10.3 Drainage Strategy

Lomond Banks

Appendix 10.3 – Drainage & SuDS Strategy

On behalf of

Project Ref: 332010549/DS | Rev: - | Date: April 2022

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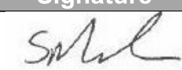
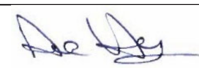
Prepared by:	Scott MacColl	Senior Engineer		28th April 2022
Reviewed by:	David Warren	Principal Engineer		28th April 2022
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For and on behalf of Stantec UK Limited				

Revision	Date	Description	Prepared	Reviewed	Approved

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1 Introduction

1.1 Appointment and Brief

1.1.1 This drainage and SuDS strategy has been prepared by Stantec UK Ltd to support an application for planning permission in principle (PPiP) for the erection and operation of a proposed tourism and leisure-led mixed-use development ("the proposed development") on land at West Riverside and Woodbank House, Balloch ("the site"). The planning application is submitted on behalf of Flamingo Land and Scottish Enterprise ('the Applicants') to the Loch Lomond and the Trossachs National Park Authority (LLTNPA) as the relevant local planning authority.

1.1.2 The objective of this report is to inform the client of key foul, surface water drainage and sustainable drainage systems (SuDS) issues and constraints, which may influence the development process and provide an integrated drainage solution for site development whilst ensuring compliance with all current design guidance and best management practice.

1.1.3 The report describes the existing foul and surface water drainage networks, and identifies the drainage and SuDS features to be introduced to service the development as well as identifying the proposed discharge locations for the foul drainage and surface water drainage.

1.1.4 This report has been prepared solely for the development described within this report and no responsibility is accepted to any third party for all or part of this report.

1.2 Proposed Development

1.2.1 The proposed development comprises the erection and operation of a tourism and leisure-led mixed-use development, including:

Station Square

- Refurbished tourist information building;
- 32-bedspace budget accommodation;
- 1200m2 craft brewery and visitor centre;
- 150m^2 restaurant;
- Enhanced public square;
- Performance Amphitheatre (400m^2 performance space, 200m^2 storage); and
- Monorail Station.

Riverfront

- 43 Forest lodges;
- Picnic, BBQ and Playground area;
- Monorail; and
- Riverside Walkway.

Drumkinnon Wood

- Managed Woodland; and
- 700m^2 staff and service area.

Pierhead

- 60-bedroom Apart-hotel;
- Leisure / pool / water park area up to approximately 2,500m^2;
- Reception & Atrium;
- Monorail Terminal and Attractions (incl staff areas); and
- Water Sports Hub – boathouses.

Woodbank

- 37 large lodges, 30 smaller lodges and 17 bothies;
- 15 new flats within Woodbank House, 6 self-catering properties within ancillary buildings;
- Woodland planting; and
- Boathouse activity centre and storage (95m^2).

Other

- Associated parking (up to 320 additional spaces), landscaping and infrastructure development works; and
- Access to be taken from the surrounding road network including Ben Lomond Way and Pier Road.

1.2.2 A more detailed description of the proposed development is provided in **Chapter 3 – The Proposed Development** in **EIA Report Volume 1 – Main Text** which accompanies the planning applications for the proposed development.

1.2.3 The key physical elements of the proposed development are shown on the submitted **Site Layout Plan**. Additional drawings are also provided in support of the planning application to illustrate specific elements of the proposed development.

1.3 Drainage Strategy Requirements

1.3.1 Drainage is a material consideration in the determination of planning applications. An acceptable method of disposal for both foul and surface water must be demonstrated.

1.3.2 For the consideration of drainage strategies, the scope of the report should follow the guidance outlined in Water Assessment and Drainage Assessment Guide[1] produced by the Sustainable Urban Drainage Scottish Working party (SUDSWP). The intention of this guidance is to help guide those involved with the installation of water and drainage infrastructure through the necessary stages required to obtain relevant permissions, whilst complying with current standards and policies.

1.3.3 For the purposes of this drainage strategy, the following key areas outlined in the Water Assessment and Drainage Assessment Guide have been considered:

- Surface Water and SuDS general considerations;
- Foul water; and
- SuDS – hydraulic design considerations.

1.3.4 The key planning legislation of relevance to this Drainage Strategy:

- The National Parks (Scotland) Act 2000 as amended; and

[1] Water Assessment and Drainage Assessment Guide, available at:
https://www.sepa.org.uk/media/163472/water_assessment_and_drainage_assessment_guide.pdf

- Loch Lomond and the Trossachs National Park Authority (LLTNPA) Local Development Plan 2017-2021.

National Parks (Scotland) Act 2000

1.3.5 Section 1 of the National Parks (Scotland) Act 2000 as amended identifies the four aims of Scotland's National Parks including Loch Lomond and the Trossachs National Park (LLTNP), namely:

- *"(a) to conserve and enhance the natural and cultural heritage of the area;*
- *(b) to promote sustainable use of the natural resources of the area;*
- *(c) to promote understanding and enjoyment (including enjoyment in the form of recreation) of the special qualities of the area by the public; and*
- *(d) to promote sustainable economic and social development of the area's communities".*

1.3.6 These National Park aims are material planning considerations.

Loch Lomond and the Trossachs Local Development Plan 2017-2021

1.3.7 The current statutory Development Plan applicable to the site of the proposed development comprises the Loch Lomond and the Trossachs Local Development Plan 2017 – 2021 ('the LDP'), which was adopted by LLTNPA in December 2016, and associated adopted Supplementary Guidance.

1.3.8 Section 4 of the LDP sets out three overarching policies which apply to all development proposals, followed by a suite of subject specific policies. Policies of relevance to the proposed development which should be considered in this Drainage Strategy are highlighted in Table 1.1 below.

Table 1-1 Relevant Planning Policies

LDP Policy Title	Summary
Overarching Policy 1 - Strategic Principles	Sets out principles linking the LDP with the Scottish Planning Policy (SPP, 2014 –All proposals should demonstrate their accordance with relevant principles, including: • Collective achievement of the four statutory National Park aims and implementation of the National Park Partnership Plan; • Contributing to sustainable development and climate change mitigation, including through sustainable design; • *"Addressing climate change impacts";* • *"Avoiding significant flood risk";* • *"Relating well to the landscape context and setting", including in terms of cultural heritage and local built form*"; and • "*Incorporating appropriate soft and hard landscaping, a planting scheme, and measures to protect existing trees and other landscape features*".
Overarching Policy 2 - Development Requirements	Provides high level design and environmental assessment criteria to assess all proposals, including the following of relevance to the PPiP application for the proposed development: • *"Safeguard visual amenity and important views, protect and/or enhance rich landscape character, and features and areas specifically designated for their landscape values at any level;* • *avoid any significant adverse impacts of: flooding,*

LDP Policy Title	Summary
	• *protect and/or enhance the biodiversity, geodiversity, water environment, sites and species designated at any level…including ancient and semi-natural woodland, green infrastructure and habitat networks;*
Natural Environment Policy 11 - Protecting the Water Environment	Requires proposals not to have a significant adverse effect on the water environment.
Natural Environment Policy 12 - Surface Water and Wastewater Management	Requires proposals to connect to public sewers where available.
Natural Environment Policy 13 - Flood Risk	Requires compliance with the SPP (2014) Flood Risk Framework.

1.3.9 Local Authority guidance states that SuDS will be required for any developments, with few exceptions, including single dwellings, and where the surface water discharge is made directly to coastal waters. This will be incorporated into the overall design of the development. SuDS features will provide treatment of surface water runoff which will be allowed to discharge to receiving waters at greenfield runoff rates. SuDS will be designed in accordance with CIRIA C753 The SuDS Manual. Correspondence with can be found in **Appendix A.**

1.4 Terminology

1.4.1 The following terminology has been adopted in this report:

- Catchment – the area contributing flow to a point on a drainage system;
- Curtilage – land area within property boundaries;
- Drain – a private or un-adopted pipe;
- Foul drainage – the infrastructure that drains water and sewage that is discharged from properties;
- Gully – opening in the pavement, usually covered by metal grates, which allows water to enter conventional drainage systems;
- Permeable paving – pavement construction that allows road runoff to infiltrate through the surface layer to underlying treatment and storage media;
- Runoff – water flow over the ground surface to the drainage system. This occurs if the ground is impermeable, saturated or rainfall is particularly intense;
- Sewer – a pipe or channel taking domestic foul and/or surface water from buildings and associated paths and hardstanding from two or more curtilages and having a proper outfall, vested and maintained by the sewerage undertaker;
- Surface Water – water that appears on the land surface, i.e. ponds, rivers, streams, standing water, lochs;
- Swale – A shallow vegetated channel designed to convey and retain surface water runoff, and which can also allow for infiltration. The vegetation filters suspended solids;
- Watercourse – a natural or artificial channel that conveys surface water; and
- Wayleave – a right of access to the route of a pipeline or service crossing privately owned land.

1.5 Assumptions Made

1.5.1 The areas stated in this document are indicative only and should not be considered as binding maxima and minima.

1.5.2 This report has been prepared solely for the development. Therefore, no responsibility is accepted to any third party for all or any part of this report in connection with any other development.

1.5.3 This report does not address in any detail the temporary situation, i.e. during the construction phase of any part of the proposed development, which may have implications on the foul and surface water drainage.

2 Existing Conditions

2.1 Site Location

2.1.1 A **Site Location Plan** to identify the site in the context of neighbouring land and the surrounding area is contained in **Appendix A**.

2.1.2 The site of the proposed development comprises approximately 26.77 a of land, situated to the north of Balloch at the southern tip of Loch Lomond. The site contains two distinct but contiguous areas, known for the purposes of this DS and the PPiP application as West Riverside and Woodbank House. The West Riverside area encompasses the south western bank of the River Leven at its confluence with Loch Lomond and extends eastwards across Drumkinnon Wood, whereas the Woodbank House area comprises the remains of the Grade A listed Woodbank House hotel, associated structures and attendant grounds.

2.2 Site Topography

2.2.1 The general topography of the site falls from the west down to the east towards Loch Lomond and the River Leven. In the west of the site surrounding Woodbank House and adjacent to the A82, the ground is at a maximum elevation of approximately 45mAOD. From here the ground slopes down relatively steeply towards Old Luss Road, beyond which the ground levels off and undulates at 15-19m AOD. Adjacent to the shores of the Loch, the ground level is approximately 7.5mAOD.

2.2.2 Within Drumkinnon Wood the ground levels undulate significantly, but in general slope from the west to the east towards Pier Road, from a level of approximately 16mAOD down to approximately 12mAOD.

2.3 Land Use

2.3.1 The site currently consists of a range of different uses including leisure and recreation (water sports) along the shores of the loch, several areas of car parking which serve the public slipways as well as the neighbouring Loch Lomond Shores development, areas of woodland through Drumkinnon Woods and open parkland along the banks of the River Leven.

2.3.2 A tourist information and visitor centre is located at the south eastern point of the site, opposite Balloch train station and Sweeney's Cruises.

2.4 Geology

Bedrock Geology

2.4.1 The British Geological Survey's (BGS) geological data (BGS, n.d.-a) (1:50,000 scale) indicates that the site is underlain by Teith Sandstone Formation. No fault lines are present within the site.

Drift Deposits

2.4.2 The BGS (BGS, n.d.-b) data indicates that the superficial deposits are predominantly formed of Glaciofluvial Deposits - Gravel, Sand and Silt, which cover the southern and western parts of the site. To the north and surrounding the shore of Loch Lomond the superficial deposits consist of Raised Marine Deposits of Holocene Age - Clay, Silt, Sand and Gravel.

Soils

2.4.3 Soil survey of Scotland 1:25,000 scale mapping (Soil Survey of Scotland Staff, n.d.) shows the site to be underlain by brown soils which have been stated to have parent materials of fluvioglacial sands and gravels derived from acid schists and Lower Old Red Sandstone sediments and lavas.

Hydrogeology

2.4.4 The Hydrogeological Map of Scotland (BGS, n.d.-c) shows that the site is underlain by the Strathmore Group, a moderate to highly productive aquifer with intergranular/fracture flow.

2.4.5 The Hydrogeological Maps highlight that superficial deposits classified as glaciofluvial are associated with high productivity intergranular flow, and raised marine deposits would be classified under low to moderate productivity with intergranular flow in the region of 0.1-10l/s.

2.4.6 The aquifer vulnerability is classed as 4a in the Groundwater Vulnerability dataset (Ó Dochartaigh, Doce, Rutter & MacDonald, 2011). Class 4a is groundwater which is described as being 'vulnerable to those pollutants not readily absorbed or transformed, and may have low permeability soil and less likely to have clay present in superficial deposits.'

2.4.7 Under the RBMP the development site is located within the *Loch Lomond and Leven Sand and Gravel (ID:150766)* and *Balloch (ID:150651)* groundwater bodies, both of which have overall classifications of Good.

2.5 Existing Drainage

2.5.1 Based on a Scottish Water Asset Plan, provided in **Appendix B** It is understood that much of the existing foul drainage in the area is captured in combined sewers, which carry wastewater to the Ardoch Wastewater Treatment Works in Dumbarton. It is assumed that there is no existing surface water infrastructure on site.

2.5.2 There is an existing pumping station on site, which is owned by Scottish Enterprise (SE) but is managed on their behalf by Saltire Property Management Ltd (SPM), who have a service agreement with the proprietors of Loch Lomond Shores. Limited information is available on the capacity or service agreements for the existing pumping station. The strategy therefore will make provision for a new pumping station, which will be subject to change should more information on the existing station become available and it can be ascertained that the proposed development can be accommodated within it.

2.6 Watercourses

2.6.1 There are four watercourses which have been identified as flowing through the site. The major watercourse is the River Leven which flows to the east of the site. To the west of the site there are two smaller unnamed watercourses which are described in more detail below. A fourth smaller watercourse is marked upon the Ordnance Survey mapping within the wooded area at Woodbank House. A plan showing the location of these watercourses is presented as **Figure 10.1** in **Appendix 10.1 – Figures**. Additional details including photographs from the site walkover are included in **Appendix 10.2 - Flood Risk Assessment**.

River Leven

2.6.2 The River Leven flows to the east of the site in a southerly direction. It rises at the outflow from Loch Lomond to the north of the development site, and routes south through the towns of Balloch and Alexandria to outfall into the River Clyde at Dumbarton. The river is approximately 11.5km long and has tidal influence for approximately 5km upstream from its confluence with the River Clyde.

2.6.3 Adjacent to the site, the river is approximately 85-90m wide and contains a number of floating pontoons for mooring boats. Approximately 550m downstream of the Balloch Station area of the site, the River Leven Barrage is located. This is operated by Scottish Water and controls the outflow from the loch limiting the discharge and maintains water levels within Loch Lomond between 7 and 7.6m Above Ordnance Datum (AOD). However, it is not formally operated as a flood prevention structure.

2.6.4 Scotland's River Basin Management Plan (RBMP)(Scottish Government, 2014) classified the River Leven in 2016 as a heavily modified water body on account of physical alterations that cannot be addressed without a significant impact from an increased risk of subsidence or flooding. As such this has been classified as having Moderate ecological potential.

Loch Lomond

2.6.5 Loch Lomond is located to the north of the site and has a surface area of approximately 71 km^2. Areas within and adjacent to the water body are designated Special Protection Areas (SPA), Sites of Special Scientific Interest (SSSI), Special Areas of Conservation (SAC), Ramsar Sites and National Nature Reserves. The loch is located wholly within the Loch Lomond and The Trossachs National Park and is used extensively for recreational use.

2.6.6 The RBMP classified Loch Lomond (south, ID:100257) as having a Moderate overall status in 2016.

Unnamed Watercourse 1

2.6.7 The Unnamed Watercourse 1 rises in the hills to the west of the A82. The burn flows in an easterly direction along the north-western boundary and passes beneath Old Luss Road before routing north of the existing car park and Loch Lomond Shores development. It outfalls into Loch Lomond at the end of a small headland in the bay north of the site.

Unnamed Watercourse 2

2.6.8 Unnamed Watercourse 2 also rises in the hills to the west of the site and the A82, and routes in an easterly direction towards Drumkinnon Farm. The burn flows through a small caravan park to the south of the site and below Lower Stoneymollan Road before routing along the boundary of the Woodbank House area of the site. The burn then passes below Old Luss Road and routes north towards the car park of the Loch Lomond Shores complex. The burn routes through a number of culverts as it passes beneath access roads and flows through an open channel through the car park area.

2.6.9 Downstream of the car park the burn routes to the east and flows parallel with unnamed watercourse 1 towards Loch Lomond where it outfalls adjacent to the aerial adventure course.

Unnamed Watercourse 3

2.6.10 Within the Woodbank House area of the site a small watercourse is shown on plan routing in an easterly direction before it sinks, with no downstream route marked on the maps. During the site walkover there was water present within the channel however there was very little flow. The channel appeared to route into a culvert structure, but it is not known where this routes to or if it discharges into the unnamed watercourse 1. There were no visible signs of a culvert downstream across this area of the site. During the site walkover for ecological surveys, as noted in **Chapter 5 - Ecology**, it was noted that there were no flows within this channel, indicating that flows within this channel may be intermittent and dependent upon runoff.

3 Water Regulatory Process

3.1 Water Framework Directive and Water Environment & Water Services (Scotland) Act 2003

3.1.1 The Water Environment and Water Services (Scotland) Act 2003 (WEWS) transposes the Water Framework Directive into national law and provides a framework to assess, protect and enhance the water environment in Scotland. The Water Environment (Controlled Activities) (Scotland) Regulations 2011, as amended, (CAR) mean that from the 1st April 2007, it is an offence to undertake the following activities without a CAR authorisation:

- Discharges to all wetland, surface waters and groundwaters;
- 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; and
- Engineering works in inland waters and wetlands.

3.1.2 CAR was updated in 2017 and the CAR practical guide has since been updated to Version 9 in January 2022. The revised guide provides updates to pollution control and engineering regimes, a summary of which can be found below:

Pollution Control Regime

- Oil Storage now covered by new GBRs 26, 27 and 28;
- Sites where there is an onward distribution of oil – new Licence requirement for those not able to comply with GBR28;
- Application of pesticide – revised GBR23 and new Registration and Licence;
- Construction site SUDS – revised GBR10 and new Licence;
    - Discharge of water run-off from a construction site to the water environment where the site exceeds 4 hectares;
- Direct discharge into groundwater of grout containing blaes for the purpose of construction or maintenance works – new Registration, and
- A licence is now required for surface water discharge from 60 hectares of residential development (>1000 houses previously) and A roads are now included.

Engineering Regime

- Operating vehicles in or near a surface water or wetland – revision to GBR9 – the Registration for this activity has been removed;
- Bank protection using trees – new GBR25 – Registration has been removed; and
- Updated information text in relation to contacting local District Salmon Fishery Boards or Trusts for advice.

3.1.3 A CAR authorisation is intended to control impacts on the water environment. It does not cover wider impacts that may be related to a development, such as visual impact or damage to terrestrial ecosystems. Under CAR, three types of authorisation allow for proportionate and risk-based regulation:

- General Binding Rules;
- Registration, and
- Licence.

