AECOM **Water**

Glasgow City Council
North Lanarkshire Council
Glasgow and Clyde Valley Green Network Partnership

Dec 2011

Gartloch and Gartcosh

Surface Water Management Strategy

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Gartloch and Gartcosh Surface Water Management Strategy

Rev No	Comments	Checked by	Approved by	Date
Draft 1		PMR	PMR	5th Sept
Draft 2		PMR	PMR	28th Oct
Final		PMR	PMR	1st Dec
Final	Page 29, number of units amended from 600 to 300	PMR	PMR	20th Dec

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Job No: 60186328 Reference: M001.005 Date Created: Dec 2011

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Executive Summary

This report has been produced for the purpose of presenting a Surface Water Management Strategy (SWMS) for the Gartloch and Gartcosh area.

The site encompasses c.24 km^2 located within the central belt of Scotland, within the boundaries of both Glasgow City Council and North Lanarkshire Council.

Glasgow City Council, North Lanarkshire Council and Glasgow Clyde Valley Green Network Partnership have proposed creating a new Wetland Park within the study area, see Collective Architectures report 2011. A draft vision and masterplan for 'The Seven Lochs Wetland Park' has been published setting out proposal to:

- create a new wetland park of both national and European significance,
- to deliver, manage and sustain a high quality innovative wetland environment that will protect and enhance the biodiversity of the area as a national resource; and
- promote the general health and wellbeing of both visitors and residents alike, and contributes to the environmental, economic and social regeneration of the area.

There are currently plans for up to 4300 new homes within and around the Wetland Park area, including 6 Community Growth Areas. The development of the Wetland Park aims to integrate these new developments into the surrounding landscape through the creation of new green infrastructure and multi-functional green networks.

This document sets out a Surface Water Management Strategy for future development in the Gartloch and Gartcosh area. The strategy aims to balance environmental constraints and opportunities within new development, and integrate development into the Wetland Park through the creation of new green infrastructure. It sets out key concepts for future surface water management in the area.

The SWMS requires to attenuate future runoff to the undeveloped 'Greenfield' runoff rates and mitigate future climate change effects to prevent and increase flood risk downstream of the CGA's. It follows the guidance and requirements set out in Scottish Planning Policy (SPP) and will meet the guidance of CIRIA 697 – The SuDS Manual, and Controlled Activity Regulations – The Water Environment (Controlled Activities) (Scotland) Regulations 2005.

The principles upon which a detailed Surface Water Management Plan (SMWP) for each CGA can be developed have been set out. Alongside this, ways of changing the adoption and maintenance approach to SuDS are discussed and a maintenance schedule in line with the SuDS manual is proposed.

Consultation has been carried out with key client stakeholders including Glasgow City Council, North Lanarkshire Council and Glasgow and Clyde Valley Green Network Partnership, with data collection for the overall study including a wider range of authorities, regulators and relevant parties.

The primary principles for the development and the design study process was to create exemplar infrastructure elements and base the design study process around the infrastructure. Establishing a more integrated approach to the design study process that looks at:

- base line constraints on site;
- exemplar infrastructure; and
- Developing a plan around the above.

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1 Introduction

1.1 Project background

This report presents a Surface Water Management Strategy (SWMS) prepared as part of a wider hydrological study of flood risk and future drainage requirements within the Gartloch and Gartcosh area, undertaken for Glasgow City Council (GCC) in conjunction with North Lanarkshire Council (NLC) and the Glasgow and Clyde Valley Green Network Partnership (GCVGNP).

The Gartloch and Gartcosh area has been identified as a community growth corridor by GCC and NLC, and various studies to examine how new development can be balanced with protection and enhancement of the environment have been carried out over the last few years. The Gartloch and Gartcosh Green Network Strategy (Land Use Consultants, 2008) proposed the creation of a Wetland Park. A site selection and development guidance study (URS/AECOM, 2010), examines sites with the potential to accommodate appropriate forms of development, and design principles for these sites. This study highlighted the area's complex hydrology as one of the most significant development issues at Gartcosh and Gartloch. This Surface Water Management Strategy has been produced side by side with a detailed hydrological study of the area to further inform the potential development in the Gartloch and Gartcosh area.

A draft vision and masterplan for the proposed Seven Lochs Wetland Perk has also been developed (Collective Architecture, 2011). This examines the development of habitat and access networks and new visitor infrastructure. It also examines how CGAs and other planned developments can be linked to the Wetland Park through the creation of new green infrastructure.

The long term vision for the Gartloch/Gartcosh area is to create a Wetland Park of national significance and integrate anticipated long term sustainable community growth with the protection and enhancement of the natural environment. Drainage of surface water lies at the root of this vision and so an understanding is sought of the hydrological interactions within the area, giving the partnership information to take forward within the overall community masterplan.

A strategic hydrological assessment undertaken by AECOM[1] also aims to further inform the masterplanning processes helping with the sustainable development objectives of the Community Growth Areas in eastern Glasgow and at Gartcosh and Glenboig in North Lanarkshire.

The holistic approach will assist the partnership in fulfilling five underlying objectives of the Metropolitan Glasgow Strategic Drainage Plan (MGSDP).

1. Flood risk reduction

2. River water quality improvement

3. Enabling economic development

4. Habitat improvement

5. Integrated investment planning

Within the Gartloch and Gartcosh Hydrological Assessment AECOM have provided a hydrological and hydrogeolgical study for the site, whilst this report presents a Surface Water Management Strategy (SWMS). The hydrological study includes the definition of areas that would flood for return periods of 50, 10, 3.33, 2, 1, 0.5, and 0.2% AEP events with consideration given to a climate change allowance, referring to increased rainfall intensities and depths of 30%. The study encompasses an assessment of the sewerage system involving Integrated Drainage Models and reference to the interactions with the surface water regime.

1.2 Gartloch and Gartcosh Site

The study area is located within the central belt of Scotland lying within the boundaries of both Glasgow City Council and North Lanarkshire Council and forms parts of the Glasgow Green Belt, with the study area encompassing approximately 24km^2 at grid reference 268800, 667000.

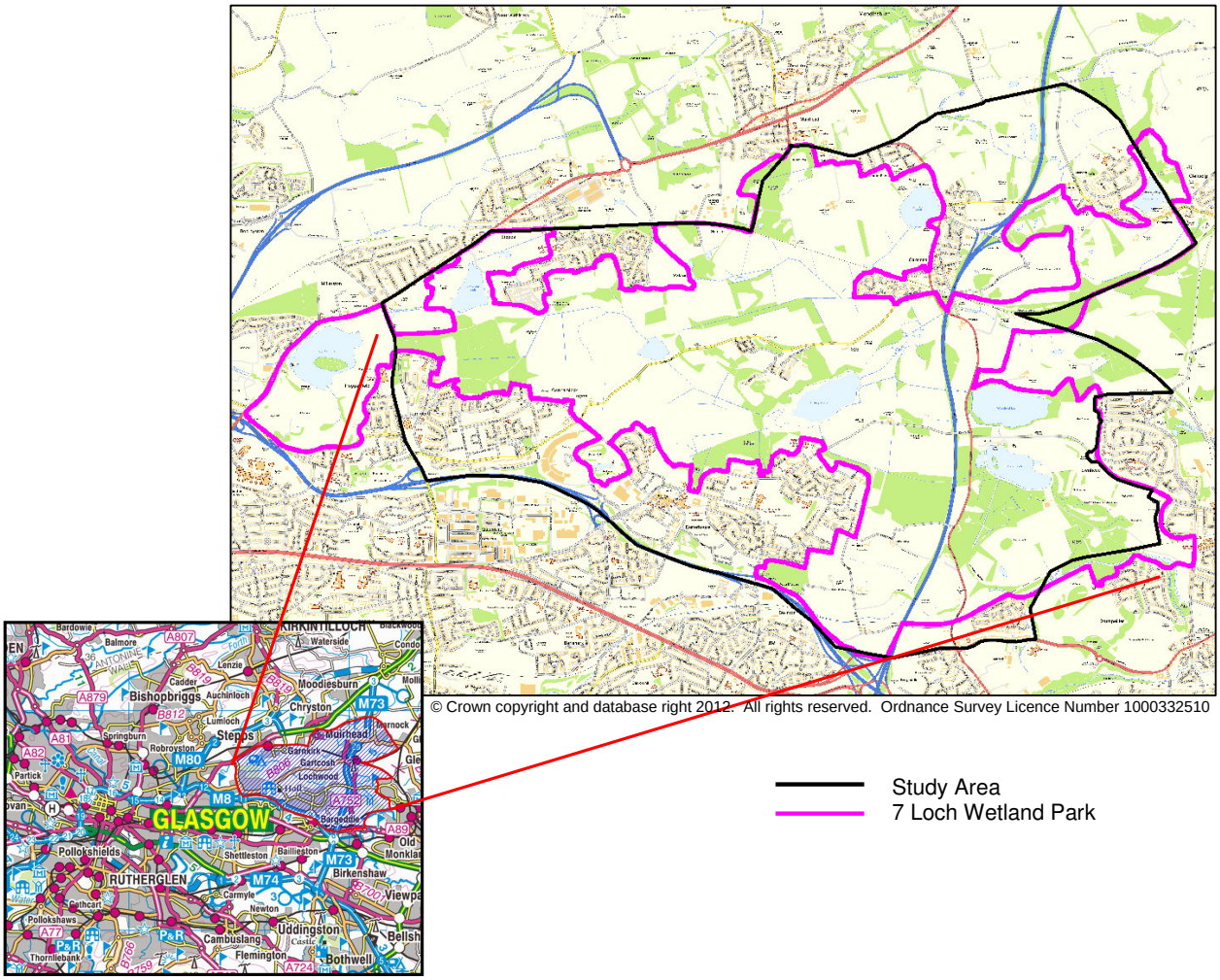
Figure 1.1 shows the extent of the study area which stretches from Hogganfield Loch in the west to Woodend Loch and Lochend Loch in the east. The proposed boundary for the Seven Lochs Wetland Park is also shown.

[1] Gartloch and Gartcosh Hydrological Assessment, Dec 2011, AECOM

The western edge of the park is situated 5km to the east of Glasgow City Centre. The study area stretches for 8.7km east to west at its widest extents from the east end of Glasgow towards Coatbridge in North Lanarkshire.

The location within the central belt provides an opportunity for the study area to be of national significance with the creation of a new wetland park with good transport connections. The park is surrounded by established communities on all sides.

