

Charter Square sustainable redevelopment



SuDS used

- *Blue roof systems,*
- *bio-retention with enhanced storage,*
- *Terraced bio-retention gardens,*
- *Green Roofs*
- *linear bio-swales*
- *On street bio-retention areas with check dam orifice controls*

Benefits

This is all about Water becoming an asset in our new city centre landscapes while providing education to the public that there are alternative options for sustainable water management

Mimicking nature is our overriding theme— keeping water on or near surface in rain gardens and green streets, avoids pushing water underground through conventional gully/piped systems this creates a win, win for the spaces and the operation and maintenance of these spaces.

The key benefits to the city are:

- *Flood mitigation. Flow reduction and capture of surface water in a simplified manner*
- *Controlled runoff rates set through the planning process*
- *Treatment of all urban surfaces including highways where possible*
- *Improved water quality through treatment of highways and containment of micro plastics in the bio-swales soil matrix*
- *Increased urban biodiversity*
- *Health and wellbeing benefits*
- *Using water for passive plant irrigation*
- *Playing with water as a dynamic feature in the landscape through capture, release and capture*
- *Reduced embodied carbon through established root development and carbon sequestration of wooded tissue growth.*
- *City Cooling – helping create a healthy urban climate*
- *‘No water’ drought tolerant public planting with low maintenance objectives*
- *Improved air quality, reduced noise pollution and general calming of city centre spaces*
- *Creating a high quality setting for development*
- *Reclaiming large areas of inner city road space for city greening and pedestrian use*

1. Location

Charter square, Charter Row, Sheffield. S1

2. Description

This is a truly multi-functional project, aiming to increase the efficiency of the highway network whilst creating a green healthy corridor and setting for sustainable movement, urban biodiversity and people, We want these projects to become show cases for what urban streets and spaces can become from protecting pedestrians from air pollution through multi-layered planting, achieving

urban cooling through increased tree planting, treating contaminated water before it reaches our rivers together with the containment of potential micro plastics and promoting health and wellbeing for us. But, in addition, a key aspect is that this inspirational multifunctional project would become a stimulus and catalyst for further inward investment in the area – a real economic benefit too.

The project utilises many new and innovative sustainable practices and solutions include that embrace the design and use of green roofs, sustainable urban drainage, local natural materials, local suppliers, recycled soils, reduced maintenance methods, trialling planting lists that are adapted to dry urban conditions (looking to the future with global warming), increased urban biodiversity and improved local air quality along these transport routes.



Image from 2014 showing the traditional highway dominated spaces and complete lack of pedestrian movement.

3. Main SuDS components used

The biggest innovation has been the bringing together of not just a one size fits all approach but looking at multiply green SuDS solutions that together form a multifunctional, multi-beneficial landscape within a city centre location, this looks to provide a holistic approach to sustainable water management within a high quality environment.

The key Suds components used are:

- Blue roof system of the main building covering 2400m²
- Green roof on the pavilion building 450m² with a 180m² porous paved blue roof terrace
- Bio retention areas on a 845m² podium deck that is combined with enhanced cellular storage beneath the paving.

- Terraced bio retention gardens that step down a 4m level change allowing capture and release through outfalls to substituent lower levels.
- Linear bio-swales running along highways and cycle ways collect water at source
- Bio retention areas in street together with check dam controls

4. Specific project details

The overriding concept for the water management is to control the water at its source that's either roofs or bio-swale interventions immediately next to impervious surfaces. All the SuDS planting areas are made up of highly aerated reclaimed gravel soils. These are formed using engineered soils of 100% recycled materials using mainly locally sourced crushed sandstone quarry waste (20mm aggregate down to sand particles), small quantities of locally composted green waste and 10% of a natural silty loam reclaimed from sugar beet washings.

Global warming temperature increases and longer spells of drought mean that species selection for urban SuDS planting needs to have a wide tolerance to environmental changes. We are seeing a need for species to cope more with drought and occasional inundation rather than the more traditional use of moisture loving plants.

The planting is very much a Sheffield approach developed in collaboration with the University of Sheffield it looks to use a structural multi layered approach which provides benefits throughout the vertical layers trees for height, shade and framing, shrubs for accent and structure, meadow canopy layers for flowing sinuous form, emergent species for impact, bulbs for seasonal variation, grasses for texture and movement.

