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The North Glasgow Integrated Water Management System:

A Review.

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CREW connects research and policy, delivering objective and robust research and expert opinion to support the development and implementation of water policy in Scotland.

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This document relates to CREW Project CD2015_05 and was produced by:

Dr Richard Allan
Dr Mark Wilkinson
Dr Nikki Dodd

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Key Findings

The proposals for the North Glasgow Integrated Water Management System (NGIWMS) are to be commended. The Metropolitan Glasgow Strategic Drainage Partnership (MGSDP) have a fantastic vision for a pioneering drainage system which, if implemented, could be held up as an exemplar sustainable drainage system which promotes and enables economic regeneration and growth, social justice and the alleviation of flood risk. The studies to-date (Section 3) highlight that the proposed system is possible and that the individual partners have a desire to work together in collaboration to make the integrated drainage system a success.

In order to ensure success it is recommended that two distinct partnerships are formed, one focusing on development (the Developer Partnership) which would be led by Glasgow City Council and tasked with delivery of the infrastructure required for regeneration in North Glasgow; the other partnership (the Drainage Partnership) would be led by Scottish Canals and focus on the ongoing operation and maintenance of the integrated drainage system.

In order to make the partnership operate effectively together (and within partnerships) a set of legal and operational agreements need to be prepared which cover:

- Investment in infrastructure;
- Operation of the drainage system;
- Definition of system design capacity and expected "normal" operating conditions;
- Definition and range of the "dynamic" elements of the system (which informs the system design capacity);
- Maintenance of the drainage system;
- Emergency planning;
- Transfer of risk and liability in the event of a change to the partnership constituents;
- Financing to ensure the drainage system can operate "in perpetuity".

Overall the recommendations can be summarised as follows:

- The system is ambitious but would deliver quantifiable benefits to Glasgow and Scotland. These benefits include economic growth, environmental improvement, social justice and flood risk mitigation.
- The system should be governed through two partnerships: the Development Partnership and the Drainage Partnership.
- Scottish Canals should lead the Drainage Partnership and be the lead operator of the dynamic integrated drainage system.
- Funding for the system (in terms of asset investment, maintenance and operation) needs to be secure and presented open book to ensure sustainability of the system "in perpetuity"

Introduction

MGSDP is a partnership made up of Scottish Water, Glasgow City Council, Scottish Canals, South Lanarkshire Council, Clyde Gateway, Scottish Enterprise, Renfrewshire Council, East Dunbartonshire Council and the Scottish Environment Protection Agency (SEPA) and represents an innovative approach to water management which meets the objectives of the Hydro Nation Agenda. Since its inception the partnership has sought innovative ways to manage urban water systems that are ultimately sustainable and support the continued growth of Glasgow. The NGIWMS is at the study phase and is part of the regeneration plan for North Glasgow. The integrated approach to water management will provide a range of benefits that include:

- Long-term regional growth
- Jobs in the local area
- Ecological recreational spaces
- Green infrastructure
- Sustainable urban drainage
- Internationally recognised case study in best practice water management
- Improvements to air quality

Research Undertaken

The MGSDP partners, at two workshops, engaged and discussed the operation, charging mechanisms, investment requirements and delivery plan to translate their vision into a sustainable reality for Greater Glasgow as Glasgow City Council embark on delivering their regeneration plan for North Glasgow.

The Scottish Centre of Expertise for Waters (CREW) was asked to act as a neutral organisation and validate the plans together with hosting up to two stakeholder workshops to support the implementation of the MGSDP vision for NGIWMS. The objectives of the project were:

1. Review the current NGIWMS studies that have been carried out to date specifically of the development plans and the area. This is important to develop an overall picture of the technical as well as the socio-economic system in which the development is to take place and understand the scope of the current situation, hydrological and urban context.

2. Undertake a short review of examples of best practice from elsewhere in UK and EU. This review identified a wider context of how such developments are being carried out, or planned elsewhere.

3. Offer suggestions for enhancement to the plans, or areas where expertise should be brought in to develop certain technical aspects. Examples of this may be research or known sensor techniques for hydrology, or evaluation techniques that could be applied in terms of evidence for perceived socio-economic benefits.

4. Host two stakeholder workshops to:

a. Test the robustness of the NGIWMS proposals.
b.Help the partners shape and agree the NGIWMS commercial and operations agreement (including roles and responsibilities).
c.Present the output, findings and recommendations to the MGSDP and Scottish Government Representatives as part of the approvals process for the project to move to planning and delivery.

1. Introduction

The Scottish Government has a commitment to make Scotland a Hydro Nation. The Hydro Nation Strategy seeks to make best use of the water resource expertise, water based economy and abundant water resources that are closely allied to Scotland's environment, tourism, farming, food and drinks sectors. Three principal goals of the Hydro Nation are:

• Utilising Scottish expertise to maximise the economic benefit of our abundant water resources within a sound ecological context by reducing energy use, improving efficiency and creating a low carbon water nation.

• Raising our international profile through recognition of Scotland as an international leader on water management and governance – The first Hydro Nation.

• Developing a water centre of expertise and research with international reach.

Against a backdrop of changing urban and rural land use, key legislation such as Water Framework Directive and the Flood Risk Management Act (Scotland) 2009 demand improvements in water quality, physical river condition and space for flood management. Within Glasgow, the Metropolitan Glasgow Strategic Drainage Partnership (MGSDP), a partnership of Scottish Water, Glasgow City Council, Scottish Canals, South Lanarkshire Council, Clyde Gateway, Scottish Enterprise, Renfrewshire Council, East Dunbartonshire Council and the Scottish Environment Protection Agency (SEPA), represents an innovative approach to water management which meets the objectives of the Hydro Nation Strategy.

Since its inception the partnership has sought innovative and sustainable ways to manage urban water systems and which support the continued growth of Glasgow. The North Glasgow Integrated Water Management System (NGIWMS) is being developed to enable the regeneration plan for North Glasgow to be delivered. The NGIWMS is an innovative approach to surface water management that utilises the canals as a conduit for receiving storm water and is the central component to the drainage system. The integrated approach to water management will provide a range of benefits that include:

- Long term regional growth
- Jobs in the local area
- Ecological recreational spaces
- Green infrastructure
- Sustainable urban drainage
- Internationally recognised case study in best practise water management
- Improvements to air quality

In addition to the above, the MGSDP have identified additional significant cost benefits to adopting a systems approach to urban water management:

- Reduced water pumping costs
- Reduced water treatment costs
- Increase to property value
- An ethos of 'living with water' by de-culverting urban waterways

The MGDSP approach has identified objectives that will deliver the benefits for Greater Glasgow:

- Flood risk reduction
- River water quality improvements
- Enabling economic development
- Habitat improvement
- Integrated investment planning

2. Aims and Objectives

The MGSDP partners, at two workshops, engaged and discussed the operation, charging mechanisms, investment requirements and delivery plan to translate their vision of integrated water management into a sustainable reality as Glasgow City Council embark on delivering their regeneration plan for North Glasgow.

The Centre of Expertise for Waters (CREW) was asked to act as a neutral organisation to validate the plans together with hosting stakeholder workshops to support the implementation of the MGSDP vision for NGIWMS. The objectives of the project were:

1. Review the current NGIWMS studies that have been carried out to date specifically the North Glasgow Districts development plans.

This is important to develop an overall picture of the technical as well as the socio-economic system in which the development is to take place (Section 3).