Figure 1.1 – Site Location Plan



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The site is generally undulating with the elevation in the catchment, varying from over 105m AOD to below 65m AOD. The site is a complex network of drainage ditches, lochs, wetland, seasonal water bodies and ponds. There are several burns flowing through the site, which are tributaries to either the River Clyde or the River Kelvin and include the:

- Garnkirk Burn
- Bishop Burn
- Bothlin Burn

- Gartsherrie Burn
- Cult Burn
- Molendinar Burn

The site predominantly drains to the Bothlin Burn in the north east with the exception of Hogganfield and Frankfield Loch which drain towards the Molendinar Burn to the south west. The Bothlin Burn initially flows east, and then northwards towards Kirkintilloch. The drainage pattern on the site is complex and divided amongst three subcatchments, which include significant water bodies, shown in **Figure 1.2, Appendix A**. The main hydrological flow and wetland corridors are:

- Frankfield Loch - Hogganfield Loch - Molendinar Burn
- Cardowan Moss - 'Gartloch' - Bishop Loch - Bothlin Burn
- Woodend Loch - Bothlin Burn (westward then north)
- Craigendmuir - Heathfield - Bothlin Burn
- Johnston Loch – Bothlin Burn (south then east)

Large areas of peat are present at Baillie Moss, Cardowan Moss, Commonhead Moss and, Heathfield / Garnkirk and Drumpellier.

1.3 Proposed Development

It is anticipated that the Gartloch Gartcosh area will come under intense development pressure over the coming decade. The Glasgow and Clyde Valley Structure Plan (2006) indicates that the area has the potential to accommodate 4300 new homes, and both Glasgow City Council and North Lanarkshire Council have identified potential Community Growth Areas in their local development plans..

The Seven Lochs Wetland Park vision and masterplan examines how some of these CGAs can be linked to the development of the Wetland Park through the creation of new green networks. **Figure 1.3, Appendix A** sets out the CGA's and potential developable areas identified in the Site Selection and Development Guidance Study (URS/AECOM, 2010). The Wetland Park vision and masterplan also uses the Integrated Habitat Network (IHN) model to look at opportunities to expand habitat networks. **Figure 1.4**, **Appendix A** shows the wetland habitat networks in the study area. Opportunities for landscape, habitat and access improvements exist at all CGAs. The Wetland Park masterplan includes conceptual designs for each of the CGAs (**Figure 1.5, Appendix A)**. In general these include a main arterial route which provides a stem for 'green fingers' to branch out through development to the surrounding area. It is this green network that defines the layout of a development as well as creating public access routes and habitat corridors. This approach provides an opportunity to create sustainable places of quality design, which promote the well being of both the residents of the CGAs and visitors to the Wetland Park.

This strategy to integrate CGAs into the Wetland Park focuses on the management of surface water to provide integrated Sustainable Drainage Systems (SuDS). SuDS make use of the natural topography of the site and existing hydrological elements to create conveyance routes, swales, planted 'green and blue' corridors and retention areas, as well as providing the foundations for infrastructure requirements of future development. The concept of SuDS elements and associated design requirements are expanded on in this report.

To manage surface water in the most responsible way a catchment wide approach should be adopted. This, in essence encompasses the whole catchment in which the study areas sits. This means that the inclusion of proposed new infrastructure/SuDS should not only benefit the new development but also the surrounding areas. An example of this is taking and treating surface water discharging to water courses which perhaps has not been passed through SuDS previously.

Benefits of implementing a catchment wide strategy include:

- realising opportunities to reduce flood risk;
- incorporation of public space in the form of open green space;
- identifying multi-functional land use opportunities;

- enhancement/creation of habitat networks;
- buffering between urban forms and the natural environment;
- incorporation of sustainable construction techniques; and
- a reduction in long term maintenance costs.

The following studies propose a strategy of integration for the following identified areas of community growth:

- Garthamlock;
- Easterhouse north;
- Easterhouse south;
- Gartcosh;
- Glenboig; and
- Gartloch Pools (revised planning proposal)

A masterplanning exercise for the above areas was carried out by Collective Architecture whereby a schematic was produced for each site to illustrate a network of conveyance routes in the form of swale networks and planted green corridors; see **Figure 1.5, Appendix A**. A main arterial route provides a stem for 'green fingers' to branch into the existing environment and urban developments.

Areas identified as CGAs have significant potential for habitat improvement, due to the general lack of quality habitat currently in these locations. The quality design and integration of the CGAs into the wetland park in combination with considered proposals for new habitat areas can ensure an adequate balance of community space and habitat enhancement. Opportunities for landscape, habitat and access improvements exist at all CGAs, not least because these areas were chosen as 'developable' because the current quality of habitat is relatively poor.

1.4 Scope of Report

This report sets out a Surface Water Management Strategy for the Gartloch and Gartcosh site. This aims to promote best practice when applying SuDS techniques to new development. The report discusses the following areas:

- Surface Water Management Strategy incorporating Future Principles;
- Surface Water Management – Setting a New Agenda; and
- Recommendations.

2 Current Planning Policy and Guidance

2.1 Introduction

Flood risk is a material planning consideration for sites, including those with a history of flooding and adjacent to a watercourse. Planning decisions must be made by the Planning Authority in accordance with the Local Plan unless material considerations indicate otherwise. Scottish Planning Policy and advice from the Scottish Environment Protection Agency (SEPA) are important material considerations. Planning Advice Notes (PANs) also provide advice on good practice and other relevant information.

The EU Floods Directive has recently been translated into Scottish legislation through the ratification of the Flood Risk Management (Scotland) Act 2009, which has set out new responsibilities for competent authorities. Although, at this time the new Act has no regulations to provide delivery mechanisms, the changes will imminently come into effect and a proactive approach by all stakeholders can ensure that appropriate planning and decisions will ensure that future work meets the revised requirements and minimise risk for future development.

Apart from planning legislation, the main legal framework for dealing with surface water is the Water Framework Directive (WFD). This is wide-ranging European environmental legislation which became law in Scotland at the end of 2003 through the Water Environment and Water Services (Scotland) Act 2003. The Directive establishes a new legal framework for the protection, improvement and sustainable use of surface waters, transitional waters, coastal waters and groundwater.

Specifically the Water Framework Directive aims to:

- protect/enhance all waters (surface, ground and coastal waters);
- achieve "good status" for all waters by December 2015;
- manage water bodies based on river basins (or catchments);
- involve the public; and
- streamline legislation.

In Scotland, SEPA and the Scottish Government are responsible for taking this work forward. Regulatory controls have been established under the Water Environment (Controlled Activities) (Scotland) Regulations 2005 (CAR) which were passed by the Scottish Parliament on the 1st June 2005.

SEPA is the environmental regulator responsible for protecting “controlled waters” from pollution, and as such plays an important role in the consultation process. SEPA issues Pollution Prevention Guidelines (PPGs) for a range of activities, which outline measures that should be taken by those managing the environmental effects of those activities. The PPGs provide a basis for the assessment of effects on surface watercourses and include information relating to the design of surface water treatment systems.

Sustainable Drainage Systems (SuDS) are a requirement under CAR for most new developments draining to the water environment, and it is increasingly recognised that development and changes in land characteristics has led, and will continue to lead, to increases in surface water runoff rates and volumes and also to decreasing water quality in receiving waters as a result of pollutants from urbanised areas. Sustainable Drainage Systems (SuDS) are becoming increasingly recognised as appropriate mitigation to surface runoff from developments. There have been a number of design reports and guides produced by CIRIA and SEPA to ensure that SuDS are appropriately applied within new developments.

2.2 Scotland

2.2.1 Scottish Planning Policy (SPP)

SPP sets out the Scottish Government’s planning policy on new development and flooding and describes the principles regarding the need to recognise, consider and address flooding from all sources. To prevent further development which would have a significant probability of being affected by flooding or which would increase the probability of flooding elsewhere.

2.2.2 SEPA Policy 41 - Development at Risk of Flooding: Advice and Consultation

Policy 41 is a SEPA planning authority protocol. It is expected that the protocol assists planning authorities and SEPA to address the issues involved when flooding has to be considered in development plans and in the determination of planning applications.

2.2.3 Water Environment (Controlled Activities) (Scotland) Regulations 2005

The Water Environment and Water Services (Scotland) Act 2003 (WEWS) gave Scottish Ministers powers to introduce regulatory controls over activities in order to protect and improve Scotland's water environment. The water environment includes wetlands, rivers, lochs, transitional waters (estuaries), coastal waters and groundwater.

The regulations mean that, from 1 April 2006, it is an offence to undertake the following activities without a CAR authorisation:

- Discharges to all wetlands, surface waters and groundwaters (replacing the Control of Pollution Act 1974 (CoPA));
- Disposal to land (replacing the Groundwater Regulations 1998);
- Abstractions from all wetlands, surface waters and groundwaters;
- Impoundments (dams and weirs) of rivers, lochs, wetlands and transitional waters;
- Engineering works in inland waters and wetlands.

2.2.4 Planning Advice Note (PAN) 61: Planning and Sustainable Urban Drainage Systems

Please note that PAN 61 will be consolidated with two other PAN's relating to water and drainage (69 and 79) in 2012. PAN 61 gives good practice advice for planners and the development industry complementing the Sustainable Urban Drainage Systems Design Manual for Scotland and Northern Ireland, which was published by CIRIA in March 2000 for the Sustainable Urban Drainage Scottish Working Party, this was superseded by the CIRIA SuDS manual released in 2007.

2.2.5 SuDS for Roads Guidance

A SuDS for Roads Guidance document by SCOTS/SUDSWP was released in November 2010 it aims to encourage the inclusion of SuDS features within road design, setting out appropriate design choices and also aimed at encouraging adoption of appropriate SuDS measures.

This technical guidance document is intended for use by roads engineers, consulting engineers and by other professionals within the built environment involved with planning, design, construction, operation, adoption and maintenance of roads, surface water drainage and associated SUDS for new and existing developments.

2.2.6 SEPA Pollution Prevention Guidelines (PPGs).

PPGs give advice to industry and the public on legal responsibilities and good environmental practice, each PPG is targeted at a particular industrial sector or activity. The key documents include:

- PPG1: "General Guide to the Prevention of Water Pollution";
- PPG2: "Above Ground Oil Storage Tanks";
- PPG5: "Works In, Near or Liable to Affect Watercourses";
- PPG6: "Working at Construction and Demolition Sites";
- PPG7: "Refuelling Facilities";
- PPG8: "Safe Storage and Disposal"; and
- PPG21: "Pollution Incident Planning Response".

2.2.7 Green Networks Integrated Urban Infrastructure

The Green Network Integrated Urban Infrastructure design studies aimed to demonstrate best practice in sustainable drainage and urban planning. The project was initiated by GCVGNP, who worked with SEPA, local authorities and others and was co-funded through multiple organisations, to consider a fresh approach to masterplanning by considering that 'infrastructure comes first'. Design studies were developed for six sites across three local authorities in the Glasgow and Clyde Valley area..

