

Conceptual SuDS strategy report

For the proposed development at
**The Node Court, Drivers End
Lane, Codicote, Herts**

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Update: SW to bore hole soakaway
October 2024



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1 Introduction

1.1 Site location

The project is at The Node Court, Drivers End Lane, Codicote, Herts, SG4 8TR (see Figure 1).

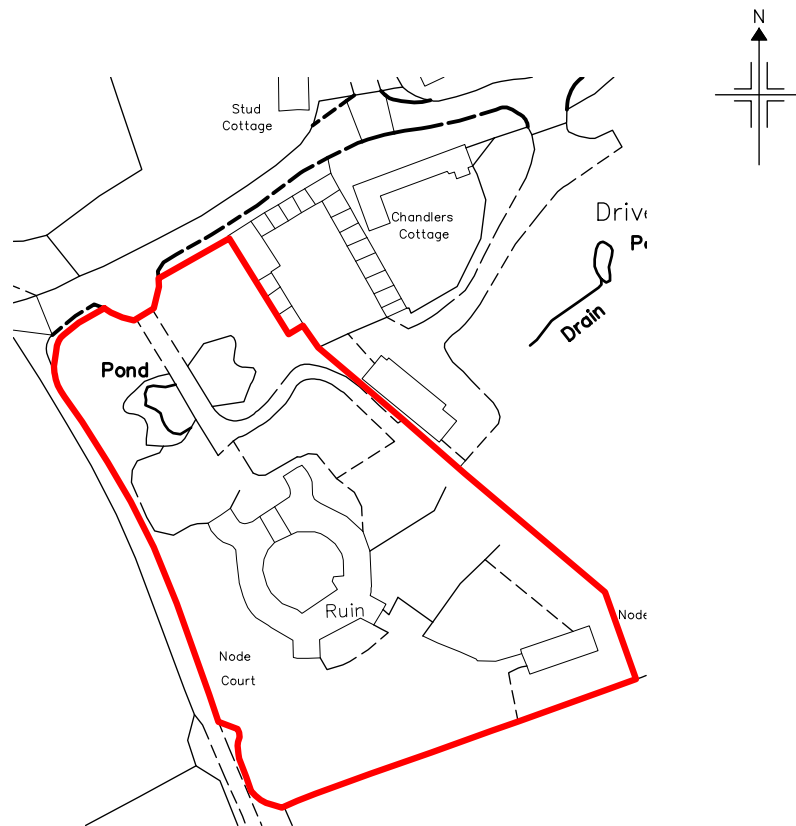


Figure 1: Site location plan, as indicated with North topmost. (source: client)

1.2 Development description

While the works are planned to run concurrently, they can be divided into two parts:

1.2.1 Part I

Re-construction of a Listed Building following extensive fire damage throughout to the building and the thatched roof and the conversion of the building into to eight domestic units.

1.2.2 Part II

This part of the project refers to the construction of a new block of six domestic units with a total of 283m² in footprint. The proposed location of this is onto an existing area of impermeable tarmac.

The existing and proposed layouts and proposed sections are as provided under separate cover.

1.3 Site geology

Geological mapping data and data from bore holes from within the site's immediate vicinity indicate Lowestoft Formation - Diamicton. These superficial deposits will offer poor to limited permeability. For the shallow SuDS design a very low assumed value of $1.4 \times 10^{-6} \text{ms}^{-1}$ (5mm.hr⁻¹) has been used taking into account the local geology ^[1].

1.3.1 Bore hole testing

Recent bore hole testing has concluded:

“Generally speaking the result was good, suggesting that borehole soakaways are a viable method for surface water disposal” Southern Testing Ltd (18.10.24).

The Southern testing report will be submitted under separate cover so as to respect copyright.

2 Surface water management

2.1 Existing surface water disposal strategy

The existing, pre fire damaged, building drained directly to the ground by eaves drop as shown in Figure 2.



Figure 2: Section of undamaged roof (source:client)

Many of the paved areas are formed in un-bonded brick sets so an element of background losses can be assumed.

The vast majority of the existing hard surfaces are surveyed as “tarmac” which does not appear to be formally drained. Given the site topography, a large open water feature (a pond) to the North of the site would form the sites natural outfall. This appears, again given the contours, to be a historic “man-made” surface water solution. The pond sits within a low spot and there is no apparent surveyed outfall from this.

2.2 Site constraints impacting on SuDS

- Listed building with strict requirements regarding reinstatement on a like for like basis (from historical records).
- Thatched roof.
- Previously developed site.
- No existing SW drainage infrastructure.

- Large areas of external space in designated root protection zones.
- Pitch roof design on the new terrace and dwellings.

2.3 Estimation of existing peak run-off rate

The Wallingford Procedure^[3] is used as the basis for the following calculation by using a site specific IDF curve to establish i_1 and i_{100} rainfall intensities. Hence for the upper limit on flow from the site:

2.3.1 Variables

$$i_1 = 50.4^1 \text{ mm hr}^{-1}$$

$$i_{100} = 153 \text{ mm hr}^{-1}$$

$$A = 0 \text{ m}^2$$

$$C_r = 1$$

$$C_v = 0.9$$

2.3.2 Impermeable area run-off rate for pre-developed site

$$\begin{aligned} Q_{BF1} &= \frac{0.9 * 50.4 * 0}{3600} \\ &= 0.0 \text{ l s}^{-1} \end{aligned}$$

$$\begin{aligned} Q_{BF100} &= \frac{0.9 * 153 * 0}{3600} \\ &= 0.0 \text{ l s}^{-1} \end{aligned}$$

Existing runoff rates from the impermeable areas of the site are calculated as 0.00 l s^{-1} (based on 50.4 mm hr^{-1} , 1 in 1 yr summer storm).

¹50.4mm hr⁻¹ is the mean intensity of a 1 in 1yr 6min duration summer storm, calculated to be the worst case, using standard IDF formula.

3 SuDS Principles

3.1 SuDS design philosophy

The CIRIA SuDS^[2] manual provides the design philosophy:

“SuDS design should, as much as possible, be based around the following:

- using surface water run-off as a resource
- managing rainwater close to where it falls
- managing run-off at the surface
- allowing rainwater to soak into the ground
- promoting evapotranspiration
- slowing and storing run-off to mimic natural run-off characteristics
- reducing contamination of run-off through pollution prevention and controlling the run-off at source
- treating run-off to reduce the risk of urban contaminants causing environmental pollution.”

3.2 Source control

- Sedum roofing.
- Infiltration devices. Typically soakaways.
- Rainwater harvesting.
- Bio-retention planting, rain gardens.
- Permeable paving, porous asphalt. These provide both infiltration and short term storage volumes thus reducing overall un-mitigated run-off volumes.

3.3 “End of pipe” solutions

To be considered only after implementation of the above options.

- Retention tanks with outfall controlled by hydraulic means to limiting discharge rates and volumes to discharge to existing SW flow pathways.

Sections 4.1 to 4.6 consider the viability of a range of these SuDS devices.

3.4 Design Criteria

3.4.1 Storm period

All new SW drainage shall be designed to a 1 in 100 year storm event allowing for climate change of +40%.

