

Bilbohall, Elgin

Drainage Strategy

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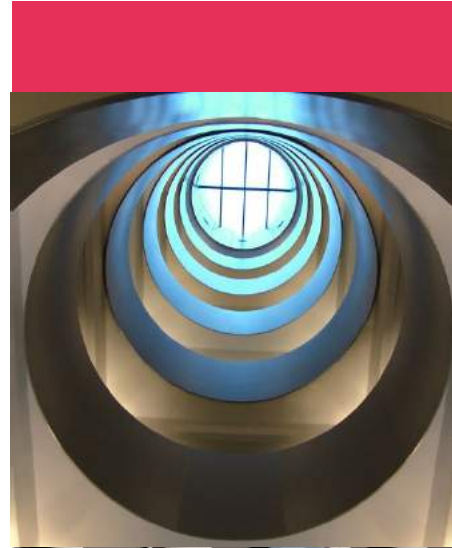
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Client Address: Lister Square, Quatermile Two, Edinburgh, EH3 9GL

Site Address: Land at Elgin, Moray



Curtins
1a Belford Road
Edinburgh EH4 3BL
Tel: 0131 225 2175
www.curtins.com

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Author	Signature	Date
Carlos Vazquez Ingeniero de Caminos, Canales y Puertos Graduate Engineer		21/09/18

Reviewed	Signature	Date
Paul Porter BSc (Hons) CEng Technical Director		21/09/18

Authorised	Signature	Date
Paul Porter BSc (Hons) CEng Technical Director		21/09/18

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1.0 Executive Summary

- 1.1.1 Curtins Consulting Limited has been appointed by Optimised Environments to prepare this Drainage Strategy to support the masterplan for development of an area of land outside Elgin, Moray.
- 1.1.2 The report gives a high-level assessment of potential drainage constraints and opportunities.
- 1.1.3 The masterplan area will be divided into development plots, which are then divided into sub-plots. It is expected these will be bought and developed separately, with their own planning applications to be submitted.
- 1.1.4 There is no identified flood risk to most of the masterplan site, from any source. The only identified risk was the potential for the very western boundary of the area noted as R12 being in the 1 in 1,000 year flood extent of the River Lossie. The risk should have minimal impact on development proposals.
- 1.1.5 An overall infrastructure network, including roads and sewers, will be required for the masterplan area. The sewer design will need to accommodate design flows from each development site. This report provides discussion on this in section 6.0.
- 1.1.6 Surface water discharge will outfall directly to the Tyock Burn and to the nature reserve, to the east of the masterplan. A Flood Risk Assessment has been carried out to ensure the proposal will not increase the flood risk downstream of the site and the results are included in a separate report.
- 1.1.7 Surface water discharge to ground may be possible in some development sites; available site investigation data in the north-eastern part of the masterplan area shows ground conditions of sands and gravels, which may have good infiltration potential, depending on the grading of the material. Groundwater levels are shown to be close to the surface around the burn and associated drainage channels, which could prevent infiltration drainage systems being used in proximity of the burn. Groundwater levels were shown to be lower, however, further away to the rear of properties at Fairfield Avenue, which may allow for infiltration measures. Further site investigation work, to include groundwater monitoring and infiltration testing to BRE 365 standards, will be required across the masterplan area.
- 1.1.8 The masterplan sewer network will need to be designed and constructed before the development sites can begin construction.
- 1.1.9 A list of further requirements for prospective developers is included in Appendix I.

2.0 Introduction

2.1 Project Background

- 2.1.1 Curtins Consulting Limited has been appointed by Optimised Environments to prepare a Drainage Strategy for an area of land outside Elgin, Moray. The report provides information on the nature of flood risk at the site and follows government guidance with regards to development and flood risk.
- 2.1.2 The report is based on currently available information and preliminary discussions.
- 2.1.3 Proposals contained or forming part of this report represent the design intent and maybe subject to alteration or adjustment in completing the detailed design for this project. Where such adjustments are undertaken as part of the detailed design and are deemed a material deviation from the intent contained in this document, prior approval shall be obtained from the relevant authority in advance of commencing such works.

2.2 Scope of Assessment

- 2.2.1 The Drainage Strategy is to be undertaken in accordance with the standing advice and requirements of the Scottish Environment Protection Agency (SEPA), Scottish Planning Policy, Moray Council's planning guidance and Sewer for Scotland 3rd Edition.
- 2.2.2 The report will:
- Investigate all potential risks of flooding to the site,
 - Consider outline design proposals to mitigate any potential risk of flooding determined to be present;
 - Prepare outline design proposals for foul and surface water drainage of the site.
- 2.2.3 The report reviews the following information:
- The SEPA flood maps for river, coastal and surface water flooding likelihood;
 - Moray Council local development plan and guidance;
 - Scottish Water Public Sewer Records;
 - Scottish Planning Policy (SPP) (June 2014);
 - Sewer for Scotland 3rd Edition;
 - CIRIA Manual c753;

2.3 Proposed Development

2.3.1 The Drainage Strategy is to support the development of a masterplan for a 40.74 ha greenfield site, at a strategic level. There are no fixed site layouts yet. It is anticipated though that the overall land use will be residential housing. The overall masterplan area will be divided into development plots that will be sold off separately and require individual planning applications.

2.3.2 The illustrative, proposed development drawings are included in Appendix A.

3.0 Existing site Details

3.1 History and Current Use

- 3.1.1 The development site is located on land outside Elgin, Moray. The site comprises greenfield land, situated between Fairfield Avenue to the north, the residential area of New Elgin to the east and Elgin High School to the south-east. The approximate grid reference is 320797,861765 and the overall site covers an area of 40.74 ha. The site location is shown in Figure 3-1.

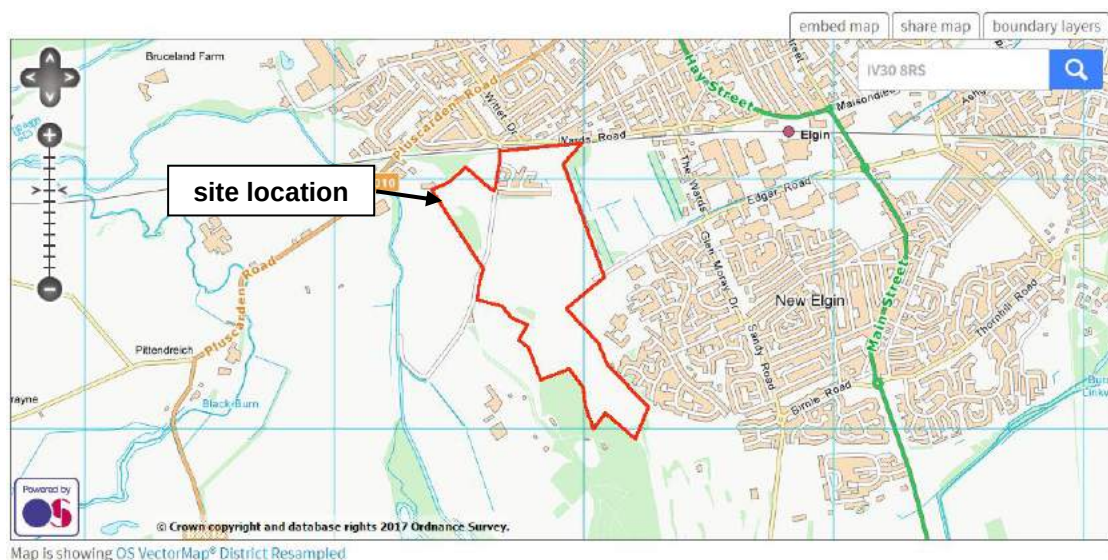


Figure 3-1. Site location (source: OS Open Data).

3.2 Local Watercourses

- 3.2.1 The River Lossie runs to the west of the site, approximately 150 m from the closest point at the north-west site boundary. There are a series of open land drains in the nature reserve to the east of the site, appearing to feed into the Tyock Burn, which runs east alongside Edgar Road, discharging ultimately into the River Lossie at the east of the town.

3.3 Existing Drainage

- 3.3.1 Public sewer plans have been obtained from Scottish Water. They show the public sewers around the site are concentrated in the residential areas to the north, east and south-east.
- 3.3.2 Figure 3-2 shows the residential area in the north of the site. Foul waste is collected and pumped via a rising main north, to connect with the combined sewer at Wards Road. Surface water is drained via a separate network, discharging into the land drain system to the east.

