

GREEN ROOFS



Green roofs are designed to collect and hold rainwater and other forms of precipitation, in turn this reduces the amount of water that will run into nearby drains. They are made of different layers, an impermeable layer, a growing medium and a drainage layer.



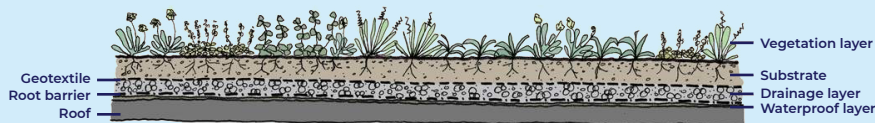
¹ Green Roof

ADVANTAGES

- Able to remove urban pollution that may be deposited by rainfall.
- Can be used in areas of high development/ urbanisation.
- Can be added onto buildings long after they have been built.
- They have ecological, aesthetic and amenity benefits to the surrounding area.
- They don't take up additional space.
- Help improve air quality.
- Help manage impacts of urban heat islands.
- Insulates buildings against temperature extremes.
- Can help reduce the expansion and contraction of roof membranes.
- Helps reduce noise pollution.

CONSIDERATIONS

- Higher cost than a conventional roof.
- Can't be applied to all roofs (e.g. steep roofs).
- If being added to an old building it may not be possible due to design floors (e.g. strength of roof).
- Vegetation needs to be maintained.
- Any subsequent damage to waterproof membrane likely to be more critical since water is encouraged to remain on the roof.



² Green Roof Schematic



BENEFITS



¹ Image collated from susdrain.org, 2022. N. Dunnett. <https://www.susdrain.org/delivering-suds/using-suds/suds-components/source-control/green-roofs.html>

² Green roof schematic and information collated from susdrain.org, 2022. <https://www.susdrain.org/delivering-suds/using-suds/suds-components/source-control/green-roofs.html>

RAINWATER HARVESTING¹



Rainwater from roofs and hard surfaces can be stored and used. If designed appropriately, the systems can also be used to reduce the rates and volumes of runoff. Rainwater harvesting can be done on a large scale from big building or on a smaller scale from individual houses.



ADVANTAGES

- If designed correctly large scale water butts can control stormwater runoff.
- Water butts reduce the pressure put on the surrounding drainage systems.

CONSIDERATIONS

- Large scale systems can be costly to design and implement.
- Large scale water butts can be unsightly.
- Potential requirement for pumping.
- Perceived risks to public health.



BENEFITS



¹ Information and images collated from susdrain.org, 2022. <https://www.susdrain.org/delivering-suds/using-suds/suds-components/source-control/rainwater-harvesting.html>

PERMEABLE PAVEMENTS / SURFACES¹

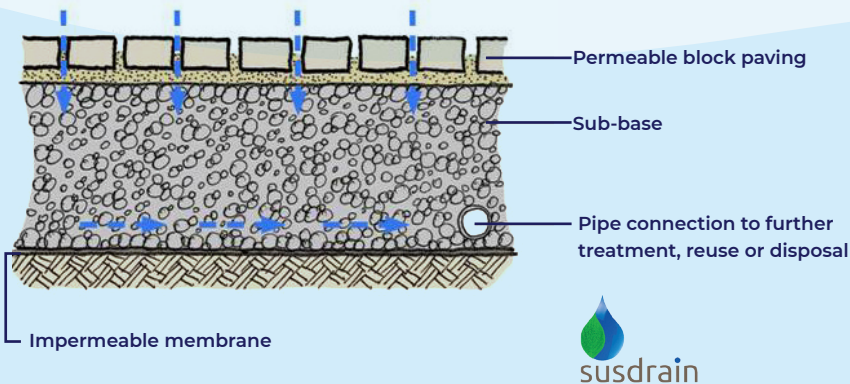


Permeable paving and surfaces can be made of porous (allows water to pass through) material or nonporous (doesn't allow water to pass through) blocks that are spaced out, allowing water to pass in-between them. These surfaces allow both pedestrians and vehicles to pass over them whilst allowing water to pass through.



ADVANTAGES

- Slows down the flow of water into drainage systems, therefore reducing the risk of downstream flooding.
- Reduces pollution runoff into the environment.
- Can be used in a variety of areas and high-density developments.
- Reduces the need for more drainage pipes to be installed – reducing disruption to community and lowers costs.
- No additional land taken.
- No need for manholes.
- Stops surface water pools and surface ice.
- Minimal maintenance needed.
- Flexible design to meet community needs.



CONSIDERATIONS

- Not suitable in areas where large amounts of sediment will be washed onto the surface.
- Current UK use only in low traffic areas with low weighted vehicles travelling less than 30mph.
- Weed growth and clogging may occur if no maintenance is carried out.

