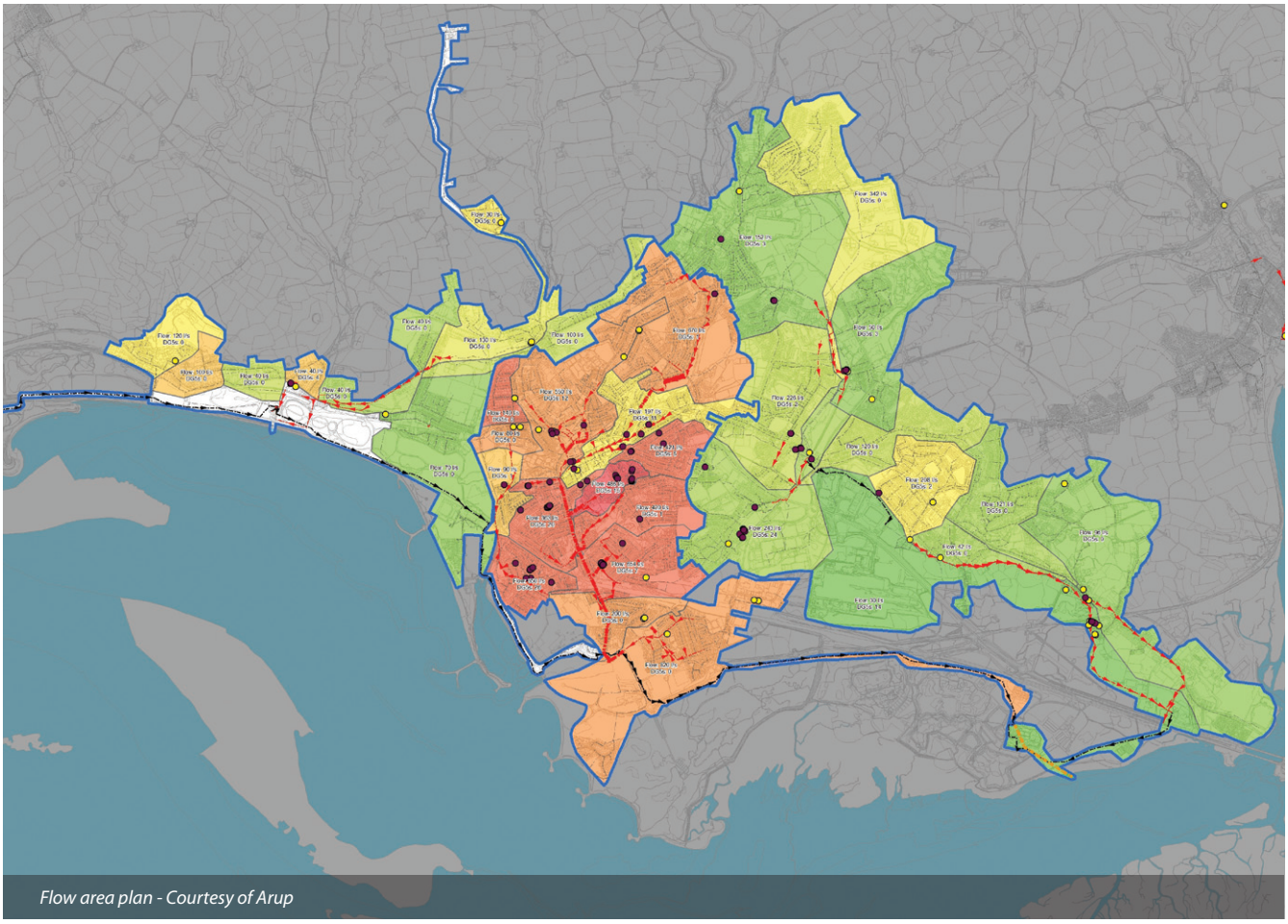
Burry Inlet Investigations

DCWW uses retrofit SuDS to reduce CSO spills into a protected shellfish water with a 75% cost saving and 86% carbon saving over traditional methods

by Louise Ellis MEng Hons (Oxon)

Surface water inflow and infiltration into the combined sewerage networks in the Llanelli and Gowerton catchments in South Wales has led to excessive spills from combined sewer overflows into the Burry Inlet, a protected shellfish water, resulting in the threat of European Commission Infraction Proceedings. Welsh Water, in collaboration with Morgan Sindall and Arup, undertook a complete package of catchment-wide hydraulic modelling and detailed solution design, which led to a range of targeted, sustainable solutions to deliver reduced CSO spills for a projected £145m compared to an estimated £600m for the traditional solution of 432,280m^3 storage.