3.4.2 Statutory requirements - Building Regulations

All drainage on site, both foul and SW will be subject to compliance with Part H of the Building Regulations. Hence all SW runs, pipe diameters etc. will comply in full with the requirements of Part H, be designed following the guidance of Approved Document H, and be inspected and approved by the Building Control body at the time of construction.

3.4.3 Consent to discharge

No further consents will be required since there is no additional loading to any network and no new drainage infrastructure being added.

4 Appraisal of SuDS options

4.1 Infiltration devices

With reference to Section 3.1, soakaways promote the following SuDS design criteria:

- manages rainwater close to where it falls
- allows rainwater to soak into the ground
- slows and stores run-off to mimic natural run-off characteristics
- treats run-off to reduce the risk of urban contaminants causing environmental pollution.

4.2 Expansion of vegetation and rain gardens

With reference to Section 3.1, vegetation expansion and rain gardens promote the following SuDS design criteria:

- manages rainwater close to where it falls
- manages run-off at the surface
- promotes evapotranspiration
- slows and stores run-off to mimic natural run-off characteristics
- treats run-off to reduce the risk of urban contaminants causing environmental pollution.

and also

- Promotes bio-diversity
- Provides amenity

4.3 Pervious hard standing

With reference to Section 3.1, permeable paving promotes the following SuDS design criteria:

- manages rainwater close to where it falls

- manages run-off at the surface
- allows rainwater to soak into the ground
- slows and stores run-off to mimic natural run-off characteristics
- treats run-off to reduce the risk of urban contaminants causing environmental pollution.

4.3.1 Pervious surface - Type 3 sub-base

A 30% void ratio is assumed through a 350mm sub-base formed using a Type 3, low fines sub-base. Hence the storage capacity equates to circa 105mm per 1m² therefore based on a M6 100hr + cc storm of 87mm rainfall the paving offers, without any allowance for infiltration, a circa 1:2 drained volume:storage volume capacity. Hence there is no anticipated exceedance flow from the areas of permeable paving.

TSS 0.7, Metals 0.6, Hydrocarbons 0.7 = suitable for trafficked areas

All pervious paving offers sufficient storage volume to accommodate the 5mm event.

4.4 Rainwater harvesting

With reference to Section 3.1, Rainwater harvesting promotes the following SuDS design criteria:

- uses surface water run-off as a resource
- manages rainwater close to where it falls

4.4.1 For external use

Rain water harvesting / water butts: These provide additional, “off line²” SuDS, and are deemed a suitable SuDS component for small plots^[2], extract at Figure 3. The image shows a water butt in “off-line” configuration using a standard diverter.

²The term “off-line” refers to the fact that a water butt is a harvesting device that is not “in-line” in the same manner that a pipe is in-line. Water is collected (harvested) until the water butt is full. When full, the rainwater continues down the rainwater pipe. Outflow from the tank is not “automatic” since this would negate the reason to harvest rainwater. Instead, manual drawdown occurs with the harvested water being used for external uses. Since a water butt may be full, the useful volume is not accounted for in storage and run-off calculations.



Figure 10.7 On-plot SuDS (courtesy Illman Young, Robert Bray Associates)

There are many opportunities for small on-plot SuDS, such as downpipe reconnections to rain gardens, planted rills and water butts.

Figure 3: Use of water butts as provided in the SuDS manual

The collection and re-use of water can reduce run off volumes arising from roofs. The collected water, via readily available diverters (e.g. Web link: [Standard diverter example](#), as per Figure 4), being used for external uses.



Figure 4: Standard rainwater diverter

Rainwater butts can, in part, accommodate the 5mm event dependent on manual drawdown and evaporation.

4.5 Sedum/green roofs.

Due to site constraints, as per Section 2.2, sedum roofs are not possible.

4.6 “End of pipe” solutions

To be considered only after implementation of the above options.

- Retention tanks with outfall controlled by hydraulic means (e.g. hydrobrakes, pipe sizing, orifice plate etc.) to limiting rates and volumes to discharge to existing flow pathways.

5 Proposed Surface water disposal strategy

The following sections consider the strategy for water arising from the roof areas, driveways and hard standing and areas of landscaping for both Parts I and II.

5.1 Part I

5.1.1 Roof area

Due to the exceptional constraints as noted at Section 2.2 there is very little, if any thing that can be provided as a betterment on the existing scenario for the roof area.

5.1.2 Local paved areas

Many of the paved areas are to be replaced/repaired.

All repaired/replaced paved areas will be formed on a SuDS standard sub-base as detailed at Section 4.3.1.

5.2 Part II

5.2.1 Roof area - terrace of six dwellings

Water from the an area of circa 144m² per new roof (front elevation 6 x 24m²) will flow to rainwater planter “rain gardens” to offer a level of pre-treatment, attenuation and flow control, Figure 5 (planting and soil guide at Appendix B).

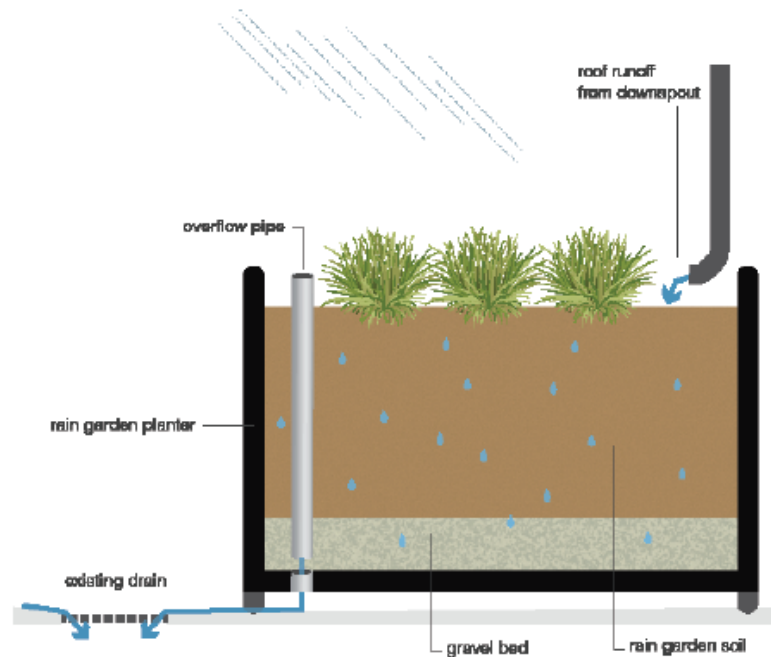


Figure 5: Typical rain garden/bio retention section

All planters offer sufficient storage volume to accommodate the 1 in 1yr, 5mm event.

Planter design

Planter design based on 100yr return period

Climate change factor = 1.4

Urban Creep factor = 1

Cv = 0.9

Engineered, rootzone soil, infiltration rate = 100mmhr⁻¹.

Drained area = 24m²

Design width of 1.2m, length of 3.50m and depth of 0.6m

Design planter area = 4.20m²

Critical Duration

Critical storm duration has been calculated by considering the inflow rate minus the outflow rate of storm durations from 5 minutes and increasing in 1 minute intervals. From this the critical storm duration for this planter is 51 minutes.