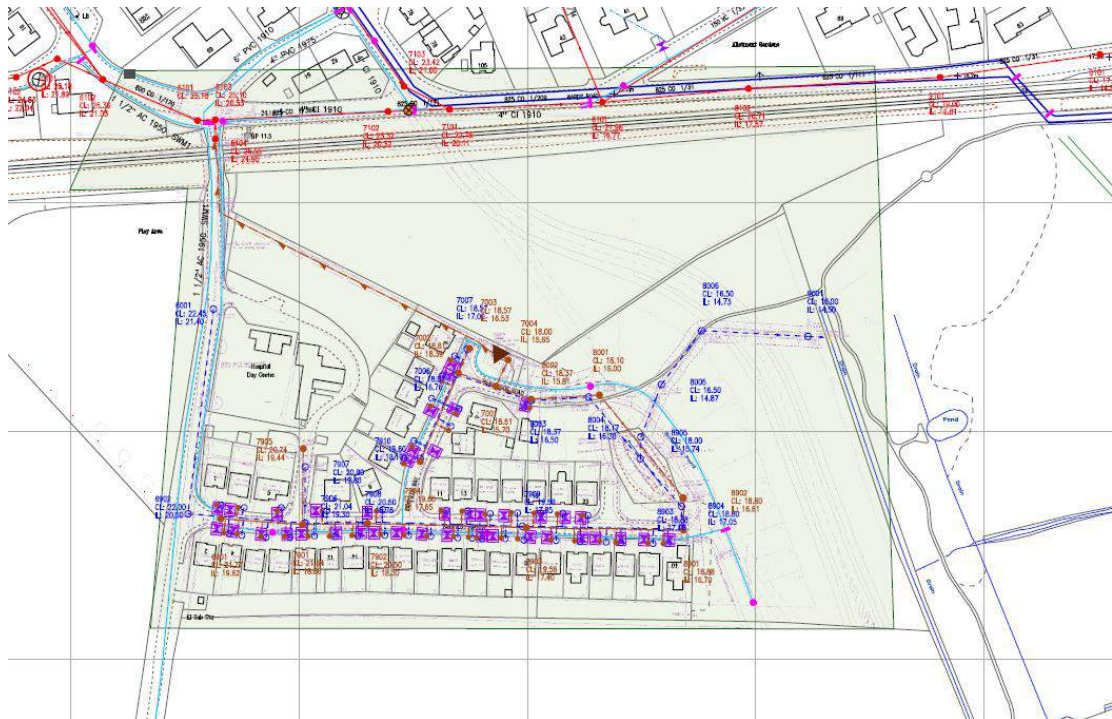


Figure 3-2. Public sewers and water mains around residential area in the north of the site. Note surface water sewer discharging east to land drain system.

- 3.3.3 Figure 3-3 shows the public sewers and water mains around the residential area and primary school to the east of the site. The plan shows separate foul and surface water systems, draining east into the wider network.



Figure 3-3. Public sewers and water mains around the residential area and primary school to the east of the site.

- 3.3.4 Figure 3-4 shows public sewers and water mains around the high school to the south east of the site.
- 3.3.5 It is anticipated these areas to the north, east and south-east will be used for new foul water connections, pending discussion with Scottish Water.



Figure 3-4. Public sewers and water mains around the high school to the east of the site.

- 3.3.6 The full surface water and foul sewer plans are included in Appendix B.

3.4 Topography

- 3.4.1 A topographical survey has been carried out for the site. It indicates varying levels across the wide area. The central part of the site is shown to be higher ground at around 32.0 mAOD, increasing to approximately 44.0 mAOD in the south west and falling to the eastern site boundary, around 14.0 mAOD.
- 3.4.2 The topographical survey plan is inserted as Appendix C and a Height Band Analysis is included within the Appendix D.

3.5 Ground Conditions

- 3.5.1 A Ground Investigation Report was carried out in 2010 by Allied Exploration & Geotechnics Limited. It found general ground conditions of sand, with gravel, clays, cobbles and boulders. Groundwater was found at relatively shallow depths around the burn, rising to 0.65 – 1.60 m

bgl after 20 minutes of being struck in boreholes. Groundwater in a borehole to the rear of properties on Fairfield Avenue was recorded at 8.87 m bgl, suggesting some variance across the site.

4.0 Development and Flood Risk

4.1 Scottish Planning Policy

- 4.1.1 The Scottish Planning Policy (SPP) is a statement of Scottish Government policy on nationally important land use. The SPP was published in 2014 and consolidated a series of topic specific policy statements into a single statement. This document is intended to be used in conjunction with the National Planning Framework (NPF) (2014), Planning Advice Notes (PANs), and Design Advice Guidance (DAG).
- 4.1.2 The guidance relating to flooding (SPP) is summarised in terms of the flood risk to a proposed development in the following extracts.

4.2 Risk Framework

- 4.2.1 Little to no risk area.

Definition: Annual probability of watercourse, tidal or coastal flooding: less than 0.1% (1:1000), i.e. less frequently than the so-called 1 in 1000 year flood.

Appropriate Planning Response:

No constraints due to watercourse, tidal or coastal flooding.

- 4.2.2 Low to medium risk area.

Definition: Annual probability of watercourse, tidal or coastal flooding: in the range 0.1% - 0.5% (1:1000 – 1:200).

Appropriate Planning Response:

Suitable for most development. A flood risk assessment may be required at the upper end of the probability range (i.e. close to 0.5%), and for essential infrastructure and the most vulnerable uses. Water resistant materials and construction may be required.

Generally, not suitable for civil infrastructure. Where civil infrastructure must be located within these areas or is being substantially extended, it should be designed to be capable of remaining operational and accessible during extreme flood events.

4.2.3 Medium to high risk area.

Definition: Annual probability of watercourse, tidal or coastal flooding: greater than 0.5% (1:200).

Appropriate Planning Response:

May be suitable for:

- Residential, institutional, commercial and industrial development within built-up areas provided flood protection measures to the appropriate standard already exist and are maintained, are under construction, or are a planned measure in a current flood risk management plan;
- Essential infrastructure within built-up areas, designed and constructed to remain operational during floods and not impede water flow;
- Some recreational, sport, amenity and nature conservation uses, provided appropriate evacuation procedures are in place and;
- Job-related accommodation, e.g. for caretakers or operational staff.

Generally not suitable for:

- Civil infrastructure and the most vulnerable uses;
- Additional development in undeveloped and sparsely developed areas, unless allocation is essential for operational reason, e.g. for navigation and water based recreation, agriculture, transport or utilities infrastructure (which should be designed and constructed to be operational during floods and not impede water flow), and an alternative, lower risk location is not available; and
- New caravan and camping sites.

Where built development is permitted, measures to protect against or manage flood risk will be required and any loss of flood storage capacity mitigated to achieve a neutral or better outcome.

Water resistant materials in construction should be used where appropriate. Elevated buildings on structures such as stilts are unlikely to be acceptable.

4.3 Interpretation of the Risk Framework

4.3.1 The annual probabilities relate to the land at the time an application is submitted or a land allocation is made.

4.3.2 In the longer term, the calculated probabilities of flooding may be affected by climate change, improved data/methods and land uses elsewhere in the catchment.

4.3.3 This framework is a simplification of the situation as noted in SPP paragraph 258.

4.4 Moray Council Advisory Note for Planning Applicants on Flood Risk and Drainage

4.4.1 The Moray Council Advisory Note reflects that “the DIA should demonstrate, that the post-development runoff rate does not exceed the pre-development runoff rate or increase flood risk through discharge to a receiving watercourse”.

4.4.2 It is also notes that “Subsoil porosity test for proposed infiltration devices should be undertaken in line with the requirements in Building Research Establishment (BRE) Digest 365”, “the capacity of the drainage system including attenuation measures such as SuDS features should be designed to withstand a 1:30 year event, without surcharging” and “Exceedance events up to and including the 1 in 200 year event plus climate change should be contained and managed on site, such that they do not increase flood risk. Details of the method used to manage this flow should be provided in the DIA. This method should also be shown on the general arrangement drawing”.

4.5 Climate Change

4.5.1 Sewers for Scotland 3rd Edition, requires a 30% allowance for climate change is made for rainfall in designing surface water drainage systems.

5.0 Flood Risk

- 5.1.1 A Flood Risk Assessment has been carried out and the report and conclusions are provided under separate cover.

6.0 Drainage Strategy

6.1 Scottish Planning Policy Requirements

6.1.1 SPP requires that:

“Infrastructure and buildings should generally be designed to be free from surface water flooding in rainfall events where the annual probability of occurrence is greater than 0.5% (1:200 years).”

6.1.2 To achieve this, the drainage system will be required to either fully attenuate and store the surface water runoff in such an event, or if it does surcharge then the site should be designed to accommodate the water in surface storage without allowing it to leave the site overland, or to flood buildings or infrastructure. The design should include an allowance for an increase in rainfall because of climate change.

6.1.3 SPP also states:

“Surface Water drainage measures should have a neutral or better effect on the risk of flooding both on and off the site, taking account of rain falling on the site and run-off from adjacent areas.”

6.1.4 This provides a general requirement that new developments do not increase the risk of surface water flooding, above the existing level of risk.

6.1.5 Under the Water Environment Controlled Activity (Scotland) Regulations 2011, SUDS are a statutory requirement for almost all development and must be considered during the site design to ensure adequate space will be available.

6.2 Local Planning Policy Requirements

6.2.1 Moray Council's local development plan policy EP5 'Surface Water Drainage: Sustainable Urban Drainage Systems (SUDS)' requires that “surface water from development should be dealt with in a sustainable manner that has a neutral effect on the risk of flooding or which reduces the risk of flooding”. It provides requirements for the provision and maintenance of SUDS.

6.2.2 Policy EP10 'Foul Drainage' notes that “all development within or close to settlements (as defined in the Local Development Plan) of more than 2,000 population equivalent will require to connect to the public sewerage system unless connection to the public sewer is not permitted due to lack of capacity”. In such circumstances, temporary provision of private sewerage systems may be permitted, subject to design requirements to provide a standard that will be adoptable by Scottish Water.

- 6.2.3 Policy EP10 goes on to state that “all development within or close to settlements (as identified in the Local Development Plan) of less than 2,000 population equivalent will require to connect to public sewerage system except where a compelling case is made otherwise”.