3.1.4 GBRs represent the lowest level of control and include the discharge of surface water runoff. GBR activities taking place in accordance with the rules do not require an application for authorisation from SEPA, and therefore, there are no associated charges. The GBR activities specified by schedule 3 of CAR include:

- The operation of any weir that does not result in a level difference of more than 1m between the upstream and downstream water surfaces;
- The abstraction of less than $10m^3$ per day;
- The construction or extension of any well, borehole or other works by which water may be abstracted, where such works are:
  - Not intended for abstraction; or
  - Intended for the abstraction of less than $10m^3$ in any one day; or
  - Intended for the abstraction of less than $150m^3$ in any period of one year.
- The abstraction from a borehole for sampling or testing;
- The dredging of a river, burn or ditch that:
  - Has an average width less than 1m at the stretch to be worked, measured at the bottom of the channel; and
  - Has been artificially straightened or canalised along the length to be worked.
- The construction of minor or temporary bridges;
- The laying of a pipeline or cable by boring beneath the banks and bed of a river, burn or ditch;
- Works to control the erosion of a bank of a river, burn or ditch revetment;
- Operating any vehicle, plant or equipment for the purposes of the above activities;
- Discharge of water runoff from a surface water drainage system to the water environment from construction sites, buildings, road, yards or any other built developments; and
- Discharge into a surface water drainage system.

3.1.5 **Registrations** allow for the recording of small-scale activities, which individually pose a small environmental risk but, cumulatively, can result in environmental harm. Operators must apply to SEPA to register these activities, for which there is an application fee.

3.1.6 **Licences** allow for site-specific conditions to be set to protect the water environment. They will be able to cover linked activities occurring at a number of sites over a wide area, as well as multiple activities on a single site. Application fees apply to all licences. SEPA has divided licence activities into simple licence and complex licence activities dependent on the risk and scale.

Pollution Control

3.1.7 The Water Environment and Water services Act (WEWS) requires any activity that is liable to cause pollution is to be authorised. SEPA will use these powers to control point source discharges of pollution.

3.1.8 CAR Authorisation GBR 10 refers to the discharge of water runoff from a surface water drainage system to the water environment from construction sites, buildings, roads, yards or any other built developments and states under part (d):

- The discharge shall not contain any water runoff from any buildings, roads, yards or other built developments, the construction of which is completed after 1st April 2007, or from construction sites operated after 1st April 2007, unless:

i. During construction those developments or construction sites are drainage by a SuD system or equivalent equipped to avoid pollution of the water environment;

ii. Following construction those developments are drained by a SuD system equipped to avoid pollution of the water environment;

iii. The runoff is from a development that is a single dwelling and its curtilage; or

iv. The discharge is to coastal water.

3.1.9 The levels of authorisation applicable for point source-controlled activities relating to the drainage for the proposed development are outlined in **Table 3-1**:

Table 3-1 CAR Authorisations

General Binding Rule	Registration	Simple Licence	Complex Licence
Sewage and Organic Effluents			
	Organic effluents ≤15pe (including discharges to soakaways)	Organic effluents >15–100pe	Organic effluents >100pe
	Sewage: proposed or has been in use less than 2 years serving ≤3 domestic properties or for nondomestic developments serving ≤15pe (including discharges to soakaways)	Sewage: proposed or has been in use less than 2 years >15pe – 100pe	Sewage >100 pe
		Low significance CSOs	Medium and high significance CSO
			Emergency overflows
Surface Water Drainage			
Discharge of water run-off from a surface water drainage system to the water environment from buildings, roads other than waterbound roads, yards or any other built development constructed before 1 April 2007, unless covered by one of the listed exceptions [GBR10A]		Discharge of water run-off from a surface water drainage system to the water environment from any motorway/trunk road where any one outfall serves a length of road >1km and the road was either constructed before 1 April 2007 and the footprint of the road or its associated infrastructure is enlarged or otherwise altered on or after 1 April 2007, or the road was constructed on or after 1 April 2007.	
Discharge of water run-off from a surface water drainage system to the water environment from buildings, roads other than waterbound roads, yards or any other built development constructed on or after 1 April 2007, unless covered by one of the listed exceptions [GBR10B]		Discharge of water run-off from a surface water drainage system to the water environment from: land of >30 hectares used for residential premises; industrial estates; or land used as a motorised vehicle parking area with >1,000 parking spaces; in each case where constructed on or after 1 April 2007.	
Discharge of water run-off from a quarry or borrow pit constructed on			

General Binding Rule	Registration	Simple Licence	Complex Licence
or after 1 January 2022 [GBR10C]			
Discharge of water run-off from a construction site to the water environment where the site, including any constructed access tracks, does not: (i) exceed 4 hectares; (ii) contain a road or track length in excess of 5km; or (iii) include any area of more than 1 hectare or any length of more than 500 metres on ground with a slope in excess of 25°. [GBR10D]		Discharge of water run-off from a construction site to the water environment where the site, including any constructed access tracks: (i) exceeds 4 hectares; (ii) contains a road or track length in excess of 5km; or (iii) includes any area of more than 1 hectare or any length of more than 500 metres on ground with a slope in excess of 25°	
Discharge of surface water from waterbound roads and tracks, including during the construction and maintenance of such roads and tracks [GBR22]			

p.e. population equivalent
CSO Combined sewer overflow

3.1.10 The proposed development construction phase will require a simple licence application to be made with accompanying pollution prevention plans, prepared in accordance with SEPA's Supporting Guidance WAT-SG-75.

3.1.11 The Simple Index Approach should be utilised to establish the amount of treatment required for developments such as the development site at West Riverside. This is discussed further in Section 5.2 of this report.

4 Site Drainage Strategy

4.1 Proposed Development

4.1.1 The proposed development comprises the erection and operation of a tourism and leisure-led mixed-use development.

4.1.2 A more detailed description of the proposed development is provided in **Section 1.2** of this report and **Chapter 3 – The Proposed Development** in **EIA Report Volume 1 – Main Text** which accompanies the planning application for the proposed development.

4.1.3 The key physical elements of the proposed development are shown on the submitted **Site Layout Plan**. Additional drawings are also provided in support of the planning and marine licence applications to illustrate specific elements of the proposed development.

4.2 Foul Drainage

Flows

4.2.1 The assessment of foul flows has been undertaken using the flow data presented in the British Water Code of Practice – Flows and Loads 4 – Sizing Criteria, Treatment Capacity for Sewage Treatment Systems, and Sewers for Scotland 4th Edition, with the peak flows, for sewer design, calculated as 6 times the dry weather flow (DWF). Foul flows were calculated based upon a Development Accommodation Schedule, available in **Appendix D.**

4.2.2 Calculated foul flows are shown in Table 4-1.

Table 4-1 Calculated Foul Flows

Foul Discharge			Flow (l/sec)	
		Average 12hr	Average	Peak[1]
Brewery				
	Details provided by brewery		0.150	1.000
	Restaurant (Station Square)			
	Estimated 85 covers/day			
	F&Ls4[2] = Pre-prepared food 25 l/cover			
	85 covers x 25 l = 2125l/day			
	Assume 12 hr day; 2125 l/12 hours		0.049	0.147
Hostel/Budget Accommodation				
	32 beds			
	F&Ls4[2] = students accom = 100/person			
	32 beds x 100l/day = 3,200 l/day		0.037	0.111
Tourist Office				
	F&Ls = Office no canteen = 100l/person			
	Estimate 6 staff = 600 l/day		0.007	0.021
Forest Lodges				
	F&Ls = holiday camp chalet resident			
	227l/person and lodges are for 4 people			
	Riverfront - 43 lodges			
	Waterfront - 37 larger lodges, 30 smaller lodges, 17 bothies			
	Total 127 Lodges			
	127 lodges x 4 people x 227 = 115316l/day		1.334	4.004
Apart Hotel				
	F&Ls = Hotel 250 l/person			
	60 beds = say 90 people			
	90 people x 250 l = 22500 l/day		0.260	0.781
Water Park[3]				
	Estimate 500 users/day[4]			
	Based on 10 l/person[1]		0.058	0.174
	Showers 40 l/person[1]		0.231	0.694
Staff Service area				
	F&Ls - office - no canteen			
	Estimate of 15 staff			
	50l/person = 750 l/day		0.009	0.026
Residential				
	Woodbank House - 15 flats, 6 self catering			
	Assume 200l/person/day			
	21 houses x 4 persons x 200l = 16800 l/day		0.194	0.583
	Total Discharge (litres/sec)		**2.329**	**7.541**
Notes;				
1	Peak flows normally assumed as 3 times average flow.			
2	F&Ls4 = British Water Code of Practice; Flows & Loads 4			

Layout

4.2.3 The proposed foul drainage layout network will comprise of a gravity closed pipe system located in the roads, verges and open spaces on-site. The intention would be for Scottish Water to adopt the new wastewater drainage infrastructure on the site. All foul drainage would therefore need to be designed to the standards contained in Sewers for Scotland, 4th Edition, 2018.

4.2.4 The Woodbank, and Drumkinnon Wood sections of the site can be drained under gravity and it is proposed that the foul sewers would connect into Scottish Water's existing combined sewers on Old Luss Road and Pier Road respectively. However, this would be subject to confirmation that there is sufficient capacity in the existing network to accept the flows from the development. The proposed network would generally follow the alignments of proposed and existing access roads and tracks before tying into the existing combined sewer network.

4.2.5 The riverfront section of the site presents a challenge for foul drainage as this area is extremely flat. The ground undulates with levels ranging between 10.0m and 11.0m AOD across the length of the Riverfront development area (approx. 500m). The gradients across sections of this area are as flat as 1:750 (0.13%). Providing a gravity sewer at an appropriate gradient for the expected flows, which can tie into the invert levels of the existing sewer network, is not possible without land raising or Scottish Water's approval to use oversize pipes laid at shallower gradients. This presents an issue, as SEPA have advised that they would oppose any proposal for land raising which encroaches on the fluvial flood plain of the River Leven.

4.2.6 Impacts on the floodplain could be avoided by reducing the platform areas such that the earthworks do not extend beyond the modelled extents of the flood plain. However, this would reduce the developable area. In addition, Scottish Water is unlikely to approve the use of oversize pipes laid at shallower gradients when the expected flows are unlikely to generate self-cleansing velocities in the sewer.

4.2.7 As a gravity-based system is unlikely to be a practical solution for connecting into the existing combined sewer network, it would be necessary to install a pumping station in the riverfront section of the site. A gravity sewer would capture foul drainage from the Riverfront and Pierhead areas of the site and direct it to the pumping station. This would pump the wastewater up a rising main to a connecting manhole on the existing combined sewer network at Balloch Road.

4.2.8 The existing pumping station on site is owned by Scottish Enterprise (SE) but is managed on their behalf by Saltire Property Management Ltd (SPM), who have a service agreement with the proprietors of Loch Lomond Shores. There may be an opportunity to connect the new drainage to this existing pumping station, thereby potentially removing the requirement for a new pumping station. An upgrade may be necessary to accommodate the additional flows.

4.2.9 Limited information is however available on the capacity or service agreements for the existing pumping station. The strategy therefore makes provision for a new pumping station at this time. This is subject to change should more information on the existing pumping station become available to ascertain that the proposed development flows can be accommodated within it.

4.2.10 A Pre-Development Enquiry (PDE) was made to Scottish Water to ascertain potential constraints that may be encountered due to existing infrastructure as well as ensuring they have suitable capacity within their network to accommodate foul flows from the development. Scottish Water's response, dated the 7th of May 2019 failed to indicate if suitable capacity was available in their network, however it did highlight three key areas of concern for Scottish Water:

- The presence of a steel raw water main at high pressure running through the site near Hamilton House;
- An existing combined sewer overflow pipe to the northeast of the site with a 3m standoff to this pipe; and
- There is an existing 400mm surface water overflow at the south-east side of the site which may cause conflict with proposed development.

4.2.11 Correspondence with Scottish Water can be found in **Appendix A.**

4.2.12 The foul drainage layout and design should follow the guidance provided in Sewers for Scotland 4th Edition, 2018 and current design standards.

4.3 Surface Water Drainage

4.3.1 As noted in the previous section, much of the existing foul drainage in the area is captured in combined sewers and it is the intention for the proposed development to capture foul and surface water drainage separately, with surface water from roofs and impermeable areas being collected in an open swale network and/or a closed pipe gravity system prior to being treated and discharged back into the water environment using a variety of SuDS techniques. This has previously been discussed with SEPA and Scottish Water who were supportive of the approach.

4.3.2 The site is approximately 26.77h and therefore significant new surface water drainage infrastructure is required to service the various facilities proposed for the site. For the basis of drainage calculations, the site has been split into two drainage catchments: Woodbank and West Riverside with a contributing area of 9.4ha and 9.6ha, respectively. The remaining site area around Drumkinnon Wood is to remain as existing and has therefore been discounted from calculations going forward.

Flows

4.3.3 The existing greenfield runoff rates for the site have been calculated using MicroDrainage Source Control software for the 2, 30, 100 and 200-year storm events. Based on development proposals provided by Anderson Bell + Christie Architects, it has been calculated that a hardstanding area for Woodbank and West Riverside is representative of 20% and 30% of total site area, respectively, and should be used for the calculation of post development flows from the site, whilst 1% and 8% representative hardstanding area has been used for existing site runoff calculations. The results of both are presented in **Table 4-2** and **4.3**, respectively with full MicroDrainage calculations provided in **Appendix E**

Table 4-2 Woodbank Runoff Rates

Return Period (Years)	Existing Runoff – Woodbank (l/s)	Un-attenuated Runoff from Site Post-Development (l/s)
2	85.7	112.2
30	177.0	211.8
100	244.4	271.9
200	276.7	301.5

Table 4-3 West Riverside Runoff Rates

Return Period (Years)	Existing Runoff – West Riverside (l/s)	Un-attenuated Runoff from site post-development (l/s)
2	97.1	130.3
30	194.1	234.9
100	261.0	294.8
200	293.1	323.7

Layout

4.3.4 The proposed surface water drainage network servicing each area of the development will comprise of a network draining surface water runoff from roofs and other impermeable areas to SuDS treatment and attenuation features, described in more detail in Chapter 5 of this report. A conceptual drainage layout is provided in **Appendix F.**

4.3.5 Current proposals for the Woodbank area of the site include lodges as well as residential development and access roads. The proposed SuDS strategy for this area is shown in **Figure 4.1.** It is proposed that roadside swales be implemented to treat and attenuate the surface water runoff from the site before discharging to the watercourse at the southeast corner of the Woodbank site. An additional ponded area could be created here for further treatment and ecological benefits. Surface water falling onto the woodland area surrounding the Bothies would not require treatment and can be adequately dealt with at source using infiltration.

4.3.6 The Drumkinnon Wood area of the site will be retained as managed woodland and therefore no treatment or attenuation of surface water will be required in this area. Runoff from the service and deliveries area would require treatment in line with the SIA. Permeable paving could be constructed in parking bays to capture surface water runoff and provide the treatment and attenuation required. An alternative solution would be for the surface and roof runoff from this area to be conveyed to a SuDS pond/basin located to the south west prior to discharging to the small watercourse to the south west of the parking area. Both are viable options which could provide the required level of SuDS treatment and attenuation.

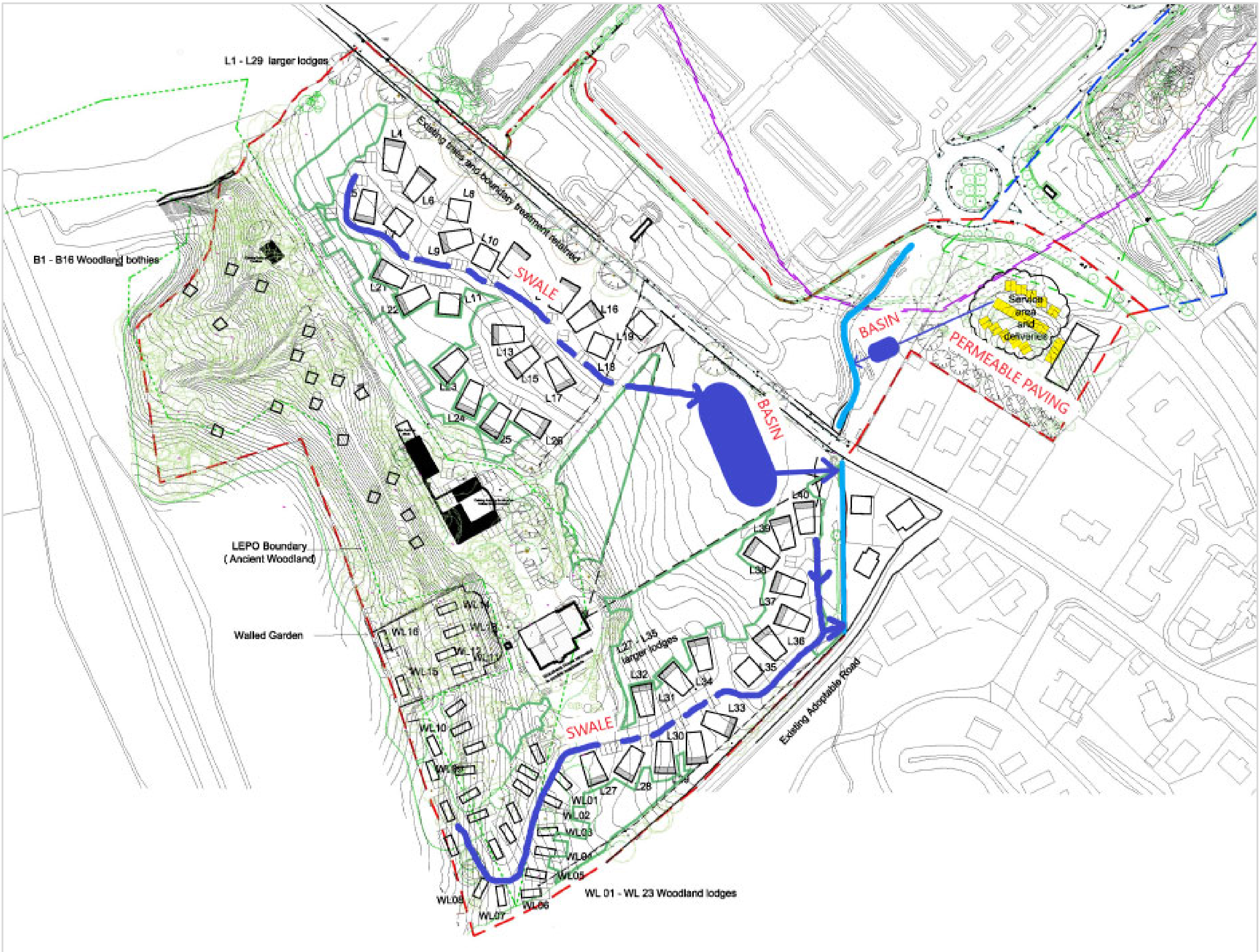

Figure 4-1 Woodbank Conceptual SuDS Layout

4.3.7 Surface water drainage of the Riverfront area of the site has the same issues as the foul drainage in that the site is very flat. Significant land raising would be required to provide a piped network with an outfall above the flood level. The proposed strategy therefore is for open channel systems to be implemented as flat as possible to manage treatment and attenuation of runoff, thereby avoiding land raising.

