Glasgow Strategic Drainage Plan

dealing with the legacy and providing for the future

By Harry Adshead

In July 2002, an extreme storm hit Glasgow, Scotland's largest city. Five hundred properties were flooded, businesses were damaged, transport on major roads and railways was severely disrupted. The total cost of the damage was estimated at over £100m. The worst affected area was the East End, home to some of the poorest residents of the city. The issue became high profile and Members of the Scottish Parliament (MSPs) became involved. Who was to blame for the flooding? Did it come from the sewers or the watercourses? What should be done to stop it happening again?

Glasgow flooding *courtesy Hyder Consulting*

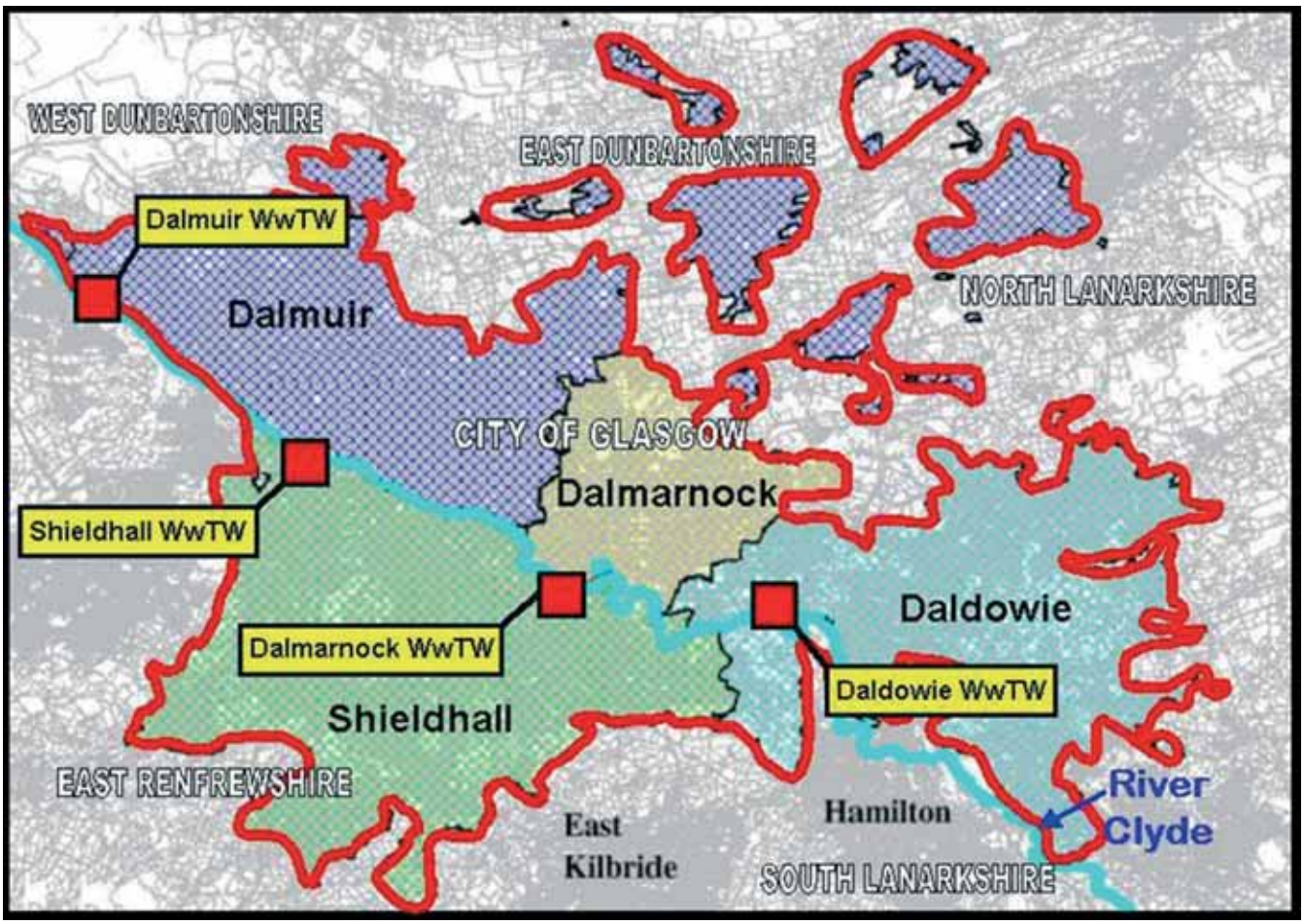
The scale of the flooding was a setback for Glasgow and its plans for extensive development. Both Scottish Water and Glasgow City Council found themselves under considerable pressure to identify solutions to this major threat. Hyder Consulting was appointed to organise a workshop on the East End flooding, bringing together all the key stakeholders. It soon became apparent that Glasgow's drainage problems were not limited to the East End and that some joined up thinking and co-operation on a wider scale was required.

Plan objectives

In June 2003, *Hyder* was engaged to produce the Glasgow Strategic Drainage Plan – a comprehensive assessment of drainage needs across Glasgow and surrounding towns, an urban area covering nearly four hundred square kilometres and home to over a million people. Having recognised the benefits of an integrated, multi agency approach early on, the Plan has been promoted and guided from the outset by a Steering Group comprising Scottish Water, Glasgow City Council, The Scottish Environmental Protection Agency (SEPA) and Scottish Enterprise Glasgow. This group now includes Scottish Water Solutions, appointed by Scottish Water to deliver the project.