The project aimed to make a shift in the current policies. Two key shifts in thinking to come from the project are listed below:

- Future land uses to consider multi-use for spaces within the development areas, seeking opportunities for areas and systems to provide greater benefits and be cost effective, e.g. using sustainable drainage systems for heating and cooling through source heat pump technology.
- Introduce the definition of surface water floodplain to define areas that will be vulnerable to flooding but not prevent use as recreational space and incorporating these open spaces within home zones allowing easy access to recreational areas within new development.

The design studies will be taken forward through the GCVGNP Integrated Green Infrastructure (IGI) project, and further design studios have been commissioned.

3 Surface Water Management Strategy

3.1 Strategic Approach

To assist the future development in meeting the principles summarised above in the legislation documents, set out as part of the SWMS, it is proposed that the SuDS be developed and implemented for each CGA as a whole, to avoid a piecemeal approach.

These SuDS will receive surface water flows from the future development areas and, drain to the existing loch and channel system without increased flood risk.

This strategy will utilise the conveyance and treatment train set out in the SuDS manual[2] to its maximum capacity:

PREVENTION – SOURCE CONTROL – CONVEYANCE – ATTENUATION/RETENTION

- Prevention – preventing an increase above the natural runoff from occurring by using soft landscaping and incorporating appropriate surface types;
- Source control – limiting direct discharge rates to the system at the point of origin through utilising elements that include porous paving and green roofs within the development;
- Conveyance – providing clearly defined drainage paths to convey runoff and provide 'holding points' where water will be contained and stored during extreme events, and alternative routes can be created to provide exceedence routes where water will be anticipated to flow during extreme events including those which exceed the design standards for the drainage systems, clearly directing water to the least vulnerable areas; and
- Attenuation/Retention – wetlands, ponds or detention basins will provide treatment volume storage and the remaining amount of the attenuation which is not being contained within the upper elements of the system.

The aspiration of the proposed strategy is to change the current practice of incorporating the minimum requirements in achieving compliance with regulations and guidance and introduce a more holistic approach to surface water management. By looking at a more comprehensive suite of SuDS tools and considering these as not only surface water management tools, but also as assets with greater value to the place in which they are built, potential for incorporating water elements throughout the development create strong bubetween the urban to the natural environment. For the Gartloch and Gartcosh site it is also key that the new development areas create key links into the wetland park in the surrounding areas.

3.1.1 Adaptation to Climate Change and Designing for Exceedence

Planning for the future is an essential part of designing the surface water systems. With rainfall intensities projected to increase it is a factor that has to be planned for. For the Gartloch and Gartcosh area the UK Climate Change Projections a high emissions scenario at the 67th percentile for the winter months has been used to project a 30% increase in rainfall up to the 2080's. It is stated that this value is unlikely to be exceeded and is used when modelling all elements of the drainage; see **Figure 3.1**

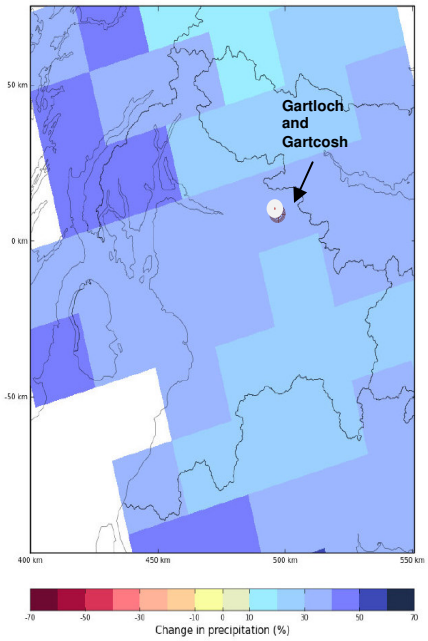
Two key changes in climate are identified:

- 30% increase in winter rainfall
- Increase in extreme weather patterns

Exceedence of drainage systems during extreme events is inevitable; how designers choose to manage it will determine whether there is a risk associated with this flooding. If exceedence is not designed into urban developments, pathways will be formed during extreme events, which may flow to receptors which are vulnerable and create unacceptable risks. To prevent this, exceedence pathways must be incorporated into designs. **Figure 3.2** highlights how the sewers and exceedence routes interact during extreme events.

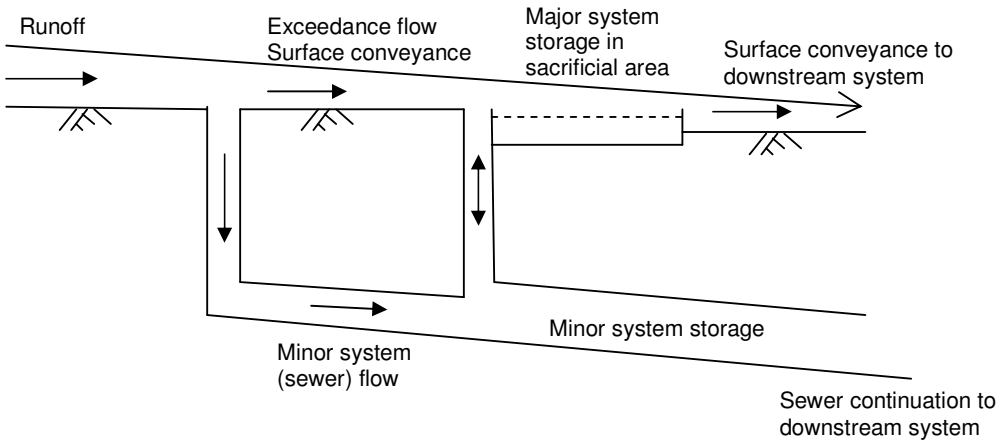
[2] CIRIA C697 The SuDS Manual

Figure 3.1 - UK Climate Change Projection for the Clyde Catchment



The future climate is uncertain – Design for Exceedance

Figure 3.2 – Interaction between minor and major systems during extreme events[3]



[3] CIRIA C635 Designing for Exceedance in Urban Drainage – Good Practice

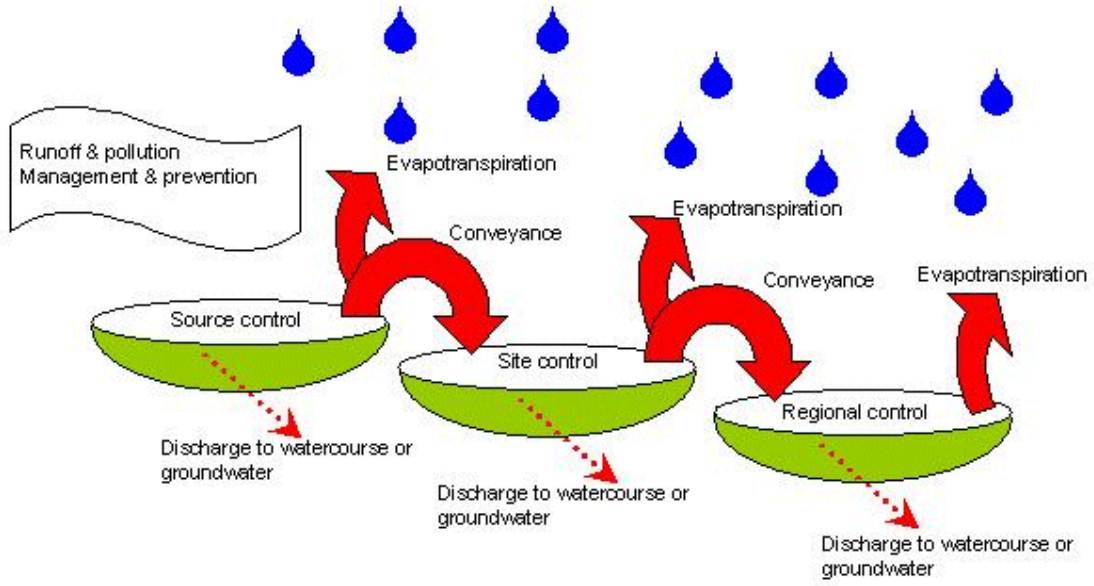
3.1.2 Catchment and Sub-catchment Definitions

The catchments were self defined as the CGA's were selected to enhance the network habitat and the integration of the wetland park into the developments. Within each area sub-catchments were naturally divided in-line with the topography.

3.2 Strategic Approach to SuDS

When a site is developed, impermeable surfaces and artificial piped drainage systems are introduced. As a result, natural drainage patterns are disrupted and surface water runoff rates and volumes increase, with a resulting increase in downstream flood risk and diffuse pollution entering the water environment. A management train has been set up in order to enable the designer to mimic the natural drainage patterns. **Figure 3.3** sets out the management train.

Figure 3.3 – SuDS Management Train



A proposed Strategic Surface Water System (SSWS) concept has been developed to determine approximate requirements, potential locations and required volumes for the treatment and attenuation facilities at a sub-catchment scale, see **Section 3.4** and **Appendix B**. Flows from the developments, which will have passed through source control, will then flow into the SWSS to be conveyed, further treated and attenuated prior to being discharged at greenfield rates into the receiving watercourses.

3.2.1 Rainwater Harvesting and Recycling

Rainwater harvesting and recycling is a useful opportunity for water conservation, for example, when hosepipe bans are in place.

Grey water recycling is also a possibility within CGAs. Reuse of water and rainwater etc can radically reduce the overall water consumption of a development radically.

Enforcing the use of rainwater harvesting on a plot scale will be extremely difficult. The main areas where this will be a viable measure is in larger residential flatted developments and commercial areas, where a larger scale approach can be adopted. However, wide scale residential application of water butts can be shown to provide significant benefits, through reducing peak runoff rates by ~ 15%, capturing and slowing extreme convective short duration rainfall events, which can present significant threats of pluvial flooding within urban areas.

3.2.2 Source Control

As part of the development process the developer will still be required to provide onsite source and site controls. There are a number of options available such as swales, lined permeable paving, filter strips etc. It is advised that guidance in CIRIA C697 – *The SuDS Manual* is followed when providing source control at each development site.

When the source control elements are being considered the underlying principles of the SWMS should be incorporated.

Enforcement, adoption and management of source control elements within private curtilage is currently limited, therefore where possible SuDs elements should be kept within the public domain, i.e. provide community parking areas, which can comprise of permeable paving and can be adopted within SuDS for Roads guidance.

Community parking will facilitate permeable paving inclusion and maintenance

3.2.3 Drainage/Conveyance Paths

The SSWS should include open water courses which will receive flows from individual development areas. These watercourses can be incorporated within the urban design to provide additional capacity in the event of extreme rainfall events. Included in this are blue green corridors which are designed to act as access through the site on a day to day basis but during a storm event will be designed to convey flood waters in a series of small detention basins.