6.3 Proposed Surface Water Drainage

- 6.3.1 Any new development site drainage will be designed in accordance with current best practice to provide adequate capacity so that the proposed surface water drainage network shall be designed so that flood water generated up to the 1 in 200 year plus climate change storm event shall be constrained within areas on site so not to cause damage to buildings, essential services or adjoining developments and services.
- 6.3.2 In following the standard hierarchy of drainage solutions, consideration will firstly be given to the discharge of surface water runoff by sustainable methods such as infiltration.
- 6.3.3 A Ground Investigation Report, prepared in 2010 by Allied Exploration & Geotechnics Limited, contains borehole records covering a north-eastern area of the site. These indicate ground conditions of sand, with gravel, clays, cobbles and boulders. Soil of this type may be expected to have good infiltration potential, but the borehole investigations also encountered groundwater at relatively shallow depths. High groundwater levels will limit the potential for using infiltration-based surface water drainage systems, by restricting the basins' ability to drain, or even by encroaching into the basins themselves.
- 6.3.4 Groundwater monitoring results showed groundwater depths of 0.08 to 1.07 metres below ground level and boreholes in the areas around Elgin High School and the Burn of Tyock (and associated land drains). One borehole to the north though, close to the existing residential properties at Fairfield Avenue, had levels of approx. 8.9 metres below ground, indicating variance across the masterplan area. This suggests there may be possibility for infiltration measures in some of the development sites.
- 6.3.5 The Borehole 03 from the Ground Investigation is located at the proximity of the proposed basin for Catchments E-M. The Borehole shows water strike at 0.90m bgl, therefore infiltration has not been considered in the design for this SuDS element. As there are no borehole records within the proximity of the other basins, the SuDS basin calculations have not considered infiltration techniques. A drawing showing the infiltration considerations is included within the Appendix H.
- 6.3.6 Infiltration testing in accordance with BRE 365 (Soakaway design) at locations for basins will be necessary before carrying out further drainage design work.
- 6.3.7 The drainage proposal will consider infiltration techniques, when available, as the first option. Discharge into a watercourse would be the next most desirable option. Whilst the site is in proximity to the River Lossie, it does not border with it. Discharge would only be possible via pipe connections and outfalls in third party land.

- 6.3.8 The location of the SuDS basins is shown as indicative at this stage, the final locations and volume required will need to be confirmed following the site investigation/infiltration testing works along with the detailed drainage design at the detailed planning stage.
- 6.3.9 As the eastern boundary of the masterplan site is adjacent to the Tyock Burn and the nature reserve, the proposal is to discharge the proposed development areas to two outfall points: one discharging to the nature reserve and the other directly to the Tyock Burn.
- 6.3.10 A study of the pre development scenario has been carried out based on visual inspection during a site walkover, topographical survey (refer to Appendix D for the Height Band Analysis of the Topographical Survey) and the FEH Webservice information (see figure 6-4 and figure 6-5).
- 6.3.11 The study shows the site is divided, in surface water catchment terms, into three areas: catchment north (comprising 15.98 ha), south (21.24 ha) and west (3.51 ha), (see Appendix F). The catchment north is currently discharging east to the nature reserve, the catchment south is draining east directly to the Tyock Burn and catchment west is draining west to the river Lossie. The proposal, at the post development scenario, is to discharge the surface water, attenuated and treated, from Plots A, B, C and D to the nature reserve. Plots E, F, G, H, I, J, K, L, M, N, O, P, Q, R and S will drain, attenuated and treated, to the Tyock Burn and the green/landscape at the west of the site will drain west to the river Lossie, as existing. It is proposed, therefore, that the catchment areas at the post development scenario will be refined from the pre development scenario. The catchment area proposed to drain to the nature reserve will be 12.11 ha, 3.87 ha reduction from the pre development scenario. The catchment area proposed to drain to the Tyock Burn will be 26.38 ha, 5.14 ha increase at the post development scenario and the catchment area proposed to drain west to the river Lossie will be 2.24 ha, 1.27 ha reduction from the pre development scenario. The details of the pre development and post development scenarios are included within Appendix F and G.



Figure 6-1. Catchment area from the site discharging directly to the Tyock Burn. Source: FEH Webservice.



Figure 6-2. Catchment area draining to the Tyock Burn downstream of the site. Source: FEH Webservice.

6.3.12 The residential areas to the north of the masterplan site are served by a combined sewer network. Scottish Water do not usually approve new surface water connections into combined sewers, unless there are extenuating circumstances.

- 6.3.13 Moray Council have stated a preference that SuDS and attenuation be above-ground where possible.
- 6.3.14 Consultations have been made with SEPA and they have advised that requirements for future applicants shall be included within the report. The Summary of Planning Application Requirements table for future developers has been included in Appendix I.

6.4 Allowable Discharge Rate

- 6.4.1 The greenfield runoff rate, or QBAR rural, is the mean annual surface water flood flow from a rural (i.e. undeveloped) catchment. It is roughly equivalent to a 1 in 2.3 year return period and represents the surface water discharge from the site in an undeveloped state. This greenfield runoff rate is typically used as a basis for determining the allowable surface water discharge rates from new developments, as it encourages sustainable development and helps to mitigate the risk of surface water floods.
- 6.4.2 Using the ICP SuDS method in the Micro Drainage software package, the pre development QBAR rural discharge was calculated for each catchment area. The QBAR rural values are summarised in Table 6-1 along with the runoff for the 30 year event.

Table 6-1. Greenfield runoff rates for each catchment area at the predevelopment scenario.

Catchment Area:	Total Area (ha):	Greenfield runoff Qbar rural (l/s):	runoff Q30 year (l/s):	Discharge to:
Catchment North	15.98	52.5	99.1	Nature reserve
Catchment South	21.24	69.7	131.8	Tyock Burn
Catchment West	3.51	11.5	21.8	West, ultimately river Lossie

- 6.4.3 The pre development QBAR rural rates will form the basis for determining the allowable surface water discharge rates from each new catchment area at the post development stage included within Appendix G, with the exception of new Catchment Area D, which will be determined for a maximum orifice diameter of 75mm (as per Sewer for Scotland 3rd Edition requirements), new Catchment Areas A,B and C, which has been increased from 10 l/s to 18l/s with the storage

deficit being accommodated in the next basin downstream (basin D) and new Catchments Areas from E to M, which the discharge limit is the total of all catchment areas discharging to this basin. MicroDrainage output sheets are included within Appendix E.

- 6.4.4 The proposed allowable discharge rates for each development area are summarised in Table 6.2 and are provided for each of the larger plots, as well as values for the smaller sub-plots. Details of the catchment areas are included in Appendix G

Table 6-2. Proposed discharge rates at the post development scenario.

Plot Ref:	Sub-Plot Ref (If Applicable)	Total Area (ha)	Q allowable for the 1 in 30 year event + 30% CC (l/s)	Q allowable for the 1 in 200 year event + 30% CC (l/s)	Total runoff volume (m ³) Pre Development Scenario 60min Storm. 1in30yr + 30%CC (1in 200yr + 30%CC)	Total discharge volume (m ³) Post Development Scenario 60min Storm. 1in30yr + 30%CC (1in 200yr + 30%CC)	Discharge to:
R1 + OP7	D	0.62	3.0	3.0	47.4 (75.2)	1166.9 (1241.2)	Nature Reserve
	Green area	6.51	52.5 (no attenuated)	78.1			Nature Reserve
R12	A	3.06	10.0	10.0	233.7 (370.9)	486.4 (740.4)	Nature Reserve
	B						
	C						
	Green area	1.92	0.6 (10% Hardstanding)	0.6			Nature Reserve
TOTAL FROM BASIN		12.11	13.6	13.6		1166.9 (1241.2)	Nature Reserve
R3 + CF2	E	7.21	23.7	23.7	549.8 (872.5)	3444.9 (4181.7)	Tyock Burn
	F						
	G						
	H						
	I						
	J						
	K						
	L						
	M						
R4	N						

	O	1.38	4.5	4.5	105.4 (167.3)	219.7 (334.2)	Tyock Burn
	P	1.25	4.1	4.1	95.5 (151.5)	199.0 (302.7)	Tyock Burn
	Q						
	R						
	S						
	T	2.46	8.1	8.1	187.9 (298.2)	390.9 (594.9)	Tyock Burn
Roads		2.48	8.1	8.1			Tyock Burn
Green areas		11.6	3.8 (10% hardstanding)	3.8			Tyock Burn
TOTAL FROM BASIN		26.38	52.3	52.3		3444.9 (4181.7)	Tyock Burn
West green area		2.24	18.1 (no attenuated)	26.9			West, ultimately river Lossie

- 6.4.5 As the green area at the north east of the site will be maintained undeveloped, the proposal is to discharge the surface water unattenuated to feed the nature reserve as existing.
- 6.4.6 The table 6.2 shows an increase in the total discharge volume at the post development scenario due to the increase of hardstanding areas. However, this has been mitigated through the proposal of surface water attenuation onsite, limiting the discharge at the equivalent Qbar at pre development scenario. Therefore and as result of this the runoff volumes incorporated to the Tyock Burn during the critical hydrograph time (please refer to the Flood Risk Assessment document) have been reduced at all post development scenarios as shown in the Table 6.3b.
- 6.4.7 The total allowable discharge will be limited to 13.6 l/s, from basin D, for the areas discharging to the nature reserve and 52.3 l/s, from basin E-M, for the areas discharging directly to the Tyock Burn. Table 6-3a includes a comparison between the discharges flows at pre and post development scenario.

Table 6-3a. Pre and Post development discharge rates comparison table.

