# Greener Grangetown, Cardiff

## SuDS used

- *Rain Gardens*
- *Tree pits*
- *Permeable paving*
- *Combined kerb drainage and channel drainage*

## Benefits

- *4.4 Ha surface water removal from combined sewer*
- *127 new trees*
- *1,700m2 of new green space*
- *108 Rain Gardens*
- *14 safer road junctions for inclusive mobility*
- *550m new Bicycle Street (priority for cyclists) along the Taff Trail*
- *550m new footway for pedestrians along Taff Trail*
- *Improved public realm with new street furniture & surfacing*
- *Estimated value of the wider benefits of the project of over £8.4 million*

## 1. Location

Grangetown is located close to Cardiff city centre on the western side of the River Taff.

**Address:** Grangetown, Cardiff, CF11 7AE

## 2. Description

The project site covers 12 Victorian streets and 550 properties. Prior to the scheme, surface water entered the combined sewer network and was then pumped a total of 8 miles before being treated and discharged into the Severn Estuary. The concept for Greener Grangetown developed from the original aim of removing surface water that entered Dŵr Cymru Welsh Water's combined sewer network. This would reduce operational costs for the company and provide resilience against the impacts of climate change and urbanisation by providing extra capacity in the combined sewer system.


Figure 1 - Pre-construction unsustainable drainage

A delivery partnership of Cardiff Council, Dŵr Cymru Welsh Water and Natural Resources Wales allowed the wider benefits of the SuDS project to be identified and maximised. A feasibility study undertaken in 2013 by Arup identified that the public realm, environment, and transport infrastructure could all be improved as part of the project, with a calculated annual benefit of £381,760 using various cost databases available at the time. The feasibility study provided a business case for the project and helped secure funding by identifying and monetising the benefit to each of the partnership organisations.

## 3. Main SuDS components used

Innovative SuDS technology, in the form of 108 raingardens containing native trees and plants, targets improved water quality achieving both physical and biological treatment of surface water runoff before being discharged into the nearby River Taff via a new pipe network (this is continuously monitored). The CIRIA SuDS Manual was introduced part way through the design development. The site assessed as medium within the pollution hazard indices, with most of the site residential. The rain gardens and tree pits act as bioretention systems that can mitigate against this indices. Research is also underway to understand water quality benefits of the SuDS components, including research led by Dŵr Cymru Welsh Water into the effectiveness of the rain gardens and tree pits in removing microplastics.


Figure 2 – Project extent showing new and improved green space

## 4. How it works

Greener Grangetown removes an average of 40,000m$^3$ of surface runoff from the combined sewer system annually. Rain gardens are engineered SuDS components that cleanse the rainwater through physical and biological processes. After filtering through the soil media, water is then collected in

perforated sub-surface perforated drainage pipes within a clean stone material at the base of the rain gardens, which are lined and water is then conveyed to the river via 4 new outfalls.

Grangetown is located on reclaimed former estuarine land. It was found through geotechnical investigations that infiltration into the ground was not feasible in Grangetown due to the presence of contaminated made ground and impermiable material. All of the SuDS features are therefor lined with an impermiable liner, which also protects nearby buildings from the impacvts of tree roots.

Figure 3 – Artistic impression of section through rain garden showing perforated pipe at the base

Drainage is kept shallow wherever possible using recycled plastic composite kerb drainage and channel drainage units to convey flows from the busy Corporation Road into rain gardens located at existing dead ends of 7 of the streets. These create features within an improved public realm by adding green space to the area.

Figure 4 – Rain garden within regenerated public realm. Kerb and channel drainage keep water at the surface

Figure 5 - **School planting event**

Community engagement was at the heart of Greener Grangetown. Having the community involvement during option selection and the design process and showing that their views were being listened to has helped achieve a key project objective in improving community pride. The community is diverse with 48 different languages spoken at a local primary school. Therefore different ways of communicating ideas such as school visits, indoor and outdoor community events used visualisations and drawings to help convey ideas and inform decisions. Engagement continued throughout construction with weekly drop-in sessions, planting events and updates through leaflets and social media. Key concerns from the community related to parking availability and the presence of litter in streets, which were then considered as part of the scheme. This resulted in increased residential parking allowances and more litter bins.

## Water quantity

The hydraulic design was undertaken prior to new SuDS legislation coming into effect in Wales (Schedule 3 of the Flood and Water Management Act 2007, enacted in Wales 2019). Non-mandatory standards were however in place. The design is based on Sewers for Adoption 7$^{th}$ Edition standards of 1 in 30-year standard of protection including a 30% allowance for climate change. No property flooding is predicted in a 1 in 100-year event.