2. Undertake a short review of examples of best practice from elsewhere in the UK and EU. This review should identify how such developments are being planned and carried out elsewhere (Section 4).

3. Offer suggestions for enhancement to the plans, or areas where expertise should be brought in to develop certain technical aspects. Examples of this may be research or known sensor techniques for hydrology, or evaluation techniques that could be applied in terms of evidence for perceived socio-economic benefits (Sections 5 and 6).

4. Host two stakeholder workshops to:

- Test the robustness of the NGIWMS proposals.
- Help the partners shape and agree the NGIWMS commercial & operations agreement (including roles and responsibilities).
- Present the output, findings and recommendations to the MGDSP and Scottish Government Representatives as part of the approvals process for the project to move to planning and delivery.

3. Review of the existing NGIWMS proposed plans

The project team were supplied with a range of documents by project partners. Below is a strategic review of the existing development plans for the surface water management strategy of North Glasgow to provide an overall picture of the technical and socio-economic system in which the development is taking place. The documents submitted which informed the review, were:

- "Green Networks Integrated Urban Infrastructure – 6 Candidate sites; Cowlairs – Surface Water Management Strategy"; AECOM; January 2011 (AECOM, 2011)
- "North Glasgow Integrated Water Management Study"; AECOM, Biomatrix Water; June 2013 (AECOM, 2013a)
- "NGIWMS Commercial Workshop #1"; AECOM; June 2013 (AECOM, 2013b)
- "North Glasgow Integrated Water Management System (NGIWMS) Summary Business Case"; AECOM; October 2014 (AECOM, 2014a)
- "North Glasgow Integrated Water Management Study – Phase 3 Reports"; AECOM; December; 2014 (AECOM, 2014b)

The documents supplied give a comprehensive overview of the development and evolution of the concept, purpose, strategy, value, benefits, risks and potential commercial arrangements to deliver an integrated approach to surface water management in North Glasgow. In particular, the integrated approach is an enabling factor in the proposed regeneration of North Glasgow which includes benefits to society and delivering economic growth. There has been a great deal of time and consideration given to the functionality of the integrated water management system as well as the aesthetics and the inclusion of green corridors and other green space that will further enhance the environmental and social benefits of the proposed master plan for North Glasgow. The detail of the overall economic benefits is set out in AECOM (2014a).

The studies to-date recognise some of the difficulties in implementing a multi-agency integrated water management system with two strategically important areas which need to be considered. Firstly the drainage system needs to be maintained and operated in perpetuity so the legal framework needs to reflect the responsibilities of each accountable agency and the consequences of each agency changing its operating model, status, ownership, financing, etc. In other words, if an agency no longer functions or exists, who will then be accountable for maintaining and operating all or part of the drainage system? Secondly the financing of the system needs to be clearly defined. What are the contributions of the accountable agencies and again, if one agency changes its status or no longer has access to the required capital, who then pays for the system to ensure it continues to operate as designed? These points are addressed in Section 5 of this report.

The first commercial workshop (AECOM, 2013b) initiated a conversation on operating principles, the commercial arrangements needed to enable operation and the risks associated with an ambitious multi-agency approach to integrated water management. The risks identified cover the strategic operation, technical and governance aspects. The

majority of risks identified were similar to those discussed at the first of two CREW workshops in November 2015. At the time of the workshop, risk owners were not identified. The ownership of the risk is discussed further in Section 6 of this report. The work to-date promotes a very positive and ambitious set of proposals for the integrated water management plan that, if implemented, presents an opportunity to create a unique multi-agency operating model which could be seen as an exemplar project in the context of the "Smart City" agenda within the European Union. The initial designs presented, for example Cowlairs, set a vision for a green growth agenda which supports national and European objectives. The use of green space and green corridors will have a positive effect on flood risk management and improving the environment, and provide a social space for the residents and businesses in North Glasgow which should act, in part, as an incentive for further investment and growth in the city (as set out in AECOM, 2014a).

The cumulated information in all of the submitted documents supports the view that the partners of the NGIWMS, as part of the broader MGSDP, are working well together and want the project to succeed. The further interaction of the partners and willingness to continue to support the development of the NGIWMS in itself re-enforces the belief that the project has real value.

4. Review of best practice

A short review of existing drainage partnership schemes in the UK has been undertaken to identify current best practice and inform the operating arrangements of the proposed NGIWMS. A summary of a selection of schemes is presented here in Section 4.

4.1 Open arrangements

Case study: The Learning and Action Alliance (LAA)

Learning and Action Alliances (LAA) are open arrangements where stakeholders form a joint understanding of an issue and its possible solutions based on debating and group discussions (Lamond, 2014). This leads to the partnership developing a feeling of trust and mutual ownership. This can therefore develop new innovative ideas. For example, LAAs were used in an EU INTERREG IVb funded project call Managing Adaptive Responses to Changing Flood Risk in Europe (MARE) which involved cities in the UK, Netherlands, Germany and Norway. These areas were located in the Don Catchment, Bergen, Dordrecht and Hannover.

4.2 Partnership approaches

Case study: Making Space for Water

The Defra-funded Making Space for Water (MS4W) Urban flood risk and integrated drainage project ran from 2003 to 2009. It consisted of 15 pilot catchments (Gill, 2008). Nearly all pilot projects worked on a partnership approach which had a local authority, the water company or the Environment Agency in the lead role. The critical success factor in the pilots was the people rather than the institutions leading the projects (Gill, 2008). Gill (2008) noted that the water companies were effective in leading the projects/plans where surface water management was the main issue.

It was also noted that direct links to, and responsibility for, the planning system made local authorities best suited to address the needs of new developments. Further details from an example pilot case study are given below (Newcastle upon Tyne). Gill (2008) concluded that barriers exist in current institutional arrangements to coordinate and fund integrated water management and these need to be addressed by the Government (i.e. to clarify responsibilities and identify who should lead and oversee surface water management plans).

4.3 Catchment steering groups

Case study: Newcastle upon Tyne

The city of Newcastle upon Tyne has had numerous surface and fluvial flood events over the past decade. The Ouseburn, a tributary of the River Tyne, flows through the city centre and presents a flood risk as it passes through housing estates on the city outskirts. There is a perception amongst the public that flooding will increase in the older estates when newer estates are developed upstream. However, with the development of Green Infrastructure around new developments this should not be the case. These issues led to the formation of the Ouseburn Catchment Steering Group (OCSG) whose mission statement is: "A commitment to continuously improve water quality and ecological status, lower flood risk, increase access, recreation and amenity value whilst optimising economic/business activity, using an active public participation process". The OCSG

noted that non-attendance of critical groups to meetings caused damage to the process. That is, when the developer did not turn up to the meeting, it led to an 'us and them' mentality (Quinn and Tellier, 2009). Quinn and Tellier (2009) also commented that conveying the message to the public about the complex nature of the Ouseburn is still needed. Public confidence and the increased funding of local rangers and local groups is an immediate win-win option for all (Ouseburn Catchment Steering Group, 2009).