Flow area plan - Courtesy of Arup

Project drivers

The primary catchment driver for this project is for all combined sewer overflows (CSOs) to be in compliance with the Shellfish Waters Directive. Environment Agency Wales have set a standard of 10 spills per annum for each CSO averaged over 10 years, whether the impact is direct or indirect and significant. The spills are aggregated over the shellfish water.

There were two further drivers: reducing flooding due to hydraulic overload of the combined network and lifting restrictions on development due to lack of capacity in the sewerage network.

Understanding the catchment

Gaining a comprehensive understanding of the catchments was central to this project. The strategy adopted by Welsh Water to meet the requirements of the Shellfish Waters Directive, involved hydraulic modelling and coastal dispersion modelling.

Key Project Participants	
Role	*Company*
Client	Dŵr Cymru Welsh Water
Design Engineer and Hydraulic Modeller	Arup
Coastal Modeller	Intertek-Metoc
Contractor	Morgan Sindall
Programme	
Project Phase	*Dates*
Model Build and Verification	May 2010 – April 2011
Solution Development	April 2011 – September 2011
Design and Build Phase 1 Largest Impact Solutions	September 2011 – March 2015

The hydraulic model produced is one of the largest and most detailed hydraulic models in the UK, a 7,000 node Infoworks model covering 2,493ha with a population of 120,721 people , to assess sewage spill frequency, duration and volume at all assets in the catchments. The sewer network data including dimensions and levels were obtained from Welsh Water's GIS database and supplemented with surveys of 390 (No.) manholes and all CSOs and sewage pumping stations; 66 (No.) in total.

The model was verified for dry weather and storm flow using 308 (No.) flow monitors and 60 (No.) rain gauges and Welsh Water's historical records of flooding incidents and the spill data over the period 2000 to 2010.

The outputs of spill duration, volume and frequency from the hydraulic model were transferred to the coastal dispersion model to assess the significance of impact for each asset.

Glenalla St bioretention planter - Before
Courtesy of Arup

Glenalla St bioretention planter – After (Artist impression)
Courtesy of Arup

Glevering St bioretention planter - Before
Courtesy of Arup

Glevering St bioretention planter - After (Artist impression)
Courtesy of Arup

Targeting interventions and investment

The challenge for Llanelli and Gowerton has been to decide where to target interventions and investment in the catchments. The following tools were used:

- ***Catchment schematic***
  The catchment schematic shows how key assets are laid out in the network, including all CSOs, pumping stations, gravity and rising mains with a representation of the size of sub-catchments.
- ***Spill overview***
  The verified hydraulic model was run with 10 years of Environment Agency rain gauge data and the average number of spills annually, the average duration of spills and the average volume of spills displayed on the Spill Overview Plan.
- ***Coastal modelling***
  The significance of each asset was assessed using the coastal model. In the early stage of solution development, this helped with prioritising individual CSOs for investigation.
- ***Flow/area metric***
  The removal of storm flows from the combined network is the key to reducing spills from CSOs. Using GIS analytical techniques, the peak flows recorded during the flow survey were compared to the contributing area upstream of the flow monitor locations. The resulting flow/area plan gave an indication of where investment could deliver the greatest flow reduction.
- ***Operator inputs***
  Regular meetings were held with operators to ensure that the known issues within both catchments were being addressed.

Solution development

A baseline storage solution was developed to reduce the predicted spills from all assets in Llanelli and Gowerton to 10 spills per annum for the 10 year rainfall set. This solution requires 432,280m^3 storage at an estimated cost of £600 million. This solution is not practical, sustainable or cost-effective. A range of alternative solutions were considered for both Llanelli and Gowerton. The two catchments are different in nature and in the main, different solutions have been considered for each catchment.

Llanelli is a predominantly urban catchment with a large impermeable rainfall response. The road and roof drainage drain via road gulleys into the combined network. The solutions considered include:

- ***Retrofit SuDS in an urban environment***
  In these schemes, the existing topography directs flows to civil elements, for example, retention basins and planters,

Queen Mary's Walk outfall (Artist impression)
Courtesy of Arup

Queen Mary's Walk outfall zoomed (Artist impression)
Courtesy of Arup

Queen Mary's Walk swale - Before
Courtesy of Arup

Queen Mary's Walk swale – After (Artist impression)
Courtesy of Arup

combined kerb drainage and permeable surfaces, which control the overland flows as required.

- ***Best use of existing assets***
  A number of assets in the catchment were not being used effectively, for example, at the head of the Llanelli catchment, a set of storage tanks filled only twice per annum. By using the appropriate flow controls and installing new link sewers, flow is diverted to fill the storage tanks on a more frequent basis.