Exceedance flow paths are challenging for retrofit sites as site levels cannot be altered drastically due to existing buildings and infrastructure. The alleyways to the side and back of properties were not included in the surface water removal to retain some self-cleansing of the combined brick sewers. The existing drainage for these alleyways also forms the exceedance flow path for the site to protect against property flooding.

The level of the receiving watercourse is managed by Cardiff Bay Barrage which was constructed in 2001. The watercourse is no longer dictated by the tide and the level rarely deviates from a level of 4.5mAOD. This means flood risk is significantly reduced, and there was not requirement for the rate of discharge to the watercourse to be significantly limited. This meant large storage volumes were not required to meet greenfield runoff rates, and the design could instead focus on water quality, amenity and biodiversity.

Due to impermeable ground conditions, and groundwater control zone and contaminants within the made ground soakaways were not feasible.

## Water quality

Runoff is managed at source using bioretention rain gardens. These are typically located at existing gully locations to avoid changing site levels and thresholds. The rain gardens are sized with the aim of intercepting a minimum of 5mm of runoff volume to target the 'first flush' of highway contaminants. Prior to entering the rain gardens siltation is encouraged at inlets using stone forebays or existing gully arrangements.

Additional storage is available in most instances within and above the soil, and when the capacity of the storage is full overflow gullies convey exceedance into the new pipe network. The gullies provide a feature that is familiar to drainage maintenance crews, so the catchpit arrangement can be maintained easily by operatives.

The soil used within the rain gardens was engineered to provide a balance of drainage and plant nutrient properties. The specification was developed by Arup, GreenBlue Urban (tree cell suppliers), Natural Resources Wales and soil scientists. Soil cell systems were used to maximise soil volume for trees and provide water management benefits while minimising the impact on parking. The cells take highway loading above (550Kpa) while providing a loose free draining soil within them. The tree pits provide up to 12m$^3$ of engineered soil per tree.


Figure 6 – Rain garden with below ground tree root cells during construction

## Biodiversity

A multi-discipline design team included scheme partners. Arup's landscape architect worked closely with NRW and tree officers at Cardiff Council to establish a planting pallet that provides a range of ecological benefits. This includes native tree species, a mixture of evergreen and decisions plants, and pollinators. All planting was sourced from the UK.

The planting considers both drought and flooded conditions. A matrix analysis was undertaken by the Arup Landscape Architect to ensure planting selection achieved a mixture of desired outcomes. All planting and trees were specified and semi-mature to achieve a quicker ecological and visual impact. The design team worked closely with NRW and the Councils Parks team to ensure trees and shrubs were suitable.

The design was engineered around 100 existing trees on the site. The desire was to add to the canopy cover, rather than replace it. Two existing trees that did require removal as part of the project were re-planted in an adjacent green space.

## Amenity

A key example of how amenity was considered in the design is the new cycling provisions. A bicycle street was designed along 555m of the Taff Trail, a concept previously used on precedent projects in the Netherlands. A 900 millimetre central rumble strip separates a two-way system with a maximum of 2 metres per lane. The strip makes drivers wary of the lack of space and thus slow down making

the stretch much safer for all. The riverside footpath has been widened and resurfaced. Locating rain gardens at junctions also improves visibility, making it safer for pedestrians, cyclists and vehicles.

Figure 7 - Bicycle street, safer junction and widened pedestrian footpath along the Taff Trail

The benefits of the project were targeted during the feasibility stage. A Sustainable Project Appraisal Routine (SPeAR) assessment was carried out to identify where scope for improvement, including aspects such as outdoor experience, community pride and encouraging sustainable behaviours of the community.