Key objectives of the Glasgow Strategic Drainage Plan are:

* reduction of flood risk - both from sewers and urban watercourses;
* improvement of water quality - in watercourses and the River Clyde;
* removal of development constraints - imposed by inadequate drainage infrastructure;



Glasgow Strategic Plan Area *courtesy Hyder Consulting*

* habitat improvement - including daylighting of culverted watercourses and provision of attenuation ponds: and
* integrated investment planning - to ensure that the most cost effective solutions are defined and that finance is resolved between the various agencies responsible.

Integrated sewer & river models

First stage of the work concentrated on the Dalmarnock Wastewater Treatment Works catchment, which encompasses the East End of Glasgow. Here, an integrated sewer and watercourse model was developed and used to identify and assess improvement options. The spread of urbanisation since the industrial revolution has left the East End watercourses in a far from natural state: rainfall that used to run into the streams now falls on hard, impermeable surfaces and is collected by the combined sewer system. In dry weather, base flows in the streams are very low; in wet weather, flows are dominated by spills from combined sewer overflows. It is not surprising that most of the streams are classified by SEPA as seriously polluted.

The integrated hydraulic model provided a full understanding of the interactions between sewers and watercourses and meant that a variety of options could be tested, with the impacts on both systems properly assessed. The options ranged from 'hard' engineering such as new interceptor tunnels to sewer separation and 'soft' solutions incorporating Sustainable Urban Drainage Systems (SUDS).

The initial; Masterplan

This approach has now been extended to produce an Initial Masterplan for all of Glasgow, comprising sewerage, drainage and wastewater treatment schemes totalling some £1.5 billion, to be implemented over the next twenty years. The schemes have utilised cross-catchment solutions that maximise the use of existing assets, e.g. transfer of flows from one wastewater treatment works catchment area into another.

Supporting studies

A number of supporting studies were undertaken, all of which provided important inputs to the strategic planning process. An Urban Pollution Management (UPM) Initial Planning Study collated information on discharges from numerous sources, including over six hundred combined sewer overflows, and established an environmental planning framework for the Clyde, the major tributaries and minor watercourses. Water quality modelling of the River Clyde allowed a range of alternative strategic options to be tested for compliance with target water quality objectives.

Assessment of Glasgow's four main Waste Water Treatment Works was undertaken in order to understand available treatment capacity, the potential for upgrading at the existing sites, and the possible need for new facilities. A detailed land use study, carried out with the assistance of local authority and regional planners, required conversion of planning data in GIS format from political boundaries into drainage boundaries. This permitted calculation of loadings on drainage systems and wastewater treatment works up to a 2025 design horizon.

At some of the wastewater treatment works, as much as 85% of the incoming dry weather flow is infiltration. An analysis of measured infiltration in all the Glasgow sewerage subcatchments meant that the worst affected areas could be prioritised. A number of infiltration 'hotspots' were identified where initial economic appraisals demonstrated that efforts to reduce infiltration would be justified.

A thorough review of drainage policy was also carried out, in consultation with the stakeholders, to develop a set of agreed drainage design criteria and policies. Consideration of the impacts of climate change was a key part of this process.

Climate change is predicted to influence future rainfall, river flows and sea levels, all of which affect the performance of Glasgow's drainage system. An assessment of joint probabilities of occurrence of these variables was also undertaken.

Innovative approach

The Glasgow Strategic Drainage Plan has shown that a major investment is now needed in Glasgow to address the legacy position. To ensure that this investment will meet all of the Plan objectives in the most cost effective manner, a range of innovative studies were undertaken in selected pilot areas. These included a Surface Water Management Plan for part of the East End which considered community SUDS schemes and sewer separation and the extent to which these could reduce the need for new 'hard' engineering solutions. Overland flow analyses used flooding volumes from sewers and watercourses, in conjunction with a two-dimensional routing model and digital terrain data, to predict flood depths in two pilot areas where historical flooding had occurred. Excellent correlation was achieved between predicted and observed flooding.

Immediate benefits

Glasgow is bidding to host the 2014 Commonwealth Games and there are plans to provide the athletes' village and various sports facilities in the Clyde Gateway, a metropolitan Flagship Initiative area in the East End. Confirmation of drainage requirements for this zone is a high priority but decisions can now be informed by the proposals set out in the Strategic Drainage Plan. Infrastructure in priority zones can be sized and located to allow for known future connections from upstream areas.

The Glasgow Strategic Drainage Plan now provides a blueprint for all agencies to address not only the urgent flooding problems which triggered the process but also to permanently improve water quality and remove long standing development constraints. Urban regeneration in Glasgow is a top priority for the Scottish Executive.It is very encouraging that drainage improvements are now being implemented in a determined manner by Scottish Water and Glasgow City, with the full support of SEPA and the other responsible agencies.■

Note: *The author of this article, Harry Adshead, is Principal Engineer, Hyder Consulting and Technical Manager for the Glasgow Strategic Drainage Plan.*