Glasgow City Centre Surface Water Management Plan

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Abstract

MWH are working with Glasgow City Council to deliver a surface water management plan (SWMP) for the city centre. The plan supports Glasgow's strategy to reduce flood risk, remove constraints to development and promote green infrastructure within the city. This SWMP is one of the first to be completed in Scotland and includes some novel approaches to also take account of Glasgow City Council's desire to "clean and green" the city.

The plan identifies a number of solutions to manage the surface water from 'source to sink' which are sympathetic to the urban environment. 2D model results demonstrate the positive impact on flood risk and a headroom assessment quantifies the capacity created for development. The plan presents an economic assessment which applies monetary values for the reduction in property damages and the intangible benefits of green infrastructure over the whole life.

Introduction

The Glasgow City Centre SWMP is a long term plan for managing surface water and surface water flooding. Climate change, population growth and urban development increase the pressure on the existing drainage network. Without the provision of adequate infrastructure, it is likely that this will lead to an increase in flood risk within the city (including important commercial areas) and restrict future development. Glasgow City Council commissioned MWH to carry out a study of the current drainage arrangements and develop the SWMP to safeguard long-term development aspirations. The plan identifies sustainable drainage solutions to:

- Reduce flood risk
- Free up capacity in the existing drainage infrastructure for future development
- Enhance the environment and amenity

The plan complies with Scottish Government guidelines and considers key stakeholder views.

Flood Risk In Glasgow City Centre

Glasgow suffered severe flooding in 2002 following heavy rainfall with the East End of Glasgow being the worst affected district of the city. In contrast, other than below ground rail infrastructure, Glasgow City Centre was not so severely affected. The study area is at the head of the drainage catchment and the study area topography falls gradually towards the River Clyde. Its characteristics indicate the area is not susceptible to regular flooding from the sewer network. However this area is the heart of the city and contains the principle retail areas, Glasgow's foremost civic area, George Square, and commercial and tertiary education centres and the likely costs of flood damage to these properties are high.

The study area is bounded by the M8 motorway to the north, High Street and Castle Street to the east, the River Clyde to the south and Hope Street to the west. The drainage system is from Victorian times and has expanded with the city. Waste water and rainfall is collected by a combined drainage system which conveys flows to the Dalmuir Sewage Treatment Works 12km west of the city centre. Combined sewer overflows (CSOs) relieve the sewer network in storm conditions by spilling to the River Clyde.

MWH developed an Infoworks 2D model (using a model provided by Scottish Water) of the study area to predict the extent and depth of flooding. Results were broadly in line with flood reports and correlated

with flood maps provided by SEPA. Predictably, most of the flooding appears in the lower, flatter reaches of the study area. The "Multi Coloured Manual (MCM), The Benefits of Flood and Coastal Management: A Manual of Assessment Techniques (2010)" guidance presents a method for calculating the likely costs of flood damage to residential and commercial properties. The Annual Average Damages is a long-term, average estimate of costs to properties from contact with flood water. The present day and future (considering climate change uplift) Annual Average Damages for the study area are £3.6m and £4.5m respectively.

Strategy For Managing Surface Water

The adopted strategy disconnects surface water from the combined sewer network and manages surface water through a new sustainable drainage network:

- Disconnect surface water before it reaches the existing drainage network at gulleys, rainwater pipes and other easily accessible points.
- Create a new surface water network using SuDS, where possible, and following the source – pathway – receptor concept of surface water management.
- Identify strategic routes to convey flows and link measures through the catchment for every day, design and exceedance rainfall events, following existing north-south flow paths to the River Clyde where possible.

Surface water management measures will be either:

- structural components, e.g. a pond, a basin, or a swale constructed by the council; or
- non-structural, for example, development policies or awareness raising programmes which encourage developers and property owners to manage their surface water locally.

Solutions consist of a number of measures working together to manage the surface water from source to final disposal. Solutions typically consist of some form of source control, a conveyance measure and a receptor, which will be either a receiving watercourse (River Clyde, Molendinar Burn) or a regional storage measure such as a detention basin or below ground proprietary storage. SuDS measures such as a pond, a basin, or a swale are designed to accommodate moderate flows, up to the 1 in 30 year event say. Above this, exceedance measures such as surface flood pathways and sacrificial flood areas manage exceedance flows on the surface.

Engaging key stakeholders is essential to the success of the plan. In particular, consultation within Glasgow City Council (planning, transportation and other technical departments) ensures the plan links to the City Centre Strategy and proposals complement transport and future regeneration aspirations.