4.4 Management plans and operational partnerships

Case study: City of Hull

The city of Hull was flooded during summer 2007, resulting in widespread disruption and damage to infrastructure. As a result, a surface water management plan was implemented and operational partnerships established. The partnership comprised of Hull City Council (Economic Development and Regeneration, Development and Design Group and the council Gateway group), the Environment Agency, Yorkshire Water, the University of Hull, East Riding of Yorkshire Council, Yorkshire Forward and the Government office. The partnership was overseen by Hull City Council Economic Development and Regeneration. The partnership meetings aimed to discuss information needs, provide the opportunity to comment both on progress made and on the approach to be adopted in subsequent stages, and to discuss and comment at key stages of the plan development (Hull City Council, 2009). The main objectives of the meetings were to produce a plan that was realistic, practical and acceptable to all parties who would be involved in its implementation (Hull City Council, 2009). The partnership did not create a formal engagement plan but it was discussed. In developing a surface water management plan for Hull a number of constraints were identified, some of the most pertinent were that different partner organisations were working to different standards of protection and information sharing agreements.

The concept diagram for the OCSG was:

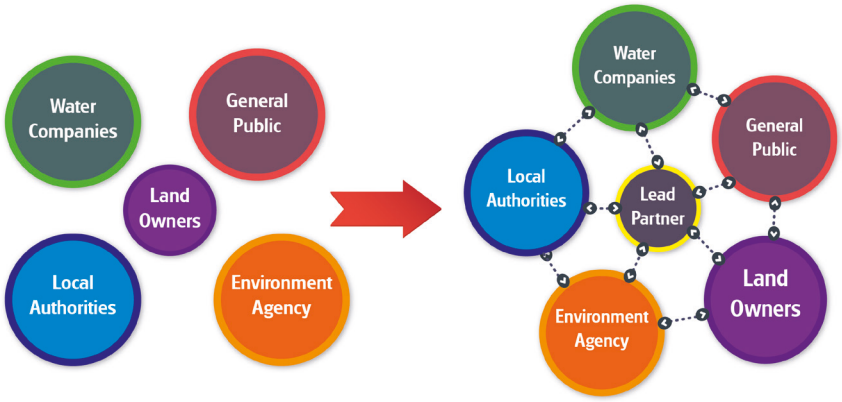

Figure 1: The partnership process (Gill, 2008)

Which lead to the formation of the actual OCSG:

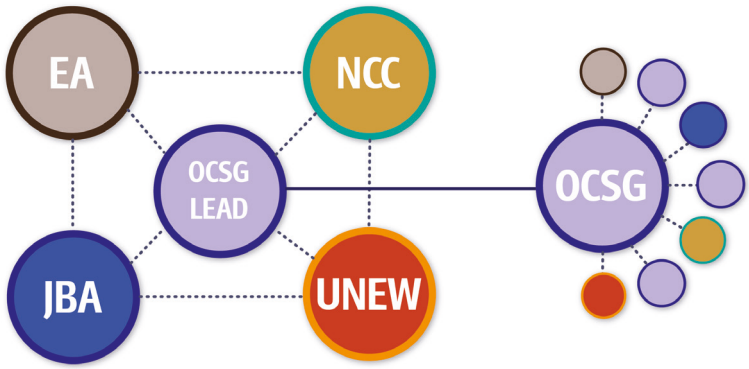

Figure 2: A representative and well networked, appropriate lead organisation: OCSG (Quinn and Tellier, 2009).

4.5 Other urban water management solutions

Wilkinson et al.(2013) highlighted that the risk of runoff from rural areas is a function of the state of the soil storage, tillage regime and factors that affect flow connectivity. The same rule applies in urban areas, that is, consideration is needed to allow water to filter into the soil system (and less permeable surfaces) as well as managing connectivity with water storage techniques.

One example of an urban water management solution is to use a porous media, for example, Topmix Permeable instead of a more traditional impermeable surface. This type of permeable surface allows storm water to seep through it at high rates.

5. Improvements to existing proposals

CREW facilitated two workshops with the partners of the NGIWMS to explore the construction of an appropriate governance structure, operational model, and to discuss some legal considerations. The workshops also explored risks and identified risk ownership (Section 6). Section 5 describes suggested improvements to the existing proposals, related to:

- Governance structure (5.1)
- The design and build of the agreed planned assets (5.2).
- The adoption, operation and maintenance of the asset infrastructure (5.3).
- Operating principles (5.4).
- Legal agreements (5.5).

5.1 Governance structure

An outcome of the discussions was the consensus around a multi-layered structure designed to enable delivery of construction, development and regeneration while ensuring an appropriate drainage system is implemented and maintained. The discussions at the workshops centred on establishing (i) a drainage partnership that would be responsible for establishing, operating and maintaining the integrated drainage system, and (ii) a developer partnership focused on regeneration of North Glasgow, with investment to deliver component parts of the integrated drainage system (for example SuDS components). The majority of stakeholders present agreed that such an approach would give accountability for design and build of the system (or components of the system) together with accountability for operations and ongoing maintenance. Figure 3 is a representation of the two partnerships and how they would interface.

***Optional**

Figure 3: The developer partnership and drainage partnership connections

In order to fully understand the roles and responsibilities of the two partnerships, the project team built a representation of the "drainage system". Figure 4 depicts the overall system with symbolistic representation of the nodes which the workshop participants agreed were the most significant components of the system. In particular, the components represent asset types and activities required to operate the system and which may have multiple agency ownership, adding complexity to the operational and legal agreements required to ensure successful operability of the system.

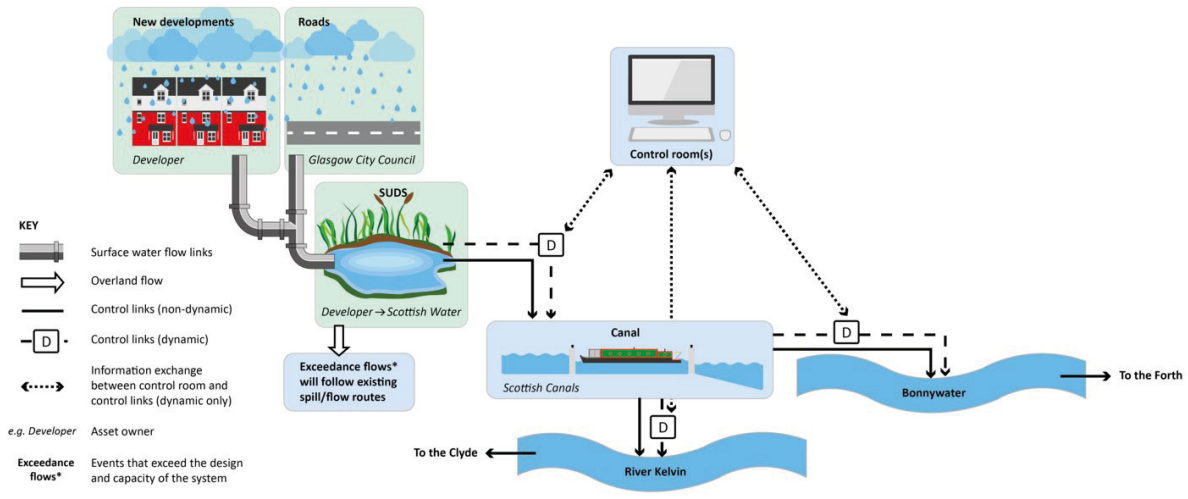

Figure 4: A symbolistic representation of the operational nodes within the proposed North Glasgow Drainage system

The workshop participants identified a number of activities which support the redevelopment of North Glasgow. Ultimately the project sets out to achieve improved living standards for the residents of North Glasgow; improved social space, and; sustainable business growth through the provision of fully-serviced sustainable commercial property. In addition, all activity undertaken as part of the "Master Plan" for North Glasgow must support infrastructure which delivers the improvements needed for the delivery of a smart and sustainable city. The activities fall into two broad categories:

(i) The capital investment required to build the civil infrastructure: this will include building assets such as roadways, housing, commercial premises, services (water, sewers, electricity, gas, telecoms, etc.) and the Sustainable Urban Drainage systems (SuDS). The participants agreed that these activities would be developer-led, supported by the partners (Glasgow City Council, Scottish Water, etc.). The principal stakeholders for delivery of infrastructure investment would make up a Developer Partnership (Section 5.2).