M100 51 min rainfall depth = 39mm

Storm capacity check

Required capacity: $V_t = \frac{24 \times 1 \times 1.4 \times 45.4 \times 51}{60 \times 1000} = 0.8m^3$

Required ponding depth above planter = $0.8/4.2 = 200mm$.

Drain down check

Saturated drain down time, $t =$

$$\frac{V_t L}{k (h + L) A_f}$$

where:

Critical duration = 51 mins

1 in 100yr, 51min mean intensity = 45.4 mmhr^{-1}

L (planter depth) = 0.6m

h = 0.1m

Engineered $k = 100 \text{ mmhr}^{-1}$. For design 50% of this rate is used.

$$\frac{0.8 \times 0.6 \times 1000}{50 (0.1 + 0.6) 4.2} = 3.30$$

Planter design draindown time = 3.30hrs.

Max design outfall flow rate

The max design outfall rate from the underdrain is based on the 100 yr design storm event entering the system when fully saturated.

$$Q_{max} = \frac{k A_f (h + L)}{L} m^3 s^{-1}$$

For this planter, peak outfall is given as:

$$Q_{max} = \frac{100 * 4.2 (0.1 + 0.6)}{0.6 * 3600} = 0.14 l s^{-1}$$

Any residual flow from the planters and remaining roof area will be directed to a bore hole soakaway.

Flows will be restricted by means of an orifice plate (or vortex) to 50% of the borehole outflow rate (i.e. a FoS of 2).

Outfall rate from the bore hole will be determined once installed. Any balance volume will be accommodated within a geo-cellular tank. Typical system components are provided at Appendix C

Bore hole soakaway design

All to K.C.C guide (that being the only trustworthy design guide available).

https://www.kent.gov.uk/__data/assets/pdf_file/0014/13037/Making-it-Happen-Soakaway-design-guide-July-2000.pdf

5.3 General site wide provisions

5.3.1 Water butts

All new units will have rainwater butt(s) installed to offer further attenuation. These will also serve to reduce potable water demand for external use.

5.3.2 Pervious surfaces

All areas of hardstanding, currently shown as a tarmac surface are to be reformed with a resin-bound gravel surface. The sub-base for these areas will be re-constructed in line with Section 4.3.1 with a minimum 350mm sub-base thickness.

Perimeter linear fin drains can be used to convey water below ground level so as to reduce surface water flows across the surface. The perimeter fin drains will direct water towards to a deep bore soakaway.

Based on a nominal outflow rate of $5\text{mmhr}^{-1}\text{m}^{-2}$, the following applies to a 100m^2 drained area which can be scaled pro-rata. This shows a minimum sub-base thickness of 200mm is required to achieve the required hydraulic performance.

Designed to accomodate all surface water arising from a design drained area of 100m^2 requires a minimum attenuation volume of 6 m^3 . This can be achieved using an overall storage volume of 10.5 m^3 formed within a $100\text{m}^2 \times 0.35\text{m}$ deep 30% void ratio sub-base. See Table 1.

Drained area	100m ²	
Urban Creep	1	
Designed drained area	100m ²	
Return periods considered	1yr, 30yr, 100yr	
Storm profiles used	50% Summer	75% Winter
Storm coeffs	a = 0.1, b = 0.815	a = 0.06, b = 1.026
Storm range, storm increments	From 5 minutes duration in further 2 min. intervals until critical storm reached	
M5-60	20mm	
r	0.4	
Rainfall model	FSR	
Critical design storm	219 mins, Winter	
Climate change	1.4	
Storm mean intensity	15.1mm.hr ⁻¹	
Design mean intensity	21.1mm.hr ⁻¹	
Storm peak intensity	40.6mm.hr ⁻¹	
Design peak intensity	56.9mm.hr ⁻¹	
Design maximum head	0.20m	
Calculated maximum head	0.20m	
Minimum attenuation volume required	5.98m ³	
Void ratio	30%	
Design attenuation volume	6m ³	(0.3 × 100m ² × 0.20m)
Provided attenuation volume	11m ³	(0.3 × 100m ² × 0.35m)
1 in 1yr maximum outfall rate	0.1ls ⁻¹	(See Figure 6.)
1 in 30yr maximum outfall rate	0.1ls ⁻¹	(See Figure 7.)
1 in 100yr maximum outfall rate	0.1ls ⁻¹	(See Figure 8.)
1 in 100yr Time to peak	209 mins	
Design head: Time to drop to 50%	5.98 hrs	
Time to 50% total capacity	1.50 hrs	
Outfall control method	Nominal GF outflow	