4.3.8 The SuDS strategy for the Riverfront area is shown in **Figure 4.2**. In parking areas out with the floodplain, it is proposed that permeable paving be introduced to treat and attenuate surface water at source. If ground conditions allow this could be constructed as an infiltration system. If conditions do not allow, then this could discharge to a detention basin or pond for additional treatment and attenuation prior to discharging to the River Leven.

4.3.9 It is proposed that a swale/under-drained swale be aligned with the access road running through the middle of the riverfront area from north to south. This would capture surface water runoff and provide treatment to the roof runoff from the lodges and car parking in the Pierhead area to the north prior to connecting to the surface water network upstream of the outfall. If finished levels in this area do not allow for a straight fall towards the outfall, then multiple outfalls at low spots within the swale system would be required to ensure the swale can be adequately drained. Alternatively, if ground conditions were favourable, this under-drained swale could be utilised as an infiltration system.

4.3.10 The roof runoff originating from the development to the north west is proposed to be picked up by filter drains enclosing the building footprint prior to discharge to the River Leven or through an outfall into the bay.

4.3.11 The outfalls for the SuDS basin is likely to be below the 1:200 Year + Climate Change flood level but efforts would be made to achieve the highest level possible to allow free flow from the basin in most situations and limit the attenuation needed during high return period events. Non-return duckbill or flap valves would be required to prevent the basin and drainage network from being surcharged by flood waters from the river.

4.3.12 The proposed SuDS features discussed here are described in more detail in Chapter 5 of this report, with a proposed drainage arrangement provided in **Appendix F.**

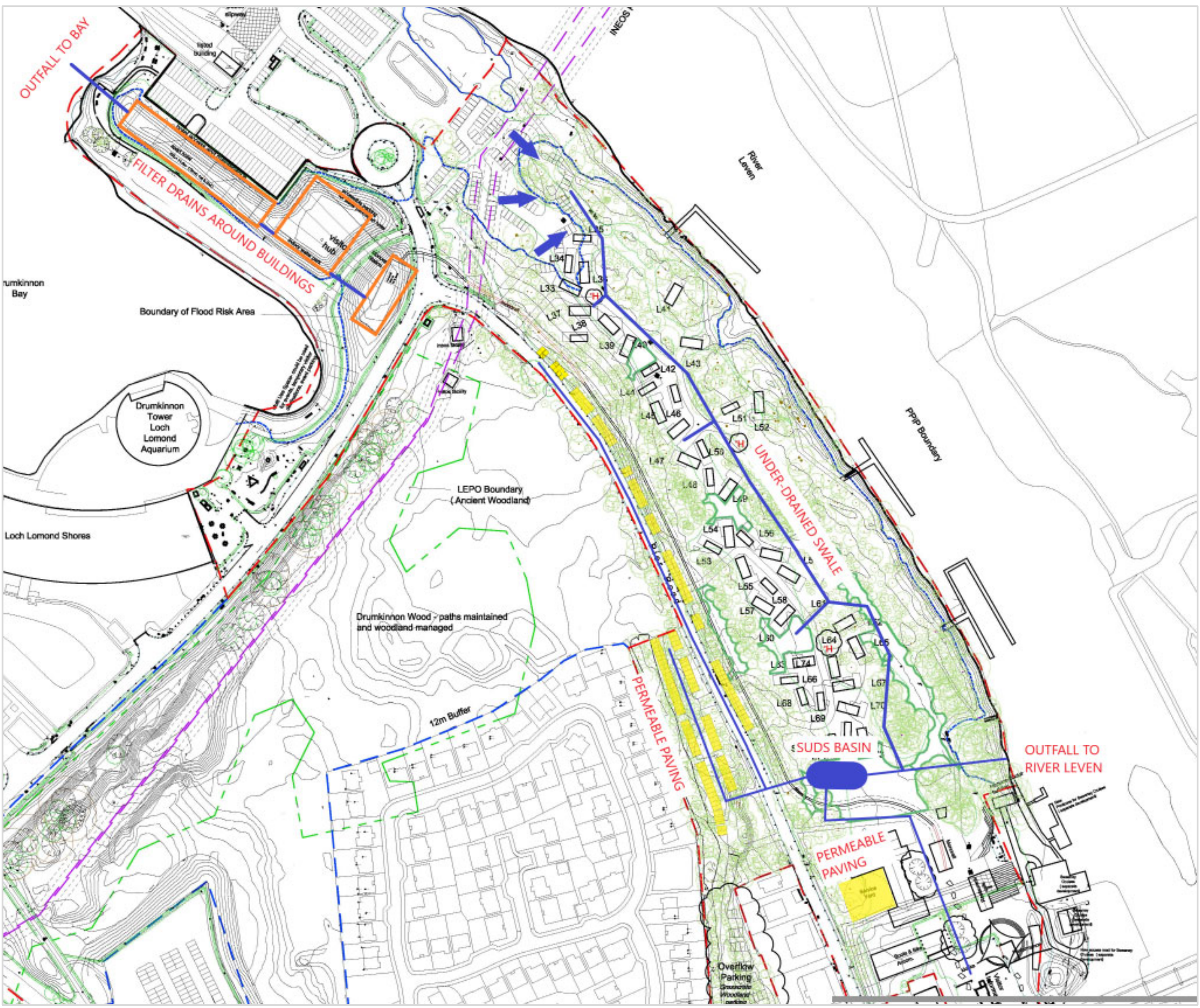

Figure 4-2 West Riverside Conceptual SuDS Layout

5 SuDS Strategy

5.1 Site Topography

5.1.1 The proposed finished site levels will take account of the existing levels. Given the flat nature of the existing ground at West Riverside, land raising was considered as part of the conceptual drainage design. However, due to part of the site being located within a floodplain, it was deemed that this would be undesirable due to SEPA requirements for compensatory storage to be provided to balance loss of floodplain within the site.

5.1.2 SEPA's requirements set out in *Technical Flood Risk Guidance for Stakeholders*, state an allowance for freeboard should be made. SEPA recommend a minimum 600mm freeboard to any finished floor levels, in line with CIRIA Guidance (*CIRIA C624 Development and Flood Risk – Guidance for the Construction Industry 2004*) unless a more detailed assessment of freeboard is made.

5.1.3 Consideration should be given to road gradients to ensure compliance with the National Roads Development Guide[2].The low points on the site will most likely coincide with the location of the SuDS features throughout the site, and these will need to be kept out of the floodplain.

5.2 Treatment/Water Quality

5.2.1 Treatment of surface runoff that discharges to the water environment is a SEPA requirement in accordance with Regulatory Method (WAT-RM-08) for the regulation of urban drainage.

5.2.2 The main regulatory driver for SUDS is to protect water quality, and through construction of retrofit SuDS, to begin to achieve improved water quality, and reduce the length of polluted waters downgraded because of urban drainage impacts. For new developments, SuDS aim to protect water quality, which includes groundwater. Where groundwater pollution is identified as a risk, then appropriate SuDS such as lined SuDS to prevent groundwater pollution should be used.

5.2.3 SuDS should be designed in accordance with CIRIA C753 The SuDS Manual, and SuDS for Roads.

5.2.4 In accordance with current guidance, the Simple Index Approach should be employed to establish suitable SuDS features that could be utilised in the development to provide treatment prior to discharge to the water environment.

Surface Water Management Train

5.2.5 The philosophy of the SuDS 'Management Train' is to replicate natural drainage processes as closely as possible. This concept is fundamental to the design and implementation of a successful SuDS scheme where drainage techniques are used in series to incrementally reduce pollution, flow rates and volumes. The SuDS will be integrated within the landscape proposals to enhance amenity, biodiversity and habitat, whilst protecting and/or enhancing water quality.

Water Quality Treatment

5.2.6 CIRIA C753 The SuDS Manual (Chapter 26) provides guidance on methods that should be used to design SuDS to meet water quality requirements and design standards.

5.2.7 For the basis of assessing the water quality risk management for the site, the *"simple index approach"* is normally used to check the suitability of SuDS to provide adequate treatment of surface water runoff. This approach can be categorised into 3 key steps:

- Allocate suitable pollution hazard indices for the proposed land use;

[2] National Roads Development Guide, available at: http://localapps.pkc.gov.uk/internet/flashmag/councils/nationalroadsguide/roadsfeb2014.pdf

- Select SuDS with total pollution mitigation index that equals or exceeds the pollution hazard index; and
- Where the discharge is to protect surface waters or groundwater, consider the need for a more precautionary approach.

5.2.8 It must be noted that in cases where the mitigation index of an individual component is insufficient, two components (or more) in series will be required, where:

Total SuDS mitigation index = mitigation index + 0.5 (mitigation index)

5.2.9 The Simple Index Approach (SIA) Tool (MS Excel) was used to determine the effectiveness of SuDS in providing suitable mitigation indices to exceed that of the pollution hazard index. The results of this exercise are shown in Table 5-1.

Table 5-1 Simple Index Approach Summary

	Land Use	Pollution Index			Proposed SuDS	Mitigation Index			Suitability
		TSS	Metals	Hydrocarbons		TSS	Metals	Hydrocarbons	
West Riverside	Commercial Roofing (Brewery etc)	0.3	0.2	0.05	Pond	0.7	0.7	0.5	
West Riverside	Retail Car Park	0.7	0.6	0.7	Under-drained swale	0.7	0.8	0.8	
West Riverside	Car Park (Pier Road)	0.7	0.6	0.7	Permeable Paving	0.7	0.6	0.7	
West Riverside	Commercial Yard (Brewery)	0.7	0.6	0.7	Permeable Paving + Pond	>0.95	0.95	0.95	
West Riverside	Commercial Roofing (Apart Hotel)	0.3	0.2	0.05	Filter Drain	0.4	0.4	0.4	
West Riverside	Residential Roofing (Lodges)	0.2	0.2	0.05	Swale/under-drained swale	0.5	0.6	0.6	
West Riverside	Low traffic roads (access to lodges)	0.5	0.4	0.4	Swale/under-drained swale	0.5	0.6	0.6	
Woodbank	Residential Roofing (Lodges)	0.2	0.2	0.05	Swale	0.5	0.6	0.6	
Woodbank	Low traffic roads (access to lodges)	0.5	0.4	0.4	Swale	0.5	0.6	0.6	

5.2.10 The pollution Hazard Index for each land use area can be satisfied using the following SuDS features:

- **Swales** - A swale is a shallow, flat bottomed, vegetated open channel designed to convey and treat surface water runoff. When incorporated into the site design, they can be used to enhance the natural landscape and provide aesthetic and biodiversity benefits;
- **Infiltration Trench** - narrow stone filled trenches that can capture surface runoff from any catchment, but often alongside roads. Infiltration trenches allow slow discharge along their length to the underlying geology. Clearly, such geology needs to be

capable of receiving water, and where heavy clays and bedrock prevail, this becomes difficult, so infiltration trenches are best located in areas of good permeability;

- **Filter Drain** – Similar to an infiltration trench, however the filter media is lined with a geotextile to prevent infiltration. Runoff can enter the filter drain as direct runoff or via a piped system;
- **SuDS Pond** - These are permanent water bodies which provide additional flood storage for storm runoff above normally standing water levels. Ponds should provide biodiversity and habitat benefits and where possible amenity opportunities too. By slowing the flow of stormwater within the pond, sedimentation and other processes occur which lets contaminants receive passive treatment to reduce pollution to watercourses;
- **Detention Basin** - These are normally dry, though they may have small permanent pools at the inlet and outlet. They are designed to fill during storm events and detain runoff as well as providing natural water quality treatment. After the storm has passed a slow drain-down occurs at a managed rate to control downstream flood risk, to return to the normal, generally dry condition of the basin; and
- **Permeable Paving** - a form of pavement construction that allows road runoff to infiltrate through the surface layer to underlying treatment and storage media. Permeable surfaces along with their underling media, are an efficient means of managing surface water runoff close to its source.

5.2.11 The treatment volume, Vt, as described in CIRIA C753 The SuDS Manual, is based on an empirical formula linked to the M5-60 rainfall depth for the area, equivalent to approximately 10-20mm rainfall depths, and has been calculated using the following parameters for each of the areas of the site:

D – rainfall depths of a five-year return period storm of 60 minutes duration

SOIL – soil index broadly describes the infiltration potential

I – assumed impervious fraction for development

Vt = 9D {SOIL/2 + (1-SOIL/2) i} m^3/hectare of site area

5.2.12 The treatment volumes required for the proposed development can be seen in **Table 5-1**.

Table 5-2 Treatment Volume (Vt)

Development Area	M5-60 (mm)	SOIL	Percentage Impermeable (%)	Vt (m^3/ha)	Site Area (Ha)	Vt (m^3)
Woodbank	16.0	0.45	20	54.72	9.4	514.37
West Riverside	16.0	0.45	30	65.88	9.6	632.45

5.2.13 If treatment is provided below ground using gravel media, the volume of gravel media required would depend on its void ratio, otherwise if an above ground feature such as a swale is used, the treatment volumes, stated in **Table 5-2** will remain unchanged

5.3 Attenuation

5.3.1 In accordance with West Dunbartonshire Council requirements, the discharge rate from site shall be restricted to greenfield runoff rate for each equivalent storm event e.g., the 30-year post development flow is to be restricted to 30-year greenfield runoff rate.

5.3.2 A 55% allowance for climate change has also been included in all calculations for the site, as per SEPA's requirements.

5.3.3 Provisions of this volume of attenuation through SuDS will ensure that the treatment volume is achieved.

5.3.4 Calculated volumes are shown in **Table 5-3**, with full MicroDrainage calculations provided in **Appendix E**…

Table 5-3 Attenuation Volumes

	Attenuation Volume Required (m^3)			
Development Area	**2 Year**	**30 Year**	**100 Year**	**200 Year**
Woodbank	146.8	256.3	314.9	436.5
West Riverside	290.9	527.7	711.7	847.1

5.4 Design for Exceedance

5.4.1 As a result of extreme rainfall events, it is inevitable that the capacities of sewers, watercourses and other drainage systems will become exceeded on occasion. Overland flow analysis should be undertaken at the detailed design stage using finished site contours to determine where overland flows will be routed in extreme flood events when the pipe and manhole capacities within the network have been exceeded to ensure that all surface water flooding is contained on site. This analysis should conclude that proposed buildings are not at risk of flooding during extreme events and overland flows route to the River Leven or other receiving waters.

5.5 Approvals and Adoption

5.5.1 It is the intention that both foul water and surface water networks and SuDS within the development be adopted by Scottish Water. A Pre-Development Enquiry (PDE) has already been submitted to Scottish Water and an application for Technical Approval should follow at the detailed design stage.

5.6 Construction

5.6.1 During the construction of SuDS features, it is important that the risk of pollution to the site be kept to a minimum. A Pollution Prevention Plan and Method statements for the control of pollution will be provided by the developers, and/or their contractors outlining their pollution prevention measures prior to development commencing on-site.

5.6.2 Hazardous and environmentally damaging chemicals and other materials should be managed and stored to ensure that they do not enter the existing drainage systems or cause local soil contamination. Guidance on the handling and storage of materials on site is available from SEPA. Materials which fall into this category include:

- Petrochemicals (e.g. fuel, lubricants);
- Building materials (e.g. cement); and
- General (e.g. excavation arising, mud, litter, site waste materials).

5.6.3 Please note that this is not a comprehensive list.

5.6.4 Care should be taken to ensure that any excavation works, and control of groundwater which may be necessary to facilitate the works, does not result in mobilisation of silts leading to contamination of any watercourses.

5.6.5 The works should be managed and sequenced to ensure that the risk of contaminated runoff or groundwater from the site entering the drainage systems is kept to a minimum. On site facilities for containment and controlled release of runoff and groundwater to the existing drainage system should be implemented. These facilities should be designed to trap debris and allow settlement and collection of silt.

5.6.6 In relation to The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended), SEPA's *Practical Guide* states that a complex licence will be required for any site for the management of surface water run-off from a construction site, including access tracks which is greater than 4ha. As the development site area exceeds 4ha, a complex licence will be required.

5.7 Maintenance

5.7.1 Basic maintenance schedules for the proposed SuDS features are outlined below in **Table 5-4 to 5.8**.

Maintenance Requirements for Swale

Table 5-4 Maintenance Requirements for Swale

Operation	Frequency
Inspections to determine mowing requirements	Monthly
Litter removal	Monthly
Scarifying and spiking following inspection	As required
Repair damages vegetation following inspection	As required.
Inspect inlets, outlets and overflows for blockages, and clear if required	Monthly
Inspect infiltration surfaces for ponding, compaction, silt accumulation, record areas where water is ponding for >48 hours	Monthly, or when required
Inspect vegetation coverage	Monthly for 6 months, quarterly for 2 years, then half yearly
Inspect inlets and facility surface for silt accumulation, establish appropriate silt removal frequencies	Half yearly
Reseed areas of poor vegetation growth, alter plant types to better suit conditions, if required	As required or if bare soil is exposed over 10% or more of the swale treatment area
Repair erosion or other damage by re-turfing or reseeding	As required
Relevel uneven surfaces and reinstate design levels	As required
Scarify and spike topsoil layer to improve infiltration performance, break up silt deposits and prevent compaction of the soil surface	As required
Remove build-up of sediment on upstream gravel trench, flow spreader or at top of filter strip	As required
Remove and dispose of oils or petrol residues using safe standard practices	As required

Maintenance Requirements for Permeable Paving

Table 5-5 Maintenance Requirements for Permeable Paving

Operation	Frequency
Brushing and vacuuming	Once a year, after autumn leaf fall, or reduced frequency as required, based on site-specific observations of clogging or manufacturer's recommendations – pay particular attention to areas where water runs onto pervious surface from adjacent impermeable areas as this area is most likely to collect the most sediment.
Stabilise and mow contributing and adjacent areas	As required
Removal of weeds or management using glyphosate applied directly into the weeds by an applicator rather than spraying	As required – once per year on less frequently used pavements
Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50mm of the level of the paving	As required
Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or a hazard to users, and replace lost jointing material	As required
Rehabilitation of surface and upper substructure by remedial sweeping	Every 10 to 15 years or as required (if infiltration performance is reduced due to significant clogging)
Initial inspection	Monthly for three months after installation
Inspect for evidence of poor operation and/or weed growth – if required, take remedial action	Three-monthly, 48h after large storms in first six months
Inspect silt accumulation rates and establish appropriate brushing frequencies	Annually
Monitor inspection chambers	Annually

Maintenance Requirements for Detention Basin

Table 5-6 Maintenance Requirements for Detention Basins

Operation	Frequency
Remove litter and debris	Monthly
Cut grass - for spillways and access routes	Monthly (during growing season), or as required
Cut grass - meadow grass in and around basin	Half yearly
Manage other vegetation and remove nuisance plants	Monthly (at start, then as required)
Inspect inlets, outlets and overflows for blockages, and clear if required	Monthly
Inspect banksides, structures, pipework etc for evidence of physical damage	Monthly
Inspect inlets and facility surface for silt accumulation. Establish appropriate silt removal frequencies	Monthly (for first year), then annually or as required
Check any penstock and other mechanical devices	Annually
Tidy all dead growth before start of growing season	Annually
Remove sediment from inlets, outlet and forebay	Annually (or as required)