(ii) The management of the interface, adoption and operation of a series of assets downstream of the domestic and commercial properties within the planned regeneration area. The adoption and ongoing operation and maintenance of the system should be the responsibility of the Drainage Partnership (Section 5.3).

5.2 The Developer Partnership

The Developer Partnership will oversee the design and build of the agreed planned assets for each area/plot of land within the scope of the North Glasgow Master Plan for redevelopment (Figure 5). The Chair of the Developer Partnership should rest with Glasgow City Council as they have authority and accountability for the city and the master plan. It was recognised by the stakeholders that the Developers will vary on a site by site basis and therefore the constituents of the Developer Partnership will vary.

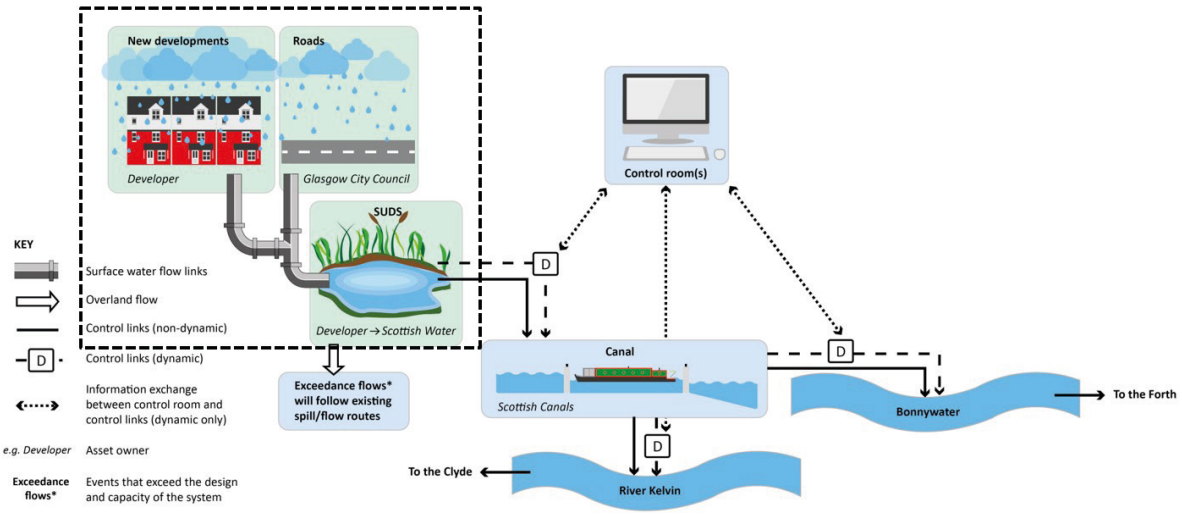

Figure 5: The Developer Partnership`s area of responsibility

5.3 The Drainage Partnership

The Drainage Partnership will be accountable for the adoption, operation and maintenance of the asset infrastructure needed to ensure that the surface water drainage system operates effectively "in perpetuity". The agencies within the Drainage Partnership will have control over a variety of elements within the "system". The principal components and owners are:

- The roads – Glasgow City Council
- The SuDS – During construction, the developers, post construction and after vesting, Scottish Water
- The Canal Network – Scottish Canals

The Drainage Partnership will:

- Focus on the area of the system outlined in Figure 6.
- Be accountable for ensuring the system has sufficient funding to deliver continued service.
- Ensure that the appropriate operational procedures and emergency planning systems are developed and enacted to ensure efficient use of the system for surface water drainage and flood elevation purposes.
- Have an overview and input into the design of the linked components of the system to ensure the design operates effectively and that adoption of the components of the system can be made timeously, meeting the required building standards, environmental regulations and other relevant standards that are deemed appropriate

The Drainage Partnership should include Scottish Water, Glasgow City Council, SEPA and Scottish Canals as a minimum. Other stakeholders can be invited on to the Drainage Partnership by agreement.

The heart of the drainage system will be the canal network (Figure 6). For the system to work effectively, the canal will need to operate as a dynamic system under the control of Scottish Canals. Other elements of the system (the roads, SuDS, etc.) will act as conduits for surface water runoff and will be diverted to the canal network. The consensus view at the workshops was that Scottish Canals should be the principal operator of the system and therefore it would be appropriate for Scottish Canals to lead the Drainage Partnership.

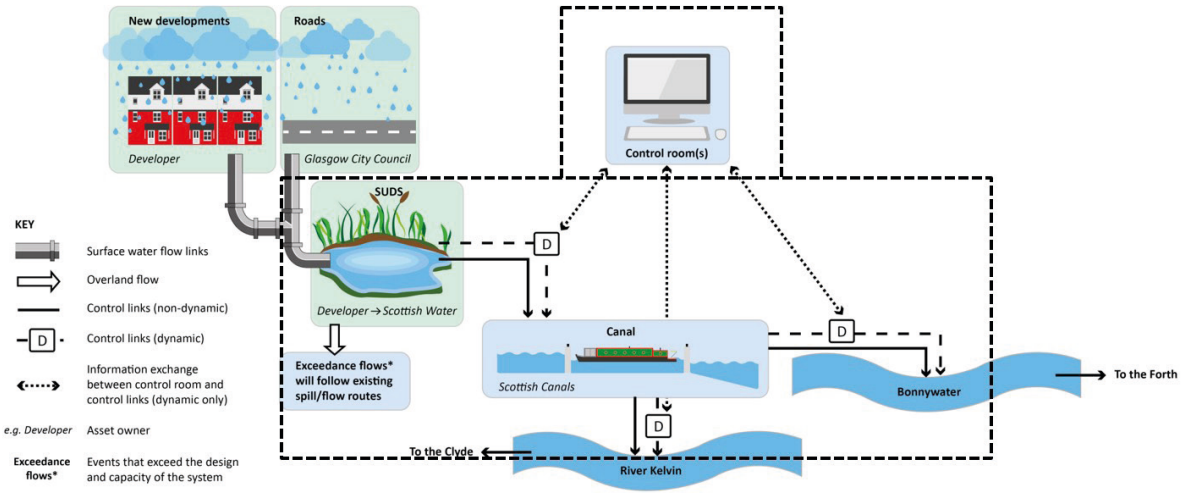

Figure 6: The Drainage Partnership`s responsibility

5.4 The Operational Agreement

For the drainage system to operate successfully, a series of operating principles acceptable to each asset owner are required, which inform an over-arching operational agreement. The operational agreement should:

- Define how the system will operate under a set of defined normal operating conditions.
- Document the operational interventions required to manage the system under stressed conditions.
- Take into account the phased nature of the re-development of North Glasgow.
- Map out how connecting each development node will alter the operational dynamic of the system.