Table 1: Storage volume design summary

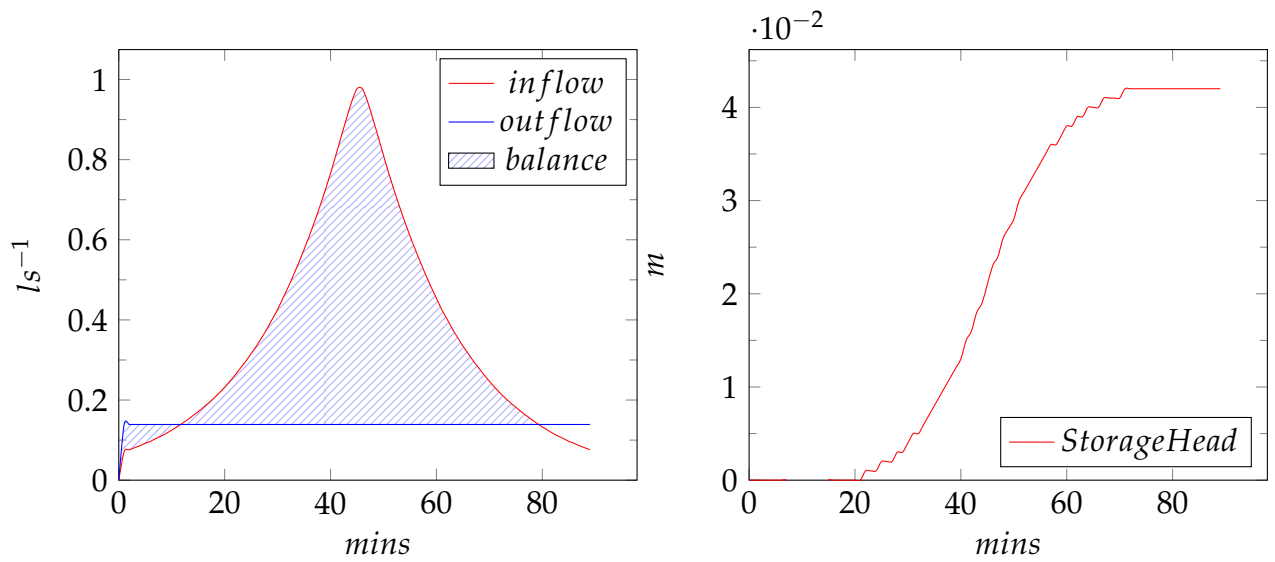


Figure 6: 1 in 1 year critical storm event

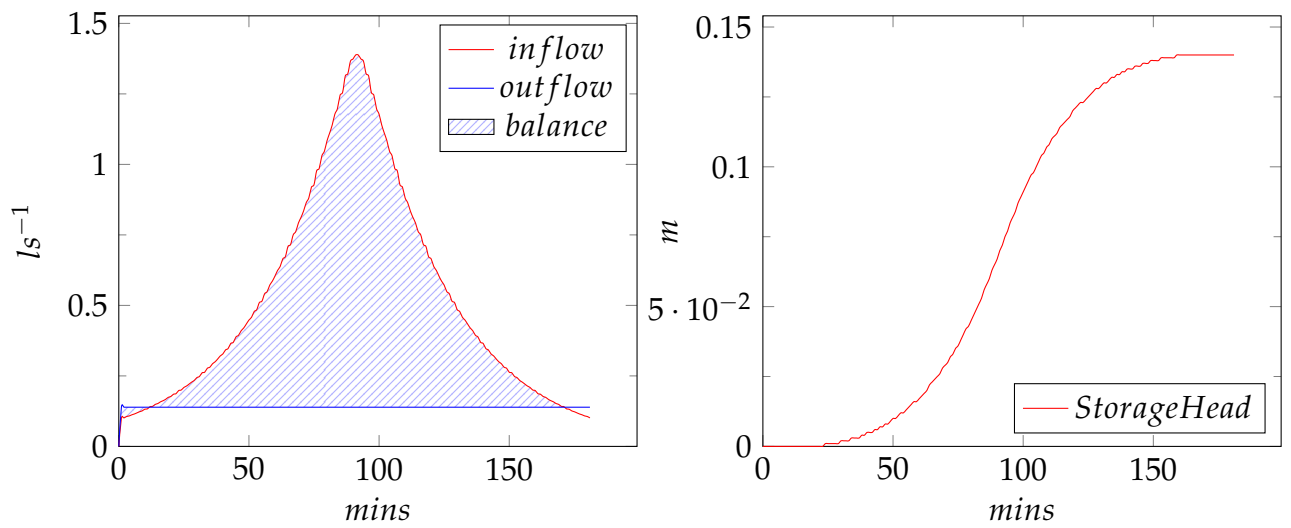


Figure 7: 1 in 30 year critical storm event

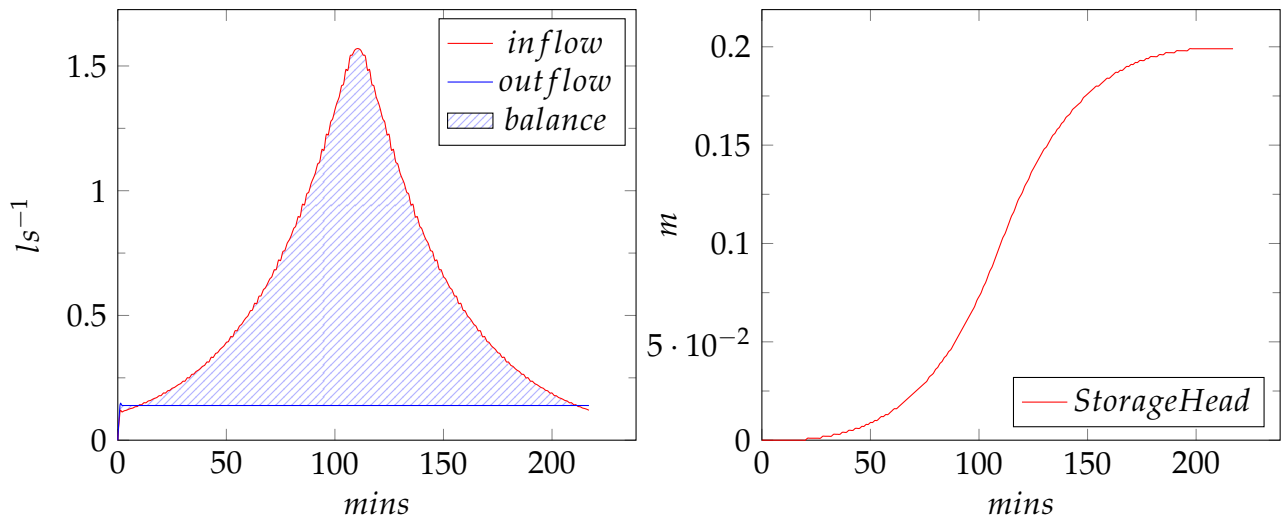


Figure 8: 1 in 100 year critical storm event

5.3.3 De-paved areas

Where areas of tarmac are no longer required as hardstanding, an area of circa 255m², will be returned to expansive landscaping. There is no expected run-off from these de-paved areas.

5.3.4 Exceedance flows

- Water butt(s) - when full, the water is diverted to the proposed surface water drainage on site.
- Rain garden planters - when saturated, the water is directed to the sub-base of the pervious surface on site.
- Pervious surfaces - Any exceedance flows at the surface will be directed to adjacent garden planting and finally onwards to the pond.
- Landscape planting - There are no anticipated exceedance flows from areas of garden planting.

There are no design overland exceedance flow paths other than as noted above.

5.4 Indicative layouts

Refer to Appendix A.1.

6 Maintenance of SuDS

Ultimate responsibility for the long term maintenance with SuDS in this environment lay with the land owner/management company.

All SuDS on site will be installed with full consideration to long term maintenance. The following guidance applies:

6.1 Deep Bore Soakaway Maintenance Plan

6.1.1 Inspection Frequency

- Initial Inspection: 6 months after installation to check for early signs of malfunction.
- Routine Inspections: Every 6 months (bi-annually) thereafter.
- After Heavy Rainfall or Storms: Additional inspections should occur after extreme weather events.

6.1.2 Regular Maintenance Tasks

Surface Inspection (Bi-annual)

- Check for standing water: Ensure that there's no water ponding on the surface, which could indicate a blockage or failure of the soakaway system.
- Visual check of grates and covers: If there's a surface grate or inspection chamber, ensure it's secure and not damaged.
- Look for signs of erosion: Check for soil erosion or surface damage near the soakaway.

Silt and Debris Removal (Bi-annual)

- Clear surface debris: Remove leaves, rubbish, and other debris that might block the inlet of the soakaway.
- Clean silt trap: If a silt trap is installed upstream, clean it to prevent silt from entering the bore.
- Flush the system: Flush through any accessible inspection chambers or pipes with clean water to prevent silt build-up in the soakaway bore.

Monitoring Water Flow

- **Measure infiltration rate:** At least annually, measure the water infiltration rate by flooding the soakaway with a controlled volume of water to ensure it's functioning as designed.
- **Check for slow drainage:** During wet periods, monitor the time it takes for water to drain. A noticeable slowdown could indicate a blockage or silt accumulation in the bore.

De-silting the Borehole (Every 3 to 5 years)

- **Mechanical de-silting:** Use a high-pressure jet or mechanical pump to clear out silt and debris that may have accumulated within the borehole. This is a specialized task that may require a contractor.
- **Inspect the bore liner:** If the bore is lined, inspect the condition of the liner for damage or deterioration during this process.

Vegetation Management (As needed)

- **Clear excessive vegetation:** If vegetation grows around the surface area of the soakaway, ensure it does not obstruct the system's inlet or compromise the integrity of the soakaway by root intrusion.
- **Root ingress checks:** If there are large trees or invasive species nearby, periodically inspect for root ingress into the bore.