Discharge:	Pre development scenario Qbar (l/s)	Post development scenario Qbar (l/s)	Pre development scenario Q30 (l/s)	Pre development scenario Q30 + 30% CC (l/s)	Post development scenario Q30 + 30% CC (l/s)	Q reduction at the post development t Q30 + 30% CC scenario (l/s)	Pre development scenario Q200 + 30% CC(l/s)	Post development scenario Q200 + 30% CC(l/s)
Nature reserve	52.5	Limited to 35.0 (21.4 + 13.6)	99.1	128.83	66.1 (13.6 + 52.5)	62.7	191.6	91.7 (13.6 + 78.1)
Tyock Burn	69.7	Limited to 52.3	131.8	171.3	52.3	119.0	254.8	52.3
West, ultimately river Lossie	11.5	7.4	21.8	28.3	18.1	10.2	42.1	26.9

Table 6-3b. Pre and Post development discharge volume**of runoff during the critical hydrograph time comparison table.**

Total volume of runoff for the 1.1 hours storm:	Pre development Q30 + 30% CC (m3)	Pre development Q200 + 20% CC (m3)	Pre development Q200 + 30% CC (m3)	Post development Q30 + 30% CC (m3)	Post development Q200 + 20% CC (m3)	Post development Q200 + 30% CC (m3)
Nature reserve	1342.2	1937.3	2093.7	560.8	802.5	866.6
Tyock Burn	1760.8	2550.1	2757.6	574.1	694.3	731.2

6.4.8 The post development scenario shows a reduction in flow for the 30 year event + 30% Climate Change of 62.7 l/s for the area discharging to the nature reserve, 119.0 l/s for the area

discharging directly to the Tyock Burn and 10.2 l/s for the area discharging west and ultimately to the river Lossie.

6.4.9 The post development scenario shows a reduction in flow for the 30 year event + 30% Climate Change of 62.7 l/s for the area discharging to the nature reserve, 119.0 l/s for the area discharging directly to the Tyock Burn and 10.2 l/s for the area discharging west and ultimately to the river Lossie.

6.4.10 The calculations provided in this report are high level and therefore, further calculations to assess greenfield runoff values will be undertaken for each developer and for each development area at the detailed planning application stage.

6.5 Surface Water Attenuation Volume

6.5.1 To restrict the surface water discharge, sufficient storage volume will be required in the drainage system to attenuate the flow without surcharging the system and causing flooding.

6.5.2 No details on the development sites are available at the time of writing, so it is not possible to accurately determine the size of attenuation required. Proposed developments will be required to calculate the appropriate level of attenuation, once details of site layouts are known.

6.5.3 Details of the attenuation sizing and how it will restrict surface water discharge to the pre-agreed rate will be required in each planning application.

6.5.4 As an initial estimate, storage volumes based on 70% drained area in each site are summarised in Table 6-4. Values are given for the overall plots, as well as the currently proposed sub-plots, depending on how the development plans are proposed.

Table 6-4. Estimated attenuation storage volume, for each development site.

Plot Ref:	Sub-Plot Ref (If Applicable)	Total Area (ha)	Total Developed Area, 70% Hardstanding (ha)	Q allowable for the 1 in 30 year event + 30% CC (l/s)	Attenuation provided (m³)
R1 + OP7	D	0.62	0.43	3.0	799.3
R12	A	3.06	2.14	10.0	1087.6
	B				
	C				
R3 + CF2	E	7.21	5.04	23.7	3855.7
	F				
	G				
	H				
	I				
	J				
	K				
	L				
	M				
R4	N	1.38	0.96	4.5	629.7
	O				
	P	1.25	0.87	4.1	551.5
	Q	2.46	1.72	8.1	1086.1
	R				
	S				
	T				

6.5.5 It is anticipated that attenuation will be provided via the main SUDS features indicated in Appendix G. Each of the main development plots will have a SUDS basin, to provide temporary storage for surface water during storm events.

- 6.5.6 The attenuation values are only estimates at this time, based on limited information. Full design will be required once details of proposed developments are known.
- 6.5.7 As the masterplan sewer network is to be adopted by Scottish Water, then the design will need to conform with Sewers for Scotland 3rd Edition. As part of this, there is a minimum allowable diameter on outflow controls (e.g. orifices and vortex control units, which limit the discharge rates from each development site) of 75 mm. This may affect the minimum discharge rate possible.
- 6.5.8 The surface water discharge from each site will be connected into a new surface water network, which will cover the overall masterplan area. It is anticipated this will be designed on the basis that each development site will be given a provision for maximum allowable surface water discharge, based on the QBAR rural values in Table 6-2.
- 6.5.9 The design discharge rates will require confirmation in the masterplan infrastructure design, pending discussion and agreement with Scottish Water and Moray Council.
- 6.5.10 The allowable surface water discharge rates from each plot (or sub-plot) will need to be enforced in planning applications, to ensure the new surface water sewer across the masterplan area functions as designed and does not fail because of development sites exceeding their design discharge rate.
- 6.5.11 The new masterplan area drainage network, along with the proposed road network, will need to be designed and constructed to a sufficient degree that allows drainage from proposed plots to be connected to the discharge points (the burn for surface water and the public sewer network for foul water) before development can begin in any of the individual development plots. Capped connection points will be included at suitable locations at the boundary of each development site. The location of each connection point and associated design flow rate will need to be available for prospective developers and should be checked as part of the planning application process.
- 6.5.12 In accordance with best practice the design calculations have been checked for events up to the 200 year + 30% year storm event to assess the exceedance is contained within the storage structure.
- 6.5.13 The basin for areas N and O shows a half drain time of 13.31h for the 1 in 30 year event + 30 % Climate Change (the design event) and 21.16h for the 1 in 200 year event + 30% Climate Change (the maximum event checked). As there is no detailed design set at this stage, the basins have been modelled, as a conservative approach, assuming all the surface water will be incorporated into the basin at the same time. The detail design will identify potential available storage volumes within the drainage system and the surface water will be incorporate into the basin in gradual periods, therefore the half drain time will be reduced when undertaking the detailed design.

6.5.14 Micro Drainage outputs are included in Appendix E.

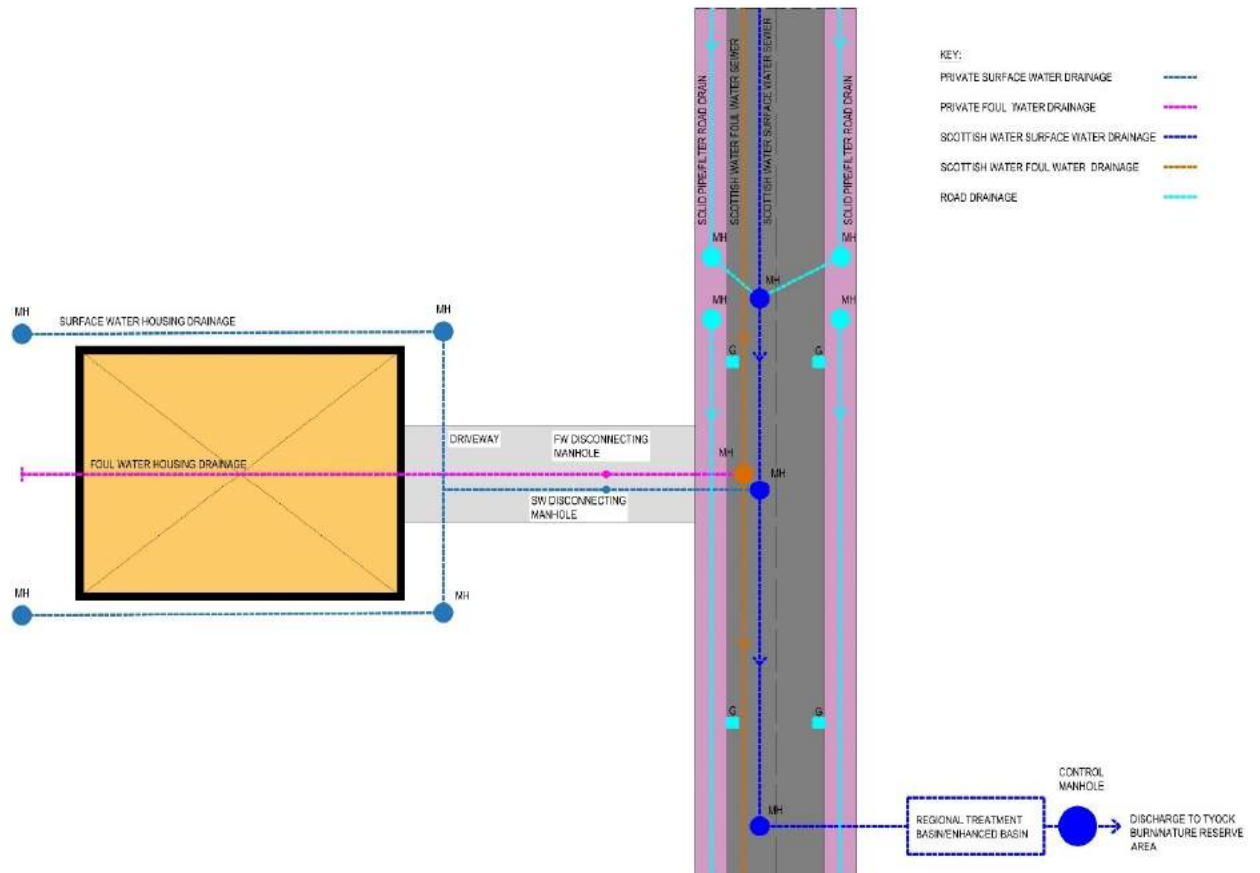
6.6 Surface Water Treatment Levels

- 6.6.1 SEPA highlights the legal requirement for the treatment of surface water by sustainable drainage systems (SUDS) for most types of development and encourage surface water runoff from developments to be treated in line with Scottish Planning Policy.
- 6.6.2 Consideration of SUDS requirements early in the planning process allows for greater flexibility and means the layout can be adopted to accommodate SUDS features, avoiding potential expense to the developer at a later stage.
- 6.6.3 CIRIA report C753 'The SUDS Manual' (2015) provides guidance on assessing pollution hazard indices for various land uses and the type of SUDS solutions required to mitigate those hazards. Each activity or land use has pollution indices, whilst each SUDS component has corresponding mitigation indices, for total suspended solids, metals and hydrocarbons. Sufficient treatment measures should be provided, such that the mitigation indices are greater than or equal to the pollution indices.
- 6.6.4 Per the manual, residential roofs have a pollution hazard level of 'very low'. The hazard index for total suspended solids (TSS) is 0.2, for metals is 0.2 and for hydrocarbons is 0.05. These are low enough to be addressed by any SUDS component.
- 6.6.5 Individual property driveways and low traffic roads have a pollution hazard level of 'low'. The hazard index is 0.5 for total suspended solids (TSS), 0.4 for metals and 0.4 for hydrocarbons. Treatment will be provided through SUDS basins.
- 6.6.6 Roads (excluding individual property driveways and low traffic roads) have a pollution hazard level of 'medium'. The hazard index is 0.7 for total suspended solids (TSS), 0.6 for metals and 0.6 for hydrocarbons. Treatment will be provided through filter drains and an enhanced SUDS basin.