The process for adopting and vesting new assets will need to be innovative and go beyond current processes because of the number of agencies involved in the end to end process. The design of the component parts of the system will inform adjustments to the system capacity and this will need to be reflected in the operational procedures and emergency response arrangements (particularly under threat

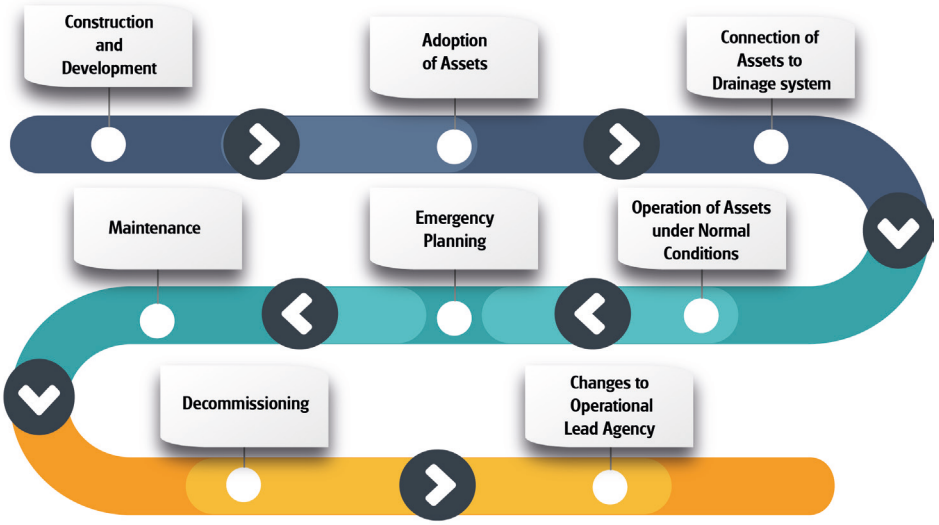

Figure 7: The operational agreement

The operational agreement and supporting legal framework will need to take into account the possible changes to the status of each partner and how this will impact on the operation of the system in perpetuity. The most predictable changes to the partners would be either a change to ownership status (for example, of Scottish Water or Scottish Canals) or the disbandment of a partner agency (for example it is conceivable that Scottish Canals may, at some point, be disbanded with the canal network being assessed as non-critical infrastructure, leading to dereliction of the canals). Changes in partner status may be regarded as unlikely, however the operational agreement and legal framework should make provision to minimise the risk to the drainage partnership and to the operability of the system. Figure 7 provides a representation of a number of the principal components that need to be considered within the operational agreement.

Construction and adoption of assets

The investment and construction of assets resides with the organisations that make up the Developer Partnership. The assets need to be designed and constructed in-line with planning conditions and relevant regulations (for example, Sewers for Scotland 3rd edition). InnH2Ovate have produced a draft guidance document for the Development Partnership (Appendix 1) which outlines the obligations of the developers to construct adequate surface water drainage systems to service the proposed developments and can be connected to the proposed NGIWMS.

The process for the adoption of assets is complex. The SuDS constructed by the developer, under the current regulatory framework, should be vested and adopted by Scottish Water. Scottish Water will sit on the Drainage Partnership and will therefore be engaged within the decisions at each stage of the design, construction and adoption process. It is reasonable to assume that Scottish Water will only vest SuDS when the system can demonstrate continued compliance with the relevant regulations.

Connection of assets to canal and dynamic control system

The connection of assets to the drainage system is one of the most important activities of both the Developer Partnership (with responsibility for ensuring that the asset is ready to connect) and the Drainage Partnership (ensuring that the drainage system has capacity and is ready to receive the connection of the asset). The Drainage Partnership has started to document the requirements needed for asset connection. Appendix I details the design considerations developers need to implement to successfully connect to the drainage system.

At the point of connection and adoption of assets, consideration needs to be given to the control systems required to allow Scottish Canals to operate the system in a dynamic way. As well as the physical control systems that might include remote sensing, there needs to be a set of operational rules agreed which recognise the impact that actions by Scottish Canals could have on the SuDS, housing, commercial premises and roadways in the event of closing or reducing the flows to the drainage system.

Sensing and monitoring of the system network

The proposed dynamic nature of the drainage system forms a critical and unique part of the proposition for flood risk management in North Glasgow. In order for this to be effective, sufficient investment in innovative controls and sensing systems are required. It should be the responsibility of the Drainage Partnership to identify, commission and implement sufficient controls and monitoring to enable the dynamic elements of the system to operate effectively and within the agreed scope of the operating parameters of the drainage system. It is proposed that Scottish Canals will be responsible for the maintenance and operation of the monitoring and sensing equipment within the context of the operational agreement.

Operation under defined "normal conditions"

The normal operating conditions will need to be defined by the partners and to include a range of control parameters which will be centred on the flows of water, with some basic quality parameters also included. The capacity of the system will need to be defined within the operational agreement to enable connection of additional parts of the system as the developers build out the planned developments. The maintenance of existing exceedance routes will off-set any shortfall in design capacity within the drainage system, meaning the risk of flooding will be minimised with the development and application of the proposed drainage system.

As part of ongoing normal operations, elements such as routine dredging will need to be considered. While the function of dredging is principally to maintain the statutory duty for navigation, Scottish Canals should consider the frequency of dredging to enable maintenance of the design capacity of the drainage system in perpetuity. Sufficient planning and monitoring of the effectiveness of dredging will need to be included in the normal operations of the drainage system.

Scottish Canals, as the lead authority of the Drainage Partnership, will be responsible for monitoring the performance of the drainage systems and will have sufficient systems in place to give early warning of a deviation from normal operating conditions. The definition of a significant deviation in normal operating conditions will need to be agreed between the Drainage Partnership members; where a significant deviation would trigger an event and the possibility of invoking the emergency planning processes.

Emergency planning

Consideration should be given to the development of robust emergency planning processes. This is particularly important where you have a multi-agency partnership approach. Incidents and events need to be managed in a very different way from normal operating conditions. It is recommended that a detailed emergency planning process is developed from existing processes documented within the Drainage Partnership Agencies. Scottish Water and Glasgow City Council have mature emergency planning systems in place, and elements of these systems can be modified and adopted by the Drainage Partnership. In particular, consideration should be given to:

- The formation of an "Incident Management Team" (IMT) during a defined incident.
- The IMT should be made up of representatives of the Drainage Partners and, other relevant interested parties.
- The IMT should have a defined communication protocol for the preparation of briefs to the Media and the Scottish Government.
- The IMT should have a defined recovery plan for a range of identified incidents and events.
- Some scenario planning and exercises should be based on possible incidents and practised at regular intervals to ensure the IMT are prepared for any incident.
- The lead decision maker for the IMT needs to be agreed.

The IMT would be accountable for ensuring that the recovery of the drainage system to normal operating conditions is achieved as soon as practically possible. This will vary with the type and severity of the incident or event.

Maintenance and serviceability

Scottish Canals, as the Drainage Partnership lead and principal operator of the system, will need to develop a maintenance plan designed to ensure ongoing serviceability of the drainage system in perpetuity and to normal operating conditions. The maintenance plan will be a combination of capital maintenance interventions, which include ensuring the integrity of the canal system, together with routine and reactive maintenance elements which cover operational maintenance and reacting to damage incurred during possible incidents and events. The maintenance plan should cover a reasonable planning period, for example 5 years, and be fully funded within the financial arrangements agreed between the Drainage Partnership members. Some additional elements of maintenance will fall out with Scottish Canals' responsibility as the assets will be owned by other partners. This may include (but is not limited to);

- Roadways
- Connecting SuDS
- Existing Exceedance routes

Each accountable agency will need to ensure that maintenance plans are developed and approved by the Drainage Partnership and in place to enable ongoing normal functioning of the drainage system.