It is important that a maintenance program is implemented to ensure that the corridors do not become blocked with litter and debris.

3.2.4 Exceedance Routes

It is proposed that, as a minimum, the open watercourses within the drainage paths will be designed to accommodate the predicted flows up to the 0.5% AEP event (equivalent to 200 year return period events) plus climate change. By integrating these watercourses with footpaths, cycleways etc. there is an opportunity to create routes for exceedance flows greater than the 0.5% AEP event. Also, exceedance routes will be utilised during short but extreme events that could have the potential to temporarily overwhelm individual elements of the drainage system, such as road drains.

It is recommended that the future detailed SWMS should be designed to convey the 0.5% AEP event plus climate change flows as a minimum and through the detailed design, design study and development of the SWMP, the quantity of the flows will be determined.

These overland flow routes can in effect be called surface water floodplains. As stated above they need to be managed as a fluvial floodplain would, being mapped and kept clear of development or managed in a way that will benefit the site and alleviate the extent of the surface water flooding.

Introduce 'Surface Water Floodplains' as specific terminology, which relates to the areas that are designed to flood during extreme rainfall events. These areas are part of the Strategic Surface Water Systems, but not part of the SuDS design, which can remove some of the burden associated with adoption, maintenance and primary use.

3.2.5 Storage Areas

The SSWSs should incorporate a series of regional storage areas in the form of storage or detention areas. These will provide treatment of flood waters primarily and attenuation of extreme flows and volumes to ensure that discharges at the greenfield rates to the surrounding watercourses are not increased as a result of future development. The permanent water body will provide the treatment volume in a wet pond or wetland and the area out with of that, surface water floodplain, will flood during extreme rainfall events.

New wetland habitat is proposed to be created with the developments through a network of swales, ponds and flood storage areas, with links to the surrounding natural wetland features.

These areas would need to be maintained appropriately after extreme flood events, debris could easily be deposited in areas and not look aesthetically pleasing. Therefore after flood events the area must be cleaned and allowed to dry so as to minimise the damage the flood event inflicts.

Photo 2.1 – Inclusion of water into the landscape and sustainable transport links

3.3 Key Principles

Due to the licensing requirements of the Water Environment (Controlled Activities) (Scotland) Regulations 2005 (CARs), as set out in Section 2, there is a legal obligation to appropriately manage future surface water runoff which includes the implementation of SuDS.

Future surface water management should look to provide benefits to the water and natural environment, reduce existing flood risks and provide capacity for adaptation for climate change. Appropriate design can integrate natural aspects and the future urban environment to provide additional benefits by allowing surface water systems to be utilised to create attractive spaces. This approach can deliver benefits to all stakeholders from the present day landowners, local authorities, developers and future communities.

Due to the existing flooding issues within the site and also downstream within the Clyde catchment, it is recognised that surface water will need to be managed and drained via SuDS to the receiving watercourses, ensuring the probability of flooding is not increased up to the 0.5% AEP events, including an allowance to adapt to future climate change and that any potential for mitigating existing flooding sources should be investigated.

The principles that have been considered for the future surface water management are set out below and future development in the Gartloch and Gartcosh area should aspire to meet these principles. Where they are not considered practical developers/planners should make appropriate justification of why an alternative approach has been considered.

The primary principles for future surface water drainage within the Gartloch and Gartcosh area should:

Ensure that surface water is kept separate and managed on the surface

Surface water runoff will be kept on the surface, infiltration should only be considered following detailed investigation and with appropriate care. Promotion of a pipe free network needs to be a focus, promoting surface water features and enhancing the environment.

By providing SSWS to drain future development, which incorporate surface features, e.g. open watercourses, attenuation basins, wetland etc., there are a number of benefits to be realised which include:

- environmental benefits including habitat enhancement and creation;
- creating focal points within the design study, incorporate open spaces and blue/green access routes;
- providing a 'buffer' between the existing water environment and urban form;
- incorporate simpler and more sustainable construction methods;
- increased adaptability, ease of modification and adaptability to potential additional climate change;
- reduce long term high cost maintenance requirements, introducing a softer landscape management requirement;
- raise public awareness of the environment and water environment, by keeping water visible; and
- Increased water quality being discharged to the surrounding natural environment.

Ensure no increased flood probability and associated risk from the surface water system

By developing SSWS and a holistic, catchment wide approach there are greater opportunities for integrating existing surface water and highway drainage systems to mitigate existing flooding problems.

Where existing water drainage infrastructure currently drains direct to the water courses mitigation should be put in place to help attenuate and treat this water. This could lead the overall water quality of the water course to improve and help meet the WFD targets.

Maximise potential for environmental benefit/ enhancement

The design of the SuDS should be linked to, and part of, the provision of open spaces for amenity/recreation, access networks and habitats for wildlife.

Ensure in-curtilage space is retained as permeable surfaces to minimise runoff

To reduce overall runoff from within the site and reduce pluvial flooding during extreme rainfall events it is recommended that the maximum possible area be kept permeable. Gardens for example should remain as permeable areas, and policies should be adopted and implemented to prevent inappropriate paving.

This requires a long term policy to implement and enforce, however, recent changes in Planning Policy in England and Wales have set a precedent for managing 'urban creep' to help protect the water environment and prevent increases in flood risk as a result of unchecked impermeable areas.

Maximise the environmental and aesthetic properties of the Gartloch and Gartcosh Wetland Park and seek opportunities for enhancing the existing environment

The Gartloch and Gartcosh area has been highly altered by man over the years exploiting the natural resources in the area. River channels have been artificially straightened; straightening of the river channels maximises available nutrient rich agricultural land. Water courses have been culverted beneath roads, railways and other developments.

River restoration techniques have the potential to reduce conveyance of flood waters, restore natural floodplain mechanisms and improve the amenity of water courses through the site.

The Gartloch and Gartcosh area presents opportunities for aspects of the drainage and infrastructure to introduce aspects that can enhance the current environment. These benefits should be considered to maximise the opportunities that developments can generate.

Photo 2.2 – Straightened Channel

The plans to extend the wetland habitat into the development through a series of swales/fingers creating green corridors within the development and out into the natural wetland.

Promote the use of 'green street' layouts to integrate habitat and sustainable drainage into the urban environment

A key feature of the CGA around the Gartloch and Gartcosh site is the integration of the surrounding habitat networks into the urban development in the form of green fingers. Examples of this can be seen in the photos below. Swales running by the road side to enable runoff to be treated and conveyed effectively.

Photo 2.3 and 2.4 – Exemplar Green Streets

Appropriate Adoption and Maintenance regimes

SuDs elements must be appropriately adopted and maintained in order for them to work efficiently and hence reduce flood risk and improve water quality to the required levels. **Section 10** expands on this further.

In summary the key principles of the SWMS are:

- Future SuDs should seek to provide multiple benefits to the water, natural and urban environments by reducing flood risk and providing capacity for climate change
- Ensure surface water is kept separate and managed on the surface
- Enusre no increased flood probability and associated risk from the surface water system
- Maximise potential for environmental benefits/enhancement
- Ensure in-curtilage space is retained as permeable surfaces to minimise runoff
- Maximise the environmental and aesthetic properties of the Gartloch and Gartcosh Wetland Park and seek to enhance the existing environment
- Promote the use of 'green street' layouts to integrate habitat and sustainable drainage into the urban environment
- Ensure appropriate adoption and maintenance regimes are in place

3.4 SuDS Selection

Through assessment of the ground conditions, topography, available land and required design criteria, the management train approach has highlighted a range of possible options appropriate for the site. The types of SuDS have been chosen and the design concepts developed around the water, habitat and road infrastructure. Once the design study has been developed the SuDS features are sized according to the contributing areas. An iterative process with development of the design study is required to ensure equilibrium between the surrounding development and the required infrastructure.

Measures taken across the entire site to reduce/prevent runoff include:

- Prevention is the first line of defence when employing the SuDS management train
- Where possible surfaces should be left permeable using soft landscaping and rainwater recycling to prevent runoff; and
- Source control should be used as a first level of treatment throughout the sub-catchments such as permeable paving and green roofs

Where possible surface water drainage should be kept on the surface and conveyed via swales/exceedance surface water flood routes to the site controls, providing further treatment and attenuation.

Table 3.1 sets out the estimated treatment and attenuation volumes for each site developed through analysis of low and high impermeability within development proposals.

Table 3.1 – Summary of SuDS Scheme

Site	Developed Area (ha)		Treatment Volume (m3)		Attenuation Volume for 0.5% AEP event (m3)	
	Low Impermeability	High Impermeability	Low Impermeability	High Impermeability	Low Impermeability	High Impermeability
Garthamlock	7.8	11.8	1129	1693	3510	5240
Easterhouse North	4	6	576	864	1835	2650
Easterhouse	19.5	29.3	2811	4216	9300	14415
Gartcosh	21.6	32.3	3105	4657	9700	14500
Glenboig	8.5	12.8	1227	1840	3750	5700
Gartloch Pools	5.34	8.01	769	1153	2340	3540

CGA's SuDS selection/requirements will depend upon the density of development over the sites. For this study the masterplans for the areas are still fluid therefore a low and high impermeability case for the SuDS elements were established, where high impermeability assumes 60% land take and low impermeability assumes 40% land take. The facts and figures for each site, including attenuation and treatment volume values, are set out in **Sections 4 to 9.**

Further details of the modelling of the SSWS is presented in **Appendix B.**

3.5 Proposed Development

Collective Architectures approach to the masterplannning of the 7 Loch Wetland Park has been to add more value to the site through creative and exemplar design of the infrastructure systems and developing a design study to support this. Collective Architecture has put forward a design study that encompasses the natural green network and hydrological aspects of the site. The design study should be driven by the understanding of the hydrological cycle, the basis for implementing SuDS and considering how the urban infrastructure can be best placed with the development to provide a holistic approach to design.

Minimise impermeable surfaces and Maximise permeable surfaces to:

- **Minimise effect on natural hydrological cycles**
- **Minimise required mitigation measures**
  - **Reduce attenuation and treatment volume requirements**
- **Optimise developable land**
- **Maximise groundwater re-charge and reduce prospects of drought**

The principles set out above are the basis that their design study was developed upon. **See Figure 1.5 Appendix A** for details of the proposed Design study.