Pollution Hazard Indices				
Land Use Type	Hazard Level	Suspended Solids	Metals	Hydrocarbons
Residential Roofing	Very low	0.2	0.2	0.05
Individual Driveways/Low Traffic Roads	Very low	0.5	0.4	0.4
Roads(excluding low traffic roads)	Medium	0.7	0.6	0.7
Pollution Mitigation Indices				
SuDS Component Description		Suspended Solids	Metals	Hydrocarbons
Detention Basin		0.5	0.5	0.6
Filter Drain + Enhanced Basin		0.85	0.85	0.9

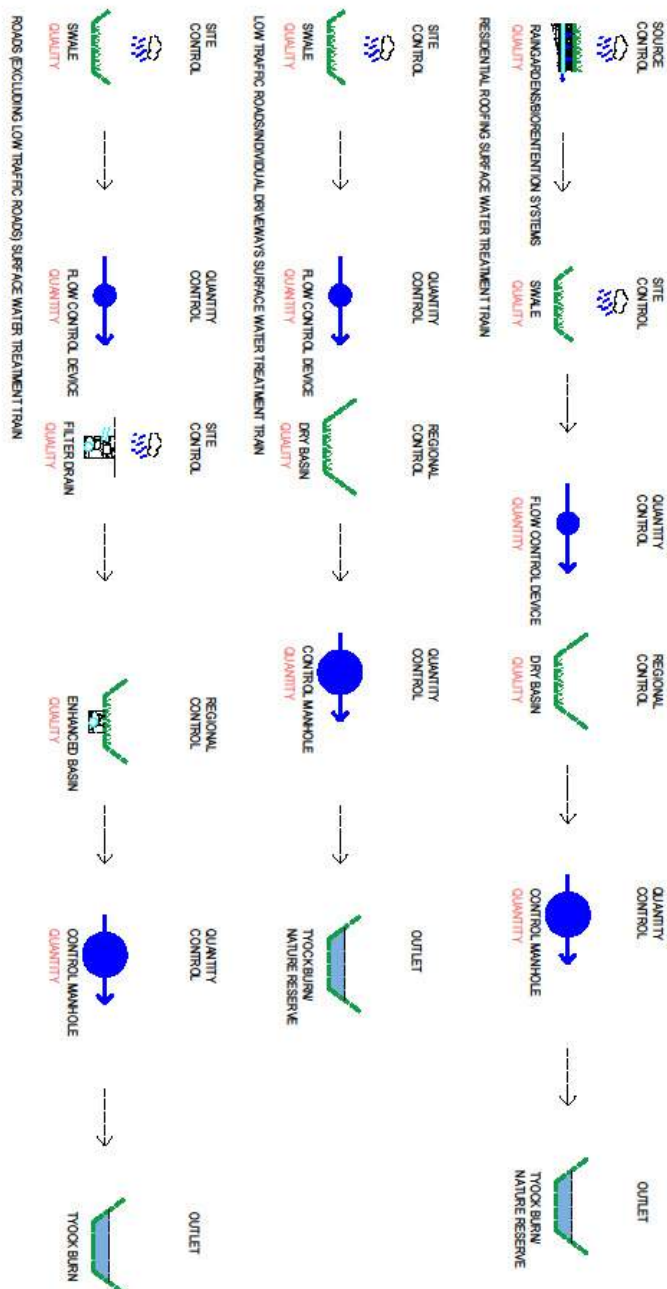
Table 7-1. SEPA Simple Index Approach.

- 6.6.7 The mitigation provided for each land use type exceeds the potential Pollution Index.
- 6.6.8 Treatment will be achieved through SUDS basins for the residential housing and low traffic roads. Roads (excluding low traffic roads) will be treated through a combination of filter drains and an enhanced SUDS basin. A diagram of the treatment train along with a sketch of the layout of an average street is included in Figure 7-2 and 7-3.



INDICATIVE LAYOUT OF AN AVERAGE STREET

Figure 7-2. Indicative street layout.



SURFACE WATER TREATMENT TRAIN

Figure 7-3. Treatment train diagram.

- 6.6.9 The surface water system shall be designed in accordance with the principles of Sustainable Drainage Systems replicating the natural drainage of the existing catchments and mitigating the effects of the surface water run-off. SUDS are to be incorporated in the public space to provide amenity benefits. Treatment will be achieved through above ground regional control basins for the residential housing along with low traffic roads. Roads (excluding low traffic roads) will be treated through a combination of filter drains and an enhanced SUDS basin.
- 6.6.10 The SUDS basins will be designed as per Sewer for Scotland 3rd Edition along with the CIRIA SuDS Manual c753 and will mitigate adverse visual impacts on landscape and visual receptors using natural characteristics, it is encouraged in future planning applications to integrate the SUDS basins with the surround topography with minimum cutting and filling and grading out of side slopes to a minimum of 1 in 4 as per Sewer Scotland 3rd Edition. Straight edges are discouraged and naturalistic appearance should be achieved through planting with native marginal and emergent aquatic species and native terrestrial vegetation suitable to local context to provide wildlife habitat.
- 6.6.11 Where possible, grass conveyance swales are to be incorporated into the layout to provide an extra above ground source control and treatment level. Proposed swales locations are included within the Appendix G
- 6.6.12 Additionally, future applicants shall incorporate into future drainage strategies bioretention or raingardens systems within the streetscape in a range from 10% to 25% of the total site storage requirement. Areas as the green/landscape spaces between the development areas E, F and H identified in Appendix A, are low points of the site and therefore they, initially, show potential for the incorporation of bioretention or raingarden systems.
- 6.6.13 Planning applications for Individual development sites will require to be supported with provision of a drainage strategy within the planning submission. The drainage strategies should include details on how treatment requirements will be met, once the final land-uses are decided. This will be particularly relevant if proposed developments have higher pollution hazards (e.g. are not residential) and SUDS basins are insufficient on their own.

6.7 Proposed Foul Water Drainage

- 6.7.1 It is anticipated the foul drainage from the proposed development will be discharged into the public sewers identified in the residential areas to the north, east and south-east of the site.
- 6.7.2 The masterplan is still in development, but an initial pre-development enquiry has been submitted to Scottish Water based on current estimations of residential property density.
- 6.7.3 Scottish Water replied to say there is sufficient capacity in Glenlatterach and Moray West water treatment works to service the development. A further water impact assessment (WIA) and drainage impact assessment (DIA) will be required to establish if there is sufficient capacity in the existing network infrastructure.

6.8 Maintenance Requirements

- 6.8.1 A suitable maintenance strategy should be adopted to ensure the drainage network is cleaned regularly and the routine maintenance and cleansing regime should be documented. Unless under management of a factor or management company, the SUDS solutions will require to satisfy the adoption and maintenance requirements of Scottish Water and/or Moray Council.
- 6.8.2 It is recommended that the drainage system is inspected a minimum of twice per year, or, as per the manufacturers guidelines, with the system also being inspected after any major storm event. Significant sediment deposition is likely in areas used for storage, so a post clean-up operation may be required including the removal of litter, vegetation, sewerage debris and larger objects.
- 6.8.3 The CIRIA SUDS Manual 2015 provides guidance on the maintenance requirements for SUDS features.

7.0 Conclusions and Recommendations

7.1 Conclusions

- 7.1.1 This report has been prepared to support a masterplan for a 40.74 ha area of land at Elgin, Moray.
- 7.1.2 The masterplan site has been divided into a number of development plots. These smaller plots will be sold and developed individually but will need to tie into an overall drainage infrastructure.
- 7.1.3 Each development plot will have allowable discharge rates for surface and foul water, which will form the design flows for the overall masterplan sewerage infrastructure.
- 7.1.4 Surface water disposal by infiltration techniques may be possible, but there is insufficient data on infiltration rates and groundwater levels across the entire masterplan area to determine at this time.
- 7.1.5 The drainage proposal will consider infiltration techniques, when available, as the first option and, as a secondary option, the whole site is proposed to discharge to two outfalls, the nature reserve to the east of the site and directly to the Tyock Burn.
- 7.1.6 Treatment will be achieved through SUDS basins for the residential housing and low traffic roads. Roads (excluding low traffic roads) will be treated through a combination of filter drains and an enhanced SUDS basin.
- 7.1.7 The location of the SuDS basins is shown as indicative at this stage, the final locations and volume required will need to be confirmed following the site investigation/infiltration testing works along with the detailed drainage design at the detailed planning stage.
- 7.1.8 The foul water from the site is expected to be discharged via new connections to public sewer network, to the north, east and south-east of the site. Consultation will be required with Scottish Water to ensure the local sewer and wastewater treatment works as well as the relevant network have sufficient capacity for a new development.