Inspection of Surrounding Areas

- **Check for surface settlement:** Look for any signs of ground subsidence around the soakaway. This could indicate that water is not infiltrating evenly or that structural elements have failed.
- **Inspect overflow mechanisms:** If an overflow or bypass is installed, ensure that it is functioning properly.

Record Keeping

- **Document each inspection:** Keep a detailed log of each maintenance visit, including date, findings, and any actions taken.

- Monitor performance over time: Record any changes in the soakaway's performance, such as slower drainage rates, and compare them with previous inspections to spot long-term trends.

Special Considerations

- Groundwater Contamination Risk: If the soakaway is designed to discharge into deep strata, it's important to monitor for any signs of pollution that might affect groundwater.
- Periodic Professional Inspection: Every 5 years, consider engaging a drainage engineer to carry out a detailed condition survey of the soakaway, especially if significant problems are detected.

Signs of Potential Problems

- Slow water drainage: Could indicate clogging or a reduction in borehole permeability.
- Standing water or flooding: Suggests that the soakaway has lost its capacity to infiltrate water effectively.
- Unusual smells or discolouration of water: Could indicate contamination or a blockage.

6.2 Pervious surfaces

The maintenance plan for pervious pavements will include:

- Monthly litter removal;
- Bi-Annual jet wash and sweeping - where applicable.
- Annual inspection and repairs as/if required.

6.3 Inspection/control chambers

The maintenance plan for areas of geocellular systems will include:

- Regular³ inspection of silt traps, IC's, pipework and pre-treatment devices (safe access provision required)

³Six monthly or after a period of heavy or prolonged rainfall

- Removal of sediments and debris as required.

Access points are required so as to be able to use a suction tanker on an annual basis.

6.4 Vegetation expansion and rain gardens

- Monthly inspections until vegetation is established;
- Six monthly inspections after the vegetation has become established;
- Monthly litter removal;
- Occasional weeding during the first two years;
- Removal of any dead or unwanted plants in winter (other than leaving seed heads for wildlife).
- Other possible tasks will include replacement of dead vegetation, erosion repair and mulch replenishment.

7 Summary

All surface water arising can be managed on site. Exceedance flows and flows arising from system failure are managed on site.

The use of the existing pond, at the site's low point, serves to maintain the hydrological connectivity between site and this pond feature.

The use of SuDS techniques on site, as detailed above and when installed in line with best practice (I.e. CIRIA 753 & CIRIA 768), will mitigate and treat the run-off volumes in line with the core policies.

Signed 

Dr Robin Saunders C. Build E, MCABE, BEng(Hons), PhD

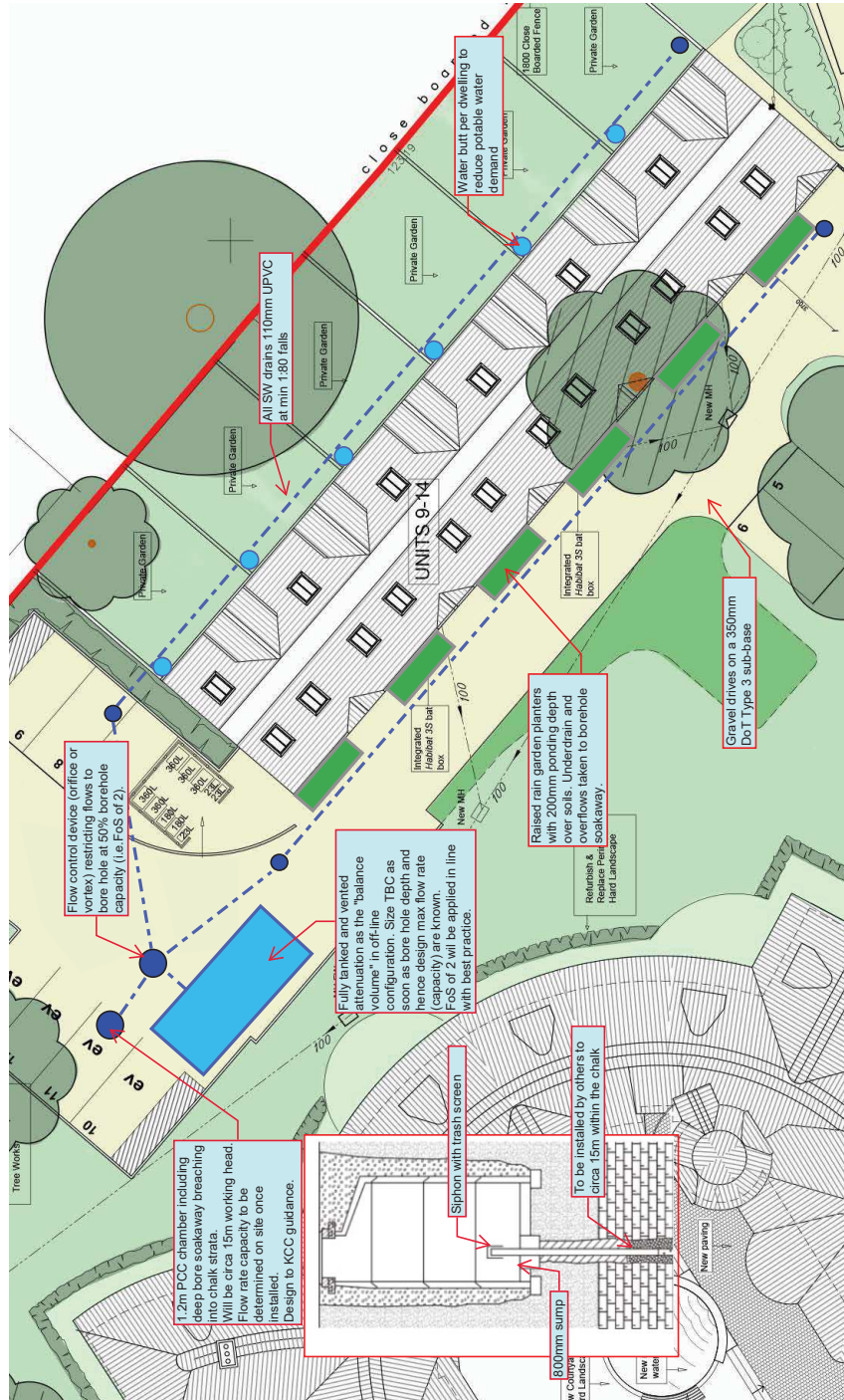
Date: 28th October, 2024

References

- [1] Anon. Code of practice for Foundations. Technical Report BS8004:1986, BSi, 1986.
- [2] CIRIA. The SUDS manual. Technical report, CIRIA, 2015.
- [3] H R Wallingford, Howbery Park, Wallingford, Oxfordshire. *The Wallingford Procedure*, volume 1 edition, 1981.