BENEFITS

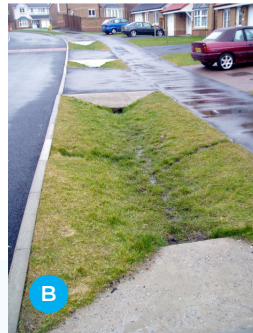


¹ Information and images collated from susdrain.org, 2022. <https://www.susdrain.org/delivering-suds/using-suds/suds-components/source-control/pervious-surfaces/pervious-surfaces-overview.html>

SWALES¹



A swale is designed to store and carry excess water through broad shallow channels. The channels can be vegetated (Image A) or covered with just grass (Image B). They can be designed to enhance infiltration into the ground where conditions allow.

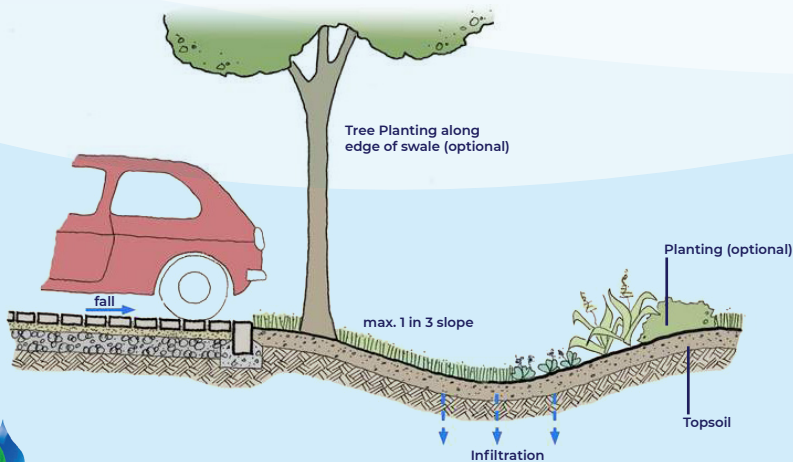


ADVANTAGES

- Aids the removal of urban pollution.
- Reduces runoff rates and volumes.
- They can also provide some storage and filtration.
- Easy to design and incorporate into landscaping.
- Low capital cost.
- Blockages and pollution easily visible so can be fixed promptly.

CONSIDERATIONS

- Unsuitable for steep areas of land.
- Risk of connecting pipes getting blocked by debris.



BENEFITS



CHANNELS AND RILLS¹



Channels (Image A) and rills (Image B) allow the flow of water within a hard-edged surface water channel. They can be empty or have plants within that both enhance their appearance but also help remove pollutants from the water.



ADVANTAGES

- Easy construction.
- Fits easily within the urban environment.
- Aids the removal of silt which can be beneficial before the water enters other SuDS.
- If plants are added they benefit local biodiversity.
- If plants are added they can be effective in pollution treatment.

CONSIDERATIONS

- Consideration needs to be given to where the channel can be crossed.
- Silt build up can occur due to incorrect planting.

BENEFITS



BIORETENTION AREAS¹



A bioretention area is a shallow depression in the landscape, it's usually under drained. The use of engineered soil, vegetation enhancement and filtration are used to reduce water runoff and remove pollutants from the water.



ADVANTAGES

- Effective in the removal of pollutants.
- Reduces the runoff of water therefore reduces the risk of flooding.
- Can be tailored to fit a variety of areas.
- Can be added to developments at a later date.
- With the correct engineering in place, they are well suited for impermeable (won't allow water through) areas.
- Can be visually appealing.

CONSIDERATIONS

- Requires landscaping and maintenance.
- Without maintenance and management, they can be susceptible to clogging.
- Not suitable in steep areas.

BENEFITS



FILTER STRIPS¹



Filter strips are gently sloped vegetated strips of land. They reduce the speed at which water reaches the nearest watercourse or drainage system, they can also allow the infiltration of water into the ground. They are often found between urban developments and a close by watercourse, the aim is to slow the time it takes for the water to get from where it lands to the water course.



ADVANTAGES

- Easy to construct.
- Low construction costs.
- Effective pre-treatment.
- Easily designed and additional landscaping can be used to make the strip visually appealing.
- Well suited to be used adjacent to large areas of impermeable surfaces.

CONSIDERATIONS

- Unsuitable for areas where there are risks of groundwater contamination unless engineering is used to stop infiltration.
- Cannot significantly reduce high flows during extreme events.
- Unsuitable for steep slope areas.

BENEFITS



¹ Information and image collated from susdrain.org, 2022. <https://www.susdrain.org/delivering-suds/using-suds/suds-components/filtration/filter-strips.html>

RAIN GARDEN¹



Rain gardens are designed to provide areas for infiltration often from roofs or other 'clean' surface water collection points. Pipes from roofs etc. are disconnected from the drainage system and redirected to the rain garden. The garden itself is a small depression in the ground and is often on a small scale on private property. The rain garden is planted with plant species native to the area and that can also withstand occasional flooding.