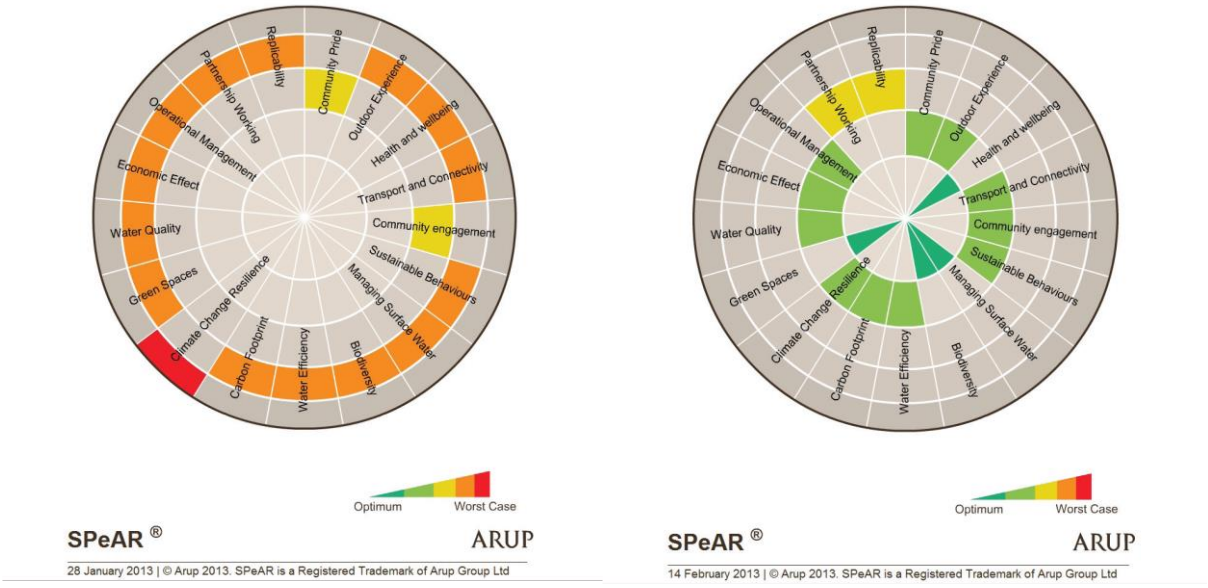


Figure 8 – **SPeAR assessment carried out during feasibility stage to establish magnitude of multiple benefits**

### Wider benefit assessment

In September 2019 an assessment of the wider benefits of the Greener Grangetown project was undertaken, this was performed using a selection of available tools, including CIRIA's Benefit Estimation Tool (B£ST). It considered a variety of aspects including; health, recreation, air quality improvements, carbon sequestration, amenity enhancements. This assessment arrived at an estimated benefit of over £8.4 million over a 30 year period from 2015 to 2045. This value includes a reduction based on uncertainty around wider benefits and does not include; the increase in water quality entering the river Taff, the value of a reduction in crime due to the enhancement of the area, the impact of the reduction in vehicle traffic and the benefits of an increase in cycling and walking in the area. As these are harder to measure without further studies or surveys which have not, to date, been undertaken.

This suggests a maximum payback period of around 12 and a half years for the project and although it must be said that there are inherently difficulties in quantifying the wider benefits, this project delivers excellent value for money.

## 5. Specific project details

N/A – within above

## 6. Maintenance & operation

Planting selection considered minimising maintenance requirements wherever possible. The construction contract period included maintenance for two growing seasons to ensure plants established.

The design team produced maintenance schedules for the contract period of 18 months and for long term adoption. A commuted sum was considered as part of funding to cover the cost of maintenance for the long term, with the soft landscaping maintenance being undertaken by Cardiff Council's parks team following the contract period. Cardiff Council Parks and Waste Collection Departments were consulted and involved in the design process to detail the current and future maintenance requirements and various other detailings, including the location of litter bins.

## 7. Monitoring and evaluation

The project provides excellent value for money due to its collaborative nature. Funding has been pooled from organisations and combining this investment has allowed multiple-benefits to be achieved. This includes 21st century water management, regeneration, and a transformaiton of Wales' busiest overall cycle route (Taff Trail No 8 etc.).

The project has performed exceptionally well in its first year during storm events such as storm Callum in October 2018, and during one of the hottest summers on record in 2018. Early indications show energy used by Marl pumping station, which receives flows from Grangetown, has significantly

reduced compared with the same period in 2016 (prior to construction), despite there being more than double the rainfall. This improvement demonstrates efficiency in reduced operational costs, environmental benefit in minimising associated carbon emissions, and future-proofing of the sewage network by freeing up capacity to deal with the effects of climate change.