A Proposal drainage

A.1 Indicative SuDS terrace



B Rain garden

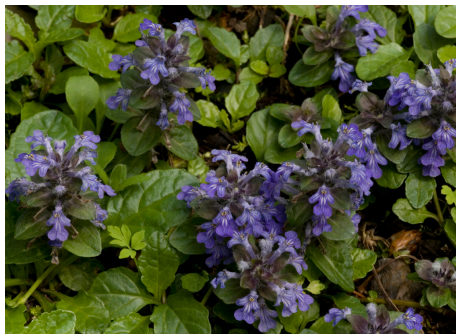
B.1 Planting guides

Planting

Your rain garden is designed to slow surface water run-off and improve water quality. However it is a garden feature and should work for you in terms of the overall design of your property. Like any garden, there is range of possible planting styles: your rain garden might have ornamental, low maintenance ground cover, designed to provide a habitat for wildlife or quirky, perhaps, with stone, gravels or even sculpture – the choice is yours. The English cottage, American prairie or ornamental grass styles are particularly well suited to rain gardens. In larger planters, you may be able to grow fruit and vegetables.

When choosing plants you may want to consider height, colour and flowering period. Taller plants tend to be situated at the centre of the garden and shorter ones around the edges, so that all can be seen and so that deeper-rooted plants can benefit from the deeper soil in the middle of the bed. By grouping plants of various size and texture you will be able to create an interesting looking garden even when few flowers are in bloom. If you wish to create habitat for wildlife, plant native species or plants that are known to attract insects like bees and butterflies and other wildlife. For further information on plants for pollinators see the Royal Horticultural Society's list, and for general advice on wildlife gardening see the Wild About Gardens website (see the Resources section).

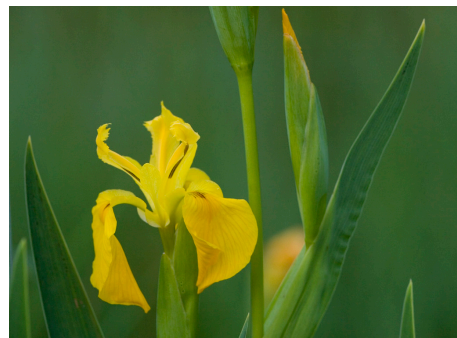
It is recommended that your rain garden is planted with a wide range of species in order to create a densely vegetated, stable and thriving bed with dense and thick root systems which will thrive without frequent maintenance. A typical rain garden is planted with about 10 species planted in 2 to 3 clumps per square metre. By planting several species, you will be creating a rain garden that can still succeed even if one or two species do not thrive. A typical planting density is 6-10 plants per square metre, but you may wish to vary this, depending on the size and nature of the plants chosen.



Bugle, *Ajuga reptans* | Bob Gibbons

Plant the rain garden with nursery-grown stock. Good results have been achieved with one or two year old plugs or potted

plants, which have a strong root system. Before you plant, it is advisable to have a good idea of what goes where, by preparing a planting plan. Excavate a hole for each plant about twice the size of the root ball, place the plant in the hole and press the soil firmly around the roots. The stem should be at the same level relative to the ground as it was in the growing container. Once the garden is planted, you may consider spreading bark mulch across bare soil to suppress weed growth.



Yellow flag iris, *Iris pseudocorus* | Bob Gibbons

The perimeter berm can be seeded with a general purpose wildflower grassland mix, which can be left to grow, or mown as required, in order to match the adjacent garden. Unless it rains, plants should be watered during establishment. During hot weather, the soil loses about 3 litres per square metre per day by evaporation, so it is advisable to replace this if possible. Once established, the plants will not need to be watered unless the weather has been exceptionally dry. Plants can be planted anytime during the growing season, as long as they are watered. If watering is difficult, it may be advisable to plant in autumn.

A very wide range of plants can be planted in rain gardens, however you should avoid using plants that do not withstand occasional flooding - for example species which are usually associated with dry Mediterranean style gardens, like Lavender. Other plants to avoid include those susceptible to root rot including Azalea, Juniper and Chinese privet.

The frequency that the rain garden is inundated will depend on the size of the rain garden and the weather, so it is important to keep an eye on the rain garden, replace any failures and adjust the planting palette to suit the actual conditions. A selection of suggested plants is included in the table. There are many others that will be suitable which are not listed, so feel free to experiment and apply your own plant knowledge if you are a keen gardener. If you have success or notice problems with particular species, please let us know at: www.raingardens.info.

Planting Suggestions

Common name	Scientific name	Habit	Sunlight and Aspect	Origin
Gelder rose	<i>Viburnum opulus</i>	Perennial shrub	Any	Native. Flowers attract insects and berries are eaten by birds.
Dogwood	<i>Cornus sanguinea</i>	Perennial shrub	Any	Native. Leaves are larval food for vase bearer moth and berries eaten by birds. Often planted for attractive winter stems.
Culvers root	<i>Veronicastrum virginicum</i>	Herbaceous perennial	Full sun or partial shade	Non-native. Tall with long terminal blue flower spikes. On the RHS 'plants for pollinators' list.
Aster	<i>Aster spp.</i>	Herbaceous perennial	Full sun or partial shade	Non-native. Often late flowering. Clump forming. Several species on the RHS 'plants for pollinators' list.
Black eyed susan	<i>Rudbeckia hirta</i>	Herbaceous annual or biennial	Full sun or partial shade	Non-native. Spectacular yellow and black flowers. On RHS 'plants for pollinators' list.
Stinking hellebore	<i>Helleborus foetidus</i>	Herbaceous perennial	Full sun or partial shade	Native. Winter flowers.
Montbretia	<i>Crocsmia spp.</i>	Deciduous rhizomatous perennial	Partial shade	Naturalised. Red flowers. Thrives in most conditions.
Bugle	<i>Ajuga reptans</i>	Rhizomatous perennial	Partial shade	Native. Low growing and will form a mat.
Columbine	<i>Aquilegia spp.</i>	Herbaceous perennial	Full sun or partial shade	Non-native. Clump forming with tall flower spikes. On RHS 'plants for pollinators' list.
Inula	<i>Inula hookeri</i>	Herbaceous perennial	Partial shade	Tall clump forming with yellow flowers. On RHS 'plants for pollinators' list.
Hemp agrimony	<i>Eupatorium cannabinum</i>	Herbaceous perennial	Full sun or partial shade	Native. Sub-shrubs with pink flowers.
Bellflower	<i>Campanula glomerata</i>	Herbaceous perennial	Full sun or partial shade	Native. Clumps bearing violet-blue bell shaped flowers.
Sneezeweed	<i>Helenium sp.</i>	Herbaceous perennial	Full sun	Non-native. Clump forming with red flowers. On RHS 'plants for pollinators' list.
Lesser periwinkle	<i>Vinca minor</i>	Perennial sub-shrub	Any	Non-native. Ground cover with blue flowers.
Elephants ear	<i>Bergenia sp.</i>	Rhizomatous perennial	Full sun or partial shade	Non-native. Large leaves and pink flowers.
Plantain lilies	<i>Hosta spp.</i>	Herbaceous perennial	Part shade	Non-native. Attractive light coloured flowers.
Yellow flag	<i>Iris pseudocorus</i>	Rhizomatous perennial	Full sun or partial shade	Native. Likely to prefer wetter areas near inlet.
Siberian flag	<i>Iris sibirica</i>	Rhizomatous perennial	Full sun or partial shade	Non-native. Blue flowers. Prefers moist but well drained soil.
Garlic and onions	<i>Allium spp.</i>	Bulbous perennials	Full sun	Non-native. On RHS 'plants for pollinators' list.
Soft rush	<i>Juncus effusus</i>	Evergreen perennial	Full sun or partial shade	Native. Form tussocks – likely to prefer wetter areas.
Pendulous sedge	<i>Carex pendula</i>	Rhizomatous perennial	Full sun or partial shade	Native. Nodding flower spikes. Likely to prefer wetter areas near inlet.
Zebra grass	<i>Miscanthus sinensis</i>	Perennial, deciduous grass	Full sun	Non-native. Tussock forming ornamental grass with silky flowers.
Switch grass	<i>Panicum virgatum</i>	Deciduous perennial grass	Full sun	Non-native. Tussock forming ornamental grass.
Royal fern	<i>Osmunda regalis</i>	Deciduous fern	Any	Native. Large clump-forming plants.
Male fern	<i>Dryopteris felix-mas</i>	Deciduous or evergreen fern	Partial shade or full shade	Native. Large shuttlecock-like form.
Broad buckler fern	<i>Dryopteris dilatata</i>	Deciduous or evergreen fern	Partial shade or full shade	Native. Large shuttlecock-like form.