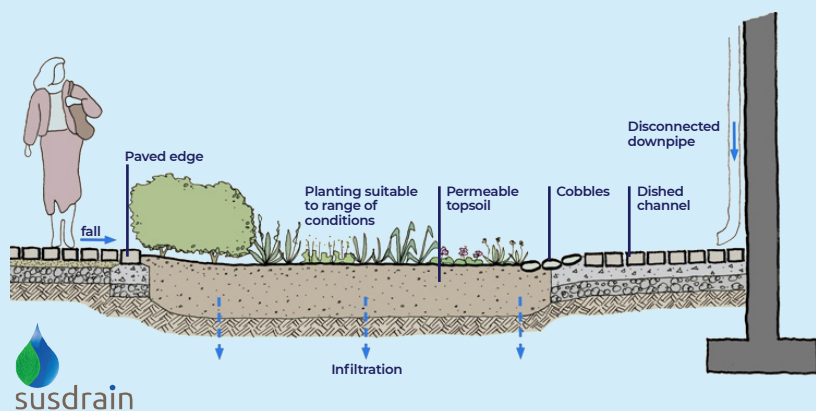


ADVANTAGES

- Small, does not require much land.
- Can be made visually appealing.
- Reduces the volume of water entering the drainage system.
- Can be designed to sit within impermeable areas.
- Minimal / easy maintenance.

CONSIDERATIONS

- Small scale so they don't have a large impact on reducing overall water volume reaching the system.
- Landscaping and maintenance required
- Clogging of the system if the surrounding area is not managed effectively.
- Unsuitable for steep slope areas.



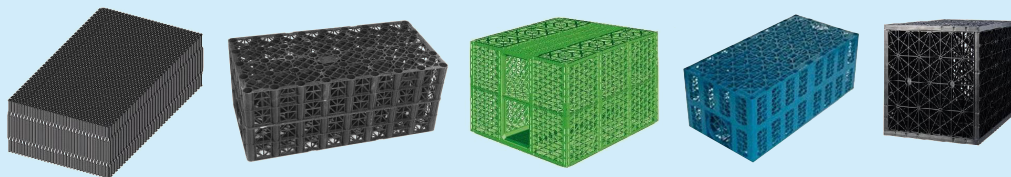
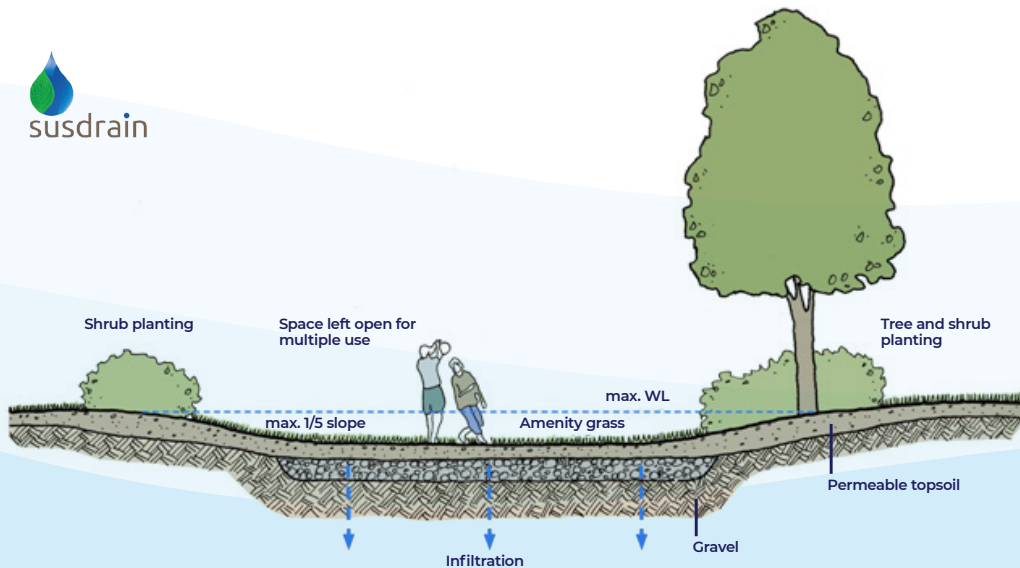
BENEFITS



SOAKAWAYS¹



Soakaways are very common systems in the UK. They store and allow efficient infiltration of water from a house or development into the surrounding soil. A soakaway allows water to pass through its surface to a gravel sub-base below, the gravel will then temporarily hold the water before it then soaks into the surrounding soil. A soakaway is usually a large excavation (hole) that's filled with rubble, polyethylene rings, pre-cast concrete or storage structures that are filled with gravel.