Decommissioning

The drainage system must be functional in perpetuity. However, some assets within the system will have a useful functioning lifespan less than the expected functioning lifespan of the drainage system. This will necessitate the decommissioning, upgrading or re-designing of a range of assets within the system to ensure ongoing functioning of the drainage system as a whole. The operational agreement will need to make provision for their decommissioning and allow for new assets to be built and adopted as replacements. It should be the responsibility of the Drainage Partnership as a whole to ensure that decision making and governance over asset decommissioning (and subsequent asset adoption)

is managed in such a way as to ensure the integrity of the drainage system functionality in perpetuity.

5.5 The Legal Agreement

The legal agreements required for the Drainage Partnership should detail the funding arrangements, liabilities of each partner, requirements to maintain the system in perpetuity and the actions required in the event of a change to the constituents of the Drainage Partnership. The Heads of Terms will need to set out the guiding principles which will then inform the legal agreements required to build and operate the system. The following section outlines a range of principles which may be considered for inclusion in the Heads of Terms and Legal agreements.

Open book financial arrangements

A principal risk (outlined in Section 6) is the ongoing finances required to build, maintain and operate the assets in perpetuity. The partners are in agreement that the drainage plan will deliver sustainable growth and other societal benefit to North Glasgow. However, agreement has yet to be made on the structure of the financing of the strategic plan. The financing will be derived from a range of sources and from the partner agencies and other funding routes (through developers, Scottish Government grant funding, etc.). Given the range of possible revenue streams, consideration should be given to an open book arrangement so that all partners have complete transparency on the funding of the project.

Contract review

The drainage system needs to exist and operate in perpetuity. However, as highlighted previously, there could be a change in status of the partner organisations which may put the partnership at risk and/or change the investment or operational dynamic of the operating agreement. Given that this is a possibility, consideration should be given to building in a contract break within the legal agreements and/or a suitable notice period of change. Within the contract review function, detail should be given on which partner would assume the role of operator of last resort in the event of the lead operator having a fundamental change to the status of the organisation. As each of the members of the Drainage Partnership constitutes a public body, the risk remains within the public sector and with the Scottish Government; unless and until the Scottish Government decides to divest the assets of the public body to a private enterprise.

Service provider of last resort

The Heads of Terms should make reference to a service provider of last resort as a consequence of change of status of the nominated lead operator to ensure that the drainage system can operate in perpetuity. The legal agreements should detail the statutory requirements that would be placed on the service provider of last resort and provision should be made to ensure that financing the service provider of last resort can be achieved to allow continuation of the drainage system operations (to the service levels agreed).

Delivery of service in perpetuity

The Heads of Terms and legal agreements should make reference to and define what is meant by "in perpetuity" and the obligations that this places on the partnership. The detailed operational agreement should define the baseline level of service required of the drainage system and the expected performance under a defined set of stressed operating conditions. It is advisable to include reference to the maintenance of existing exceedance routes to ensure sufficient existing capacity to manage storm water accumulation from unpredicted extreme events.

Liabilities in the event of service failure

The level of expected service needs to be defined and in addition the actions to be taken in term of recovery of service in the event of failure. It is recommended to define a range of possible failures through the emergency planning process and have recovery plans in place. It is recognised that, at times, unpredicted or unforeseen failures may occur and that should be reflected in the operational agreement. The Drainage Partnership may wish to consider making provision for failure recovery within the financial planning of the operational budget. The legal agreements should define each partner's responsibility and liability for the possible failures for each of the nodes within the system.

6. Risks and Opportunities

Risk and opportunities were discussed at the two workshops held as part of this project. The principal risks are listed in Table 1, along with the risk owners, who bares the costs and some indication of possible mitigation measures. The risks are discussed in more detail in the following section.

Table 1: Risks and risk owners within the integrated drainage system

System Node	Owner	Capital Cost	Operational cost	Risks	Mitigation Measures
Developments	Developer, domestic and commercial residents	Developer	Developer, domestic and commercial residents, GCC	The developers need clarity on the guarenteed support from GCC and SW to provide infrastructure for Growth	SW are funded for growth and GCC are committed to supporting growth and regeneration of North Glasgow
Roadways	Glasgow City Council	GCC	GCC	The risk here is that the road systems are designed to take a specific load of surface water based on the Scottish Canals system but then the planned system does not perform or funding is not obtained for implementation of the scheme.	Ensure that the planned systems are flexible enough to partially mitigate any design uncertainty with the Scottish Canals system.
Existing surface water drainage routes	Scottish Water and Glasgow City Council	GCC and SW and other third parties	GCC and SW and other third parties	Existing surface water drainage routes are not maintained.	Ensure that existing drainage routes are available until the new system is tested. Ensure there is sufficient residual capacity within the system to compensate for any uncertainty with the Scottish Canals Scheme.
SuDS	Developer then vested by Scottish Water	Developer	Scottish Water	SuDS are not fit for purpose and therefore not vested by SW.	Ensure early engagement at the design phase between SW and the developers (possibly through the developer partnership). This will enable SW to assess the SuDS design to ensure it is compliant before vesting.
Control systems	The Drainage Partnership	TBC	TBC	The delegated authority for the control systems is not clear leading to a failure to manage the dynamic system resulting in floods in North Glagsow	Ensure the partnership is clear on accountability for controlling the system with penalties; incident management systems and recovery plans detailed.
Canal system	Scottish Canals	Scottish Canals	Scottish Canals	The design of the scheme fails to deliver the design capacity resulting in frequent flooding in North Glasgow.	Ensure the uncertainty of the designs are understood and documented within the contracts and operating agreement. Ensure additional existing surface water drainage capacity is maintained until the Scottish Canals Scheme is tested. The testing and verification plan should be built in as an annex to the contracts.
River systems	TBC	TBC	TBC	Pollution incidents may occur and compromise WFD targets (or other regulatory obligations). The volume of water received by the river may have an impact on the ecology and flooding.	The design and operation of the system should take into account peak flow. As part of the design work, identification of possible routes for pollution entry shopuld be identified with mitigating actions agreed with the ÒpolluterÓ to ensure minimum risk of pollution incidents.
Monitoring system	The Drainage Partnership	TBC	TBC	The monitoring system design may be insufficient to identify and report emerging risks to the system in time to take preventative action.	Ensure that the monitoring systems are funded in such a way as to build sufficent certainty into the collection and reporting of realtime data. Sufficent operator training along with robust management plans need to be defined in advance of systems Ògo liveÓ. The systems specifications and penalties for failure should be clearly defined in the contract.

6.1 Operational Risks

The two main risk categories are operational and financial. Although discussed separately here, both risk areas must be addressed collectively to ensure that the integrated drainage system operates effectively.
There are several operational risks that need to be addressed and, in the majority of cases, will be owned by the lead operator of the system. The risks include, but may not be limited to:

Control system functionality

The control systems (for example pumps, switches, valves, monitoring system, etc.) must be fully operative at all time for the drainage system to function. Failure of these components could lead to flooding, property damage, and public health related issues. The Drainage Partnership should confirm that an effective planned maintenance schedule is in place to maintain the functionality of the strategic assets. This maintenance plan should include provision for capital replacement of critical system components.