7.2 Recommendations

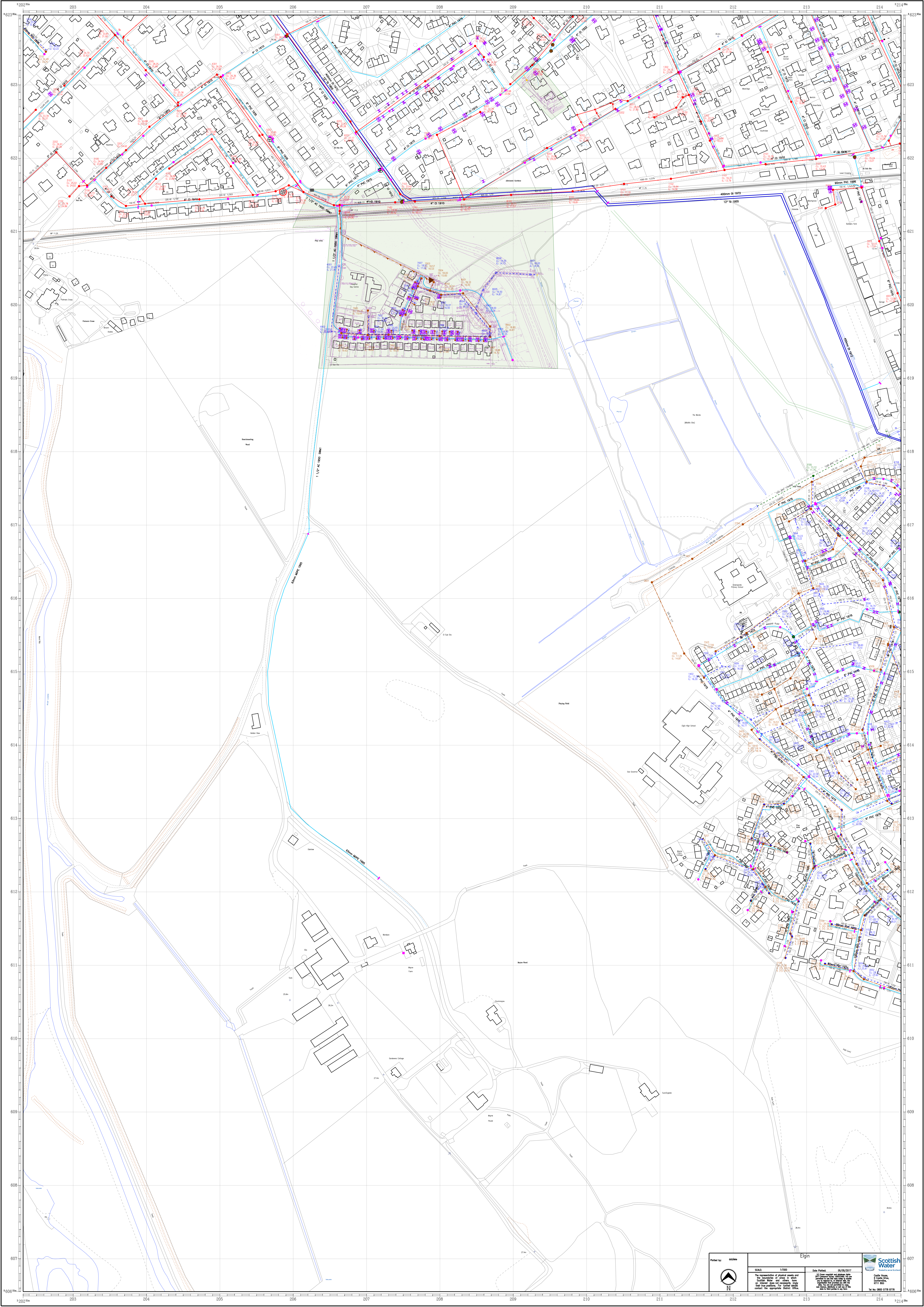
- 7.2.1 The water impact assessment (WIA) and drainage impact assessment (DIA) with Scottish Water should be reviewed with ongoing proposals for the development sites.
- 7.2.2 A summary of planning application requirements (for flooding and drainage) is included in Appendix I.

- 7.2.3 Design foul and surface water discharge rates for the development sites will require confirmation, pending discussion and agreement with Moray Council and Scottish Water, in conjunction with the design for the infrastructure across the masterplan site.
- 7.2.4 Further site investigation work will be carried out at the detailed planning application stage, to assess soil infiltration potential (soakaway testing to BRE 365 standard) and groundwater levels across the entire masterplan area.

Appendix A – Proposed Site Plans



Appendix B – Public Sewer Records



SMALLWORLD GIS – WASTEWATER LEGEND



Pipework

	Combined (red)
	Foul (brown)
	Surface Water (blue)
	Natural Water (light blue)
	CSO (dark blue)
	Trade Effluent (brown)
	Treated Effluent (black)
	Abandoned (grey)
	Water Course (dark green)
	PFI sewer (bright green)
	Rising Main (red)
	Proposed sewers (foul, combined and surface water)
	Syphon
	Chamber (same colour as pipework)
	Dual Chamber (same colour as pipework)
	Surface Water Chamber



Collapse/Choke (not visible by default)



Combined Storm Overflow



Connection (not visible)



Duct



Ghost Node (not visible by default)