Operation	Frequency
Manage wetland plants in outlet pool - where provided	Annually
Reseed areas of poor vegetation growth	As required
Prune and trim any trees and remove cuttings	Every 2 years, or as required
Remove sediment from inlets, outlets, forebay and main basin when required	Every 5 years, or as required (likely to be minimal requirements where effective upstream source control is provided
Repair erosion or other damage by reseeding or re-turfing	As required
Realignment of rip-rap	As required
Manage wetland plants in outlet pool - where provided	Annually
Reseed areas of poor vegetation growth	As required
Prune and trim any trees and remove cuttings	Every 2 years, or as required

Maintenance Requirements for Pond/Wetland

Table 5-7 Maintenance Requirements for Pond/Wetland

Operation	Frequency
Remove litter and debris	Monthly
Cut grass – public areas	Monthly (during growing season), or as required
Cut meadow grass	Half yearly
Inspect marginal and bankside vegetation and remove nuisance plants (for first 3 years)	Monthly (at start, then as required)
Inspect inlets, outlets, banksides, structures, pipework etc for evidence of blockages/physical damage	Monthly
Inspect water body for signs of poor water quality	Monthly (May – October)
Inspect silt accumulation rates in any forebay and main body of the pond and establish appropriate removal frequencies; undertake contamination testing once some build-up has occurred, to inform management and disposal options.	Half yearly
Check any penstock and other mechanical devices	Half yearly
Hand cut submerged and emergent aquatic plans (at minimum 0.1m above pond base; include max 25% of pond surface)	Annually
Remove 25% of bank vegetation from waters edge to minimum of 1m above water level	Annually
Tidy all dead growth before start of growing season	Annually
Remove sediment from any forebay	Every 1-5 years, or as required
Remove sediment and planting from one quadrant of the main body of ponds without sediment forebays	Every 5 years, or as required.
Remove sediment from the main body of big ponds when pool volume is reduced by 20%	With effective pre-treatment, this will only be required rarely, e.g., every 25-50 years
Repair erosion or other damage	As required
Realignment of riprap or other damage	As required
Repair / rehabilitate inlets, outlets and overflows	As required
Aerate pond when signs of eutrophication are detected	As required

Operation	Frequency
Replant, where necessary	As required

Maintenance Requirements for Filter Drain

Table 5-8 Maintenance Requirements for Filter Drain

Operation	Frequency
Remove litter and debris from filter drain surface, access chambers and pre-treatment devices.	Monthly (or as required)
Inspect filter drain surface, inlet/outlet pipework and control systems for blockages, clogging, standing water and structural damage	Monthly
Inspect pre-treatment systems, inlets and perforated pipework for silt accumulation, and establish appropriate silt removal frequencies	Six monthly
Remove sediment from pre-treatment devices	Six monthly, or as required
Remove or control tree roots where they are encroaching the sides of the filter drain, using recommended methods (NJUG, 2007 or BS 3998_2010)	As required
At locations with high pollution loads, remove surface geotextile and replace, and wash or replace overlying filter medium	Five yearly, or as required
Clear perforated pipework of blockages	As required
Check any penstock and other mechanical devices	Half yearly

6 Conclusions

6.1.1 The foul and surface water drainage layout and design should follow current design guidance in Sewers for Scotland 4th Edition, current British Standards and code of practice.

6.1.2 The Woodbank, and Drumkinnon Wood sections of the site can be drained under gravity and it is proposed that the foul sewers would connect into Scottish Water's existing combined sewers on Old Luss Road and Pier Road respectively. The riverfront section of the site presents a challenge for foul drainage as this area is extremely flat. As a gravity-based system is unlikely to be a practical solution for connecting into the existing combined sewer network, it would be necessary to install a pumping station in the riverfront section of the site. A gravity sewer would capture foul drainage from the Riverfront and Pierhead areas of the site and direct it to the pumping station. This would pump the wastewater up a rising main to a connecting manhole on the existing combined sewer network at Balloch Road.

6.1.3 Peak foul water discharge from the site has been calculated at a rate of **7.541l/s** based on an assessment of foul flows using current information available in an Accommodation Schedule for the development, as well as flow data presented in the British Water Code of Practice – Flows and Loads 4 – Sizing Criteria, Treatment Capacity for Sewage Treatment Systems, and Sewers for Scotland 4th Edition.

6.1.4 The proposed surface water drainage network servicing the proposed development will comprise of a gravity closed pipe network, draining surface water runoff from roofs and other impermeable areas (such as roads, car parking and hardstanding) to the SuDS treatment and attenuation features detailed in this report (permeable paving, filter drain, swales, detention basin/pond).

6.1.5 The surface water flow will discharge to the River Leven at a discharge rate equivalent to greenfield runoff, with attenuation and treatment volume managed within the SuDS features and the drainage network provided.

6.1.6 Greenfield runoff rates were calculated for the 2-, 30-, 100- and 200-year return period events for both the West Riverside and Woodbank areas. Based on these calculations it was found that the attenuation required for the 200 year + 55% climate change event was **847.1m^3** and **436.5m^3** for each area respectively.

6.1.7 SuDS should be designed in accordance with CIRIA C753 The SuDS Manual. In accordance with current guidance, the Simple Index Approach was used. This stipulates that the "total pollution mitigation index" should equal or exceed the "pollution hazard index". The required treatment to satisfy this relationship varied by each land use area and included the following SuDS features: filter drain, under-drained swale, pond/wetland and permeable paving.

6.1.8 The treatment volume is calculated to be **514.4m^3** and **632.5m^3** for the proposed development at Woodbank and West Riverside, respectively. This will be accommodated within the proposed SuDS described above.

6.1.9 Overland flow analysis should be undertaken at detailed design stage using level analysis of proposed finished levels on site to determine where overland flows would be routed in extreme flood events when the pipe and manhole capacities within the network have been exceeded. This analysis should conclude that proposed buildings are not at risk of flooding during extreme events and overland flows route to receiving watercourses.

Appendix A Correspondance with Relevent Authorities

Doidge, Aaron

From: Planning SW <planning.sw@sepa.org.uk>
Sent: Thursday, March 24, 2022 5:30 PM
To: MacColl, Scott
Subject: Automatic reply: Request for Information - West Riverside and Woodbank House (Lomond Banks)

We confirm receipt of your email and if you have requested a response we will respond to you as soon as we can. Please note that we may take longer to respond to your email than usual. If you wish to make an environmental data or freedom of information request
please follow the advice on our webpage, https://www.sepa.org.uk/about-us/access-to-information/

Kind regards,

Planning Service South West

SEPA

Information on our planning service along with guidance for planning authorities, developers and any other interested parties is available on our website at https://www.sepa.org.uk/environment/land/planning/

Doidge, Aaron

From: DevelopmentOperations <DevelopmentOperations@scottishwater.co.uk>
Sent: Thursday, March 24, 2022 5:30 PM
To: MacColl, Scott
Subject: RE: Request for Information - West Riverside and Woodbank House (Lomond Banks)

"

Thank you for contacting Scottish Water, Development Operations.

We have received your e-mail, and will assess this and route to the appropriate case owner/ team to action accordingly. If we have any further questions, we will contact you directly.

Did you know that we have a Customer Applications Portal where you can submit applications, track progress, details of your Scottish Water case owner, upload documents, pay invoices and also request pre-start meetings which is connected to our new IT system. You can visit this at www.scottishwater.co.uk/portal

Once you have an account on our portal you can then access our 'Dev Services' Remote Inspection App to submit remote inspections, by downloading from the Google Play Store / Apple App Store.

Please send any written correspondence to the following address:

Please note: Due to the current COVID-19 situation we currently have very limited access to the office therefore there will be a delay in us responding to written correspondence.

Scottish Water
Development Operations
The Bridge
Buchanan Gate Business Park
Cumbernauld Road
Stepps
Glasgow
G33 6FB

Central contact number: 0800 389 0379

Web: www.scottishwater.co.uk/portal
"

Doidge, Aaron

From: DevelopmentOperations <DevelopmentOperations@scottishwater.co.uk>
Sent: Friday, March 25, 2022 1:05 PM
To: MacColl, Scott; info@lochlomond-trossachs.org; Planning.sw@sepa.org.uk; roads@west-dunbarton.gov.uk
Cc: Warren, David
Subject: RE: Request for Information - West Riverside and Woodbank House (Lomond Banks)

Follow Up Flag: Follow up
Flag Status: Flagged

Good Afternoon,

Many thanks for your email below.

In regards to the flooding queries below you would be required to contact FloodingTeam@Scottishwater.co.uk to discuss or obtain this information.

In regards to the layout of existing infrastructure you must contact Site investigation Services to obtain plans:
Site Investigation Services (UK) Ltd.
Tel: 0333 123 1223
Email: plans@siteinvest.co.uk
Web: www.sisplan.co.uk

- Records of historical flooding in the area from all sources; **- flooding team**
- Existing flood defences in the vicinity of the development site;**- flooding team**
- Layouts of existing sewers and other services;**Site Investigation Services (UK) Ltd.**
- Records of land contamination; - **This is customer/developer responsibility to investigate**
- Discharge rate requirements from site - **This is site dependant and normally greenfield runoff**
- Design standards – any local specific guidance for drainage and flood risk? If not, best practice guidance will be assumed (E.g. Sewers for Scotland 4, CIRIA SuDS Manual) **Guidance assumed Sewers for Scotland.**
- Any other relevant information

Kind Regards,
Lisa Lennox
Customer Connections Team Leader
Development Operations Department
Scottish Water, The Bridge, Buchanan Gate Business Park, Cumbernauld Road, Stepps, Glasgow, G33 6FB
Dedicated Freephone Helpline : 0800 389 0379
Managed email Service: DevelopmentOperations@scottishwater.co.uk
Business Weblink: https://www.scottishwater.co.uk/Business-and-Developers/NEW-Connecting-to-Our-Network
Scottish Water
Trusted to serve Scotland

------------------- Original Message -------------------
From: scott.maccoll@stantec.com;
Received: Thu Mar 24 2022 17:30:03 GMT+0000 (Greenwich Mean Time)
To: Scottish Water <developmentoperations@scottishwater.co.uk>; Dev Ops Outbound Email Queue <developmentoperations@scottishwater.co.uk>; info@lochlomond-trossachs.org; Planning.sw@sepa.org.uk; roads@west-dunbarton.gov.uk;
Cc: David Warren <david.warren@stantec.com>;
Subject: Request for Information - West Riverside and Woodbank House (Lomond Banks)

EXTERNAL MAIL - Think Before You Click

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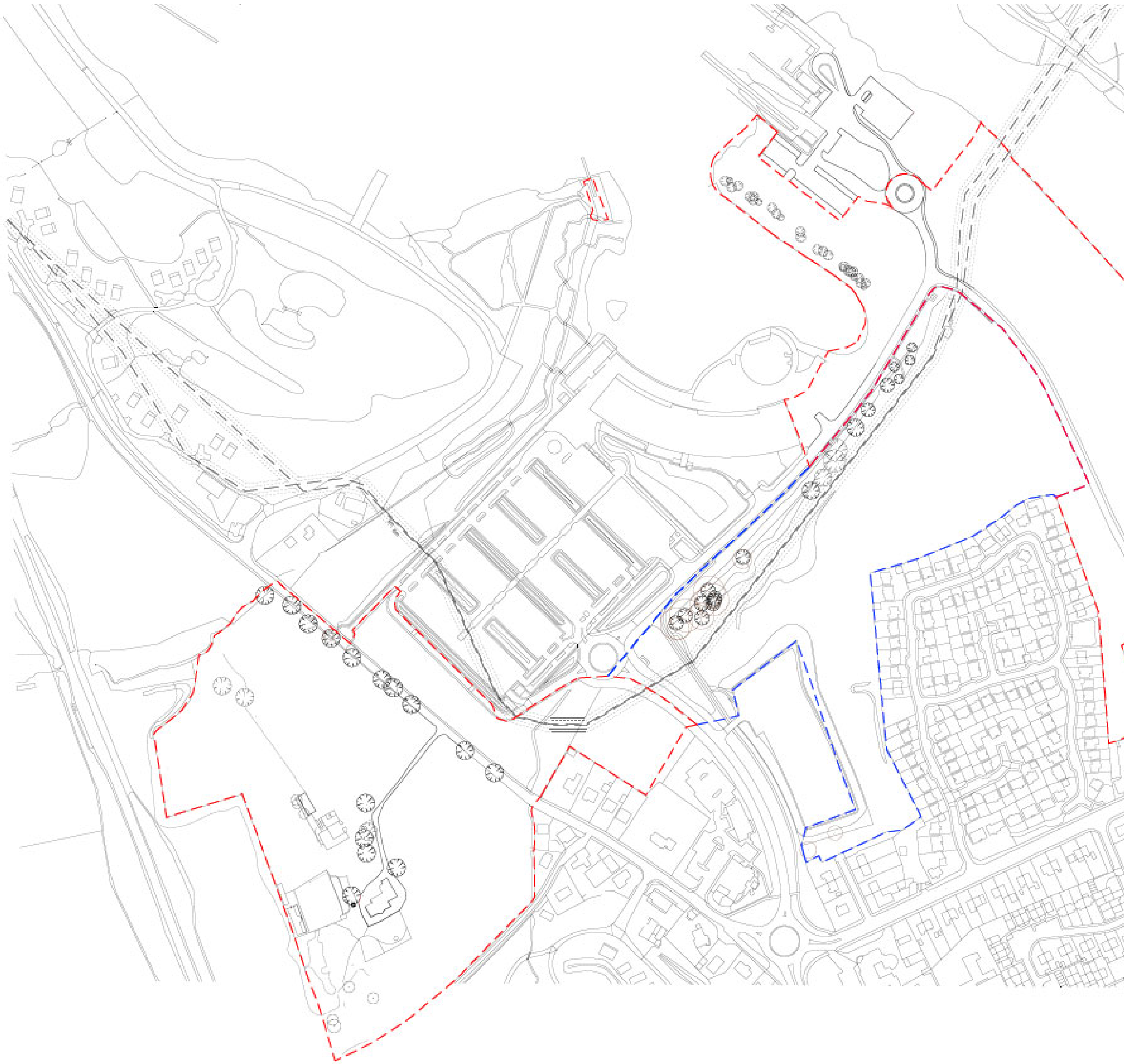

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- Any other relevant information

If I have used the wrong email address I would be much obliged if you could forward to your relevant team please. Many thanks in advance.

Kind regards,

Scott MacColl
Senior Engineer CEng MICE
3rd Floor, Randolph House
Edinburgh, EH2 4QZ
Direct: +44 131 2859 327
scott.maccoll@stantec.com

Better Together, Even If We're Apart. Read more about Stantec's COVID-19 response, including remote working and business continuity measures.

Doidge, Aaron

From: Planning SW <planning.sw@sepa.org.uk>
Sent: Friday, March 25, 2022 2:05 PM
To: MacColl, Scott
Subject: RE: Request for Information - West Riverside and Woodbank House (Lomond Banks)

Follow Up Flag: Follow up
Flag Status: Flagged

OFFICIAL

Scott,

I have forwarded your email so that it can be logged as a data request with our Flood Risk team. They will respond to the first two our bullet points below in due course. With regards to records of land contamination I recommend that you contact the Contaminated Land officer at West Dunbartonshire Council in the first instance.

Kind Regards,

Jonathan

Jonathan Werritty
Senior Planning Officer / Planning Officer - SW Team
Scottish Environment Protection Agency | Silvan House | 231 Corstorphine Road | Edinburgh | EH12 7AT

From: MacColl, Scott <scott.maccoll@stantec.com>
Sent: 24 March 2022 17:30
To: roads@west-dunbarton.gov.uk; Planning SW <planning.sw@sepa.org.uk>; info@lochlomond-trossachs.org; DevelopmentOperations <developmentoperations@scottishwater.co.uk>
Cc: Warren, David <david.warren@stantec.com>
Subject: Request for Information - West Riverside and Woodbank House (Lomond Banks)

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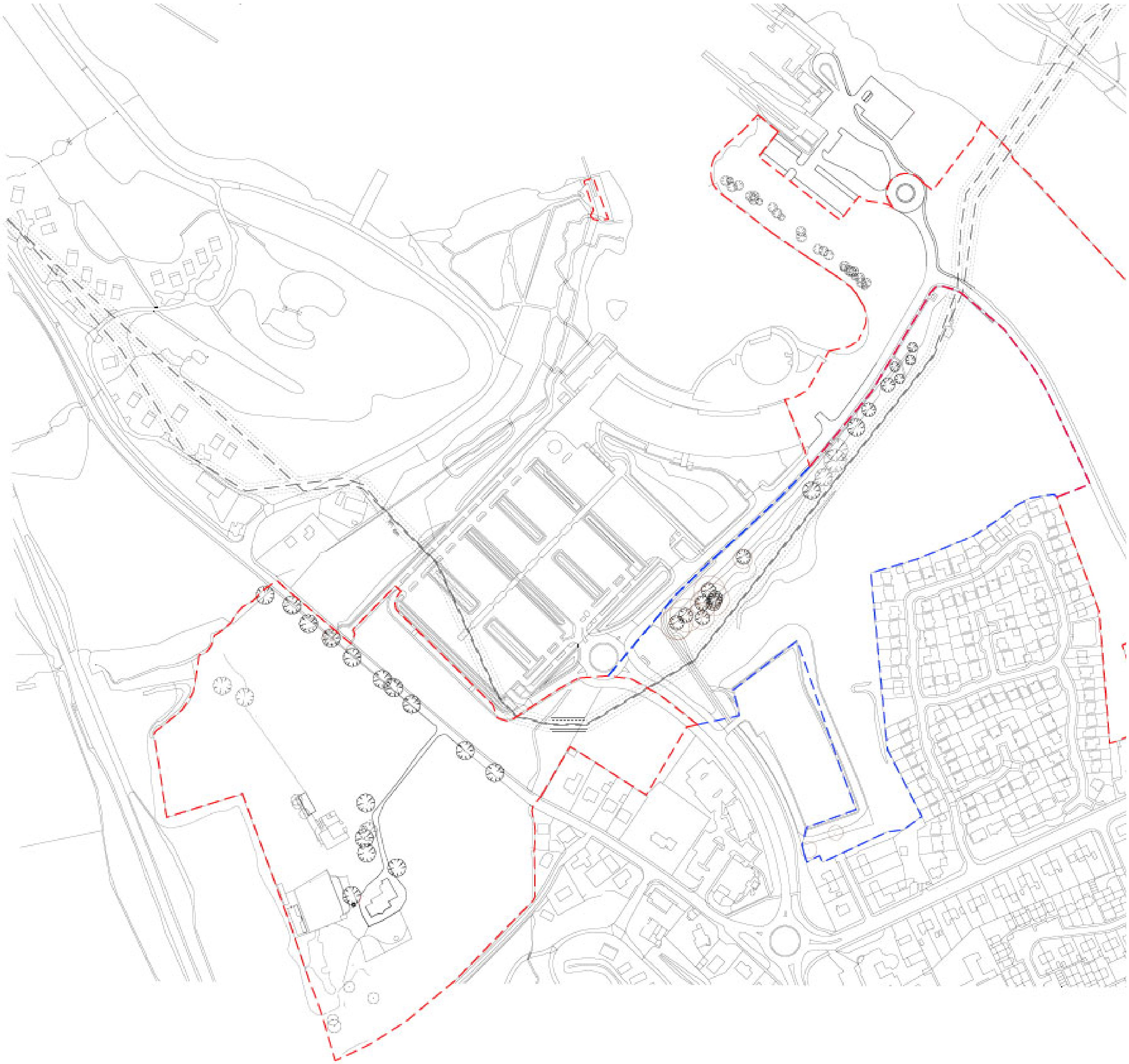

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3rd Floor, Randolph House
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Direct: +44 131 2859 327
scott.maccoll@stantec.com

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Doidge, Aaron

From: Caroline Strugnell <Caroline.Strugnell@lochlomond-trossachs.org>
Sent: Monday, March 28, 2022 5:04 PM
To: MacColl, Scott
Cc: Samantha Stubbs; Laura Baird; Bob Cook; Johnston, Mark (Glasgow)
Subject: Re: Request for Information - West Riverside and Woodbank House (Lomond Banks) - advice requested please

Follow Up Flag: Follow up
Flag Status: Flagged

Dear Scott

I refer to your enquiry below which has been passed to me for response. The National Park Authority does not hold the information requested.