Staff competence and resource availability

There is a risk to operations that staff are not competent or sufficient to operate the system. This can easily be mitigated by ensuring sufficient operational staff are identified and suitably qualified and trained with ongoing development plans. The training should include sufficient coverage of emergency planning.

Civil infrastructure maintenance and capital investment

There is a risk that insufficient attention is paid to the maintenance of the canal network, drainage routes and SuDS which contain the surface water runoff. Failure to maintain the civil components of the system could lead to either a node failure or system failure. The risk of failure can be mitigated by sufficient ongoing capital investment and good asset management planning. The lead operator should own the asset maintenance plan and ensure planned work is conducted on time and within budget.

There may be a requirement for other partners within the Drainage Partnership to own the asset maintenance of nodes within the system that they own and operate (for example Glasgow City Council have ownership and accountability for the road systems).

6.2 Financial Risks

The integrated drainage plan will only succeed in perpetuity if the system is adequately financed. Some elements of the system, for example, ongoing maintenance of the SuDS are funded through Partner organisations but many elements are less well defined. The financing arrangements of the whole system need to be well defined and it is suggested (in Section 5) that an open book policy is adopted for transparency of funding within the Drainage Partnership. A detailed budget will need to be developed which includes, but is not limited to:

- Investment requirements (for example, new SuDS and swayles, etc may be funded by the developers)
- Ongoing maintenance costs with details of the accountabilities of each partner
- Ongoing operational costs
- Provision for reactive maintenance
- Provision for emergency planning

6.3 Reputational Risks

There are opportunities and risks in terms of reputation. If the integrated management system and Drainage Partnership goes forward this could be seen as an exemplar European project and deliver a positive reputational benefit to the Drainage Partners, to Scotland and to Glasgow. Equally if the system fails then the severity of the failure could be damaging to the individual partners or collectively to the Drainage Partnership. Reputational risk can be mitigated by appropriate financial planning coupled with well-defined and implemented operational agreements and process. This would include adequate recovery planning in the event of a systems failure.

6.4 Environmental Risks

Environmental risks can be categorised into risks likely to occur during construction and risks likely to occur during ongoing operation of the system.

Construction risks

The workshop participants identified this category of environmental risk as the most likely to

occur, where construction (of a development or component of the drainage system) may cause pollution in the form of soil runoff, hydrocarbon (for example diesel spills) or other forms of infraction. The possibility of environmental risk can be mitigated by appropriate planning, site management, monitoring and control.

Pollution incidents during operation

The risk of pollution of the water bodies during normal and stressed operation of the drainage system was considered. It was felt that this risk was low as in many cases the SuDS will be designed to capture and remove contamination before it enters the canal network and river systems. It is also likely that the dilution effect of the pollution entering the canal will be such that the impact of a local pollution incident will be minimal. Mitigation of pollution incidents should be considered and written into the emergency planning processes. This should include adequate responses to a range of scenarios, contact with SEPA, monitoring and recovery planning.

6.5 Transfer of Risk and Liability

The nature of the partnership is such that the status of the partners may change during the lifetime of the partnership, meaning the ownership and transfer of risk between partners is a risk to the individual partners themselves. It may be unlikely that the status of the partner organisations change, however consideration should be given to the possibility. While it will be difficult to fully mitigate the risk of liability transfer, the legal agreements can account for this by defining the service provider of last resort (Section 5).

7. Conclusions and Recommendations

The proposals for the North Glasgow Integrated Water Management System are to be commended. The MGSDP have a fantastic vision for a pioneering drainage system which, if implemented, could be held as an exemplar sustainable drainage system which promotes and enables economic regeneration and growth, social justice and the alleviation of flood risk. The NGIWMS studies to-date (Section 3) highlight that the proposed system is possible and that the individual partners have a desire to work together in collaboration to make the integrated drainage system a success.

In order to ensure success it is recommended that two distinct partnerships are formed, one focusing on development (the Developer Partnership), led by Glasgow City Council and tasked with delivery of the infrastructure required for regeneration in North Glasgow; the other partnership (the Drainage Partnership), led by Scottish Canals and focusing on the ongoing operation and maintenance of the integrated drainage system.

In order to make the partnership operate effectively together (and within partnerships) a set of legal and operational agreements need to be prepared which cover:

- Investment in infrastructure
- Operation of the drainage system
- Definition of system design capacity and expected "normal" operating conditions
- Definition and range of the "dynamic" elements of the system (which informs the system design capacity)
- Maintenance of the drainage system
- Emergency planning
- Transfer of risk and liability in the event of a change to the partnership constituents
- Financing to ensure the drainage system can operate "in perpetuity"

Overall the recommendations can be summarised as follows:

- The system is ambitious but would deliver quantifiable benefits to Glasgow and Scotland. These benefits include economic growth, environmental improvement, social justice and flood risk mitigation.
- The system should be governed through two partnerships; The Development Partnership and the Drainage Partnerships.
- GCC should lead the Developer Partnership
- Scottish Canals should lead the Drainage Partnership and be the lead operator of the dynamic integrated drainage system.
- Funding the system (for asset investment, maintenance and operation) needs to be secure and presented open book to ensure sustainability of the system "in perpetuity"

8. References

AECOM. 2011. Green Networks Integrated Urban Infrastructure – 6 Candidate sites; Cowlairs – Surface Water Management Strategy

AECOM, BIOMATRIX WATER. 2013a. North Glasgow Integrated Water Management Study.

AECOM. 2013b. NGIWMS Commercial Workshop #1.

AECOM. 2014a. North Glasgow Integrated Water Management System (NGIWMS) Summary Business Case..

AECOM. 2014b. North Glasgow Integrated Water Management Study – Phase 3 Reports.

GILL, A. 2008. Making Space for Water Urban flood risk & integrated drainage (HA2): IUD pilot sumGILL, A. 2008. Making Space for Water Urban flood risk & integrated drainage (HA2): IUD pilot summary report. In: DEPARTMENT FOR ENVIRONMENT, F. A. R. A. (ed.). London.

HULL CITY COUNCIL 2009. Surface water management plan and Aqua Green Project. In: COUNCIL, H. C. (ed.).

LAMOND, J. 2014. Learning and Action Alliance for a Blue Green City of Newcastle. In: PROJECT, B. G. C. (ed.).

OUSEBURN CATCHMENT STEERING GROUP 2009. OUSEBURN CATCHMENT ACTION PLAN In: REPORT, O. C. S. G. (ed.). Newcastle Upon Tyne.

QUINN, P. F. & TELLIER, S. 2009. A report on the Public Engagement activities in the Upper Ouseburn Making Space for Water Project In: GROUP, O. C. S. (ed.). Newcastle upon Tyne.

Scottish Water. 2015. Sewers for Scotland - A technical specification for the design and construction of sewerage infrastructure. 3rd edition

WILKINSON, M. E., QUINN, P. F. & HEWETT, C. J. M. 2013. The Floods and Agriculture Risk Matrix (FARM): A decision support tool for effectively communicating flood risk from farmed landscapes. International Journal of River Basin Management, 11, 237-252.

Appendix 1: North Glasgow Integrated Water Management System (NGIWMS) – Draft Drainage Partnership Guidance for Developers, InnH2Ovate, 2016.