4 Garthamlock

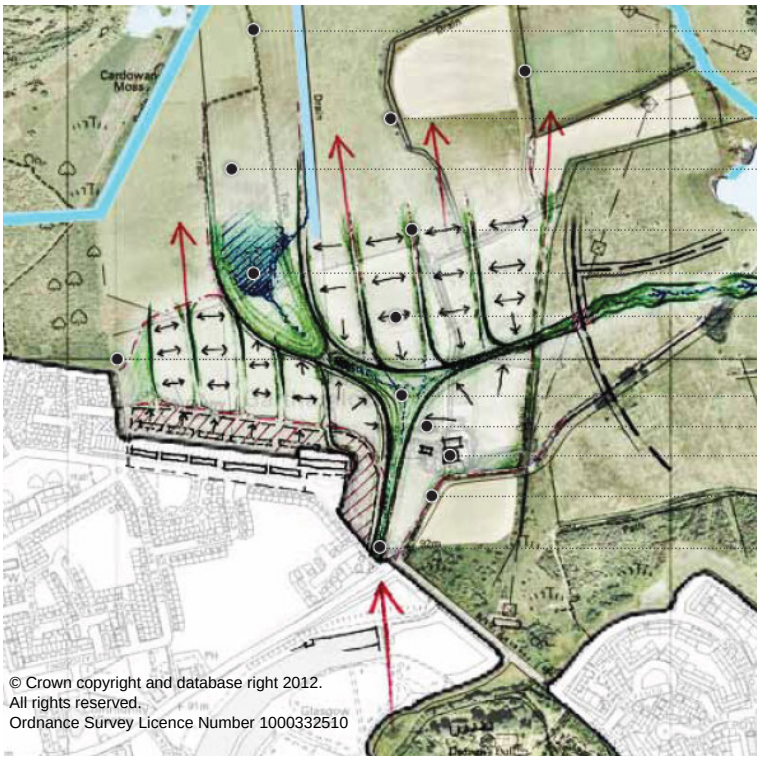


Figure 4.1 – Garthamlock Development Layout

4.1 Facts and Figures

Total Area – 19.6ha

Number of units - 374

Impermeable surface area –

- Low Impermeability – 7.8 ha
- High Impermeability – 11.8 ha

Attenuation Volume – 3510/5240m^3

Treatment Volume – 1130/1695m^3

Estimated land take for SuDS – 4640/6935m^2 assuming an average Water depth of 1m.

4.2 Key Development Strategies

The conceptual design in the Seven Loch Wetland Park masterplan (**Figure 4.1**) sets the following key development strategy:

Tertiary route network connecting CGA with principal route

Hedgerows replanted to enhance habitat network

Land drains broadened for enhanced habitat network and flood prevention

Inclusion of community leisure green space/playing fields

Green fingers: planted swales and pedestrian access lining street layout

Swale route culminating in retention pond and community wet meadows

Native woodland planting of Garthamlock quarry for extended habitat network

Quality housing with private garden space

Focal point: community green space

Front facing housing onto community green space

Blackfaulds farm house retained to become community feature block

Following Gartloch road realignment – redundant section becomes cycle route

Planted swale network, forming 'green street' layout and conveyance routes: integrates habitat and sustainable urban drainage networks while providing new pedestrian access routes

4.3 SuDS Strategy

The topography clearly splits the development site into three individual areas. Each of which can drain, via swales lining the streets, to the central blue/green corridor which follows the low lying land that is located towards the centre of the development. The blue/green corridor will convey the surface water to a detention pond to the north west of the site. From here the pond attenuates to Greenfield runoff rates and retains the appropriate volume for treatment. The pond discharges to the Bothlin burn at rates so not to increase flood risk downstream of the development.

See **Figure 4.2, Appendix A** for a schematic of the proposed surface water infrastructure

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5 Easterhouse North

5.1 Facts and Figures

Total Area – 10.0 ha

Number of units – 230

Impermeable surface area –

- Low Impermeability – 4.0 ha
- High Impermeability – 6.0 ha

Attenuation Volume – 1835/2650m^3

Treatment Volume – 576/864m^3

Estimated land take for SuDS – 2411/3514m^2 assuming an average Water depth of 1m.

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Figure 5.1 – Easterhouse North Development Layout

5.2 Key Development Strategies

The conceptual design in the Seven Loch Wetland Park masterplan (**Figure 5.1**) sets the following key development strategy:

Planted swale network, forming 'green street' layout and conveyance routes: integrates habitat and sustainable urban drainage networks while providing new pedestrian access routes

Hedgerows replanted to enhance habitat network

Quality housing with private garden space

Main access from Lochend road

Green fingers: soft landscaping and pedestrian access lining street layout

Community wet woodland to appease flooding from land drain

Community green space

Land drains broadened for enhanced habitat network and flood prevention

Swale routes culminating in wet meadows, and retention pond below flood plain area to be developed as additional wetland and grassland habitat

Access to core route of wetland park

5.3 SuDS Strategy

Swales drain the surface road drainage and incurtilage runoff long the street layout, promoting the green street initiative. The swales feed into a detention pond which attenuates storm runoff and treats the water. The pond discharges to a field drain which in turn discharges to Bishop Loch at Greenfield runoff rates.

See **Figure 5.2, Appendix A** for a schematic of the proposed surface water infrastructure.

6 Easterhouse South

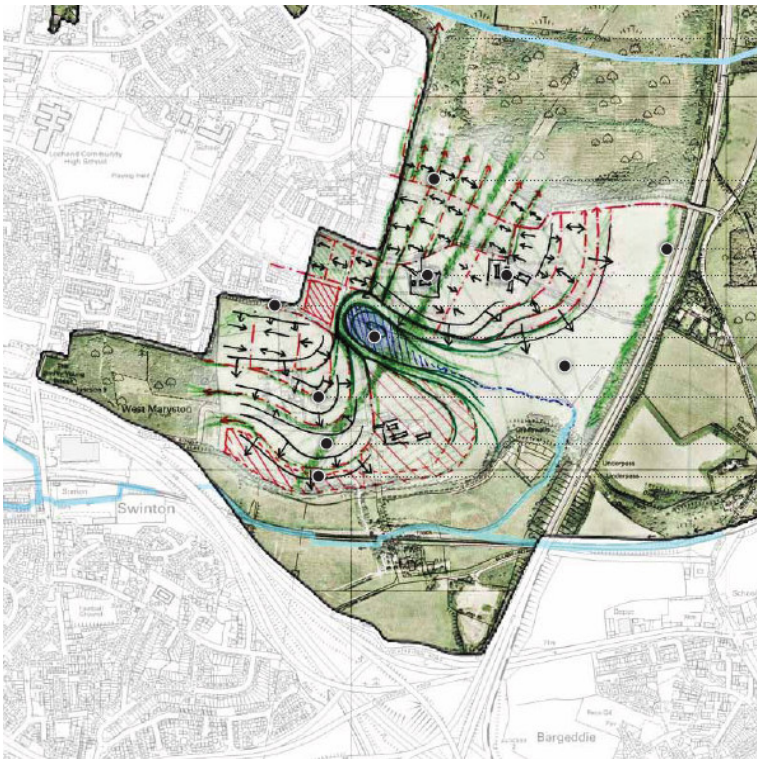

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Figure 6.1 – Easterhouse Development Layout

6.1 Facts and Figures

Total Area – 48.8 ha

Number of units – 1123

Impermeable surface area –

- Low Impermeability – 19.5 ha
- High Impermeability – 29.3 ha

Attenuation Volume – 9330/14415m^3

Treatment Volume – 2810/4216m^3

Estimated land take for SuDS – 12140/18631m^2 assuming an average Water depth of 1m.

6.2 Key Development Strategies

The conceptual design in the Seven Loch Wetland Park masterplan (**Figure 6.1**) sets the following key development strategy:

Planted swale network, forming 'green street' layout and conveyance routes: integrates habitat and sustainable urban drainage networks while providing new pedestrian access routes

Pedestrian access to core route of wetland park

Quality housing with private garden space

Soft landscaping/planting to provide a green buffer to motorway

Commonhead and Heatheryknowe farm developed into community feature blocks

Existing infrastructure and connection for site access

Swale network culminating in soft landscaped retention pond below flood plain

Community green space: wet meadow below flood plain

Site layout stepped and plateaud for housing to follow topography

Pylon network – planted to provide green corridor: new habitat/pedestrian route

Allotment gardens

6.3 SuDS Strategy

The topography of the site means it is essentially split in two divided by a detention pond central to the site. A complex network of swales conveys water down and around the two sloping mounds to feed into the central detention pond. The detention pond extends down into the existing field drain which can be widened to accept the increased flows

See **Figure 6.2, Appendix A** for a schematic of the proposed surface water infrastructure.

7 Gartcosh

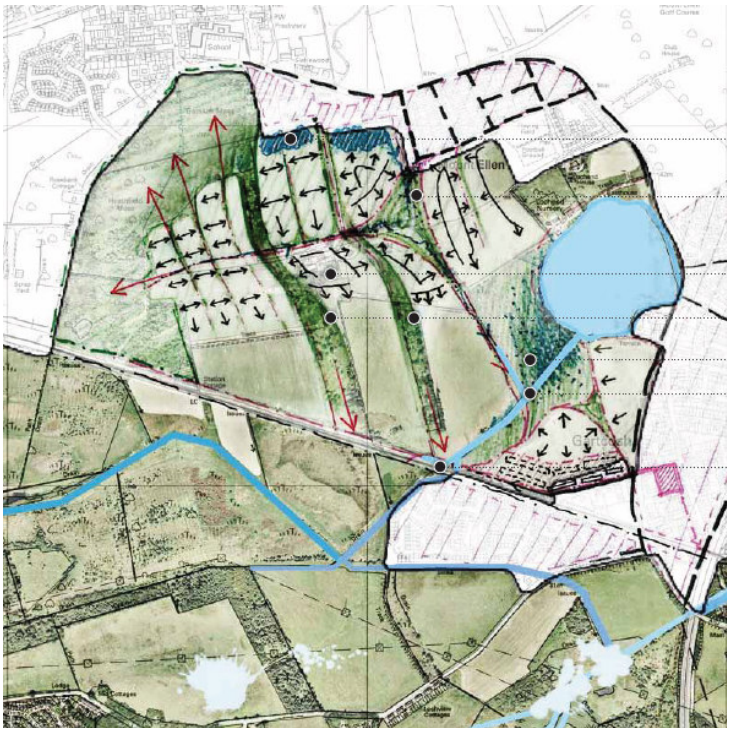

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Figure 7.1 – Gartcosh Development Layout

7.1 Facts and Figures

Total Area – 53.9 ha

Number of units – 1238

Impermeable surface area –

- Low Impermeability – 21.6 ha
- High Impermeability – 32.3 ha

Attenuation Volume – 9700/14500m^3

Treatment Volume – 3105/4657m^3

Estimated land take for SuDS –

12805/19157m^2 assuming an average

Water depth of 1m.