The only documentation we have of relevance is the design guidance on SUDS contained within our Design and Placemaking Supplementary Planning Guidance which supports Natural Environment Policies 12 and 13 of our Local Development Plan.

Mark - you may also recall the complaint regarding the overflowing of the sewers in the vicinity of Sweenies Cruises which may be of relevance to this enquiry. I believe I forwarded you the correspondence a while back but do let me know if you wish me to dig it out and resend it.

Regards
Caroline

Caroline Strugnell MRTPI
Development Management Planner

Loch Lomond & The Trossachs National Park
Direct: 01389 722148
www.lochlomond-trossachs.org

In line with current guidance on the Covid-19 / Coronavirus pandemic, I am working remotely. My working hours are 8.30am to 16:30pm. You can best contact me via 01389 722148 or caroline.strugnell@lochlomond-trossachs.org National Park Authority staff can reach me via Teams.

For more information about our planning services at this time, please visit https://www.lochlomond-trossachs.org/planning/coronavirus-covid-19-planning-services/. Information on how to respect, protect and enjoy the National Park can be found in our latest advice to visitors.

From: MacColl, Scott <scott.maccoll@stantec.com>
Sent: 24 March 2022 17:30

To: roads@west-dunbarton.gov.uk; Planning.sw@sepa.org.uk; infomailbox <infomailbox@lochlomond-trossachs.org>; DevelopmentOperations <developmentoperations@scottishwater.co.uk>
Cc: Warren, David <david.warren@stantec.com>
Subject: Request for Information - West Riverside and Woodbank House (Lomond Banks)

Good afternoon,

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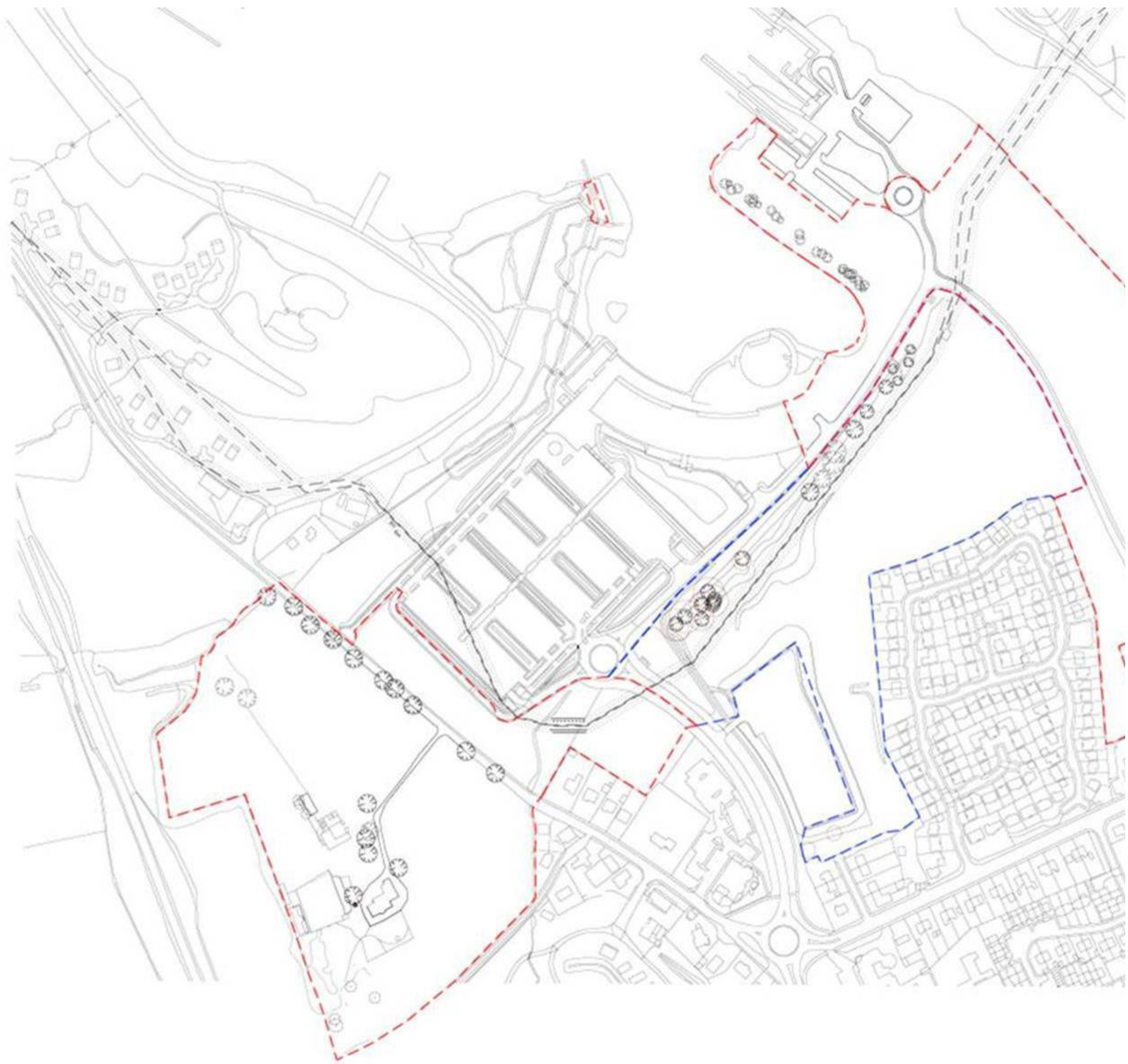

I would be grateful if you could assist us on this by providing any information held or any thoughts on any of the following:

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- Design standards – any local specific guidance for drainage and flood risk? If not, best practice guidance will be assumed (E.g. Sewers for Scotland 4, CIRIA SuDS Manual)
- Any other relevant information

If I have used the wrong email address I would be much obliged if you could forward to your relevant team please. Many thanks in advance.

Kind regards,

Scott MacColl
Senior Engineer CEng MICE
3rd Floor, Randolph House
Edinburgh, EH2 4QZ
Direct: +44 131 2859 327
scott.maccoll@stantec.com

Doidge, Aaron

From: Iain Hastings <Ian.Hastings@west-dunbarton.gov.uk>
Sent: Thursday, March 31, 2022 3:56 PM
To: MacColl, Scott
Cc: Raymond Walsh
Subject: FW: Request for Information - West Riverside and Woodbank House (Lomond Banks)

Afternoon Scott,

We get flooding on Old Luss Road just at the site boundary due to it being the low flat spot in the area. Source of flooding is the road drainage being blocked by leaves & usual happens in the autumn time. The flooding is usual between 100-200mm & the road remains fully open.

There was a flood event on Old Luss Road at its junction with Lower Stoneymollan Road after storm Desmond & Frank of winter 2014/2015. The combination of the road drainage not coping with the run off, the water course overtopped as it leaves the holiday park under Lower Stoneymollan Road & the combined sewer was surcharging at the location at the same time resulted in the area flooding & 2 properties being affected. Scottish Water did survey the combined system & discovered the sewer had a blockage within it at the time. Since they have removed the blockage & installed non return valves at the properties affect there has been not flooding at this location since.

There are no existing flood defences within the vicinity of the proposed development site.

Discharge rate would be site specific/standard greenfield run off.

SUDS manual for roads for design standards.

Any further question with regards to flooding don't hesitate to get in touch.

Regards

Iain

Iain Hastings
Technical Assistant
Flood Risk Management
Roads & Transportation
West Dunbartonshire Council
Bridge Street Office
Dumbarton
G82 1NT

------------------- Original Message -------------------
From: scott.maccoll@stantec.com;
Received: Thu Mar 24 2022 17:30:03 GMT+0000 (Greenwich Mean Time)
To: Scottish Water <developmentoperations@scottishwater.co.uk>; Dev Ops Outbound Email Queue <developmentoperations@scottishwater.co.uk>; info@lochlomond-trossachs.org; Planning.sw@sepa.org.uk; roads@west-dunbarton.gov.uk;
Cc: David Warren <david.warren@stantec.com>;

Subject: Request for Information - West Riverside and Woodbank House (Lomond Banks)

EXTERNAL MAIL - Think Before You Click

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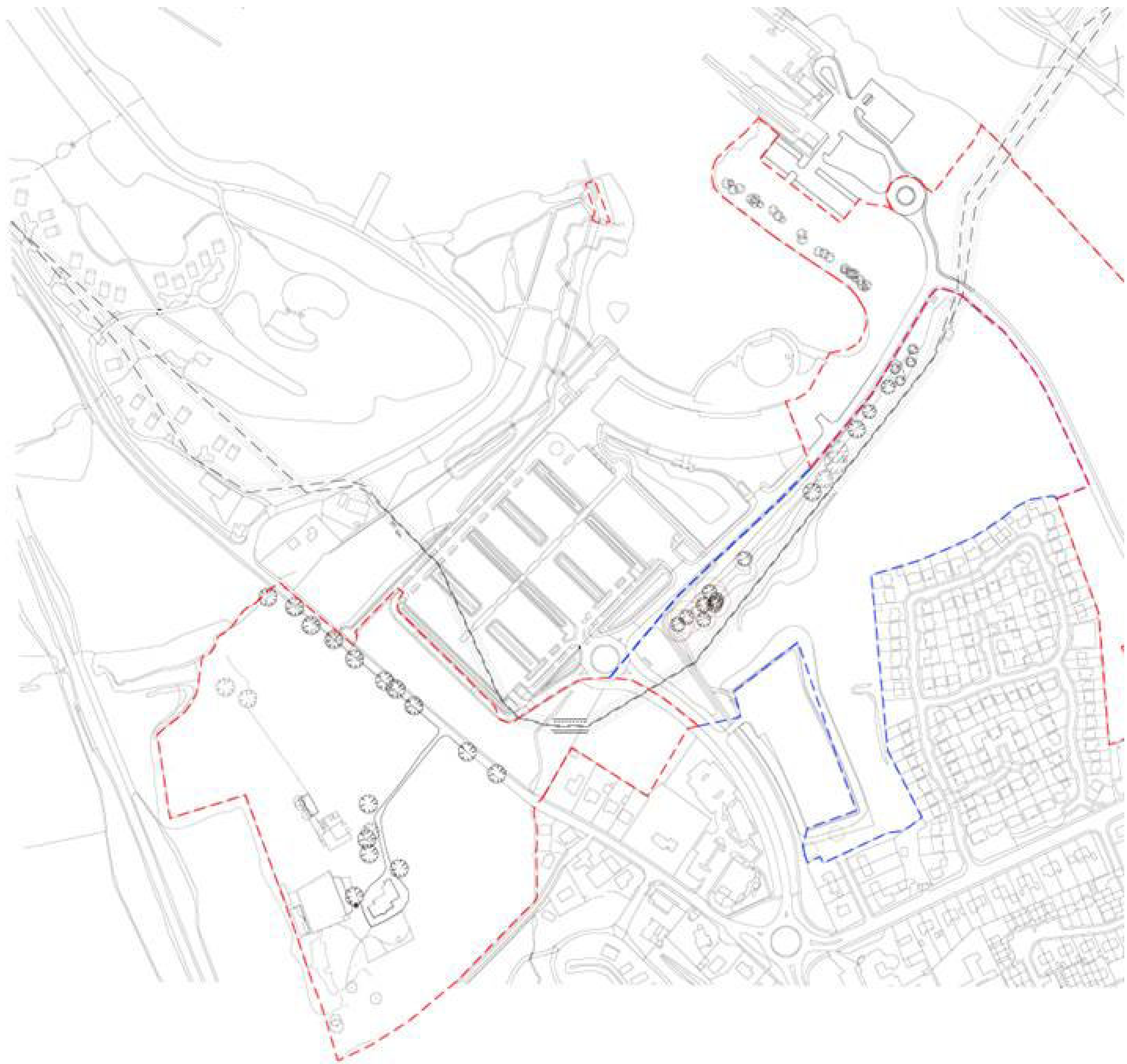

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- Any other relevant information

If I have used the wrong email address I would be much obliged if you could forward to your relevant team please. Many thanks in advance.

Kind regards,

Scott MacColl
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3rd Floor, Randolph House
Edinburgh, EH2 4QZ
Direct: +44 131 2859 327
scott.maccoll@stantec.com

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Doidge, Aaron

From: FOI <FOI@scottishwater.co.uk>
Sent: Wednesday, April 6, 2022 8:16 AM
To: MacColl, Scott
Subject: Freedom of Information Request - CAS-1821912-N6M5T CRM:068300000794

Dear MacColl,

Thank you for your request for information which we received from the Flooding Investigation Team yesterday.

I can confirm that I have logged your request under the above reference number and we will respond to your request in accordance with the EIRs by 05/05/2022.

We will endeavour to get a response to you as soon as we can.

If you have any queries regarding your FOI request please feel free to contact me quoting the above reference number, and I will be happy to assist.

Yours sincerely,
Andrew Ross | FOI Officer
Scottish Water
Phone : 01414830897

Doidge, Aaron

From: FRAM <fram@sepa.org.uk>
Sent: Thursday, April 14, 2022 11:22 AM
To: MacColl, Scott
Subject: RE: Request for Information - West Riverside and Woodbank House (Lomond Banks)

PUBLIC

Good Morning Scott,

Thank you for your enquiry which has been forwarded to me by the SEPA Contact team. As you may be aware SEPA is recovering from a significant cyber-attack which has had a major impact on the way we work. You can find out the latest status of our service through the following link: https://regulatoryapproach.sepa.org.uk/cyber-attack-service-status/ This is updated weekly.

We currently have approximately 11 records of flooding affecting your site of interest. These occur at various dates between January 2005 and February 2020. The records generally relate to fluvial flooding from the River Leven or Loch Lomond, but also note there are several pluvial records. A number of records relate to a specific event in January 2005 that highlight flooding to public toilets and footpaths from the River Leven. Within this event, a record notes overtopping of the left bank of the River Leven alongside a number of streets, but no specific details are provided. Similarly, an event in February 2020 has a few records that relate to flooding along Stirling Road and Balloch Road.

The Observed Flood Event database is a collection of flood event records known to SEPA at this time and does not constitute a complete record of all flooding that may have occurred in the area. We are also unable to provide any data on flood events that may have occurred since December 2020 due to a cyber-attack which has significantly impacted our internal systems.

Unfortunately, SEPA was subject to a cyber-attack which has significantly impacted our internal systems. Due to this we are unable to provide any information on past flood events for Scotland or other large areas. We are still able to respond to local requests / enquires for small areas but do not have access to the same level of information we previously held or any data on flood events that may have occurred since December 2020.

We do not have any records of any flood defences in the area of interest. However, it is recommended that you get in touch with the Flood Risk Management Authority, West Dunbartonshire Council, for any records of flood defences they may have.

I hope this is of use.

Regards,

Ross

Ross Garland | Scientist
Flood Risk Modelling Team
Hydrology & Flooding

From: MacColl, Scott <scott.maccoll@stantec.com>
Sent: 24 March 2022 17:30
To: roads@west-dunbarton.gov.uk; Planning SW <planning.sw@sepa.org.uk>; info@lochlomond-trossachs.org; DevelopmentOperations <developmentoperations@scottishwater.co.uk>
Cc: Warren, David <david.warren@stantec.com>
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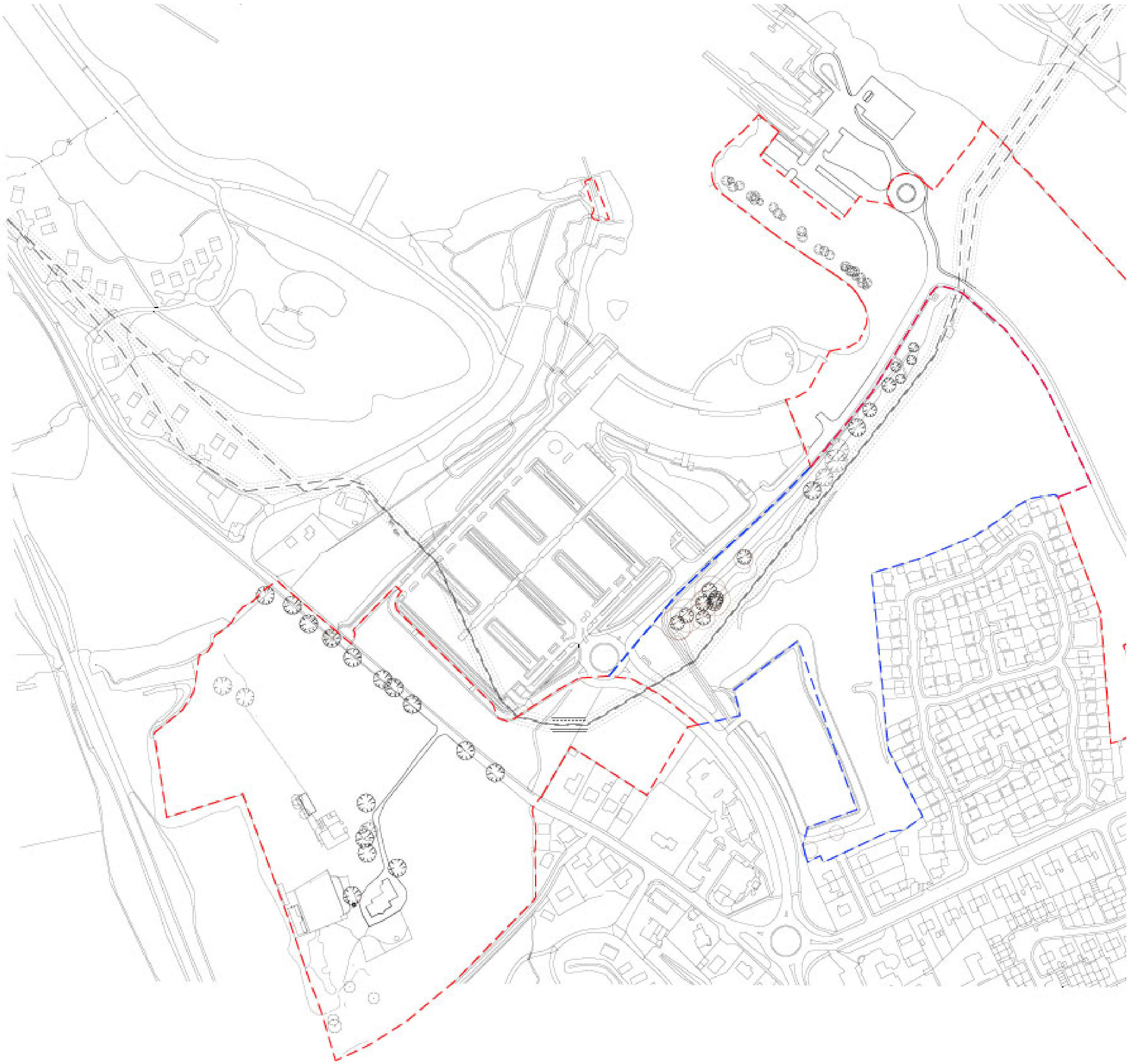

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If I have used the wrong email address I would be much obliged if you could forward to your relevant team please. Many thanks in advance.