Hatchbox



Hydraulic Control Chamber



Lamphole



Change of Attributes



Outfall



Inlet



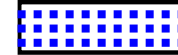
Pumping Station



Wash Out



Bifurcation Chamber



Balancing Pond



Rodding Eye



Septic Tank



Sewer Junction



Sewer Structure



Sewerage Air Valve



Sewerage Pipe Bridge



Sluice Valve



Storm Tank



Unknown End



Treatment Plant



Vent Column

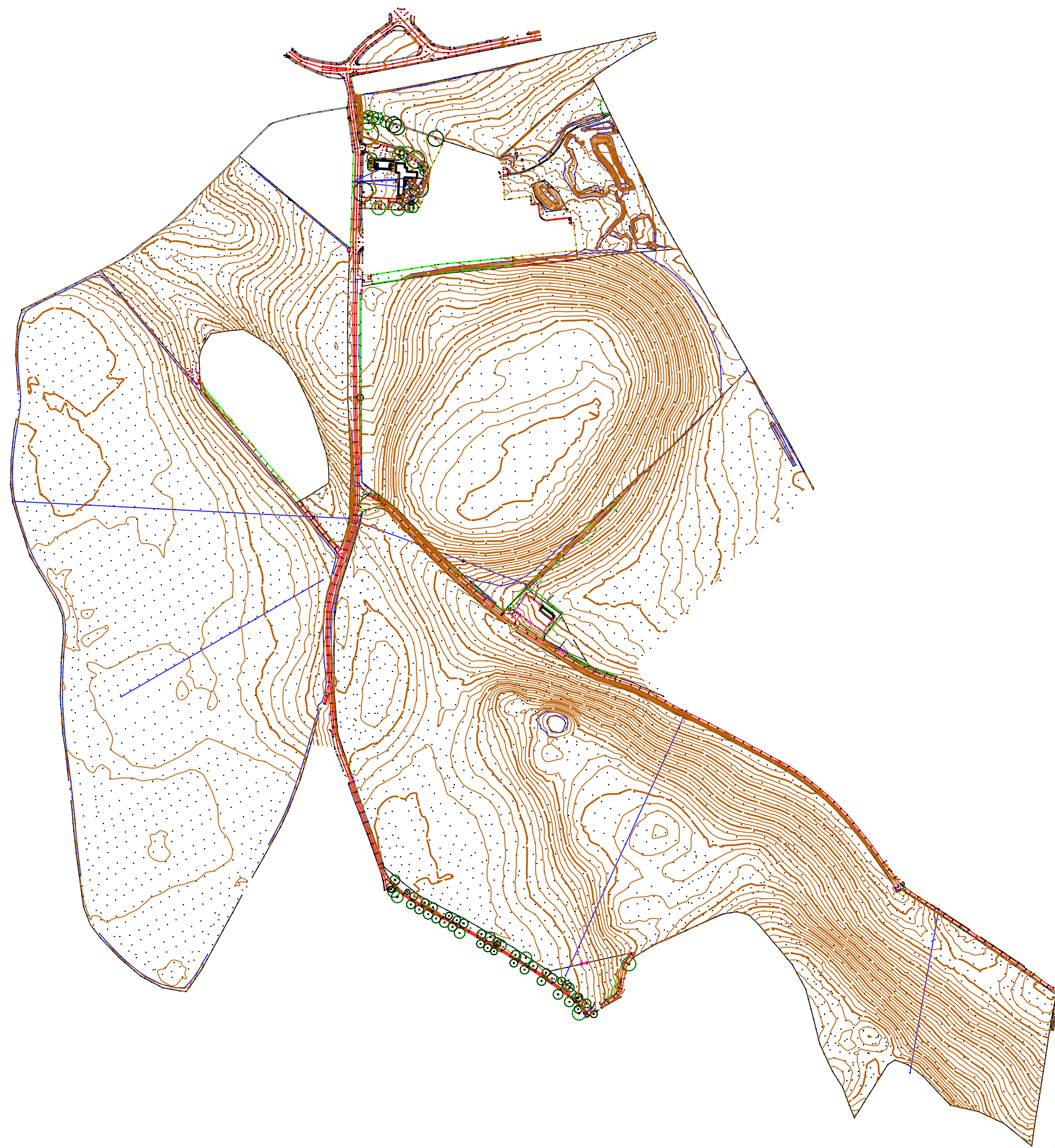


Buchan Trap

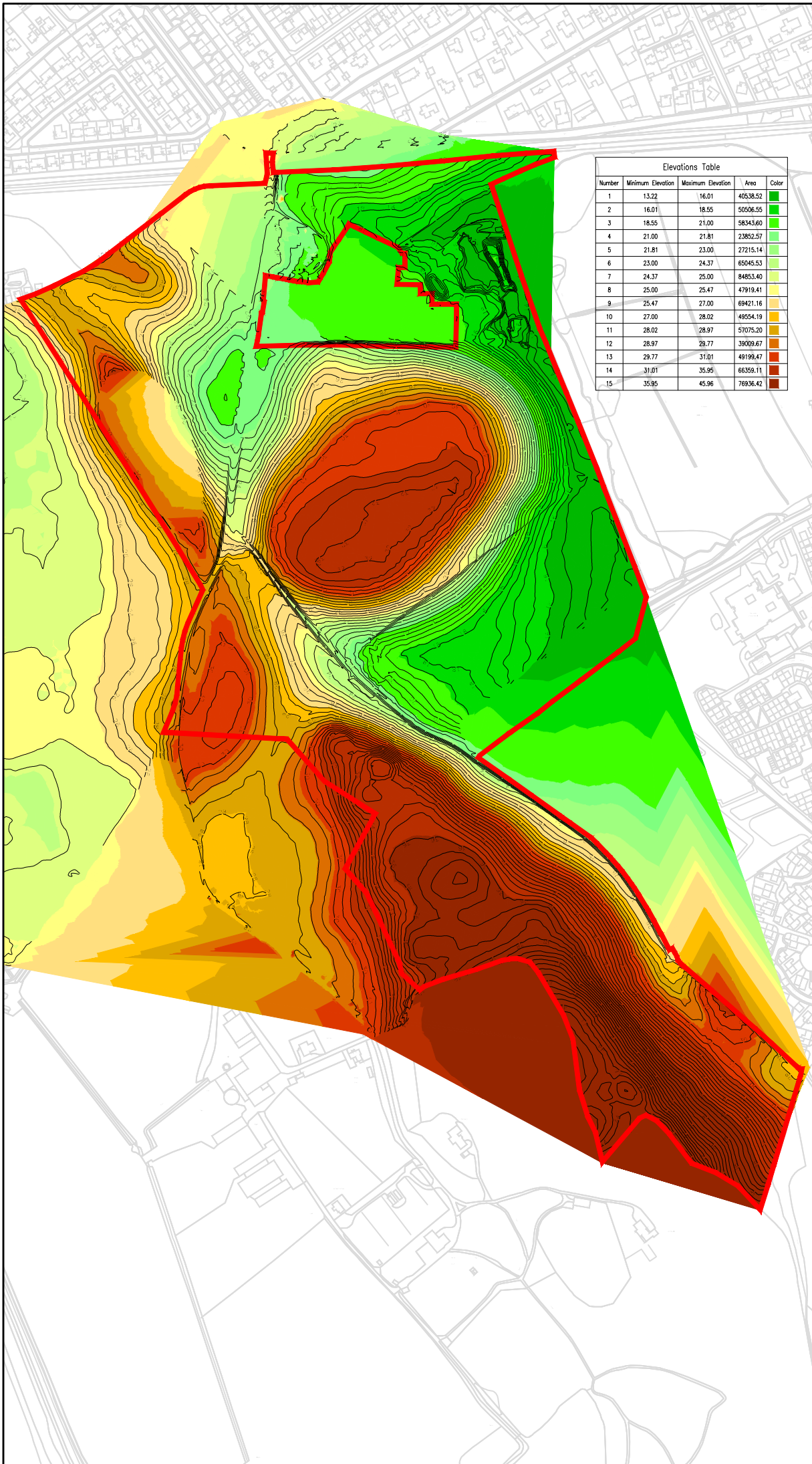


Capped End (same colour as pipework)

Appendix C – Topographical Survey



Appendix D – Height Band Analysis



Elevations Table				
Number	Minimum Elevation	Maximum Elevation	Area	Color
1	13.22	16.01	40538.52	
2	16.01	18.55	50506.55	
3	18.55	21.00	58343.60	
4	21.00	21.81	23852.57	
5	21.81	23.00	27215.14	
6	23.00	24.37	65045.53	
7	24.37	25.00	84853.40	
8	25.00	25.47	47919.41	
9	25.47	27.00	69421.16	
10	27.00	28.02	49554.19	
11	28.02	28.97	57075.20	
12	28.97	29.77	39009.67	
13	29.77	31.01	49199.47	
14	31.01	35.95	66359.11	
15	35.95	45.96	76936.42	

GENERAL NOTES:

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS AND ENGINEERS DRAWINGS AND SPECIFICATIONS.
2. DO NOT SCALE THIS DRAWING. ANY AMBIGUITIES, OMISSIONS AND ERRORS ON DRAWINGS SHALL BE BROUGHT TO THE ENGINEERS ATTENTION IMMEDIATELY. ALL DIMENSIONS MUST BE CHECKED / VERIFIED ON SITE.
3. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.
4. FOR GENERAL NOTES REFER TO DRAWING.

Rev.	Description	Date	By	Chk.			
 15 Bedford Road, Edinburgh, EH4 3EL 0131 225 2715 edinburgh@curtins.com www.curtins.com Drain & Structure - Transport Planning - Environmental - Infrastructure - Geotechnical - Conservation & Heritage - Principal Designer Birmingham - Bristol - Cardiff - Cardiff - Dublin - Edinburgh - Glasgow - Glasgow - London - Liverpool - Manchester - Nottingham							
Status: PRELIMINARY							
Project: Bilbollah, Masterplan							
Dwg Title: Drainage Strategy - Height Band Analysis							
Project No.	Site	Date	Drawn By	Designed By	Checked By		
063268	XX	17/07/18	CVB	CVB	PP		
Scale: 1:2500							
Project No.	Originator	Volume	Level	Type	Role	Category / Number	Rev.
063268	-CUR	-XX	-XX	-DR	-C	92004	-P01

Appendix E – Micro Drainage Outputs

Curtins Consulting Ltd		Page 1																								
. . .	Qbar Existing Catchment North																									
Date 03/10/2018 10:26 File QBAR EXISTING.SRCX	Designed by CVB Checked by																									
Innovyze Source Control 2017.1.2																										
<u>ICP SUDS Mean Annual Flood</u> Input <table> <tr> <td>Return Period (years)</td> <td>200</td> <td>Soil</td> <td>0.400</td> </tr> <tr> <td>Area (ha)</td> <td>15.980</td> <td>Urban</td> <td>0.000</td> </tr> <tr> <td>SAAR (mm)</td> <td>679</td> <td>Region Number</td> <td>Region 1</td> </tr> </table> Results l/s <table> <tr> <td>QBAR Rural</td> <td>52.5</td> </tr> <tr> <td>QBAR Urban</td> <td>52.5</td> </tr> <tr> <td>Q200 years</td> <td>147.4</td> </tr> <tr> <td>Q1 year</td> <td>44.6</td> </tr> <tr> <td>Q30 years</td> <td>99.1</td> </tr> <tr> <td>Q100 years</td> <td>130.1</td> </tr> </table>			Return Period (years)	200	Soil	0.400	Area (ha)	15.980	Urban	0.000	SAAR (mm)	679	Region Number	Region 1	QBAR Rural	52.5	QBAR Urban	52.5	Q200 years	147.4	Q1 year	44.6	Q30 years	99.1	Q100 years	130.1
Return Period (years)	200	Soil	0.400																							
Area (ha)	15.980	Urban	0.000																							
SAAR (mm)	679	Region Number	Region 1																							
QBAR Rural	52.5																									
QBAR Urban	52.5																									
Q200 years	147.4																									
Q1 year	44.6																									
Q30 years	99.1																									
Q100 years	130.1																									
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Curtins Consulting Ltd		Page 1																								
. . .	Qbar Existing South Catchment																									
Date 03/10/2018 10:28 File QBAR EXISTING.SRCX	Designed by CVB Checked by																									
Innovyze	Source Control 2017.1.2																									
<u>ICP SUDS Mean Annual Flood</u> Input <table> <tr> <td>Return Period (years)</td> <td>200</td> <td>Soil</td> <td>0.400</td> </tr> <tr> <td>Area (ha)</td> <td>21.240</td> <td>Urban</td> <td>0.000</td> </tr> <tr> <td>SAAR (mm)</td> <td>679</td> <td>Region Number</td> <td>Region 1</td> </tr> </table> Results l/s <table> <tr> <td>QBAR Rural</td> <td>69.7</td> </tr> <tr> <td>QBAR Urban</td> <td>69.7</td> </tr> <tr> <td>Q200 years</td> <td>196.0</td> </tr> <tr> <td>Q1 year</td> <td>59.3</td> </tr> <tr> <td>Q30 years</td> <td>131.8</td> </tr> <tr> <td>Q100 years</td> <td>172.9</td> </tr> </table>			Return Period (years)	200	Soil	0.400	Area (ha)	21.240	Urban	0.000	SAAR (mm)	679	Region Number	Region 1	QBAR Rural	69.7	QBAR Urban	69.7	Q200 years	196.0	Q1 year	59.3	Q30 years	131.8	Q100 years	172.9
Return Period (years)	200	Soil	0.400																							
Area (ha)	21.240	Urban	0.000																							
SAAR (mm)	679	Region Number	Region 1																							
QBAR Rural	69.7																									
QBAR Urban	69.7																									
Q200 years	196.0																									
Q1 year	59.3																									
Q30 years	131.8																									
Q100 years	172.9																									
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. . .	Qbar Existing Catchment West	
Date 03/10/2018 10:29 File QBAR EXISTING.SRCX	Designed by CVB Checked by	
Innovyze	Source Control 2017.1.2	
<u>ICP SUDS Mean Annual Flood</u> Input Return Period (years) 200 Soil 0.400 Area (ha) 3.510 Urban 0.000 SAAR (mm) 679 Region Number Region 1 Results l/s QBAR Rural 11.5 QBAR Urban 11.5 Q200 years 32.4 Q1 year 9.8 Q30 years 21.8 Q100 years 28.6		
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. . .	Bilbohall Masterplan 063268 Q bar A, B and C	
Date 17/07/2018 09:28 File R12 STORAGE ESTIMATION....	Designed by CVB Checked by	
XP Solutions	Source Control 2017.1.2	