7.2 Key Development Strategies

The conceptual design in the Seven Loch Wetland Park masterplan (**Figure 7.1**) sets the following key development strategy:

Linear retention pond to edge of site along new pedestrian route

Planted swale network, forming 'green street' layout and conveyance routes: integrates habitat and sustainable urban drainage networks while providing new pedestrian access routes

Quality housing with private garden space

Heathfield farm house retained to become community feature block

Native woodland extended to wetland boundary for enhanced habitat network and new pedestrian route into wetland park

Community wetland garden

Linear retention ponds below flood plain

New underpass for access into wetland park

7.3 SuDS Strategy

The site is divided into three by strips of woodland that is located to enhance the habitat network and pedestrian routes into the wetland park. A ridge runs along the centre of the site with the land falling away on both sides. Swale networks convey surface runoff flood waters to detention ponds to the north of the site and a retention area to the north east of the site. The northern detention ponds discharge at green field runoff rates to a drainage ditch to the north of the site that in turn discharges to the Bothlin Burn. The north eastern retention area drains at the appropriate rates to Johnston Loch.

See **Figure 7.2, Appendix A** for a schematic of the proposed surface water infrastructure.

8 Glenboig

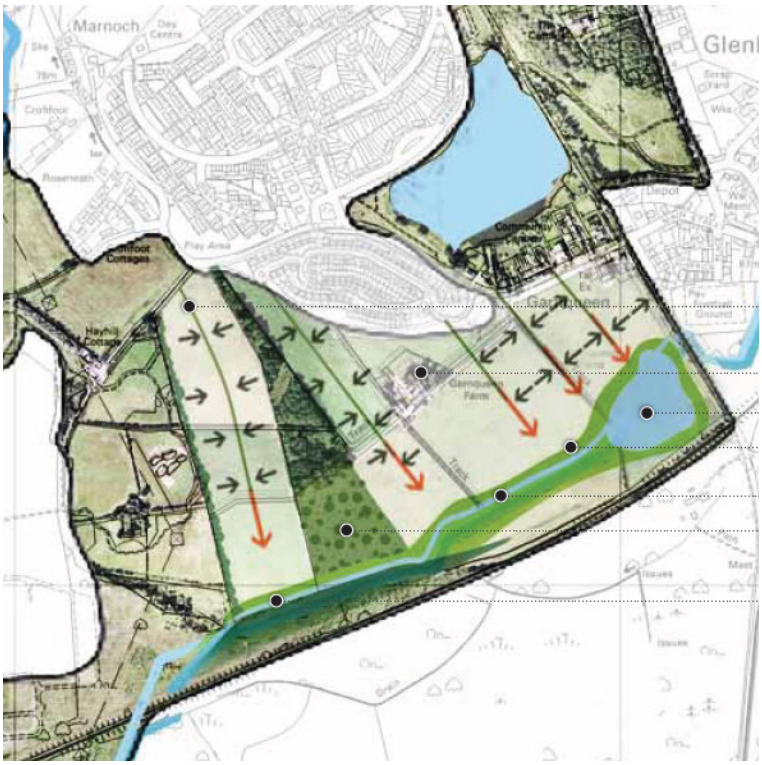

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Figure 8.1 – Glenboig Development Layout

8.1 Facts and Figures

Total Area – 21.3 ha

Number of units – 432

Impermeable surface area –

- Low Impermeability – 8.5 ha
- High Impermeability – 12.8 ha

Attenuation Volume – 3750/5700m^3

Treatment Volume – 1227/1840m^3

Estimated land take for SuDS –

4977/7540m^2 assuming an average

Water depth of 1m.

8.2 Key Development Strategies

The conceptual design in the Seven Loch Wetland Park masterplan (**Figure 8.1**) sets the following key development strategy:

Planted swale network, forming 'green street' layout and conveyance routes: integrates habitat and sustainable urban drainage networks while providing new pedestrian access routes

Garnqueen farm house retained to become a community feature block

Swale network culminating in retention pond below flood plain with pondscape link for amphibian movement

Soft landscaped community wetland

Quality housing with private garden space

Linear retention pond to edge of flood plain along new pedestrian route

Native woodland extended to site boundary for enhanced habitat network and new pedestrian route into wetland park

Land drains broadened for enhanced habitat network and flood prevention

8.3 SuDS Strategy

The site slopes down to the south east of the site. Main central swales run in line with the slope to two detention basins at the east and west of the site. The detention basin to the east of the site as well as treating a small proportion of surface water runoff from the proposed development site could potentially help treat runoff from the upstream catchment. The detention basin to the west will attenuate and treat the majority of the surface water from the new development site. Both basins drain to a broadened drainage ditch which flows into the Bothlin Burn.

See **Figure 8.2, Appendix A** for a schematic of the proposed surface water infrastructure.

9 Gartloch Pools

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Figure 9.1 – Gartloch Pools Development Layout

9.1 Facts and Figures

Total Area – 26.7 ha

Number of units – 300

Impermeable surface area –

- Low Impermeability – 5.34 ha
- High Impermeability – 8.0 ha

Attenuation Volume – 2340/3540m^3

Treatment Volume – 769/1153m^3

Estimated land take for SuDS –

3109/4693m^2 assuming an average

Water depth of 1m.

9.2 Key Development Strategies

The conceptual design in the Seven Loch Wetland Park masterplan (**Figure 5.1**) sets the following key development strategy:

Proposed traffic bridge over Bothlin Burn: to allow uninterrupted passage of Bothlin Burn/habitat networks/ pedestrian boardwalk which form part of the wetland park principle route

Hedgerow planting along perimeter of anticipated road: for extended habitat network and green buffer to wetland park

Quality housing with private garden space

Swale network culminating in community wetland below flood plain

Land drains broadened and integrated into swale network, forming 'green street' layout and conveyance routes: integrates habitat and sustainable urban drainage networks while providing new pedestrian access routes

Native woodland planting along development perimeter: for green buffer to proposed Gartloch pools local nature reserve

9.3 SuDS Strategy

The site is essentially split in two by the topography with ridges running along the north and south of the site. As can be seen in **Figure 9.2** by the location of the detention ponds, both falling to the North eastern edges of the topographic highs. **Figure 9.1** highlights the possibility of blue/green routes to run north to south with the main escape route for surface water being a central artery. See **Figure 9.3, Appendix A** for a schematic of the proposed surface water infrastructure.

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Figure 9.2 – Gartloch Pools Initial Masterplan by Hypostyle Architects

10 Surface Water Management – Setting a New Agenda

One of the challenges to overcome with SuDS features in developments is how isolated they become once they are fenced off or placed at the back of people's houses becoming disconnected and increasing the perception of the hazard. We have considered how water features can create a 'sense of place' within the development or create blue/green corridors through the site which provide both conveyance of flood water and access through the site.

10.1 Setting a New Agenda

With large bodies of permanent or temporary water there are inherent health and safety challenges to overcome. Sewers for Scotland 2nd edition states stringent safety regulations which have been adopted by Scottish Water when designing ponds and detention basins. The following is a list of the main safety features:

- Signs and safety equipment should be provided;
- Vertical drops over 1.2m should be fenced;
- Aquatic benches should be planted with appropriate species to achieve a high density barrier, which will dissuade people from trying to get access to the open water;
- Signs denoting any infrequent and temporary flooding areas, warning against swimming should also be provided; and
- Barrier fencing must be provided at all detention ponds. All access gates must be lockable with a minimum fence height of 1.1m.

Whilst many of these aspects are good design attributes, they can create a series of requirements which result in standard designs. These requirements are normally applied without thought to the individual design criteria of the site and surrounding development.

Our aim for this SWMS is to push the boundaries for existing policies and look at the design of each individual SuDS components. Our aim is set out in a quote taken from the newly released Designing Streets document:

> *'.....design should derive from an intelligent response to location, rather than the rigid application of standards, regardless of context. Designing Streets does not, thus, support a standards based methodology for street design but instead requires a design-led approach. This demands taking into account site specific requirements and involves early engagement with all relevant parties. Designing Streets marks the Scottish Government's commitment to move away from processes which tend to result in streets with a poor sense of place and to change the emphasis of policy requirements to raise the quality of design in urban and rural development.*[4]

The above clearly emphasises that each individual design element should be looked at on its own merits with the risks and benefits assessed and an appropriate solution found.

Health and safety is a key area of debate in recent times, with the UK as a whole being increasingly health and safety conscious. There have been numerous cases brought forward where an individual has sued a land owner for lack of safety cover on their land.

A specific case is Tomlinson versus Congleton, 2003, where Tomlinson was injured diving into a lake on Congleton's land. Tomlinson lost his case and follows are several quotes from a variety of cases that explain why:

'If the danger is obvious, the visitor is able to appreciate it, he is not under any kind of pressure and he is free to do what is necessary for his own safety, then no warning is required. So, for example, it is unnecessary to warn an adult of sound mind that it is dangerous to go near the edge of an obvious cliff'. Exceptions – where there is no informed choice, where the individual lacks capacity – eg a child[5]

[4] A policy guide for Scotland – Designing Streets

[5] Cotton v. Derbyshire Dales D.C.(June 10, 1994, CA, unreported). From Darby v National Trust

'Clear from case law that the duty imposed upon an occupier does not extend to providing protection against obvious and natural features of the landscape. Therefore there was no duty to provide fencing, warning signs, or notices[6]'

'It is a fallacy to say that because drowning is a serious matter that there is therefore a serious risk of drowning."[7]

Where SSWS are being incorporated into a development and the proposed solution has bodies of permanent water, it will be necessary to provide safety cover in places; however, to completely fence off all water bodies from public access would go against the design aim for this project. To include water infrastructure into the development and use these areas as public space will entail breaking with the standard requirements set out above. To ensure the benefits of adding this amenity to the development out way the risks careful design measures must be put in place such as:

- Where there is an obvious risk i.e. permanent deep water close to developments, ensure fencing is provided;
- Recognise that people want access to water, therefore provide access to the water at specific locations and ensure a large shallow bay is designed to minimise the risk of an incident occurring;
- Provide educational boards for the public to appreciate the wetland/ponds for their dual purpose of water quality treatment and as an amenity value;

To set a new agenda with regards to SuDS safety regulations, sound reasons and design should be put forward to enhance the way the public view these features and how they can be used for dual purpose adding value to an area as well as providing a service.

10.2 Adoption and Maintenance schedule

Adoption and maintenance has been a challenging subject since 2004 when SEPA set out that the 0.5% AEP event should be attenuated. Whilst Scottish Water have authority over drainage up to the 3.33% AEP event there has become a 'void' in the ability for developers to have appropriate design adopted and maintained within the public sector.