Kind regards,

Scott MacColl
Senior Engineer CEng MICE
3rd Floor, Randolph House
Edinburgh, EH2 4QZ
Direct: +44 131 2859 327
scott.maccoll@stantec.com

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PUBLIC

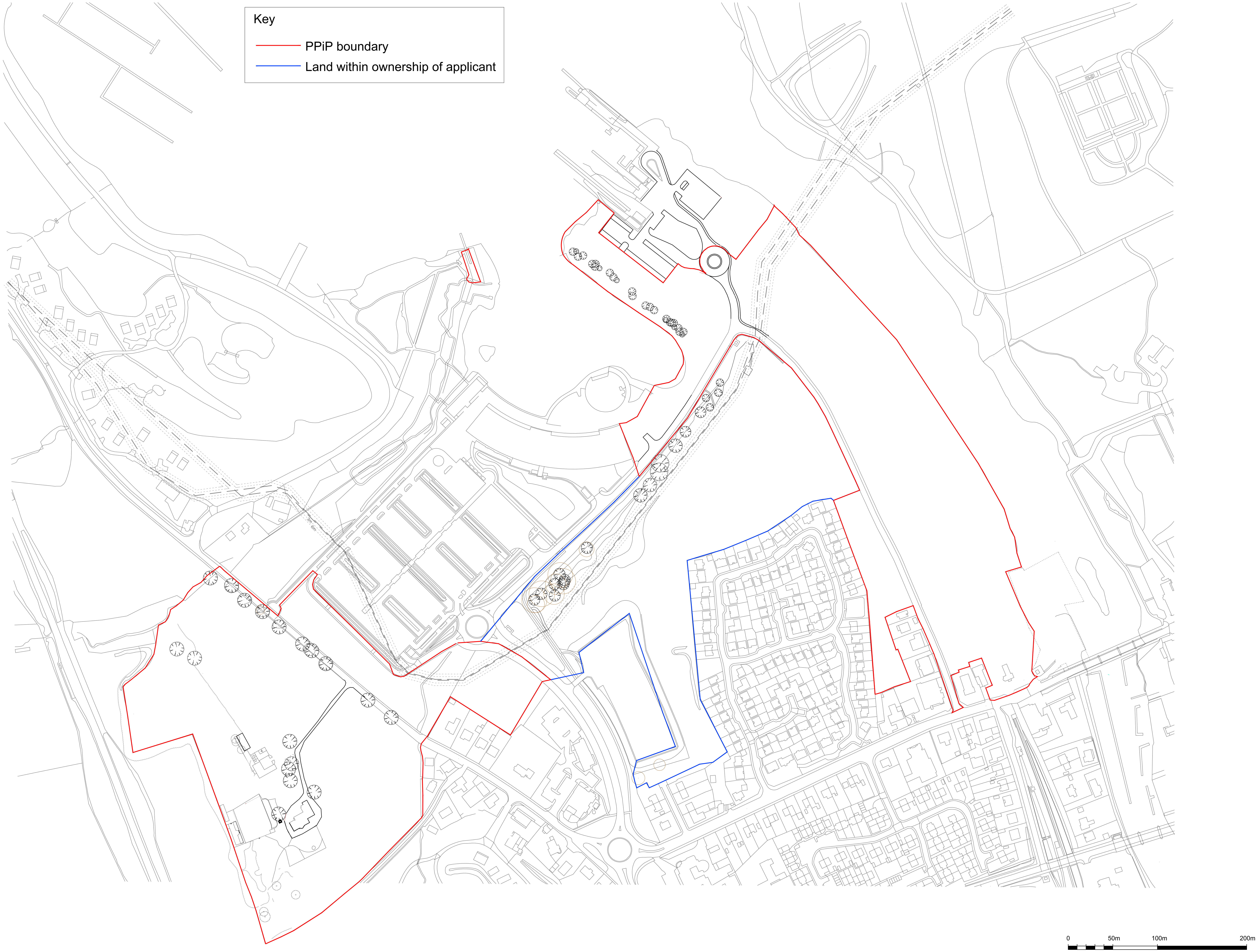
PUBLIC

PUBLIC

Appendix B Scottish Water Asset Plan


Supplies Drumkinnon Tower Aquarium
Plotted by:
dalzieke
N
West Riverside Development
SCALE: 1:1500
Date Plotted: 23/01/2017
The representation of physical assets and the boundaries of areas in which Scottish Water and others have an interest does not necessarily imply their true positions. For further details contact the appropriate District Office.
(c) Crown copyright and database rights 2017 Ordnance Survey 100023460. You are permitted to use this data solely to enable you to respond to, or interact with, the organisation that provided you with the data. You are not permitted to copy, sub-licence, distribute or sell any of this data to third parties in any form
Scottish Water
Trusted to serve Scotland
Castle House,
6 Castle Drive,
Dunfermline,
KY11 8GG
Tel No: 0800 0778 8778

Appendix C Site Location Plan



Rev	Date	Notes
A	09.03.22	Redline Boundary Updated
B	29.04.22	Site Boundary updated to solid line

RISK REGISTER

No.	Date	Description

NOTES

DO NOT SCALE
The Contractor must check & verify all Site & Building Dimensions, Levels & Sewer Inverts at DCM's before commencing work.
This Drawing must be read with the NBS Contract Specification and any related Structural Engineer or Specialist Contractors Drawings.

Project
Lomond Banks

Client
Flamingo Land

Drawing
Site Location Plan

Drg No.
ABC-XX-XX-DR-A-0001

Job No. 1363 | Rev. B

Scale	Sheet	Scale	Sheet	Scale	Sheet
1:2000	A1				

Drawn	Date	Checked
PP	12/05/21	RS

anderson bell + christie
architects

382 Great Western Road
Glasgow G4 9HT
T:(+44) 0141 339 1515
F:(+44) 0141 339 0505
E:gen@andersonbellchristie.com
W: www.andersonbellchristie.com

CAD Ref:

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Appendix D Development Accommodation Schedule

Draft development accommodation schedule

Station Square	Area	Notes	Building heights
Refurbished Tourist Information	As existing	To incorporate Bike Hire, Flamingo Land ticketing /management, other commercial uses Base for temporary lodge registration as phased development progresses	As existing
32 Bed Budget accommodation	To be determined - based on 64 bed spaces of which 24 are double bedrooms + 8 adjoining double rooms forming 4 family rooms	Budget accommodation for cyclists /walkers - 2 beds per room with ensuite - Access to other bar /restaurants at Station Sguare. - Similar type of accommodation to www.bikeandboot.com	12 m max height
Craft Brewery & Visitor Centre	1200 sqm GIFA (single storey)	Working brewery based on dimensions previously agreed by ABC and Loch Lomond Brewery	TBA
Restaurant	150 sqm GIFA (two storey)	85 covers (1.5 sqm per cover incl kitchen, WCs etc.)	Max height 9m
Enhanced public square	TTO	To integrate with (a) Sustrans proposals – currently being managed by WDC (b) Sweeney Cruises improvements (refer to masterplan layout)	n/a
Performance Amphitheatre	400 sqm performance space (footprint) 200 sqm GIFA (support & storage)	Refer to ABC masterplan layout for location Outdoor theatre area with tented cover	Max height 8m
Monorail Station	TTO		At ground level

<table>
<tr><th>Riverfront</th><th>Area</th><th>Notes</th><th>Building heights</th></tr>
<tr><td>Forest Lodges</td><td>43no single storey lodges
<table>
<tr><th>QTY</th><th>LENGTH</th><th>WIDTH</th><th>M2</th></tr>
<tr><td>20</td><td>11.50</td><td>5.00</td><td>57.50</td></tr>
<tr><td>23</td><td>3.60</td><td>9.40</td><td>33.84</td></tr>
</table></td><td>Access to lodges by buggy - remote parking
Pumped sewerage
Path network to include John Muir Way</td><td>Single storey dual pitch roof</td></tr>
<tr><td>Picnic / BBQ; Playgrounds</td><td>TTO</td><td>Part of the path network</td><td></td></tr>
<tr><td>Monorail</td><td>As per masterplan drawing</td><td>Destinations confirmed as Station Square and Pierhead Hub</td><td>Max height of track 3.5 metres – rising to 5.5 metres above access road to pierhead - height to be confirmed</td></tr>
<tr><td>Riverside Walkway</td><td>As per masterplan drawing</td><td>Woodland path outwith flooding zone at riverside
May need to be part of the John Muir Way if required by LLTNP</td><td>n/a</td></tr>
</table>

Drumkinnon Wood Staff & service area	Area	Notes	Building heights
Managed woodland	As existing	Existing paths upgraded Existing woodland retained and managed Retention and integration of Ineos pipeline infrastructure	
Staff & service area	700 sq metres (two storey)	Deliveries, storage, management, welfare, workshop & security uses	8m max height

Pierhead	Area	Notes

(Rev E) Accommodation - Floor Areas	Ground Floor	First Floor	Second Floor	Total Floor Area	Avg. StoreyHeight	Notes
	(m2)					
1. Apart Hotel (60 Bed)						
Floor Areas	1200	1200	665	3065	3m	60 Bed Apart Hotel - Apart hotel = studio rooms only, no reception, no restaurant etc
2. Water Park (incl staff areas)						
Floor Areas	1165	1225	645	2428	3.5	Waterpark - Size based on 'The Splash Zone', Flamingoland - includes pool area, changing, plant and WCs. Sizes taken fromSplash Zone at Flamingo Land Yorkshire
3. Reception & Atrium						
Floor Areas	555	260	100	915	3.5	Reception - Assumed facilitiesfor lodges, day guests, visitorsand Hotel Check-in.
4.Mono-Rail Terminal & Attractions (incl staff areas)						
Floor Areas	840	840	900	2064	3.5	Mono-Rail Terminal & Offices -Additional Attractions - Assumed indoor activities i.e. food & beverage & retail
5. Water Sports Hub - Boathouses						
Floor Areas	150	100	0	250	3.5	Water Sports Hub - Outdoor Activities requiring changing and storage
Total Floor Area Per Floor (m2)	3910	3625	2310	8722	m2	

Woodbank	Area	Notes	Building heights

<table>
<tr>
<td>Lodges</td>
<td>37no Larger lodges in grazing land
30no smaller lodges and 17no bothies (pods) in woodland
<table>
<tr><th>TYPE</th><th>No</th><th>LENGTH</th><th>WIDTH</th><th>M2</th></tr>
<tr><td>Bothies (pods)</td><td>17</td><td>5.00</td><td>4.00</td><td>20.00</td></tr>
<tr><td>Woodland lodges</td><td>30</td><td>11.50</td><td>5.00</td><td>57.50</td></tr>
<tr><td>Larger lodges (ardgarten)</td><td>22</td><td>15.00</td><td>8.00</td><td>120.00</td></tr>
<tr><td>Larger lodges (strathyre)</td><td>15</td><td>10.00</td><td>10.00</td><td>100.00</td></tr>
</table>
</td>
<td>Within grazing land and area for smaller lodges - minimum path width 3.7 metres where access is needed for emergency vehicles.
Bothies (pods) accessed by foot only and have no services (shower blocks and kitchen facilities to be located within refurbished ancillary accommodation)</td>
<td>Lodges - single storey dual pitch roof
Ridge height 4.8m from existing ground level

Bothies – single storey monopitch roof, ridge height 3.5m from existing ground level</td>
</tr>
<tr>
<td>Woodbank House</td>
<td>15 new flats within Woodbank House
6 self catering properties within ancillary buildings</td>
<td>Façade of Woodbank House retained, building converted into holiday apartments</td>
<td>As existing</td>
</tr>
<tr>
<td>Woodland planting</td>
<td></td>
<td>Location for compensatory planting</td>
<td></td>
</tr>
<tr>
<td>Boathouse activity centre and storage for water based activities</td>
<td>95 sqm</td>
<td>Existing building footprint</td>
<td>Two storey houses with dual pitch roof
Ridge height 9.3m from existing ground level</td>
</tr>
</table>

ALL AREAS Infrastructure	Area	Notes	Building heights
SUDs/drainage	As per masterplan layout	Engineer has carried out a provisional assessment – incorporated into previous layout	
Ineos pipeline	N/A		
Pier Road	n/a	Assume Pier road open to traffic, with lower section adopted	
Monorail			3.5 m track height (rising to 5.1 metres at access road to Pierhead)
Compensatory woodland planting	Refer to page 6 of this document for compensatory planting areas	Await current LLTNP position regarding compensatory tree planting	
New access ways and footpaths		New vehicular access - Gravel bound access road Woodland parking areas - Gravel bound access road & parking 3.8m pedestrian /cycle path - Gravel bound access road Tertiary small footpath - Gravel bound walkway Sustrans improvement area (likely to be developed in partnership with WDC and Abellio) Finishes as elsewhere in Balloch	

Appendix E MicroDrainage Calculations

Summary of Results for 2 year Return Period (+55%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.564	0.564	97.0	169.2	O K
30 min Summer	0.734	0.734	97.0	220.1	Flood Risk
60 min Summer	0.856	0.856	97.0	256.8	Flood Risk
120 min Summer	0.890	0.890	97.0	267.0	Flood Risk
180 min Summer	0.835	0.835	97.0	250.4	Flood Risk
240 min Summer	0.768	0.768	97.0	230.4	Flood Risk
360 min Summer	0.634	0.634	97.0	190.1	O K
480 min Summer	0.522	0.522	96.8	156.6	O K
600 min Summer	0.441	0.441	95.6	132.3	O K
720 min Summer	0.385	0.385	93.8	115.5	O K
960 min Summer	0.335	0.335	84.7	100.4	O K
1440 min Summer	0.285	0.285	68.2	85.5	O K
2160 min Summer	0.244	0.244	53.6	73.3	O K
2880 min Summer	0.220	0.220	45.1	65.9	O K
4320 min Summer	0.190	0.190	35.0	56.9	O K
5760 min Summer	0.171	0.171	29.2	51.3	O K
7200 min Summer	0.158	0.158	25.3	47.4	O K
8640 min Summer	0.149	0.149	22.6	44.6	O K
10080 min Summer	0.141	0.141	20.5	42.2	O K
15 min Winter	0.642	0.642	97.0	192.7	O K
30 min Winter	0.841	0.841	97.0	252.4	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	44.092	0.0	237.2	21
30 min Summer	30.577	0.0	329.3	31
60 min Summer	20.634	0.0	445.2	48
120 min Summer	13.668	0.0	590.0	82
180 min Summer	10.628	0.0	688.3	116
240 min Summer	8.927	0.0	770.8	148
360 min Summer	6.977	0.0	903.8	210
480 min Summer	5.843	0.0	1009.1	268
600 min Summer	5.092	0.0	1099.3	324
720 min Summer	4.550	0.0	1178.9	380
960 min Summer	3.812	0.0	1316.6	498
1440 min Summer	2.965	0.0	1536.4	738
2160 min Summer	2.300	0.0	1788.4	1100
2880 min Summer	1.922	0.0	1991.8	1468
4320 min Summer	1.489	0.0	2315.3	2200
5760 min Summer	1.240	0.0	2571.1	2912
7200 min Summer	1.076	0.0	2788.1	3632
8640 min Summer	0.958	0.0	2978.7	4392
10080 min Summer	0.868	0.0	3149.8	5112
15 min Winter	44.092	0.0	265.8	21
30 min Winter	30.577	0.0	368.9	32

Summary of Results for 2 year Return Period (+55%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	0.970	0.970	97.0	290.9	Flood Risk
120 min Winter	0.960	0.960	97.0	287.9	Flood Risk
180 min Winter	0.833	0.833	97.0	250.0	Flood Risk
240 min Winter	0.706	0.706	97.0	211.8	Flood Risk
360 min Winter	0.497	0.497	96.6	149.1	O K
480 min Winter	0.374	0.374	93.4	112.2	O K
600 min Winter	0.333	0.333	84.2	99.9	O K
720 min Winter	0.307	0.307	75.9	92.2	O K
960 min Winter	0.274	0.274	64.1	82.1	O K
1440 min Winter	0.234	0.234	50.1	70.3	O K
2160 min Winter	0.202	0.202	39.0	60.6	O K
2880 min Winter	0.182	0.182	32.6	54.6	O K
4320 min Winter	0.158	0.158	25.3	47.4	O K
5760 min Winter	0.143	0.143	21.1	42.9	O K
7200 min Winter	0.133	0.133	18.4	39.8	O K
8640 min Winter	0.125	0.125	16.4	37.4	O K
10080 min Winter	0.118	0.118	14.8	35.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	20.634	0.0	498.7	52
120 min Winter	13.668	0.0	660.8	90
180 min Winter	10.628	0.0	770.9	124
240 min Winter	8.927	0.0	863.4	156
360 min Winter	6.977	0.0	1012.3	214
480 min Winter	5.843	0.0	1130.3	264
600 min Winter	5.092	0.0	1231.2	320
720 min Winter	4.550	0.0	1320.4	378
960 min Winter	3.812	0.0	1474.7	498
1440 min Winter	2.965	0.0	1720.9	740
2160 min Winter	2.300	0.0	2003.1	1104
2880 min Winter	1.922	0.0	2230.9	1468
4320 min Winter	1.489	0.0	2593.2	2172
5760 min Winter	1.240	0.0	2879.7	2896
7200 min Winter	1.076	0.0	3122.7	3624
8640 min Winter	0.958	0.0	3336.2	4312
10080 min Winter	0.868	0.0	3527.9	5120

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	2	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	16.000	Shortest Storm (mins)	15
Ratio R	0.250	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+55

Time Area Diagram

Total Area (ha) 2.880

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	0.960	4	8	0.960	8	12	0.960

Model Details

Storage is Online Cover Level (m) 1.000

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	300.0	1.000	300.0	1.001	0.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0387-9710-1200-9710
Design Head (m)	1.200
Design Flow (l/s)	97.1
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	387
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	450
Suggested Manhole Diameter (mm)	Site Specific Design (Contact Hydro International)

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	97.1
Flush-Flo™	0.571	97.0
Kick-Flo®	0.961	87.2
Mean Flow over Head Range	-	76.9

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	10.8	1.200	97.1	3.000	151.7	7.000	229.6
0.200	38.4	1.400	104.6	3.500	163.5	7.500	237.6
0.300	73.4	1.600	111.7	4.000	174.6	8.000	245.2
0.400	94.4	1.800	118.2	4.500	184.9	8.500	252.6
0.500	96.6	2.000	124.5	5.000	194.7	9.000	259.8
0.600	96.9	2.200	130.4	5.500	204.0	9.500	266.8
0.800	93.9	2.400	136.0	6.000	212.9		
1.000	88.9	2.600	141.4	6.500	221.4		