Demonstrating the flood risk benefits of proposals using integrated 2D modelling

The Infoworks 2D model predicted the extent and depth of flooding assuming the full solution is in place. A comparison between existing and solution flooding shows that that the combination of solutions reduces flooding for all storm events. The SuDS solutions contain the majority of flows up to the 1 in 30 year event while designated pathways hold surface flows within roads and open spaces. Flooding remains in some areas and property protection measures may be the most suitable solution in these locations.

The results of this high-level assessment of the damages associated with both the 'do nothing' and the 'SuDS solution' scenarios, both including and excluding an allowance for the impacts of climate change, are

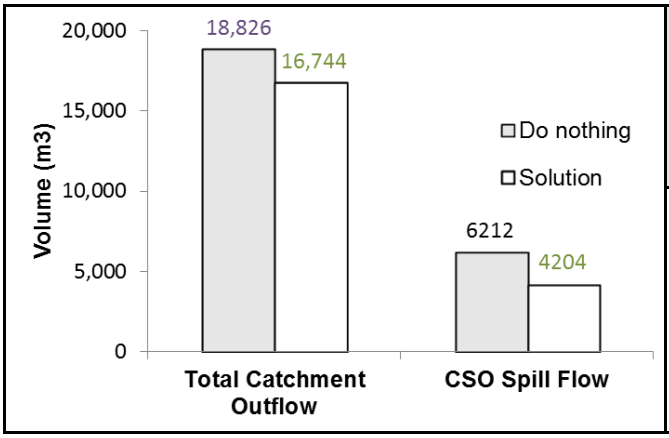
	Do nothing	SuDS solution
No climate change	£3,637,000	£986,000
With climate change	£4,453,000	£1,358,000

The results show a significant benefit from implementing the full SuDS and exceedance management solution. The annual average damage under the 'do nothing' scenario (assuming no climate change) would be £3.64 million. By implementing the 'SuDS solution', this would reduce to £0.99 million.

Removing Surface Water From The Sewer Network Frees Capacity For Development

Removing and reducing the volume of surface water entering the combined sewer network frees up capacity for future development. The model demonstrates that solutions proposed as part of this plan will reduce flows to the sewer network by 10% during storm conditions. This also has the added benefits of reducing the amount of flow being treated by the Dalmuir sewage treatment works. The study area is served by a fully combined drainage system and storm flows are controlled by combined sewer overflows which relieve the sewer network in storm conditions. The model also predicts that solutions will reduce combined sewer overflow spills to the River Clyde by 30%, providing important water quality improvements.

Sewer flow leaving the study area for a typical storm event



Equivalent population created by surface water disconnection

Total Population	Population where impermeable area is disconnected	Additional Capacity Created (Population Equivalent)
9394	3480	5523

Solutions move existing properties from a combined to a separate system. Assuming the total catchment outflow remains the same then, based on a theoretical Formula A setting, additional separate population capacity is created. The table shows the additional capacity created, expressed in terms of a population equivalent.

Quantifying Tangible And Intangible Costs Demonstrates Economic Benefits

An Economic Impact Assessment measures the capital and operational costs and applies monetary values for the reduction in property damages and intangible benefits of green infrastructure over the whole life.

The assessment identifies the most significant benefits as

- Land/property values
- Increased drainage capacity
- Physical/mental health
- Aesthetic benefits
- Water quality
- Greenhouse gas emissions

Monetary values for these benefits are available from previous studies and the assessment applies these values to the study using a benefits transfer approach. The assessment uses a whole life cost calculation taking into consideration the capital and operational costs for the SuDS solution. Flood risk benefits are calculated from the Average Annual Damages as:

	Do nothing	SuDS solution
Flood risk impacts	-£80.95m	-£21.95m
Cost of measures	£0	-£18.38m
Wider benefits	£0	+£9.75m
Total (Net Present Value)	-£80.95m	-£30.58m

The assessment shows that the costs from flood risk in a 'do nothing' option would be over £80 million. These would be reduced to less than £22 million under the SuDS solution proposed within this SWMP and would be reduced further to just over £12 million if wider benefits are taken into account. The total saving of the solutions is therefore likely to be in the region of £50 million over 40 years.

Conclusions

The Glasgow City Centre surface water management plan (SWMP) is a long term plan for managing surface water and surface water flooding in the area. The plan supports Glasgow's City Centre Strategy to reduce flood risk, remove constraints to development and promote a "clean and green" city environment.

The study demonstrates that:

- A new green network of SuDS and an exceedance management approach can significantly reduce flood risk in the city centre
- Tangible additional capacity is created
- There is an economic case for proposals in terms of flood risk and broader environmental and social benefits

The SWMP presents the benefits of the full solution, though it is anticipated that benefits will accrue as regeneration and other improvements progress over time. Engagement of key stakeholders is essential to the success of the plan.