[6] Struthers-Wright v Nevis Range Development Co PLC [2006] CSOH 68 4 May 2006

[7] Tomlinson v Congleton, HL 2003

This issue has been recognised and there is now a significant change developing through Section 7 agreements between Scottish Water and Local Authorities, which now provides an opportunity for developers to develop, build appropriate SSWS and have these vested in public authorities.

However this issue is likely to always present a constraint to how integrated the urban infrastructure can become.

This issue was addressed during the Green Network Integrated Urban Infrastructure (GNIUI) project[8], for these exemplar sites we considered how the proposed SSWS elements could logically be adopted and maintained. The general principles are again set out below for consideration; they are based on considering the skill sets that exist within Local Authorities and Scottish Water, shared responsibility between these organisations and recognition that a single surface water drainage system is the most suitable for the future.

- The SSWS will attenuate and treat runoff from highways and curtilage alike;
- All systems conveying water from source to storage below ground designed to the 3.33% AEP event plus climate change are adopted and maintained by Scottish Water;
- All surface water runoff in exceedance of the 3.33% up to the 0.5% AEP plus climate change will be adopted and managed by the local authorities. These could be in the form of exceedance routes such as swales running in line with the Scottish Water systems;
- Wet storage areas will have a permanent water body holding the treatment volume for the site, this will be adopted and maintained by Scottish Water;
- Outwith this will be the 0.5% AEP storm event plus climate change 'surface water floodplain'. This will only flood under extreme conditions and will be maintained and adopted by the local authorities as managed open space; and
- Inlets and outlets to the permanent water body will be adopted and maintained by Scottish Water.

The principles set out above were formed during the GNIUI project through several workshops and several discussions between SEPA, Scottish Water, Collective Architecture and AECOM.

It was perceived that the maintenance and adoption challenges were prohibiting SuDS projects to reach their full potential. To overcome this and ensure the scheme proposed for the new developments can be made a reality the current policies were reviewed. It was thought the below ground infrastructure was best adopted by Scottish Water due to their specialism in that area. Other open areas such as swales or filter strips would be adopted and maintained by the local authorities. For the large SuDS components a different approach was taken as specified above where the permanent water body would be adopted by Scottish Water. This permanent water could be managed and maintained by Scottish Water. For flood events the land outwith the treatment volume would be treated as surface water floodplain and adopted by the local authority. **Table 10.1 and 10.2** taken from the Green Network study set out further information on how individual SuDS elements adoption and maintenance could be shared respectively.

A proposal was set out in the GNIUI project for developing SSWS which provide a holistic catchment response to surface water management for future developments. Within these systems Sustainable Drainage Systems are designed to perform specific objectives, in terms of treatment and attenuation to a specific level of performance. Beyond these levels, surface water floodplains provide the additional land areas to manage flooding to the required planning criteria.

The introduction of surface water floodplain terminology, changes the perception of these spaces, to allow them to be seen as opportunities for good urban design as open space with amenity, being removed from the adoption and maintenance burden of SuDS.

[8] Green Network Integrated Urban Infrastructure – 6 candidate sites
http://gcvgreennetwork.gov.uk/projects/Integrating-Green-Infrastructure/Integrating-Green-Infrastructure-Overview.html

Table 10.1 – Adoption Schedule

SuDS	Description	Management Train Suitability						Adoption Schedule	
		Prevention	Conveyance	Pre-treatment	Source Control	Site Control	Regional Control	Out/Inlet Structure	General
Water Butts, site layout and Management	Good housekeeping and good design practice	♠	⊕		♠			LA/Landowner	LA
Pervious Pavements	Allow inflow of rainwater into underlying construction/soil	♠			♠	⊕		SW/LA/Land owner (where required)	LA/Landowner
Filter Drain	Linear drains/trenches filled with a permeable material, often with a perforated pipe in the base of the trench		♠		♠	⊕		SW/LA (where required)	LA/Landowner
Filter Strips	Vegetated strips of gently sloping ground designed to drain water evenly from impermeable areas and filter out silt and other particulates			♠	♠			SW/LA	LA
Swales	Shallow vegetated channels that conduct and/or retain water. The vegetation filters particulates.		♠		♠	♠		SW/LA	LA
Ponds	Depressions used for storing and treating water. They have permanent pool and bank side emergent and aquatic vegetation					♠	♠	SW	LA/SW)
Wetlands	As ponds, but the runoff flows slowly but continuously through aquatic vegetation that attenuates and filters flow.		⊕			♠	♠	SW	LA
Detention Basins	Dry depressions designed to store water for a specified retention time					♠	♠	SW	LA
Soakaways	Sub-surface structures that store and dispose of water via infiltration				♠			/LA/ Landowner	SW/LA
Infiltration trenches	As filter drains, but allowing infiltration through trench base and sides		⊕		♠	♠		/LA	SW/LA
Green roofs	Vegetated roofs that reduce runoff volume and rate	♠		♠	♠			SW/Landowner	SW/Landowner
Pipes, subsurface storage	Conduits and their accessories as conveyance measures and/or storage. Water quality can be targeted using sedimentation and filter measures.		♠			♠		SW up to 3.33% AEP	SW up to 3.33% AEP
Exceedance routes	Any manmade route created for the diversion of pluvial flood waters.		♠					LA above the 3.33% AEP	LA above the 3.33% AEP

Key to Symbols: ♠ - High/Primary process ⊕ - some opportunities subject to design, LA – Local Authorities, SW – Scottish Water

Any agreement on adoptions will require detailed proposals to be presented to the Local Authority and Scottish Water in advance in order to assess and approve any proposals prior to an agreement on adoption being made.

Table 10.2 – Maintenance Schedule

SuDS	Adoption Schedule		Maintenance Schedule		
	Out/Inlet Structure	General	Inlet/outlets/ structures	Sediment/blockages and general maintenance	Monitoring
Water Butts, site layout and Management	LA/Landowner	LA/Landowner	Annually/ when there is poor performance	Annually/ when there is poor performance	Annually/ when there is poor performance
Pervious Pavements	SW/LA (where required)	LA/Landowner	3 times annually	3 times annually or as required	Annually
Filter Drain	SW/LA (where required)	LA/Landowner	Half yearly	Monthly	Half yearly
Filter Strips	SW/LA	LA	N/A	Monthly	Half yearly
Swales	SW/LA	LA	Monthly	Monthly	Half yearly
Ponds	SW	LA (SW maintains the permanent VT)	Monthly	1-5 years in forebay, 10 years to main quadrant	Monthly/half yearly
Wetlands	SW	LA	Monthly/ as required	Sediment removal every 25years / monthly removal of rubbish	Monthly/half yearly
Detention Basins	SW	LA	Monthly/after large storms	Monthly	Half yearly
Soakaways	SW/LA/Landowner	SW	Annually	Monthly within the first year then annually	Annually
Infiltration trenches	SW/LA	LA/Landowner	Half yearly	Monthly	Half yearly
Green roofs	LA/Landowner	LA/Landowner	Annually/ after a severe storm	6 monthly or as required	Annually/ after a severe storm
Pipes, subsurface storage	SW up to 3.33% AEP	SW up to 3.33% AEP	Annually	Annually	Annually
Exceedance routes	LA above the 3.33% AEP	LA above the 3.33% AEP	Monthly	Monthly	N/A

The maintenance schedule can be tailored to site specific requirements, where factors can influence an increase or decrease in frequencies, also experience with the constructed system will provide a higher understanding of the performance of the system which can allow the maintenance schedule to be revised.

11 Recommendations

Key Principles:

- Future SuDs should seek to provide multiple benefits to the water, natural and urban environments by reducing flood risk and providing capacity for climate change
- Ensure surface water is kept separate and managed on the surface
- Ensure no increased flood probability and associated risk from the surface water system
- Maximise potential for environmental benefits/enhancement
- Ensure in-curtilage space is retained as permeable surfaces to minimise runoff
- Maximise the environmental and aesthetic properties of the Gartloch and Gartcosh Wetland Park and seek to enhance the existing environment; and
- Promote the use of ‘green street’ layouts to integrate habitat and sustainable drainage into the urban environment

How these key principles should be implemented:

- Links to the wetland park from the CGA’s should be made where possible using the SuDs elements;
- Blue green corridors/fingers can extend the wetland habitats into the urban areas;
- Planted swale network, should form ‘green streets’ and conveyance routes: this encourages the integration of habitat and sustainable urban drainage networks while providing new pedestrian access routes;
- Soft landscaping should be used where possible which minimises runoff;
- Land drains should be broadened for enhanced habitat network and flood prevention;
- Design for exceedance in urban areas using landscaping to direct the flow of surface water;
- The SWMS should be developed into a site specific Surface Water Management Plan for each individual CGA;
- Consultation should take place before site specific plans are developed
- Surface water floodplain terminology, changes the perception of flooded spaces due to surface water runoff, to allow them to be seen as opportunities for good urban design as open space with amenity.

12 References

- SPP - Scottish Planning Policy 2010
- CIRIA C635 - Designing for Exceedance in Urban Drainage – Good Practice
- CIRIA C697 - The SuDS Manual
- CIRIA C644 - Building Greener
- A policy guide for Scotland – Designing Streets
- Cotton v. Derbyshire Dales D.C.(June 10, 1994, CA, unreported). From Darby v National Trust
- Struthers-Wright v Nevis Range Development Co PLC [2006] CSOH 68 4 May 2006
- Tomlinson v Congleton, HL 2003
- SuDS for Roads, 2009
- Scottish Water (2007). Sewers for Scotland (SfS) Manual 2nd ed. Scottish Water.
- Green Network Integrated Urban Infrastructure – 6 candidate sites -http://gcvgreennetwork.gov.uk/projects/Integrating-Green-Infrastructure/Integrating-Green-Infrastructure-Overview.html
- Gartloch Gartcosh Green Network Strategy report, the URS/AECOM Site Selection and Development Guidance
- Draft Seven Lochs vision and masterplan, Collective Architecture.

Appendix A – Figures

Figures are available on request from:
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Appendix B – Surface Water Modelling

B.1 Approach

The runoff from the site is proposed to incorporate Sustainable Drainage Systems (SuDS) to provide natural treatment and attenuation to runoff which, as a result of the development, will be increased in both volume and peak rates, due to the increased impermeable area.

To assess the impact of the development on the surface water runoff from the site, initial consultation has been undertaken with SEPA, Glasgow City Council and North Lanarkshire Council to determine the required level of attenuation.