Summary of Results for 2 year Return Period (+55%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.620	0.620	85.6	92.9	O K
30 min Summer	0.804	0.804	85.6	120.6	Flood Risk
60 min Summer	0.893	0.893	85.6	133.9	Flood Risk
120 min Summer	0.842	0.842	85.6	126.3	Flood Risk
180 min Summer	0.710	0.710	85.6	106.5	Flood Risk
240 min Summer	0.597	0.597	85.6	89.5	O K
360 min Summer	0.435	0.435	84.8	65.2	O K
480 min Summer	0.348	0.348	82.3	52.2	O K
600 min Summer	0.315	0.315	74.2	47.3	O K
720 min Summer	0.293	0.293	67.4	43.9	O K
960 min Summer	0.262	0.262	57.4	39.4	O K
1440 min Summer	0.226	0.226	45.3	33.8	O K
2160 min Summer	0.195	0.195	35.4	29.2	O K
2880 min Summer	0.176	0.176	29.6	26.3	O K
4320 min Summer	0.152	0.152	22.9	22.8	O K
5760 min Summer	0.138	0.138	19.1	20.7	O K
7200 min Summer	0.128	0.128	16.6	19.1	O K
8640 min Summer	0.120	0.120	14.7	18.0	O K
10080 min Summer	0.114	0.114	13.4	17.0	O K
15 min Winter	0.714	0.714	85.6	107.1	Flood Risk
30 min Winter	0.925	0.925	85.6	138.7	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	44.092	0.0	155.2	20
30 min Summer	30.577	0.0	215.3	29
60 min Summer	20.634	0.0	290.8	46
120 min Summer	13.668	0.0	385.3	80
180 min Summer	10.628	0.0	449.5	110
240 min Summer	8.927	0.0	503.4	140
360 min Summer	6.977	0.0	590.1	198
480 min Summer	5.843	0.0	659.0	254
600 min Summer	5.092	0.0	717.8	312
720 min Summer	4.550	0.0	769.8	372
960 min Summer	3.812	0.0	859.7	492
1440 min Summer	2.965	0.0	1003.3	734
2160 min Summer	2.300	0.0	1167.6	1100
2880 min Summer	1.922	0.0	1300.4	1456
4320 min Summer	1.489	0.0	1511.7	2196
5760 min Summer	1.240	0.0	1678.4	2920
7200 min Summer	1.076	0.0	1820.1	3632
8640 min Summer	0.958	0.0	1944.6	4336
10080 min Summer	0.868	0.0	2056.4	5128
15 min Winter	44.092	0.0	173.9	21
30 min Winter	30.577	0.0	241.2	31

Summary of Results for 2 year Return Period (+55%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	0.979	0.979	85.6	146.8	Flood Risk
120 min Winter	0.832	0.832	85.6	124.8	Flood Risk
180 min Winter	0.596	0.596	85.6	89.4	O K
240 min Winter	0.439	0.439	84.9	65.9	O K
360 min Winter	0.320	0.320	75.5	47.9	O K
480 min Winter	0.282	0.282	63.9	42.3	O K
600 min Winter	0.258	0.258	55.9	38.7	O K
720 min Winter	0.240	0.240	50.1	36.1	O K
960 min Winter	0.216	0.216	42.2	32.4	O K
1440 min Winter	0.187	0.187	32.9	28.0	O K
2160 min Winter	0.162	0.162	25.5	24.2	O K
2880 min Winter	0.147	0.147	21.4	22.0	O K
4320 min Winter	0.128	0.128	16.6	19.1	O K
5760 min Winter	0.116	0.116	13.8	17.3	O K
7200 min Winter	0.107	0.107	12.0	16.1	O K
8640 min Winter	0.101	0.101	10.6	15.1	O K
10080 min Winter	0.096	0.096	9.7	14.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	20.634	0.0	325.7	48
120 min Winter	13.668	0.0	431.6	84
180 min Winter	10.628	0.0	503.4	114
240 min Winter	8.927	0.0	563.8	142
360 min Winter	6.977	0.0	661.0	194
480 min Winter	5.843	0.0	738.0	254
600 min Winter	5.092	0.0	803.9	314
720 min Winter	4.550	0.0	862.2	374
960 min Winter	3.812	0.0	962.9	492
1440 min Winter	2.965	0.0	1123.7	734
2160 min Winter	2.300	0.0	1307.7	1100
2880 min Winter	1.922	0.0	1456.4	1464
4320 min Winter	1.489	0.0	1693.1	2196
5760 min Winter	1.240	0.0	1879.8	2864
7200 min Winter	1.076	0.0	2038.5	3616
8640 min Winter	0.958	0.0	2178.0	4296
10080 min Winter	0.868	0.0	2303.2	5056

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	2	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	16.000	Shortest Storm (mins)	15
Ratio R	0.250	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+55

Time Area Diagram

Total Area (ha) 1.880

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	0.627	4	8	0.627	8	12	0.627

Model Details

Storage is Online Cover Level (m) 1.000

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	150.0	1.000	150.0	1.001	0.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0370-8570-1000-8570
Design Head (m)	1.000
Design Flow (l/s)	85.7
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	370
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	450
Suggested Manhole Diameter (mm)	2100

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	85.7
Flush-Flo™	0.524	85.6
Kick-Flo®	0.831	78.3
Mean Flow over Head Range	-	66.0

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	10.5	1.200	93.6	3.000	146.2	7.000	221.4
0.200	37.0	1.400	100.9	3.500	157.7	7.500	229.1
0.300	69.7	1.600	107.7	4.000	168.3	8.000	236.4
0.400	84.1	1.800	114.0	4.500	178.3	8.500	243.6
0.500	85.5	2.000	120.0	5.000	187.8	9.000	250.5
0.600	85.1	2.200	125.7	5.500	196.7	9.500	257.3
0.800	79.9	2.400	131.2	6.000	205.3		
1.000	85.7	2.600	136.4	6.500	213.5		

Summary of Results for 30 year Return Period (+55%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.536	0.536	190.2	321.6	O K
30 min Summer	0.690	0.690	194.1	414.0	O K
60 min Summer	0.790	0.790	194.1	474.0	Flood Risk
120 min Summer	0.803	0.803	194.1	481.7	Flood Risk
180 min Summer	0.747	0.747	194.1	448.4	Flood Risk
240 min Summer	0.681	0.681	194.0	408.6	O K
360 min Summer	0.564	0.564	191.4	338.1	O K
480 min Summer	0.484	0.484	187.1	290.3	O K
600 min Summer	0.442	0.442	173.2	265.1	O K
720 min Summer	0.412	0.412	158.5	247.3	O K
960 min Summer	0.370	0.370	135.5	222.0	O K
1440 min Summer	0.318	0.318	106.8	191.1	O K
2160 min Summer	0.274	0.274	83.2	164.5	O K
2880 min Summer	0.247	0.247	69.3	148.0	O K
4320 min Summer	0.212	0.212	52.9	127.5	O K
5760 min Summer	0.191	0.191	43.8	114.6	O K
7200 min Summer	0.176	0.176	37.6	105.7	O K
8640 min Summer	0.165	0.165	33.4	99.0	O K
10080 min Summer	0.156	0.156	30.1	93.6	O K
15 min Winter	0.603	0.603	192.7	361.6	O K
30 min Winter	0.782	0.782	194.1	469.4	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	80.788	0.0	433.1	20
30 min Summer	56.475	0.0	606.8	30
60 min Summer	37.547	0.0	809.4	48
120 min Summer	24.306	0.0	1048.4	80
180 min Summer	18.707	0.0	1210.6	114
240 min Summer	15.510	0.0	1338.4	144
360 min Summer	11.880	0.0	1538.0	204
480 min Summer	9.821	0.0	1695.3	260
600 min Summer	8.469	0.0	1827.5	318
720 min Summer	7.502	0.0	1942.6	378
960 min Summer	6.194	0.0	2138.4	498
1440 min Summer	4.727	0.0	2447.6	740
2160 min Summer	3.604	0.0	2801.4	1104
2880 min Summer	2.971	0.0	3078.9	1468
4320 min Summer	2.261	0.0	3513.2	2204
5760 min Summer	1.862	0.0	3859.6	2936
7200 min Summer	1.601	0.0	4148.9	3672
8640 min Summer	1.415	0.0	4401.0	4360
10080 min Summer	1.275	0.0	4625.5	5064
15 min Winter	80.788	0.0	485.5	21
30 min Winter	56.475	0.0	679.9	31

Summary of Results for 30 year Return Period (+55%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	0.878	0.878	194.1	527.1	Flood Risk
120 min Winter	0.839	0.839	194.1	503.2	Flood Risk
180 min Winter	0.725	0.725	194.1	434.8	Flood Risk
240 min Winter	0.614	0.614	193.0	368.4	O K
360 min Winter	0.467	0.467	185.0	280.4	O K
480 min Winter	0.412	0.412	158.5	247.5	O K
600 min Winter	0.376	0.376	138.8	225.9	O K
720 min Winter	0.350	0.350	124.2	209.8	O K
960 min Winter	0.312	0.312	103.6	187.3	O K
1440 min Winter	0.267	0.267	79.6	160.3	O K
2160 min Winter	0.230	0.230	61.0	137.8	O K
2880 min Winter	0.207	0.207	50.5	123.9	O K
4320 min Winter	0.178	0.178	38.4	106.8	O K
5760 min Winter	0.161	0.161	31.7	96.3	O K
7200 min Winter	0.148	0.148	27.2	88.8	O K
8640 min Winter	0.139	0.139	24.0	83.3	O K
10080 min Winter	0.132	0.132	21.8	78.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	37.547	0.0	906.8	50
120 min Winter	24.306	0.0	1174.4	86
180 min Winter	18.707	0.0	1356.1	120
240 min Winter	15.510	0.0	1499.2	150
360 min Winter	11.880	0.0	1722.7	202
480 min Winter	9.821	0.0	1899.0	262
600 min Winter	8.469	0.0	2047.0	322
720 min Winter	7.502	0.0	2175.9	382
960 min Winter	6.194	0.0	2395.3	502
1440 min Winter	4.727	0.0	2741.7	742
2160 min Winter	3.604	0.0	3137.8	1104
2880 min Winter	2.971	0.0	3448.6	1468
4320 min Winter	2.261	0.0	3935.3	2172
5760 min Winter	1.862	0.0	4322.9	2912
7200 min Winter	1.601	0.0	4646.9	3664
8640 min Winter	1.415	0.0	4929.4	4400
10080 min Winter	1.275	0.0	5181.1	5128

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	16.000	Shortest Storm (mins)	15
Ratio R	0.250	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+55

Time Area Diagram

Total Area (ha) 2.880

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.960	4	8	0.960	8	12	0.960

Model Details

Storage is Online Cover Level (m) 1.000

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	600.0	1.000	600.0	1.001	0.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0518-1941-1200-1941
Design Head (m)	1.200
Design Flow (l/s)	194.1
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	518
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	Site Specific Design (Contact Hydro International)
Suggested Manhole Diameter (mm)	Site Specific Design (Contact Hydro International)

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	194.1
Flush-Flo™	0.706	194.1
Kick-Flo®	1.044	181.3
Mean Flow over Head Range	-	144.7

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	12.8	1.200	194.1	3.000	303.9	7.000	460.9
0.200	47.5	1.400	209.2	3.500	327.7	7.500	476.8
0.300	96.9	1.600	223.3	4.000	350.0	8.000	492.2
0.400	152.0	1.800	236.6	4.500	370.8	8.500	507.2
0.500	188.1	2.000	249.1	5.000	390.5	9.000	521.7
0.600	192.6	2.200	261.0	5.500	409.3	9.500	535.8
0.800	193.1	2.400	272.4	6.000	427.2		
1.000	184.5	2.600	283.3	6.500	444.4		

Summary of Results for 30 year Return Period (+55%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.617	0.617	176.6	169.8	O K
30 min Summer	0.791	0.791	176.9	217.5	Flood Risk
60 min Summer	0.856	0.856	176.8	235.5	Flood Risk
120 min Summer	0.764	0.764	176.9	210.1	Flood Risk
180 min Summer	0.637	0.637	176.8	175.2	O K
240 min Summer	0.537	0.537	174.6	147.8	O K
360 min Summer	0.431	0.431	161.5	118.6	O K
480 min Summer	0.385	0.385	139.2	106.0	O K
600 min Summer	0.354	0.354	122.9	97.4	O K
720 min Summer	0.330	0.330	110.2	90.8	O K
960 min Summer	0.297	0.297	92.7	81.6	O K
1440 min Summer	0.255	0.255	71.8	70.3	O K
2160 min Summer	0.220	0.220	55.1	60.5	O K
2880 min Summer	0.198	0.198	45.5	54.4	O K
4320 min Summer	0.171	0.171	34.8	46.9	O K
5760 min Summer	0.154	0.154	28.6	42.3	O K
7200 min Summer	0.142	0.142	24.7	39.1	O K
8640 min Summer	0.133	0.133	21.8	36.6	O K
10080 min Summer	0.126	0.126	19.7	34.7	O K
15 min Winter	0.704	0.704	176.9	193.7	Flood Risk
30 min Winter	0.906	0.906	176.8	249.1	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	80.788	0.0	284.1	20
30 min Summer	56.475	0.0	397.5	29
60 min Summer	37.547	0.0	529.1	46
120 min Summer	24.306	0.0	685.1	76
180 min Summer	18.707	0.0	791.0	106
240 min Summer	15.510	0.0	874.4	136
360 min Summer	11.880	0.0	1004.7	192
480 min Summer	9.821	0.0	1107.5	252
600 min Summer	8.469	0.0	1193.8	312
720 min Summer	7.502	0.0	1268.9	374
960 min Summer	6.194	0.0	1396.9	494
1440 min Summer	4.727	0.0	1599.0	736
2160 min Summer	3.604	0.0	1829.2	1100
2880 min Summer	2.971	0.0	2010.5	1468
4320 min Summer	2.261	0.0	2294.6	2176
5760 min Summer	1.862	0.0	2519.8	2888
7200 min Summer	1.601	0.0	2708.8	3648
8640 min Summer	1.415	0.0	2873.5	4360
10080 min Summer	1.275	0.0	3020.6	5088
15 min Winter	80.788	0.0	318.3	20
30 min Winter	56.475	0.0	445.3	30

Summary of Results for 30 year Return Period (+55%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	0.932	0.932	176.8	256.3	Flood Risk
120 min Winter	0.718	0.718	176.9	197.5	Flood Risk
180 min Winter	0.525	0.525	174.1	144.5	O K
240 min Winter	0.433	0.433	162.4	119.1	O K
360 min Winter	0.364	0.364	128.1	100.2	O K
480 min Winter	0.324	0.324	107.1	89.2	O K
600 min Winter	0.297	0.297	92.9	81.7	O K
720 min Winter	0.277	0.277	82.4	76.1	O K
960 min Winter	0.248	0.248	68.4	68.2	O K
1440 min Winter	0.214	0.214	52.4	58.7	O K
2160 min Winter	0.184	0.184	40.0	50.6	O K
2880 min Winter	0.166	0.166	32.9	45.6	O K
4320 min Winter	0.144	0.144	25.2	39.5	O K
5760 min Winter	0.130	0.130	20.8	35.6	O K
7200 min Winter	0.120	0.120	17.8	32.9	O K
8640 min Winter	0.112	0.112	15.7	30.8	O K
10080 min Winter	0.106	0.106	14.2	29.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	37.547	0.0	592.6	48
120 min Winter	24.306	0.0	767.4	80
180 min Winter	18.707	0.0	885.9	108
240 min Winter	15.510	0.0	979.4	134
360 min Winter	11.880	0.0	1125.3	194
480 min Winter	9.821	0.0	1240.4	254
600 min Winter	8.469	0.0	1337.1	314
720 min Winter	7.502	0.0	1421.3	374
960 min Winter	6.194	0.0	1564.6	494
1440 min Winter	4.727	0.0	1791.0	736
2160 min Winter	3.604	0.0	2048.8	1092
2880 min Winter	2.971	0.0	2251.8	1468
4320 min Winter	2.261	0.0	2570.0	2192
5760 min Winter	1.862	0.0	2822.2	2888
7200 min Winter	1.601	0.0	3033.8	3632
8640 min Winter	1.415	0.0	3218.4	4328
10080 min Winter	1.275	0.0	3383.2	5016

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	16.000	Shortest Storm (mins)	15
Ratio R	0.250	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+55

Time Area Diagram

Total Area (ha) 1.880

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	0.627	4	8	0.627	8	12	0.627

Model Details

Storage is Online Cover Level (m) 1.000

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	275.0	1.000	275.0	1.001	0.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0502-1770-1000-1770
Design Head (m)	1.000
Design Flow (l/s)	177.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	502
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	Site Specific Design (Contact Hydro International)
Suggested Manhole Diameter (mm)	Site Specific Design (Contact Hydro International)

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	176.9
Flush-Flo™	0.659	176.9
Kick-Flo®	0.909	168.9
Mean Flow over Head Range	-	126.1

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	12.6	1.200	193.4	3.000	302.9	7.000	459.4
0.200	46.5	1.400	208.5	3.500	326.7	7.500	475.3
0.300	94.4	1.600	222.6	4.000	348.8	8.000	490.7
0.400	146.8	1.800	235.8	4.500	369.6	8.500	505.6
0.500	172.9	2.000	248.3	5.000	389.3	9.000	520.0
0.600	176.4	2.200	260.1	5.500	408.0	9.500	534.1
0.800	174.3	2.400	271.5	6.000	425.8		
1.000	176.9	2.600	282.3	6.500	443.0		

Summary of Results for 100 year Return Period (+55%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.602	0.602	225.1	433.5	O K
30 min Summer	0.768	0.768	259.6	553.0	Flood Risk
60 min Summer	0.887	0.887	259.6	638.3	Flood Risk
120 min Summer	0.909	0.909	259.6	654.3	Flood Risk
180 min Summer	0.842	0.842	259.5	606.1	Flood Risk
240 min Summer	0.768	0.768	259.6	552.9	Flood Risk
360 min Summer	0.665	0.665	244.8	478.6	O K
480 min Summer	0.593	0.593	222.1	427.1	O K
600 min Summer	0.539	0.539	203.3	388.4	O K
720 min Summer	0.498	0.498	187.8	358.6	O K
960 min Summer	0.440	0.440	163.1	316.5	O K
1440 min Summer	0.373	0.373	129.4	268.5	O K
2160 min Summer	0.318	0.318	100.8	228.7	O K
2880 min Summer	0.284	0.284	83.4	204.5	O K
4320 min Summer	0.243	0.243	63.6	174.6	O K
5760 min Summer	0.217	0.217	52.2	156.3	O K
7200 min Summer	0.199	0.199	44.6	143.4	O K
8640 min Summer	0.186	0.186	39.3	133.8	O K
10080 min Summer	0.175	0.175	35.3	126.2	O K
15 min Winter	0.670	0.670	246.4	482.6	O K
30 min Winter	0.873	0.873	259.3	628.3	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	104.546	0.0	559.8	21
30 min Summer	73.678	0.0	790.9	30
60 min Summer	48.824	0.0	1052.2	48
120 min Summer	31.340	0.0	1351.5	82
180 min Summer	23.964	0.0	1550.4	114
240 min Summer	19.773	0.0	1705.9	142
360 min Summer	15.033	0.0	1945.7	202
480 min Summer	12.359	0.0	2133.0	264
600 min Summer	10.611	0.0	2289.1	322
720 min Summer	9.365	0.0	2424.4	382
960 min Summer	7.687	0.0	2653.4	502
1440 min Summer	5.819	0.0	3012.4	742
2160 min Summer	4.399	0.0	3419.3	1104
2880 min Summer	3.603	0.0	3733.8	1472
4320 min Summer	2.716	0.0	4219.6	2204
5760 min Summer	2.221	0.0	4603.9	2936
7200 min Summer	1.899	0.0	4921.7	3672
8640 min Summer	1.672	0.0	5197.1	4400
10080 min Summer	1.501	0.0	5441.3	5136
15 min Winter	104.546	0.0	627.6	21
30 min Winter	73.678	0.0	886.4	32