Inlet slot designs continue to be a design development for these projects with the goal to make them as efficient as possible during both day to day rainfall and the capture of the important larger storm events

Many of our linear features take the form of shallow swales or rain gardens running alongside the any impervious surfaces including roads, cycle ways and hard paved pedestrian areas. This allows the water to remain on the surface and is surface controlled using lintel dams that contain the water reduces lateral surface flow and allows the water to infiltrate into the granular substrate at an even rate.

Treatment of water is through the diversely planted aerated gravel soils, any water remaining at the end of these systems is discharged to a combined sewer as no water courses are nearby.

For the buildings this has required detailed work on creating a blue roof storage over the expanse of the roof area to a depth of 100mm. The orifice-controlled outfalls restrict the flow off the roof to what equates to a 30% reduction in the total building area. Smaller buildings have extensive green roofs systems to further reduce and slow flow rates.

5. Maintenance & operation

Generally, this is a passive design which has well protected entry points to any storage cells which require little or no regular maintenance. The only routine element of maintenance comes from the biological elements namely the planting. This involves a once a year cut back and removal of

vegetation and tidy up during winter months (Feb). The scheme was adopted as part of the formal drainage adoption process in negotiation with highways and the highway drainage team.

6. Monitoring and evaluation

This involves continued detailed observation on site looking at the efficiency of various inlet slot designs tracking establishment of species selection and the infiltration rates of the various SuDS details used in this city centre public location. This is a commitment to an ongoing element of technical review for the design team.

As for the wider benefits this continues to be a genuinely holistic approach, involving wider partnerships with the Universities and green businesses, and brings together different sections within the council. This project forms part of a much wider series of schemes focussed on city resilience, together with a healthy streets approach. We are looking to research to give us the answers and currently there are PhD's looking at urban cooling, health and wellbeing of users, contaminate capture and the hydrological aspects to the SuDS approach. We have seen a huge number of requests from local authorities, private practice, foreign visits and academic institutions for further information and knowledge of these ideas which we are trialling in this very public arena.

7. Benefits and achievements

This is a truly multi-functional project, aiming to increase the efficiency of the highway network whilst creating a green healthy corridor for urban biodiversity and people, We want these projects to become show cases for what urban streets and space can become from protecting pedestrians from air pollution through multi-layered planting, achieving urban cooling through increased tree planting, treating contaminated water, containment of potential micro plastics in the bio swales and promoting health and wellbeing. Our biggest success has been that people are wanting to use these spaces and are talking about and celebrating the achievements both locally together with the wider interest.

8. Lessons learnt

We continue working on evaluation and monitoring, this is starting to inform detailed design elements going forward with new projects in the future.

We have seen a huge number of requests from local authorities, private practice, foreign visits and academic institutions for further information and knowledge on these developing design solutions and concepts.

Many of the design features were still new to highway designers and contractors, so more time had to be working through these details on site to make sure the correct solutions and approach were achieved.

All of the SuDS approaches in Charter Square and Cambridge Street are lined systems, due to ground conditions and outfall constraints that have final controlled outfalls of any remaining flow to a combined sewer. Unfortunately this is not a preferred design solution that the team would choose as it just reduces the potential for further loss from the system through infiltration. This is because

currently our water authority will only accept water to the sewer from these closed systems in case we drain ground water. We will continue to work with our water authority to try and remove or at least reduce the need for this plastic lined element of the SuDS design.

9. Interaction with local authority

The project has been designed and lead by the Local Authority together with design consultants Arup (Sheffield) in conjunction with the council’s drainage team and SAB officer. Arup designed and led of the blue roof concept and detailed design. Some elements of the scheme have been subject to specific runoff rate requirements as part of the planning process.

10. Project details

Construction completed:

Started 2017 phased completion, overall finish 2019. SuDS was a combined design and build within the main contract

Cost: £7.2m overall costs. This includes or public realm and highways works. As SuDS is designed to be integral to the design it’s difficult to separate all associated suds costs but as an estimate approx. 10% of the costs is attributable to SuDS features

Extent: 9600m² / Ha of entire scheme not including building areas.