7) Plant Selection

The plants in the lists below are a selection from what is currently grown by well known nurseries or are readily available in the trade. The selection criteria are described on Page 4 in 'planting criteria' and reflect personal preferences to some extent. There are many other plants that can be used in 'bioretention planters' subject to availability, knowledgeable selection and appropriate maintenance. However there is no substitute to being familiar with a particular plant and its behaviour in similar conditions to the 'bioretention planters' that are designed for a SUDS scheme.



Suitable for use in small footprint (<5 m²) pre-fabricated systems.
eg. Hydro Filleria™ Bioretention System

Botanical Name	Common Name	Evergreen or Deciduous	Usual Height (m)	Flowers	Berry	Autumn Leaf Colour	Sun	Shade	eg. Hydro Filleria™
Native Trees									
Acer campestre	Field Maple	D	5 +	-	-	✓	✓	✓	
Betula pendula	Birch	D	10 +	-	-	✓	✓	✓	
Malus sylvestris	Crab Apple	D	5 +	✓	✓	-	✓	-	
Pinus sylvestris	Pine	E	10 +	-	-	-	✓	-	
Sorbus aria	Whitebeam	D	5 +	✓	✓	✓	✓	-	
Sorbus aucuparia	Rowan	D	5 +	✓	✓	✓	✓	✓	
Sorbus torminalis	Wild Service Tree	D	5 +	✓	✓	✓	✓	✓	
Native Shrubs									
Buxus sempervirens	Box	E	2-5	-	-	-	✓	✓	
Fraxinus alnus	Alder Buckthorn	D	1-3	-	✓	✓	-	-	
Hippophae rhamnoides	Sea Buckthorn	D	2-5	-	✓	-	✓	-	
Ilex aquifolium	Holly	E	2-5	-	✓	-	✓	✓	
Ligustrum vulgare	Wild Privet	D	1-3	✓	✓	-	✓	-	
Viburnum lantana	Wayfaring Tree	D	1-3	✓	✓	-	✓	-	
Viburnum opulus	Guelder Rose	D	1-3	✓	✓	✓	✓	-	
Native Ground Cover									
Hedera helix	Ivy	E		-	-	-	✓	✓	
Ornamental Trees									
Acer capillipes and others	Maples	D	5 +	-	-	✓	✓	✓	
Amelanchier lamarckii	Snowy Mesquitol	D	3 +	✓	✓	✓	✓	-	✓
Betula albosinensis and others	Birch	D	10 +	-	-	✓	✓	-	
Corylus avellana	Judas tree	D	5 +	✓	-	✓	✓	-	✓
Crataegus x laevata and others	Turkish hazel	D	5 +	✓	-	✓	✓	-	✓
Eucalyptus niphophila	Gum tree	E	5 +						
Fraxinus angustifolia 'Raywood' and others	Ash	D	10 +	-	-	✓	✓	-	
Koeleria paniculata	Golden Rain Tree	D	5 +	✓	✓	✓	✓	-	✓
Malus Evereste and others	Crab apples	D	5 +	✓	✓	-	✓	-	✓
Pinus nigra maritima	Pine	E	10 +	-	-	-	✓	-	

Botanical Name	Common Name	Evergreen or Deciduous	Usual Height (m)	Flowers	Berry	Autumn Leaf Colour	Sun	Shade	eg. Hydro Filleria™
Ornamental Trees Cont ...									
Prunus 'Acolade' and others	Cherry	D	5 +	✓	-	✓	✓	-	
Pyrus nivalis	Pear	D	5 +	✓	✓	✓	✓	-	✓
Sorbus x intermedia	Swedish Whitebeam	D	5 +	✓	✓	✓	✓	-	
Sorbus commixta and other varieties	Rowan	D	5 +	✓	✓	✓	✓	-	✓
Ornamental Shrubs									
Abelia x grandiflora	Abelia	E	1.2 x 1.2	✓	-	-	✓	-	✓
Angelica tree	Angelica tree	D	3 x 2.5 +	✓	-	✓	✓	-	✓
Arbutus unedo	Strawberry tree	E	2.5 x 2 +	✓	-	-	✓	✓	✓
Aucuba japonica	Aucuba	E	1.2 x 1.2	-	✓	-	✓	✓	✓
Aucuba japonica 'Rozanne' + others	Mexican orange blossom	E	1.5 x 1.5	✓	-	-	✓	✓	✓
Chionodoxa 'Aster Pearl' & C. ternata	Flowering dogwood	D	3 x 2.5 +	✓	✓	✓	✓	✓	
Colinus kousa chinensis & C. mas	Smoke bush	D	3 x 2 +	✓	-	✓	✓	-	✓
Colinus coggygria + other varieties	Castor oil plant	E	1.5 x 1.5	✓	✓	-	✓	✓	✓
Fatsia japonica	Gaiya	E	3 x 2.5	✓	-	-	✓	✓	✓
Gaiya elliptica	St. Johns wort	D	1.5 x 1.5	✓	-	-	✓	✓	✓
Hypericum 'Hidote'	Juniper	E	1.5 x 2	-	-	-	✓	-	✓
Juripennis X media 'Pittzeriana' + others	Beauty bush	D	1.8 x 1.8	✓	-	-	✓	-	
Kolkwitzia amabilis 'Pink Cloud'	Sweet bay	E	3 x 2	✓	-	-	✓	-	✓
Laurus nobilis	Privet	E	3 x 2	✓	-	-	✓	✓	✓
Ligustrum lucidum + others	Maltonia	E	3 x 2	✓	✓	-	✓	✓	✓
Maltonia 'Charly' + others	Sacred bamboo	D	2 x 1.5	✓	✓	✓	✓	✓	✓
Nandina domestica	Osmanthus	E	2 x 1.5	✓	-	-	✓	✓	✓
Osmanthus x burkwoodii + others	New Zealand flax	E	1.5 x 1.5	✓	-	-	✓	-	✓
Phormium tenax-cockatoo hybrids	Philodendron	E	2.5 x 1.5	✓	-	✓	✓	✓	✓
Philodendron Red Robin	Laurel	E	varies	✓	-	-	✓	✓	✓
Prunus laurocerasus form like P. Etna	Prunella	E	3 x 2	✓	✓	-	✓	-	✓
Prunella 'Teton' + others	Slugs Horn	D	3 x 2	✓	✓	✓	✓	✓	✓
Rhus typhina 'Lachinlat'	Sweet box	E	0.6-1.2 & spread	✓	-	-	-	✓	
Sarcocoba confusa + nobeliana digyna	Skimmia	E	0.9 x 0.9	✓	✓	-	-	✓	✓
Skimmia x Kew Green + others	Chusan palm	E	3 x 2	✓	-	-	✓	✓	✓
Trachycarpus fortunei	Viburnum varieties	E & D	varies	✓	✓	✓	✓	✓	✓
Viburnum varieties	Yucca	E	0.6 x 0.6	✓	-	-	✓	-	✓