ADVANTAGES

- They don't require a lot of land.
- Groundwater recharge.
- Effective in slowing down both the volume and rate of water reaching drainage systems and water courses.
- Easy to construct.
- Minimal maintenance.

CONSIDERATIONS

- Can only be used in well-draining soils (field investigation required before build to ensure this).
- Must be carefully designed so they don't affect existing drainage patterns / pathways.
- Increased risk of groundwater pollution.
- Uncertainty of their long-term performance.

BENEFITS



RETENTION PONDS¹



Retention ponds hold water naturally and aid water treatment. During storm events the ponds can retain large volumes of water. Whilst the water is being held pollutants are removed through the natural processes of sedimentation and through plant uptake.



ADVANTAGES

- Have the capacity to deal with large storm events.
- good removal of urban pollutants.
- The ponds can be lined if the groundwater below is vulnerable.
- Often visually appealing.
- Positive impact on the area's biodiversity.
- Could add value to surrounding properties.

CONSIDERATIONS

- Volume of water runoff is not reduced.
- Without regular inflow anaerobic conditions may occur.
- Relatively large amount of land needed.
- Not suitable for steep slopes.
- Risk of invasive species colonisation, which would increase maintenance needed.
- Health and safety risks need to be considered.

BENEFITS



DETENTION BASIN¹



Detention basins are areas of surface storage that provide flow control, they are usually large relatively flat areas of grassland (Image A), they can also be planted with various types of vegetation (Image B). They remain dry most of the year, however during high rainfall events they collect and hold water.



ADVANTAGES

- Simple to design and construct.
- Easily maintained.
- Can be lined to protect underground water.
- Potential for dual land use opportunities.
- Can improve water quality through the settlement of sediments and the removal of pollutants through biological activity.



CONSIDERATIONS

- Depth of basin is limited by the systems inlets and outlets.
- Does not significantly reduce runoff volume.



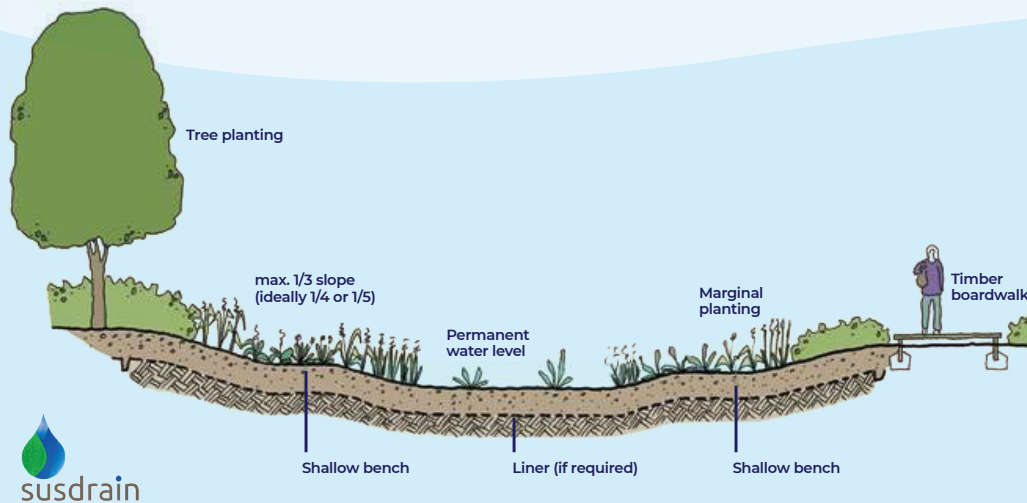
BENEFITS



¹ Information and images collated from susdrain.org, 2022. https://www.susdrain.org/delivering-suds/using-suds/suds-components/retention_and_detention/Detention_basins.html

WETLANDS¹

Wetlands are made of a variety of components including shallow ponds, marshland and a variety of vegetation. Wetlands hold water for long periods of time, which allows sedimentation and the removal of urban pollutants.



ADVANTAGES

- Effective in removing urban pollutants.
- The ponds can be lined if the groundwater below is vulnerable.
- Visually appealing.
- Positive impact on the area's biodiversity.
- Could add value to surrounding properties.

CONSIDERATIONS

- Large amount of land taken up.
- Only small reduction in run off volume.
- Unsuitable for steep sloped areas.
- Risk of invasive species colonisation, which would increase maintenance needed.
- Risk of high sediment inflows reducing performance.



BENEFITS



BENEFITS KEY



Manage local
flood risk



Manage water
quality



Enhance
biodiversity



Provide amenity/
community opportunities



Provides educational
opportunities



Multifunctional



Adaptable