B.1.1 Sustainable Drainage Systems (SuDS)

The opportunity to incorporate SuDS within the development has been identified and, where appropriate, the use of SuDS has been adopted. To help achieve the optimal use of SuDS, a management train approach to identify the most advantageous solution, according to site location, character and operational requirements has been undertaken. This procedure is presented in **Table B.1**.

Table B.1 Management Train Procedure

Management Train Stage	Considered in the design of	SuDS Selection
1. Prevention	Building layout.	The SuDS selection process included in CIRIA guide C697 has been used to help identify the most appropriate SuDS techniques for the different management train levels.
2. Source Control	Building and sub catchment layout.	
3. Site Control	Sub catchment/ Catchment layout.	
4. Regional Control	Catchment layout.	

SuDS techniques that have been considered and adopted within the overall scheme design have been selected from proven techniques/solutions that include the following:

- Permeable paving;
- Green roofs;
- Bio retention;
- Filtration techniques;
- Grassed filter srips;
- Swales;
- Infiltration devices;
- Filter drains;
- Infiltration basin;
- Extended detention ponds;
- Wet ponds;
- Storm water wetlands; and
- On/ off line storage.

In order to produce a successful detailed SuDS solution, the amenity value of proposals and the quality and quantity of the surface water discharge need to be considered for each management train stage. This has been achieved by adopting the CIRIA guide C697 - *The SUDS manual* which uses a scoring system to evaluate the main aspects of surface water discharge by considering the following issues:

- Hydrological;
- Land use;
- Physical site features;
- Community and environment; and
- Economic and maintenance.

B.1.2 SuDS Selection

By assessing the ground conditions and slope, available land and required design criteria, the management train approach has identified that a range of options are applicable to the site.

Section B.4 discusses the SuDS selection for the identified CGA's in more detail.

B.2 Criteria

B.2.1 Attenuation

The SWMP has been developed assuming that the runoff from the site will not be increased following development. Therefore, the discharge rates from the post developed site will be controlled to match those from the undeveloped site for all events up to and including the 0.5% Annual Exceedance Probability (AEP) events, equivalent to the 1 in 200 year events plus climate change.

B.2.2 Required Treatment Volume

The design treatment volume (V_t) is designed to capture 75 – 90% of the storms in a year. This ensures the smaller volumes of runoff are stored within the treatment systems and appropriately treated. The smaller volumes of runoff are those in which pollution is most concentrated, as the initial runoff from surfaces washes the pollutants into the surface water collection system.

The calculations of V_t are based on formulae and guidance published in CIRIA report C697 - *The SUDS Manual*

For the wet ponds a permanent volume of one times the Vt is stored for treatment, for the wetlands a permanent volume of four times the Vt and for the detention basins the Vt is drained over a minimum of 24 hours for any given storm.

B.2.3 Climate Change

UKCIP09 predictions were used for the Clyde Valley catchment at the 67th percentile, being highlighted as very unlikely to be exceeded up to the 2080's. A series of 25km grid squares cover the area these give a specific climate change increase for the area covering the Gartloch and Gartcosh site of 30% increase in winter precipitation.

B.3 Methodology

The proposed SuDS for the site have been developed by working through the following stages associated with developing a strategy and outline concept:

- Calculation of 'Greenfield' or undeveloped runoff rates;
- Determination of a strategy to incorporate the selected elements of SuDS;
- Determination of treatment requirements for the site;
- Identification of sub-catchments and phasing requirements;
- Modelling of individual elements within sub-catchments; and
- 'Cascading' elements together to provide a complete analysis of whole development site.

B.3.1 Existing Site Runoff

The existing site runoff has been estimated using the guidance from the Institute of Hydrology Report 124 (IoH124). The calculation is based upon the following factors:

B.3.1.1 Area

Catchment Area (ha), the area of the site has been set to 1ha to determine runoff rates per unit area for comparison with each sub-catchment.

B.3.1.2 SAAR

Average annual rainfall (1941-1970) from the Flood Studies Report (FSR) Figure II.3.1 or equivalent, which is between 875 to 925mm for this location.

Table B2 – SAAR Values

CGA	SAAR
Garthamlock	925
Easterhouse North	900
Easterhouse	875
Gartcosh	950
Glenboig	925
Gartloch Pools	925

B.3.1.3 Soil

Soil index of the catchment from FSR Figure I.4.18 or Wallingford Procedure Volume 3. Soil Types 1 to 5 have Soil Index Values of 0.15, 0.3, 0.4, 0.45 and 0.5 respectively. The classes of soil are based on their 'winter rain acceptance potential', where they are weighted on their individual runoff potential, where 0.5 indicates the largest potential to generate runoff. For the Gartloch and Gartcosh site, the soil is recorded as 50% Type 3 and 50% Type 4, with a Soil Index Value of 0.4 and 0.45 respectively; this is described as a medium permeable soil. The soil types for the CGA's are noted in Table B3.

Table B3 – SOIL Values

Site Name	SOIL
Garthamlock	4
Easterhouse North	4
Easterhouse	5
Gartcosh	4
Glenboig	4
Gartloch Pools	4

B.3.1.4 Urban

Value for how developed the existing site is. Greenfield site will have a value of 0, fully developed site 100% impermeable will have a value of 1.

B.3.1.5 Region Number

Region number of the catchment based on FSR Figure I.2.4, which is 2 for this site.

B.3.1.6 Topography

The site topography used within the development of the SWMP has been obtained from IFSAR data provided by South Lanarkshire council.

B.4 Modelling

The site was divided into sub-catchments defined by the natural drainage of the existing site. There are a total of 6 Community Growth Areas, the area of impermeable land calculated for each individual area, **Figure 1.3.**

B.4.1 Approach

The modelling of the SWMP has been undertaken by calculating the roofed and paved areas. The contributing areas were assessed by assuming the ratio of contributing area to green space for a majority of the site. A best and worst case is put forward with the proportion of impermeable areas being 40% and 60% respectively.

Taking the above assumptions into account the **Table B.2** shows the expected impermeable coverage in CGA's.

Table B.4 – Sub-catchment Impervious Areas

	Area development (ha)	Impermeable area (Low Density) (ha)	Impermeable area (High Density) (ha)
Garthamlock	19.6	7.8	11.8
Easterhouse North	10	4.0	6.0
Easterhouse	48.8	19.5	29.3
Gartcosh	53.9	21.6	32.3
Glenboig	21.3	8.5	12.8
Gartloch Pools	13.35	5.34	8.01

The drainage strategy has been developed through hydrological modelling of the site using Micro Drainage's WinDes software. WinDes is recognised as leading software for carrying out analysis and design of drainage systems.

B.4.2 Discharge Controls

The controls at the end of the system have been designed to ensure that there will be no flooding within the site for rainfall events up to and including the future 0.5% event plus climate change and that the discharge rates do not exceed current Greenfield runoff rates.

B.4.3 Simulations

The model of the proposed system has been analysed with a range of rainfall events. The events include those with the annual probability that is of particular interest, i.e. 0.5% and 3.33%, and for a range of durations from 15 minutes up to 10080 minutes, or 7 days. This is checked to ensure that the critical duration event is included within the analysis.

B.5 Results

B.5.1 Existing Site Runoff

The runoff from the overall existing site has been calculated using the methodology outlined in Section B.3.1 and B.4.1, the results are summarised in **Table B.5** and **B.6**. Using the contributing areas calculated and set out in **Table B.4**.

Table B.5 Undeveloped (Greenfield) Site Runoff (l/s) Low Impermeability

AEP (%)	Garthamlock	Easterhouse North	Easterhouse	Gartcosh	Glenboig	Gartloch Pools
50	66.8	34.1	166.2	183.6	72.5	45.5
25	86.7	44.2	215.8	238.3	94.2	59.0
10	104.1	53.1	259.2	286.3	113.1	70.9
3.33	139.4	71.1	347.1	383.4	151.5	95.0
2	159.6	81.4	397.3	438.8	173.4	108.7
1	192.6	98.3	479.6	529.7	209.3	131.2
0.5	233.3	119.0	580.8	641.4	253.5	158.9

Table B.6 Undeveloped (Greenfield) Site Runoff (l/s) High Impermeability

AEP (%)	Garthamlock	Easterhouse North	Easterhouse	Gartcosh	Glenboig	Gartloch Pools
50	100.1	51.1	249.3	275.4	108.8	68.2
25	130.0	66.3	323.7	357.5	141.3	88.5
10	156.1	79.7	388.8	429.4	169.7	106.4
3.33	209.1	106.7	520.7	575.1	227.3	142.5
2	239.3	122.1	595.9	658.2	260.1	163.0
1	289.0	147.4	719.4	794.6	314.0	196.8
0.5	349.9	178.5	871.1	962.2	380.2	238.3

B.5.2 Treatment Volume, V_t

The design treatment volume, Vt, has been calculated from the following formula and will be drained from the structure over a 24 hour period[9]:

$$V_t(m^3/ha) = 9 \times D \times \left(\frac{SOIL}{2} + \left(1 - \frac{SOIL}{2}\right) \times I \right)$$

For the Gartloch and Gartcosh site:

D = M5-60, is the statistical 5 year 60 minute rainfall event, and is predicted to be 16mm

SOIL = 0.45 and 0.4

I, impervious area = 1.0, assuming that the development area draining to the SuDS is 100% impermeable.

Table B.7 summarises the results: Please note that this volume may change depending upon the sensitivity of the receiving water course, please refer to Regulatory Method (WAT-RM-08), SEPA.

[9] CIRIA 697 '*The SUDS manual*'

Table B.7 –Required Treatment Volume for proposed SuDS development

Site Name		Treatment Volume (Detention) (m^3)
Garthamlock	Low Impermeability	1128.96
	High Impermeability	1693.44
Easterhouse North	Low Impermeability	576
	High Impermeability	864
Easterhouse	Low Impermeability	2810.88
	High Impermeability	4216.32
Gartcosh	Low Impermeability	3104.64
	High Impermeability	4656.96
Glenboig	Low Impermeability	1226.88
	High Impermeability	1840.32
Gartloch Pools	Low Impermeability	768.96
	High Impermeability	1153.44

B.5.3 SuDS Performance

The proposed scheme has been modelled within the WinDes MicroDrainage software. The Greenfield runoff rates are used as the limiting discharge for the varying AEP events. The maximum required attenuation volumes for the 0.5% AEP event are shown below, **Table B.8**.

Table B.8 – Attenuation requirements for the 0.5% AEP event

Site	Attenuation Volume for 0.5% AEP event (m3)	
	Low Impermeability	**High Impermeability**
Garthamlock	3510	5240
Easterhouse North	1835	2650
Easterhouse	9300	14415
Gartcosh	9700	14500
Glenboig	3750	5700
Gartloch Pools	2340	3540