Botanical Name	Common Name	Evergreen or Deciduous	Usual Height (m)	Flowers	Berry	Autumn Leaf Colour	Sun	Shade	sp. Hydro Filiera™
Ornamental Shrubs Cont ...									
Cotoneaster Low									
Cotoneaster 'Slosholm' + others	Cotoneaster	E	0.3-0.9 + spread	✓	✓	-	✓	✓	
Cotoneaster Erect									
Cotoneaster bullatus + others	Cotoneaster	E & D	1.5 +	✓	✓	✓	✓	✓	
Euonymus Low									
Euonymus fortunei 'Dart's Blanka' + others	Euonymus	E	0.3-0.6 + spread	-	-	-	✓	✓	
Euonymus japonicus	Evergreen spindle	E	2 x 1.5	-	-	-	✓	✓	✓
Escallonia 'Sieve Donard' and other varieties	Escallonia	E	1.5-1.5	✓	-	-	✓	✓	
Conifers - see Pinus and Junipers. Consider smaller Chamaecyparis vars. and others									
Ground Cover									
Acanthus spinosus		D	0.6	✓	-	-	✓	-	
Alchemilla mollis		D	0.3	✓	-	✓	✓	✓	
Bergenia - varieties		E	0.3	✓	-	✓	✓	✓	
Epimedium varieties eg. E. pinnatum colchicum		E & D	0.3	✓	-	-	✓	✓	
Euphorbia robbiae		E	0.6	✓	-	-	✓	✓	
Geranium - varieties eg. endressii & macrorrhizum		E & D	0.3	✓	-	✓	✓	✓	
Hedera 'Hiemalis' & other varieties.		E	0.15	-	-	-	✓	✓	
Hemerocallis - varieties eg. H. citrina & H. fulva		D	0.9	✓	-	-	✓	-	
Iris foetidissima 'Clina'		E	0.3	✓	✓	-	✓	✓	
Linopie muscari		E	0.3	✓	✓	-	✓	✓	
Ophiopogon planiscapus vars.		D	0.15	✓	-	✓	✓	✓	
Pulmonaria saccharatum vars.		D	0.3	✓	-	-	✓	✓	
Symphitum grandiflorum vars.		D	0.3	✓	-	-	✓	✓	
Vinca minor varieties		E	0.15	✓	-	-	✓	✓	
There are many other low growing plants that will behave as ground cover but each will have a slightly different character and therefore be suitable for different uses. Ivy (Hedera helix) and periwinkle (Vinca minor) are the most generally useful but are a starting point for creative plant design.									
Grasses									
Calamagrostis x acutiflora 'Karl Foerster'		D	0.9	✓	-	-	✓	-	
Carex pendula		E	0.9	✓	-	-	-	✓	
Deschampsia caespitosa		D	0.6	-	-	-	-	-	
Golden Veil		E	0.3	✓	-	-	✓	-	
Festuca amethystina		E	0.3	✓	-	-	✓	-	
Helictotrichon sempervirens		E	0.6	✓	-	-	✓	-	

Botanical Name	Common Name	Evergreen or Deciduous	Usual Height (m)	Flowers	Berry	Autumn Leaf Colour	Sun	Shade	sp. Hydro Filiera™
Grasses Cont ...									
Luzula sylvatica		E	0.6	✓	-	-	✓	✓	
Polypodioides Hamelin		D	0.9	✓	-	-	✓	-	

There are now so many grasses available to the designer that a selection must be made from a specialist supplier or following a personal evaluation of growing examples. The list above is again a starting point for the designer.

* Due to the rootball containment within the small, pre-fabricated bioretention planters, the plants may not reach the usual height specified and will generally be restricted to 1.2 - 2 m mature height.



Figure 7 - Smoke Bush (Cotinus Coccinea).



Figure 8 - Heavenly Bamboo (Nandina Domestica Richmond).

B.2 Design parameters for soil filter medium

B.2.1 Saturated hydraulic conductivity

100mmhr⁻¹. This to be checked in-situ using the single ring test method or tested in bulk prior to delivery to ASTM F1815-06.

B.2.2 Porosity

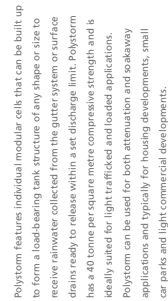
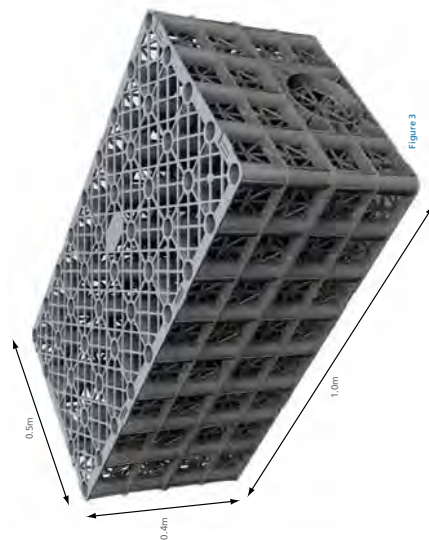
Should be > 30% when tested in accordance with BS1377-2:1990 (design porosity set lower at 25%).

B.2.3 Matrix

Indicative PSD or landscapers specification

Sieve size, mm	% passing	equivalent %	
6	100	fine gravel (2.0 - 6.0mm)	>10
2	90 - 100	coarse sand (0.6 - 2mm)	50 - 60
0.6	40 - 70	medium sand (0.2 - 0.6mm)	35 - 65
0.2	5 - 20	fine sand (0.063 - 0.2mm)	< 20
0.063	< 5	clay and silts (< 0.063mm)	< 5
Organic matter	3 - 5% (w/w)		
pH	5.5 - 8.5		
Salinity	EC < μ 3300 Scm ⁻¹		

Products 2.3

Table 4

Each unit includes 4 clips and 2 shear connectors. Please note that brick bond connector may be required at additional cost.

*** In weak clay soil conditions the maximum burial depth is reduced, please consult Polypipe WMS Technical Team on 01 509 615100

Table 3

Designed for use
in trafficked and
loaded applications
with a load bearing
capacity of:

40 tonnes

C.2 Protected orifice chamber