Gowerton is a rural catchment with pockets of urban areas. The main sewers have been laid largely through areas of marshlands and the flow survey picked up large amounts of infiltration. The solutions being considered include:

- ***Using nature to treat spills***
  Spills at Gowerton WwTW could be treated using a constructed wetland. A two-stage treatment will be implemented, primary treatment to remove gross pollutants in a lined constructed wetland, followed by secondary treatment in an unlined constructed wetland.
- ***Working with homeowners***
  Although the majority of the front roofs of properties and roads drain into the surface water system, the back roofs of properties drain into the combined system. Welsh Water are considering diverting the drainage from the back roofs of properties into water butts or rainwater harvesting systems.
- ***Attenuating land drainage***
  There are a number of recreational areas within the Gowerton catchment that connect via land drains to the combined sewerage. It is proposed to intercept existing land drains and divert flows to filter trenches.

Multi-criteria analysis was carried out on the proposed solutions, scoring them against the weighted criteria of peak flow reduction, flooding prevention, surface water reduction, spill reduction, ease of construction, amenity value, environmental impact, carbon cost and both capital cost and operational cost. The carbon costing was carried out using Arup's CO_2ST tool, a tool that considers the carbon cost associated with the construction materials, the machinery and plant used in construction and the transportation of materials, labour and plant to site. CO_2ST uses the widely recognised University of Bath's Inventory of Carbon and Energy database.

The final package of solutions comprises 181 (No.) innovative green infrastructure solutions ranked for prioritisation and programming. They will achieve the aim of reducing spills to 10 per annum with a 75% cost saving and 86% carbon saving over traditional methods. The first phase of solutions budgeted at £12 million will be implemented before 2015 reducing surface water entering the sewer by approximately 2,000l/s.

Glevering St and Queen Mary's Walk: SuDS retrofit pilot schemes

Two schemes, Glevering St and Queen Mary's Walk were highlighted at an early stage because the sub-catchments generated large storm flows from small areas, are serviced by fully combined sewers and contain five flooding properties in total.

The proposed solutions for both schemes integrate sustainable water management solutions into the urban environment, enhancing the landscape and habitat, and providing amenities for the local community. The solutions are examples of retrofit SuDs in a highly impermeable urban environment and water sensitive urban design (WSUD), both of which are rare in the UK. However, many of the principles in these schemes are well established in Portland, Oregon and Malmo, Sweden.

In Glevering Street, the ethos of the schemes is to use the existing topography as a conduit and provide civil elements to control and

direct overland flows as required. The SuDS elements being trialled in this pilot scheme include bioretention planters and basins, green back lanes, combined kerb drainage, modular soil storage with tree planting and French drains. The bioretention basins have been designed to draw interest and act as a small recreational green space in a highly urban environment.

The design for Queen Mary's Walk includes a swale to control surface water, which is landscaped to encourage biodiversity and designed to provide an educational area for the local school as well as a recreational area for local residents.

The two schemes provide significant benefit in terms of reducing flood risk and spill frequency and volume, removing 240l/s for the combined sewer in a 1 in 5 year event and 5 properties from the Definitive Flooding List.

Stakeholder engagement

Throughout the investigations, key stakeholders have been consulted regarding the strategy and solutions. During the model build, monthly technical meetings were held between Welsh Water and Environment Agency Wales, to agree the modelling method and during the solution development, regular meetings were held with Welsh Water operators to ensure that known issues were addressed.

Carmarthenshire County Council were engaged at an early stage in the design phase of the priority SuDS schemes to give feedback on the designs and discuss maintenance, landscaping, traffic management and planning. As a result of the continuing stakeholder engagement, there have been both programme and cost savings.

Public consultation is ongoing with public exhibitions for local residents and visits to local schools by the Welsh Water education team. They have developed a programme of activities, called *'Living and Learning with Water',* to give primary school children the opportunity to learn about the water cycle, water supply, water conservation and rivers, through hands-on activities linked to the National Curriculum.

In these sessions, the proposals for some of the schemes have been outlined, focusing on the bio-swale at Queen Mary's Walk, which will be used as an education facility by local primary schools.

Conclusion

The package of catchment-wide hydraulic modelling and detailed solution design has resulted in innovative, green infrastructure solutions which solve the complex problem of reducing spills to 10 per annum, resulting in EC Infraction Proceedings against Welsh Water being paused.

The solutions provide a cost saving of approximately £450 million when compared with the traditional solution of storage as well as a significant carbon reduction, demonstrating Welsh Water's commitment to reducing their CO_2 emissions.

Early stakeholder liaison has resulted in programme and cost savings and the multi-criteria analysis has been used to effectively target investment and programme future projects.

The implementation of wide-scale retrofit SuDS solutions will revolutionise the methods used to target and tackle catchment issues in the future and place Welsh Water as one of its leading proponents.

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