment from pre-treatment structures	Annually, or as required
Remedial actions	Repair/rehabilitation of 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 and after large storms



Green roofs

DESCRIPTION

Green roofs are areas of living vegetation, installed on the top of buildings, for a range of reasons including visual benefit, ecological value, enhanced building performance and the reduction of surface water runoff.

OPERATION AND MAINTENANCE REQUIREMENTS

The most maintenance is generally required during the establishment stage (12 to 15 months), and this should usually be made the responsibility of the green roof provider. Maintenance contractors with specialist training in green roof care should be used, where possible.

Table below provides guidance on the type of operational and maintenance requirements that may be appropriate. The list of actions is not exhaustive, and some actions may not always be required. Actual requirements will depend on the planting, the desired aesthetic and visual effect and the biodiversity objectives for the system. Maintenance specifications and schedules should therefore be specified for any individual green roof. If mechanical systems are located on the roof, then spill prevention measures should be exercised to ensure that roof runoff is not contaminated. The mechanical system area should be bunded and provided with separate drainage.

All maintenance actions carried out at roof level must be in full compliance with the appropriate health and safety regulations, and particularly those specifically dealing with working at height. Training and guidance information on operating and maintaining the roof should be provided to all property owners and tenants. Safety fastenings will be required for personnel working on the roof.

Access routes to the roof should be designed and maintained to be safe and efficient, and walkways should always be kept clear of obstructions. Secure points for harness attachments should be provided when access near to the roof edges is required. Specific maintenance needs of the green roof should be monitored, and maintenance schedules adjusted to suit requirements.



Maintenance schedule	Required action	Frequency
Regular inspections	Inspect all components including soil substrate, vegetation, drains, irrigation systems (if applicable), membranes and roof structure for proper operation, integrity of waterproofing and structural stability	Annually and after severe storms
	Inspect soil substrate for evidence of erosion channels and identify any sediment sources	Annually and after severe storms
	Inspect drain inlets to ensure unrestricted runoff from the drainage layer to the conveyance or roof drain system	Annually and after severe storms
	Inspect underside of roof for evidence of leakage	Annually and after severe storms
Regular maintenance	Remove debris and litter to prevent clogging of inlet drains and interference with plant growth	Six monthly and annually or as required
	During establishment (i.e. year one), replace dead plants as required	Monthly (but usually responsibility of manufacturer)
	Post establishment replace dead plants as required (where > 5% of coverage)	Annually (in autumn)
	Remove fallen leave and debris from deciduous plant foliage	Six monthly or as required
	Remove nuisance and invasive vegetation, including weeds	Six monthly or as required
	Mow grasses, prune shrubs and manage other planting as required – clippings should be removed and not allowed to accumulate	Six monthly or as required
Remedial actions	If erosion channels are evident, these should be stabilised with extra soil substrate similar to the original material, and sources of erosion damage should be identified and controlled.	As required
	If drain inlet has settled, cracked or moved, investigate and repair as appropriate	As required

**Monitoring and maintenance record**

You need to keep a record of the checks you have completed that are set out in the checklist below along with any additional checks you have made.

If you have a maintenance contract with a contractor, keep a record of any work carried out on your pond system by them. If invoices state the work carried out, these will be sufficient.

If you do the checks you should enter:

- The check or maintenance job
- Who did it;
- The result (for example when abnormal noise heard, called in specialist to investigate).

Action	Date and Time	Carried out by	Result
For example, inlet and outlet pipes checked	06/04/2012 09.30	Mr A N Other	Obstruction cleared.

**Accident and incident record**

You should record any accidents, other incidents or near misses relating to the operation of the SUDS system for example untreated sewage being released into the ponds. The form could also be used to record health and safety incidents.

"Other incidents" covers impacts on the environment that are not accidents, such as failing to maintain the system, or vandals causing damage to the detention pond.

Date and time of the incident	
What happened, what was it about?	
Was anyone else aware of this – other witnesses? If so who?	
What caused it?	
What action did you take to fix the problem?	
What have you done to make sure that it does not happen again?	
Was there any significant pollution – for example: untreated sewage being discharged into a drain, river or stream? Yes / No If yes, what pollution occurred?	
If there was significant pollution, then you must notify the Environment Agency on 0800 807060 as soon as possible. Have you done so?	Yes/No/not applicable At what time did you phone? EA Incident reference no.
You must also write or send an email to confirm this to the local office (see your accident management plan for the address). Have you done so?	Yes/No/not applicable
Please print your name, sign and date.	

**Key site and emergency contacts**

SITE DETAILS			
Address:			
Postcode:			
Site access grid reference:			
SITE CONTACTS		Office Hours (specify)	Out of hours
Owner:			
General manager:			
Site manager:			
Site supervisor:			
Security contact:			
Landowner / agent:			
EMERGENCY SERVICES		Office Hours	Out of hours
Emergency			
Medical:			
Police:			
Fire:			
REGULATORS		Office Hours	Out of hours
Health and Safety Executive (HSE):			
Local Authority:			
Environment Agency	General number:	08708 506 506	
	24-hour emergency hotline:	0800 80 70 60	0800 80 70 60
Natural England/Countryside Council for Wales			
OTHER KEY CONTACTS		Office Hours	Out of hours
Adjacent landowners:			
Neighbours:			
Specialist advisors:			