11. Project team

Funders	<ul style="list-style-type: none"> Sheffield City Council Sheffield City Region Infrastructure fund (SCRIF) 	
Clients	<ul style="list-style-type: none"> Sheffield City Council 	
Designers	<ul style="list-style-type: none"> Sheffield City Council Design Lead, Arup (Sheffield) & ABG Ltd for blue roof design 	
Contractors	<ul style="list-style-type: none"> BAM Construction ltd Phase 2 Eurovia Contracting Phase 1 & enabling 	

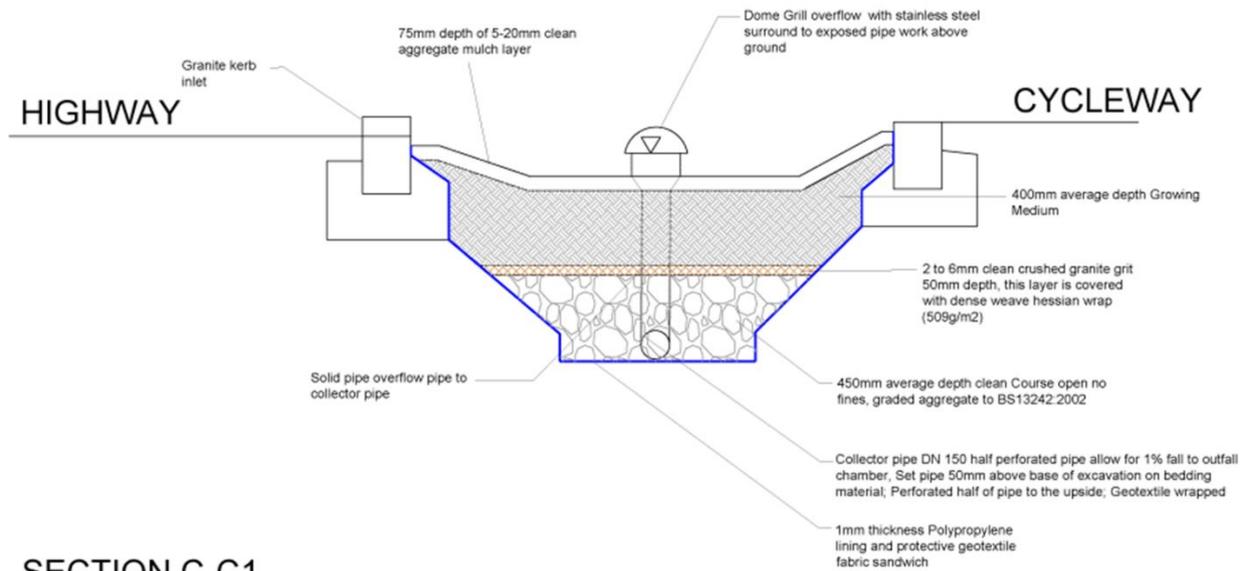


Bio-swailes gardens with enhanced storage beneath paving. This is a podium construction with 550mm of total depth including storage beneath. The planting acts as a bio-filtration inlet protecting the storage cells beneath.



Linear source control Bio-swales gardens running along the highway, cycleway and receiving all hard paved surfaces with. (see below construction detail). The image shows the potential calming and mental restorative effects that this style of planting can provide. All planting provides SuDS benefits.

HIGHWAY SUDS



SECTION C-C1
SCALE 1:20

The detail shows the lower storage area which was modified to provide a sump for water storage available to the planting. In reality the collector pipe is set higher to allow water to remain post drawdown and the separated layers are divided using dense weave Hessian to allow root penetration through the layers to create the long term flow paths. This is something we are continuing to research further in the Laboratory in conjunction with The University of Sheffield Engineering department.



Load bearing lintel surface flow check dams in the Linear Bio-swales pre planting 2018



A new setting for regeneration. Up to 2017 the area formed a key part of the highway network in the city centre, predominantly a 1960's dual carriageway sunken roundabout much of the extensive highway network was no longer required and provide a great opportunity to re-think the areas possibilities. The design now provides a framework for a new cinema, food and beverage offers and integrates the retails and commercial offers into a seamless city centre space. All planting provide SuDS functions



Linear Bio-swales with an Integrated multi-functional design approach looks to maximise the benefits whether its SuDS, active travel, setting for regeneration, or climate change resilience



Terraced Bio-retention gardens. 4m of level difference over underground loading bays provides an opportunity to play and enhance the water storage and treatment of surface waters as we collect at higher levels, outfall to lower levels and continue to recollect through infiltration at the lowest areas. These plantings are part of the active water management design of the scheme



Terraced bio-retention gardens. This images again show the drama that is part of our integrated multi-beneficial approach to SuDS design