Introduction

This document has been prepared to set out the recommended general and specific guidance, design considerations and approval processes to assist developers proceeding with the generation of proposals for surface water drainage within the North Glasgow area, which will ultimately drain to the Forth and Clyde Canal, as set out within the Concept of the NGIWMS.

The NGIWMS Drainage Partnership comprises of the following organisations:

- Glasgow City Council
- Scottish Water
- Scottish Canals

All of whom are committed to the future development of North Glasgow and the integration of surface water drainage systems to provide good design responses to water quantity and quality management requirements, combined with urban design and place making approaches, the inclusion of green infrastructure and capturing opportunities to deliver wider benefits.

Reference should be made to the following documentation and design guidance:

- SuDS Scotland Working Party – Water Assessment and Drainage Assessment Guide 2016;
- Scottish Canals Code of Practice
- NGIWMS Concept, AECOM 2013;
- CIRIA C753 – The SuDS Manual 2015;
- Sewers for Scotland 3rd Edition; and
- Water Environment (Controlled Activities Regulations) (Scotland) Act 2011.

Engagement and Approval

It is anticipated that developers who are seeking to utilise the NGIWMS infrastructure, will engage with the Drainage Partnership at a number of key stages, identified below, during the development of drainage proposals to ensure that the proposed drainage infrastructure support the overall system and are acceptable to the Drainage Partnership.

Surface Water Management Strategy

A Surface Water Management Strategy (SWMS) for developments should be developed to identify the key aspects of infrastructure, consider development requirements should opportunities arise to integrate proposals, ensure that the strategy incorporates the key aspects of design including, but not limited to the following factors:

- Greenfield runoff criteria;
- Exceedance routes
- Climate change considerations
- Design horizon;
- Overall details of drainage proposals including strategic modelling to determine volumes and flows.

An example checklist of considerations to be included within a SWMS is included in Appendix A.

Surface Water Management Plan

A Surface Water Management Plan (SWMP) should incorporate enhanced detail on the SWMS, it should include more details aspects such as:

- Detailed hydrological and hydraulic modelling, incorporating 3D surface modelling of exceedance routes;
- Asset ownership;
- Roles and responsibilities associated with future management and maintenance of all assets within the proposals;
- Risk Assessments associated with the construction, maintenance and decommissioning of the assets. The Drainage Partnership anticipate having representation invited to relevant workshops associated with the assessment and mitigation of risks associated with drainage infrastructure.

Constructions Proposals

The construction proposals should set out the details of all elements of drainage, proposed standards and specifications, highlighting any deviations to accepted standards.

Construction Supervision

During construction, the drainage partnership anticipate having regular updates on progress and access to the site to inspect and monitor the construction of drainage assets to ensure quality is maintained and the final proposals are in accordance with the overall scheme and proposals, as set out through the above process.

Vesting of Infrastructure

It is anticipated that the drainage infrastructure from property curtilage will be adopted and vested with the drainage partnership or the individual organisations which comprise the partnership.

Relevant Legislation

1. Building (Scotland) Regulations 2004
2. Climate Change (Scotland) Act (2009)
3. Environmental Impact Assessment (Scotland) Regulations 1999
4. Floods Directive 2006 (Directive 2007/60/EC)
5. Flood Risk Management (Scotland) Act 2009
6. Planning etc. (Scotland) Act 2006
7. Provision of Water and Sewerage Services (Reasonable Costs) (Scotland) Regulations 2011
8. Roads (Scotland) Act 1984
9. Scottish Planning Policy 2014
10. Sewerage (Scotland) Act 1968
11. Town and Country Planning (Scotland) Act (1997)
12. Water Environment and Water Services (Scotland) Act 2003
13. Water Environment (Controlled Activities Regulations) (Scotland) Act 2011
14. Water Framework Directive 2000 (Directive 2000/60/EC)
15. Water Industry (Scotland) Act 2002
16. Water (Scotland) Act 1980

Deviations to guidance and standards

It is recognised that the NGIWMS has specific requirements to be incorporated, whilst also presenting wide ranging and significant benefits to all involved through a partnership approach to drainage provision. These opportunities will be realised through application of innovative approaches and adopting alternative best practice solutions, which may not readily meet current recognised guidance, policy or standards. These approaches are to be encouraged by the Drainage Partnership and will be developed in response to some of the site specific requirements set out below:

SuDS design

As a result of the development of the concept and continuous improvement in best practice, non-standard SuDS solutions are anticipated to be included within developments within the NGIWMS area. To ensure that these are developed within a framework that will ensure adoption by the Drainage Partnership organisations, continuous dialogue is to be actively promoted to ensure that the proposals mitigate any potential risks to realisation, whilst maximising the potential benefits for the future developments.

Exceedance Routing

Developments should demonstrate the pre-developed exceedance routes associated with runoff. The NGIWMS is designed to accept greenfield runoff from developments, or increased values upon mutual agreement, for events up to and including the 0.5% AEP design event. Excess runoff from events exceeding this threshold is expected to follow the pre-developed exceedance routes and the process for design development and approval should be supported by appropriate evidence.

Climate Change

Each development should account for climate change, through determining the best available information to determine the future climate change scenarios, considering all forms of variance to precipitation and temperature within the design horizon of the development. Developments are expected to incorporate mitigation to the effects of climate change within the development and demonstrate that there will be no increase of flood risk elsewhere.

Dynamic Controls

The NGIWMS is based upon the incorporation of dynamic controls associated with the canal infrastructure. Future opportunities to optimise the NGIWMS will be dependent on the potential to enhance the dynamic performance of the wider drainage infrastructure and, therefore, designs should take cognisance of this option and incorporate appropriate details to suport this being implemented by the Drainage Partnership when necessary.

Appendix A – Example Surface Water Management Strategy Check List

Development type	
Climate Change allowance? • Evidence for reasoning – design horizon? Likelihood to be exceeded? • UKCP Scottish Canals CoP 4.1.2.1. requires 20% CC and 20% Urban Creep – justification for alternative to 40% requirement needs to be provided	
Greenfield runoff rates – calculations/method •IOH124 •Matching rates for return periods	
Check key parameters used in Greenfield calculations and modelling: • SAAR • SOIL • FEH	
Contributing area •Total •Hard standing •Assumptions/level of detail available in design process	
Development discharge runoff hydrographs: • Range of return periods: 1, 5, 10, 30, 50, 100, 200 year return period events • Range of durations 30, 60, 120, 240, 720, 1440, 2880, 4320, 5760 minutes	
Treatment Requirements • Proposed treatment management train • CAR Licence Requirements • CIRIA C753 The SUDS Manual	
Discharge controls • Complex control • Hydrobrake	
Exceedance events – refer CIRIA C635, demonstrate that extreme flows will not have significant adverse effect on canal infrastructure.	
Proposals for Adoption and Maintenance	
Additional consents to considered • Historic Scotland • SEPA • Local Planning requirements	
Consideration of retrofitting dynamic controls as part of wider North Glasgow Integrated Water Management Systems (NGIWMS) –developments considered integral to the NGIWMS may require to have provision for future retrofitting of dynamic controls and	

Scotland's centre of expertise for waters

CREW Facilitation Team

James Hutton Institute

Craigiebuckler

Aberdeen AB15 8QH

Scotland UK

Tel: +44 (0)1224 395 395

Email: enquiries@crew.ac.uk

www.crew.ac.uk

CREW is a Scottish Government funded partnership between the James Hutton Institute and Scottish Universities.