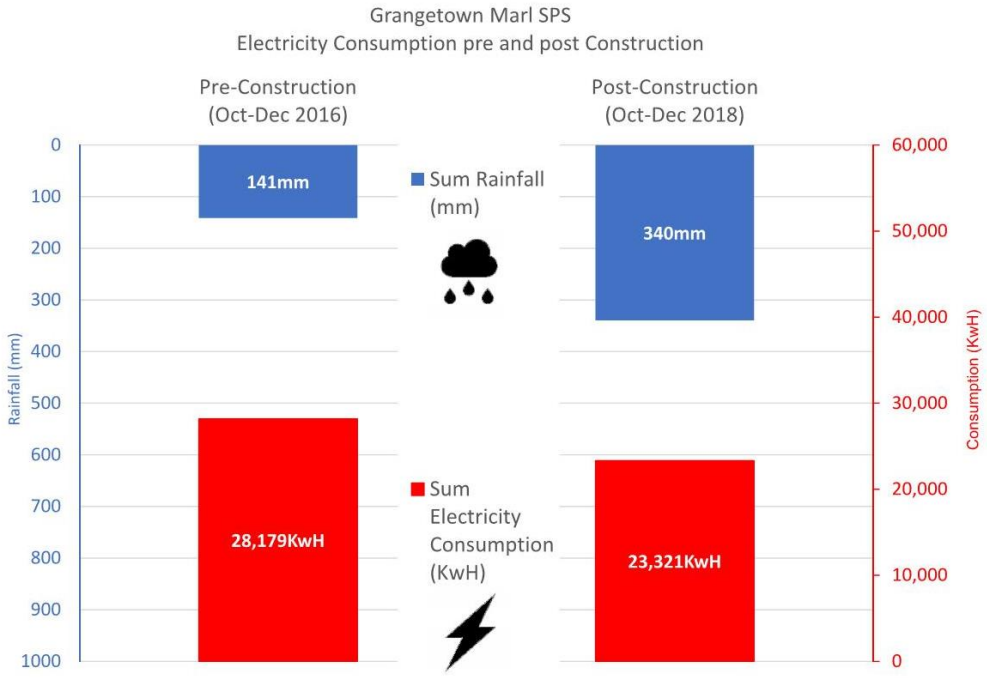


Figure 9 – **Analysis of Rainfall in Cardiff and electricity consumption at Grangetown Marl SPS pre and post construction**

Research is being undertaken by Dŵr Cymru Welsh Water to analyse water quality improvements, with specific focus on microplastic removal. Cardiff University are also planning to quantify the benefits to water quality and inform future good practice. Natural Resources Wales continue routine water quality sampling of the River Taff, and water quality to date has not changed since the scheme was commissioned despite the additional four new highway drainage outfalls constructed as part of the project.

Cardiff University School of Medicine is researching the health and wellbeing benefits to the community of an improved local environment. This has involved pre and post construction surveys, with results of this research due to be published in 2020.

Resident of Taff Embankment, Grangetown:

*"The project has made a huge, positive impact on Grangetown. My street is greener, brighter, calmer and the noise from traffic has reduced significantly. It's hard to believe I live so close to the city centre as it's so peaceful and pretty here now"*

## 8. Benefits and achievements

N/A – within above section

# 9. Lessons to be learnt

The delivery of Greener Grangetown has provided lessons to be learned for future retrofit and new-build SuDS projects.

## 9.1. SuDS can be delivered anywhere

A key lesson demonstrated by this project is that SuDS can still be delivered in incredibly challenging environments. Grangetown is heavily constrained by utilities (including a brick egg sewer network), free space, topography (flat), ground conditions and existing infrastructure ( trees, buildings, bus stops, flood walls). Parking was also a key constraint considered during the design and construction of the project. Solutions were engineered to overcome these constraints.

## 9.2. Materials and products

There are currently limited 'off the shelf' products to form rain garden features. This includes products such as edgings to rain gardens in the highway, which need different properties and dimensions compared to British standard kerbs. A key property is increased depth to allow structural haunching to be installed on the planted side of the garden without it becoming unsightly. On this project granite kerbs were used as they could be sourced with the desired properties, however this led to difficulties during the construction phase. The material has long lead times and is difficult to work with.

As part of the highways design bollards were required within rain gardens. A challenge on future projects is the engineering detail of bollards located in soft landscaping soil media. A bollard construction detail typically relies on a concrete foundation within compacted ground.

## 9.3. Pre-construction phase and Contract type

Early client, contractor and designer involvement in these types of projects is critical. While this was sought prior to construction, a longer pre-construction phase with Early Contractor Involvement is desirable. The type of contract used (New Engineering Contract 3 Option B) was also challenging financially, as the retrofit nature of the project meant additions and variations to designs were often required.

Having a design team on hand during the construction phase, and the collaborative nature of all parties, helped overcome challenges posed during construction.

## 9.4. Community engagement and communication

Engagement with the community is critical for retrofit projects. A key indicator of the success of the project is how the community feels before, during and after construction. This included participation from the community over a three-year period leading up to the construction of the project.

The design phase involved the residents in the design of their streets. Providing them with choice was a great tool for engagement and secured buy-in. This was continued during construction.

## 10. Interaction with local authority

The designs developed with input from various teams within Cardiff Council. This included drainage, parks, highways, and waste management.

Other third parties were also engaged during the design process, including South Wales Police regarding security and anti-social behaviour and Sustrans who provided feedback on cycleway improvement options.

## 11. Project details

**Construction started:** 9 January 2017

**Construction completed:** 6th July 2018

**Cost:** £3 m

**Extent:** 4.4 Ha of surface water removal. 12 Ha total site area including 12 residential streets.

**Project team:**

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|---|---|
| Client and Funders | • Cardiff City Council<br>• Dŵr Cymru Welsh Water<br>• Natural Resources Wales<br>• Landfill Communities Fund |
| Designers | • Arup |
| Contractors | • ERH Communications and Civil Engineering – Principal Contractor<br>• Gerald Davies Landscape and Maintenance Services – Landscape |
| Other | • Faithful and Gould - ECC Project Management |