Summary of Results for 100 year Return Period (+55%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	0.988	0.988	259.1	711.7	Flood Risk
120 min Winter	0.958	0.958	259.6	689.7	Flood Risk
180 min Winter	0.821	0.821	259.6	590.8	Flood Risk
240 min Winter	0.716	0.716	255.2	515.4	Flood Risk
360 min Winter	0.590	0.590	221.1	425.1	O K
480 min Winter	0.510	0.510	192.4	367.2	O K
600 min Winter	0.456	0.456	170.4	328.4	O K
720 min Winter	0.418	0.418	153.0	301.2	O K
960 min Winter	0.369	0.369	127.6	265.7	O K
1440 min Winter	0.312	0.312	97.7	224.5	O K
2160 min Winter	0.265	0.265	74.3	191.0	O K
2880 min Winter	0.237	0.237	61.1	170.7	O K
4320 min Winter	0.203	0.203	46.1	146.0	O K
5760 min Winter	0.182	0.182	37.7	130.8	O K
7200 min Winter	0.167	0.167	32.3	120.3	O K
8640 min Winter	0.156	0.156	28.5	112.3	O K
10080 min Winter	0.147	0.147	25.5	106.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	48.824	0.0	1178.8	52
120 min Winter	31.340	0.0	1514.0	88
180 min Winter	23.964	0.0	1736.7	118
240 min Winter	19.773	0.0	1911.0	148
360 min Winter	15.033	0.0	2179.5	208
480 min Winter	12.359	0.0	2389.3	268
600 min Winter	10.611	0.0	2564.2	326
720 min Winter	9.365	0.0	2715.7	386
960 min Winter	7.687	0.0	2972.2	506
1440 min Winter	5.819	0.0	3374.5	746
2160 min Winter	4.399	0.0	3829.8	1108
2880 min Winter	3.603	0.0	4182.1	1472
4320 min Winter	2.716	0.0	4726.7	2204
5760 min Winter	2.221	0.0	5156.5	2936
7200 min Winter	1.899	0.0	5512.5	3640
8640 min Winter	1.672	0.0	5821.1	4352
10080 min Winter	1.501	0.0	6095.0	5136

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	16.000	Shortest Storm (mins)	15
Ratio R	0.250	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+55

Time Area Diagram

Total Area (ha) 2.880

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	0.960	4	8	0.960	8	12	0.960

Model Details

Storage is Online Cover Level (m) 1.000

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	720.0	1.000	720.0	1.001	0.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-CHE-0520-2610-1200-2610
Design Head (m)	1.200
Design Flow (l/s)	261.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	520
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	Site Specific Design (Contact Hydro International)
Suggested Manhole Diameter (mm)	Site Specific Design (Contact Hydro International)

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	260.7
Flush-Flo™	0.767	259.6
Kick-Flo®	0.914	231.5
Mean Flow over Head Range	-	172.2

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	12.2	1.200	260.7	3.000	409.2	7.000	620.8
0.200	44.9	1.400	281.3	3.500	441.4	7.500	642.3
0.300	91.6	1.600	300.3	4.000	471.4	8.000	663.0
0.400	143.9	1.800	318.3	4.500	499.5	8.500	683.1
0.500	188.4	2.000	335.2	5.000	526.1	9.000	702.6
0.600	224.3	2.200	351.3	5.500	551.4	9.500	721.6
0.800	256.2	2.400	366.6	6.000	575.5		
1.000	238.4	2.600	381.3	6.500	598.6		

Summary of Results for 100 year Return Period (+55%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.667	0.667	243.6	213.3	O K
30 min Summer	0.859	0.859	244.4	275.0	Flood Risk
60 min Summer	0.919	0.919	244.4	293.9	Flood Risk
120 min Summer	0.796	0.796	244.4	254.9	Flood Risk
180 min Summer	0.652	0.652	243.2	208.7	O K
240 min Summer	0.550	0.550	238.2	175.9	O K
360 min Summer	0.459	0.459	206.8	146.8	O K
480 min Summer	0.411	0.411	176.1	131.4	O K
600 min Summer	0.377	0.377	154.4	120.7	O K
720 min Summer	0.352	0.352	138.0	112.6	O K
960 min Summer	0.316	0.316	115.2	101.0	O K
1440 min Summer	0.271	0.271	88.5	86.8	O K
2160 min Summer	0.233	0.233	67.3	74.5	O K
2880 min Summer	0.209	0.209	55.2	66.9	O K
4320 min Summer	0.180	0.180	41.8	57.5	O K
5760 min Summer	0.161	0.161	34.1	51.6	O K
7200 min Summer	0.149	0.149	29.3	47.5	O K
8640 min Summer	0.139	0.139	25.8	44.5	O K
10080 min Summer	0.131	0.131	23.0	42.0	O K
15 min Winter	0.760	0.760	244.4	243.3	Flood Risk
30 min Winter	0.979	0.979	244.4	313.1	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	104.546	0.0	367.7	20
30 min Summer	73.678	0.0	518.6	28
60 min Summer	48.824	0.0	688.0	44
120 min Summer	31.340	0.0	883.4	76
180 min Summer	23.964	0.0	1013.2	106
240 min Summer	19.773	0.0	1114.8	134
360 min Summer	15.033	0.0	1271.4	192
480 min Summer	12.359	0.0	1393.7	252
600 min Summer	10.611	0.0	1495.6	312
720 min Summer	9.365	0.0	1584.0	372
960 min Summer	7.687	0.0	1733.6	492
1440 min Summer	5.819	0.0	1968.5	736
2160 min Summer	4.399	0.0	2232.9	1100
2880 min Summer	3.603	0.0	2438.4	1468
4320 min Summer	2.716	0.0	2756.5	2200
5760 min Summer	2.221	0.0	3005.9	2936
7200 min Summer	1.899	0.0	3213.5	3656
8640 min Summer	1.672	0.0	3393.6	4376
10080 min Summer	1.501	0.0	3553.8	5064
15 min Winter	104.546	0.0	411.9	20
30 min Winter	73.678	0.0	580.9	30

Summary of Results for 100 year Return Period (+55%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	0.984	0.984	244.4	314.9	Flood Risk
120 min Winter	0.730	0.730	244.4	233.5	Flood Risk
180 min Winter	0.532	0.532	236.8	170.2	O K
240 min Winter	0.462	0.462	208.6	147.7	O K
360 min Winter	0.390	0.390	162.5	124.7	O K
480 min Winter	0.347	0.347	134.8	111.0	O K
600 min Winter	0.318	0.318	116.4	101.6	O K
720 min Winter	0.296	0.296	103.0	94.6	O K
960 min Winter	0.265	0.265	84.8	84.7	O K
1440 min Winter	0.227	0.227	64.4	72.7	O K
2160 min Winter	0.195	0.195	48.8	62.4	O K
2880 min Winter	0.176	0.176	40.1	56.2	O K
4320 min Winter	0.151	0.151	30.2	48.3	O K
5760 min Winter	0.136	0.136	24.8	43.5	O K
7200 min Winter	0.125	0.125	21.1	40.0	O K
8640 min Winter	0.117	0.117	18.6	37.5	O K
10080 min Winter	0.111	0.111	16.6	35.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	48.824	0.0	770.6	46
120 min Winter	31.340	0.0	989.4	78
180 min Winter	23.964	0.0	1134.9	106
240 min Winter	19.773	0.0	1248.6	134
360 min Winter	15.033	0.0	1424.0	194
480 min Winter	12.359	0.0	1561.0	254
600 min Winter	10.611	0.0	1675.2	314
720 min Winter	9.365	0.0	1774.2	374
960 min Winter	7.687	0.0	1941.8	494
1440 min Winter	5.819	0.0	2204.8	736
2160 min Winter	4.399	0.0	2500.9	1100
2880 min Winter	3.603	0.0	2731.0	1472
4320 min Winter	2.716	0.0	3087.4	2160
5760 min Winter	2.221	0.0	3366.6	2896
7200 min Winter	1.899	0.0	3599.1	3672
8640 min Winter	1.672	0.0	3800.9	4280
10080 min Winter	1.501	0.0	3980.4	5136

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	16.000	Shortest Storm (mins)	15
Ratio R	0.250	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+55

Time Area Diagram

Total Area (ha) 1.880

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.627	4	8	0.627	8	12	0.627

Model Details

Storage is Online Cover Level (m) 1.000

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	320.0	1.000	320.0	1.001	0.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0576-2444-1000-2444
Design Head (m)	1.000
Design Flow (l/s)	244.4
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	576
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	Site Specific Design (Contact Hydro International)
Suggested Manhole Diameter (mm)	Site Specific Design (Contact Hydro International)

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	244.3
Flush-Flo™	0.734	244.4
Kick-Flo®	0.944	237.6
Mean Flow over Head Range	-	166.0

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	13.7	1.200	267.1	3.000	418.7	7.000	635.6
0.200	51.0	1.400	288.0	3.500	451.7	7.500	657.6
0.300	105.5	1.600	307.5	4.000	482.3	8.000	678.8
0.400	169.1	1.800	325.8	4.500	511.2	8.500	699.5
0.500	230.6	2.000	343.1	5.000	538.4	9.000	719.5
0.600	241.2	2.200	359.5	5.500	564.3	9.500	739.0
0.800	243.7	2.400	375.2	6.000	589.0		
1.000	244.3	2.600	390.2	6.500	612.7		

Summary of Results for 200 year Return Period (+55%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.604	0.604	244.5	513.0	O K
30 min Summer	0.774	0.774	290.7	658.1	Flood Risk
60 min Summer	0.891	0.891	291.7	757.1	Flood Risk
120 min Summer	0.917	0.917	291.6	779.6	Flood Risk
180 min Summer	0.855	0.855	291.8	727.0	Flood Risk
240 min Summer	0.788	0.788	291.6	670.0	Flood Risk
360 min Summer	0.687	0.687	273.3	583.8	O K
480 min Summer	0.614	0.614	248.3	522.2	O K
600 min Summer	0.559	0.559	227.5	475.5	O K
720 min Summer	0.517	0.517	210.1	439.4	O K
960 min Summer	0.456	0.456	182.3	388.0	O K
1440 min Summer	0.387	0.387	144.8	329.1	O K
2160 min Summer	0.330	0.330	112.5	280.1	O K
2880 min Summer	0.294	0.294	93.0	250.1	O K
4320 min Summer	0.251	0.251	70.4	213.3	O K
5760 min Summer	0.224	0.224	57.7	190.5	O K
7200 min Summer	0.206	0.206	49.3	174.7	O K
8640 min Summer	0.192	0.192	43.3	162.8	O K
10080 min Summer	0.181	0.181	38.9	153.4	O K
15 min Winter	0.672	0.672	268.3	570.9	O K
30 min Winter	0.875	0.875	291.8	743.5	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	121.274	0.0	648.5	21
30 min Summer	85.866	0.0	920.9	30
60 min Summer	56.794	0.0	1223.6	48
120 min Summer	36.279	0.0	1564.0	82
180 min Summer	27.635	0.0	1787.5	114
240 min Summer	22.740	0.0	1961.4	144
360 min Summer	17.215	0.0	2227.6	204
480 min Summer	14.108	0.0	2434.2	264
600 min Summer	12.081	0.0	2605.8	324
720 min Summer	10.640	0.0	2754.0	384
960 min Summer	8.705	0.0	3004.0	502
1440 min Summer	6.559	0.0	3394.5	742
2160 min Summer	4.935	0.0	3834.8	1108
2880 min Summer	4.027	0.0	4172.0	1472
4320 min Summer	3.018	0.0	4688.6	2204
5760 min Summer	2.458	0.0	5095.7	2936
7200 min Summer	2.096	0.0	5430.1	3672
8640 min Summer	1.840	0.0	5719.0	4400
10080 min Summer	1.648	0.0	5974.2	5120
15 min Winter	121.274	0.0	727.1	21
30 min Winter	85.866	0.0	1032.1	32

Summary of Results for 200 year Return Period (+55%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	0.997	0.997	291.3	847.1	Flood Risk
120 min Winter	0.973	0.973	291.6	826.9	Flood Risk
180 min Winter	0.845	0.845	291.7	718.0	Flood Risk
240 min Winter	0.744	0.744	286.7	632.1	Flood Risk
360 min Winter	0.617	0.617	249.2	524.1	O K
480 min Winter	0.534	0.534	217.2	453.5	O K
600 min Winter	0.477	0.477	192.4	405.6	O K
720 min Winter	0.437	0.437	172.7	371.9	O K
960 min Winter	0.386	0.386	144.0	327.8	O K
1440 min Winter	0.325	0.325	110.0	276.3	O K
2160 min Winter	0.276	0.276	83.2	234.6	O K
2880 min Winter	0.246	0.246	68.2	209.2	O K
4320 min Winter	0.210	0.210	51.3	178.5	O K
5760 min Winter	0.188	0.188	41.7	159.7	O K
7200 min Winter	0.173	0.173	35.7	146.6	O K
8640 min Winter	0.161	0.161	31.2	136.7	O K
10080 min Winter	0.152	0.152	28.0	128.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	56.794	0.0	1370.8	52
120 min Winter	36.279	0.0	1752.1	88
180 min Winter	27.635	0.0	2002.4	120
240 min Winter	22.740	0.0	2197.2	148
360 min Winter	17.215	0.0	2495.3	210
480 min Winter	14.108	0.0	2726.8	270
600 min Winter	12.081	0.0	2918.9	328
720 min Winter	10.640	0.0	3084.9	388
960 min Winter	8.705	0.0	3365.0	508
1440 min Winter	6.559	0.0	3802.6	748
2160 min Winter	4.935	0.0	4295.3	1108
2880 min Winter	4.027	0.0	4673.0	1472
4320 min Winter	3.018	0.0	5252.2	2204
5760 min Winter	2.458	0.0	5707.4	2936
7200 min Winter	2.096	0.0	6081.9	3656
8640 min Winter	1.840	0.0	6405.7	4408
10080 min Winter	1.648	0.0	6692.2	5120

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	200	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	16.000	Shortest Storm (mins)	15
Ratio R	0.250	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+55

Time Area Diagram

Total Area (ha) 2.880

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.960	4	8	0.960	8	12	0.960

Model Details

Storage is Online Cover Level (m) 1.000

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	850.0	1.000	850.0	1.001	0.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-CHE-0543-2931-1200-2931
Design Head (m)	1.200
Design Flow (l/s)	293.1
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	543
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	Site Specific Design (Contact Hydro International)
Suggested Manhole Diameter (mm)	Site Specific Design (Contact Hydro International)

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	292.5
Flush-Flo™	0.796	291.8
Kick-Flo®	0.940	263.3
Mean Flow over Head Range	-	190.5

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	12.6	1.200	292.5	3.000	459.0	7.000	696.4
0.200	46.8	1.400	315.5	3.500	495.1	7.500	720.5
0.300	96.1	1.600	336.9	4.000	528.8	8.000	743.8
0.400	152.1	1.800	357.0	4.500	560.3	8.500	766.3
0.500	202.8	2.000	376.0	5.000	590.1	9.000	788.2
0.600	243.1	2.200	394.0	5.500	618.5	9.500	809.4
0.800	291.7	2.400	411.2	6.000	645.5		
1.000	268.0	2.600	427.8	6.500	671.5		

ICP SUDS Mean Annual Flood

Input

Return Period (years)	200	Soil	0.450
Area (ha)	9.600	Urban	0.080
SAAR (mm)	1392	Region Number	Region 2

Results	**l/s**
QBAR Rural	94.3
QBAR Urban	105.1
Q200 years	293.1
Q1 year	91.4
Q30 years	194.1
Q100 years	261.0

ICP SUDS Mean Annual Flood

Input

Return Period (years)	2	Soil	0.450
Area (ha)	9.600	Urban	0.300
SAAR (mm)	1392	Region Number	Region 2

Results	**l/s**
QBAR Rural	94.3
QBAR Urban	137.1
Q2 years	130.3
Q1 year	119.3
Q30 years	234.9
Q100 years	294.8

ICP SUDS Mean Annual Flood

Input

Return Period (years)	200	Soil	0.450
Area (ha)	9.400	Urban	0.010
SAAR (mm)	1392	Region Number	Region 2

Results	**l/s**
QBAR Rural	92.3
QBAR Urban	93.6
Q200 years	276.7
Q1 year	81.4
Q30 years	177.0
Q100 years	244.4

ICP SUDS Mean Annual Flood

Input

Return Period (years)	2	Soil	0.450
Area (ha)	9.400	Urban	0.200
SAAR (mm)	1392	Region Number	Region 2

Results	**l/s**
QBAR Rural	92.3
QBAR Urban	119.6
Q2 years	112.2
Q1 year	104.1
Q30 years	211.8
Q100 years	271.9

Appendix F Conceptual Drainage and SuDS Layout

Stantec

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3rd Floor, Randolph House, 4 Charlotte Lane, Edinburgh
EH2 4QZ
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Notes

UTILITIES NOTE: The position of any existing public or private sewers, utility services, plant or apparatus shown on this drawing is believed to be correct, but no warranty to this is expressed or implied. Other such plant or apparatus may also be present but not shown. The Contractor is therefore advised to undertake their own investigation where the presence of any existing sewers, services, plant or apparatus may affect their operations.

KEY

- INDICATIVE CHANNEL DRAIN
- INDICATIVE RUNOFF ROUTE PATH
- INDICATIVE SUDS POND
- INDICATIVE SURFACE WATER DRAINAGE
- INDICATIVE HEADWALL
- INDICATIVE SWALE
- INDICATIVE FILTER DRAIN
- INDICATIVE PERMEABLE PAVING
- INDICATIVE FOUL WATER DRAINAGE
- INDICATIVE FOUL RISING MAIN
- INDICATIVE PUMPING STATION

Issued/Revision	By	Appd	YYYY.MM.DD
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Issue Status

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Client/Project Logo

Client/Project

FLAMINGO LAND AND SCOTTISH ENTERPRISE

LOMOND BANKS

DRAINAGE STRATEGY

Title

CONCEPTUAL DRAINAGE AND SUDS LAYOUT

Project No.	Scale
332010549	1:2000

Revision	Drawing No.
-	332010549_DR_001