ICP SUDS Mean Annual Flood

Input

Return Period (years)	30	Soil	0.400
Area (ha)	3.060	Urban	0.000
SAAR (mm)	679	Region Number	Region 1

Results l/s

QBAR Rural	10.0
QBAR Urban	10.0
Q30 years	19.0
Q1 year	8.5
Q30 years	19.0
Q100 years	24.9

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. . .	Bilbohall Masterplan 063268 Q bar Area D	
Date 17/07/2018 08:58 File R1 STORAGE ESTIMATION.SRCX	Designed by CVB Checked by	
XP Solutions	Source Control 2017.1.2	

ICP SUDS Mean Annual Flood

Input

Return Period (years)	200	Soil	0.400
Area (ha)	0.620	Urban	0.000
SAAR (mm)	767	Region Number	Region 1

Results 1/s

QBAR Rural	2.3
QBAR Urban	2.3
Q200 years	6.6
Q1 year	2.0
Q30 years	4.4
Q100 years	5.8

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. . .	R1+OP7 Qbar Green Area																									
Date 03/10/2018 11:06 File QBAR EXISTING.SRCX	Designed by CVB Checked by																									
Innovyze Source Control 2017.1.2																										
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Return Period (years)	200	Soil	0.400																							
Area (ha)	6.510	Urban	0.000																							
SAAR (mm)	679	Region Number	Region 1																							
QBAR Rural	21.4																									
QBAR Urban	21.4																									
Q200 years	60.1																									
Q1 year	18.2																									
Q30 years	40.4																									
Q100 years	53.0																									
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. . .	R12 Green area (10% Hardstand) Qbar	
Date 12/09/2018 File QBAR.SRCX	Designed by CVB Checked by	
Innovyze	Source Control 2017.1.2	
<u>ICP SUDS Mean Annual Flood</u> Input Return Period (years) 30 Soil 0.400 Area (ha) 0.192 Urban 0.000 SAAR (mm) 679 Region Number Region 1 Results l/s QBAR Rural 0.6 QBAR Urban 0.6 Q30 years 1.2 Q1 year 0.5 Q30 years 1.2 Q100 years 1.6		
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. . .	Bilbohall Masterplan - 063268 Q bar Areas E, F, G, H, I, J, K, LM	
Date 08/08/2018 09:42 File STORAGE FROM E TO M.SRCX	Designed by CVB Checked by	
XP Solutions	Source Control 2017.1.2	

ICP SUDS Mean Annual Flood

Input

Return Period (years)	30	Soil	0.400
Area (ha)	7.210	Urban	0.000
SAAR (mm)	679	Region Number	Region 1

Results l/s

QBAR Rural	23.7
QBAR Urban	23.7
Q30 years	44.7
Q1 year	20.1
Q30 years	44.7
Q100 years	58.7

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. . .	R4 Green area (10% Hardstand) Q bar existing																									
Date 12/09/2018 File QBAR.SRCX	Designed by CVB Checked by																									
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Date 17/07/2018 10:01 File Storage R, Q, S and T.srcx	Designed by CVB Checked by	
XP Solutions	Source Control 2017.1.2	

ICP SUDS Mean Annual Flood

Input

Return Period (years)	30	Soil	0.400
Area (ha)	2.460	Urban	0.000
SAAR (mm)	679	Region Number	Region 1

Results l/s

QBAR Rural	8.1
QBAR Urban	8.1
Q30 years	15.3
Q1 year	6.9
Q30 years	15.3
Q100 years	20.0

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Basin A, B and C
1 in 30 yr + 30% CC
70% Hardstanding



Date	10/09/2018
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Summary of Results for 30 year Return Period (+30%)

	Storm	Max	Max	Max	Max	Max	Max	Status
	Event	Level	Depth	Infiltration	Control	Σ	Outflow	Volume
		(m)	(m)	(l/s)	(l/s)		(l/s)	(m³)
	30 min Winter	19.123	0.623	0.0	18.0		18.0	335.1
	60 min Winter	19.271	0.771	0.0	18.0		18.0	437.6
	120 min Winter	19.405	0.905	0.0	18.0		18.0	538.1
	180 min Winter	19.474	0.974	0.0	18.0		18.0	593.5
	240 min Winter	19.514	1.014	0.0	18.0		18.0	626.0
	360 min Winter	19.549	1.049	0.0	18.0		18.0	655.5
	480 min Winter	19.556	1.056	0.0	18.0		18.0	661.6
	600 min Winter	19.555	1.055	0.0	18.0		18.0	661.2
	720 min Winter	19.550	1.050	0.0	18.0		18.0	656.7
	960 min Winter	19.526	1.026	0.0	18.0		18.0	636.5
	1440 min Winter	19.442	0.942	0.0	18.0		18.0	567.7
	2160 min Winter	19.278	0.778	0.0	18.0		18.0	442.2
	2880 min Winter	19.115	0.615	0.0	18.0		18.0	329.6
	4320 min Winter	18.852	0.352	0.0	17.8		17.8	170.6
	5760 min Winter	18.716	0.216	0.0	16.5		16.5	99.4
	7200 min Winter	18.679	0.179	0.0	14.7		14.7	81.0
	8640 min Winter	18.660	0.160	0.0	13.0		13.0	72.1
	10080 min Winter	18.648	0.148	0.0	11.8		11.8	66.1

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
30 min Winter	40.351	0.0	359.7	39
60 min Winter	27.116	0.0	486.4	66
120 min Winter	17.601	0.0	631.7	124
180 min Winter	13.575	0.0	731.0	180
240 min Winter	11.262	0.0	808.7	238
360 min Winter	8.635	0.0	930.3	346
480 min Winter	7.143	0.0	1026.1	446
600 min Winter	6.162	0.0	1106.5	482
720 min Winter	5.460	0.0	1176.5	560
960 min Winter	4.509	0.0	1295.3	718
1440 min Winter	3.441	0.0	1482.5	1022
2160 min Winter	2.625	0.0	1699.3	1424
2880 min Winter	2.166	0.0	1869.1	1792
4320 min Winter	1.650	0.0	2134.7	2432
5760 min Winter	1.359	0.0	2346.8	3056
7200 min Winter	1.169	0.0	2523.3	3680
8640 min Winter	1.034	0.0	2676.7	4408
10080 min Winter	0.931	0.0	2812.9	5136

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Innovyze	Source Control 2017.1.2	

Model Details

Storage is Online Cover Level (m) 20.000

Infiltration Basin Structure

Invert Level (m) 18.500 Safety Factor 2.0
 Infiltration Coefficient Base (m/hr) 0.00000 Porosity 1.00
 Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	422.0	1.200	921.0	1.500	1069.0
0.600	652.0	1.201	922.0		

Hydro-Brake® Optimum Outflow Control

Unit Reference MD-SHE-0182-1800-1500-1800
 Design Head (m) 1.500
 Design Flow (l/s) 18.0
 Flush-Flo™ Calculated
 Objective Minimise upstream storage
 Application Surface
 Sump Available Yes
 Diameter (mm) 182
 Invert Level (m) 18.500
 Minimum Outlet Pipe Diameter (mm) 225
 Suggested Manhole Diameter (mm) 1500

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	18.0
Flush-Flo™	0.443	18.0
Kick-Flo®	0.967	14.6
Mean Flow over Head Range	-	15.6

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	6.4	1.200	16.2	3.000	25.1	7.000	37.7
0.200	16.2	1.400	17.4	3.500	27.0	7.500	39.0
0.300	17.5	1.600	18.6	4.000	28.8	8.000	40.2
0.400	17.9	1.800	19.6	4.500	30.4	8.500	41.4
0.500	17.9	2.000	20.6	5.000	32.0	9.000	42.5
0.600	17.7	2.200	21.6	5.500	33.5	9.500	43.7
0.800	16.8	2.400	22.5	6.000	35.0		
1.000	14.9	2.600	23.4	6.500	36.3		

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Basin D

1 in 200yr event + 30% CC
70% Hardstansing

Date 03/10/2018 10:37

Designed by CVB

File STORAGE D.SRCX

Checked by



Innovyze

Source Control 2017.1.2

Summary of Results for 200 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	19.217	0.717	0.0	13.6	13.6	271.2	O K
60 min Winter	19.371	0.871	0.0	13.6	13.6	354.4	O K
120 min Winter	19.571	1.071	0.0	13.6	13.6	476.6	O K
180 min Winter	19.680	1.180	0.0	13.6	13.6	550.9	O K
240 min Winter	19.740	1.240	0.0	13.6	13.6	594.1	Flood Risk
360 min Winter	19.800	1.300	0.0	13.6	13.6	638.2	Flood Risk
480 min Winter	19.841	1.341	0.0	13.6	13.6	669.6	Flood Risk
600 min Winter	19.874	1.374	0.0	13.6	13.6	695.9	Flood Risk
720 min Winter	19.903	1.403	0.0	13.6	13.6	719.4	Flood Risk
960 min Winter	19.955	1.455	0.0	13.6	13.6	761.6	Flood Risk
1440 min Winter	19.964	1.464	0.0	13.6	13.6	769.0	Flood Risk
2160 min Winter	19.760	1.260	0.0	13.6	13.6	608.8	Flood Risk
2880 min Winter	19.451	0.951	0.0	13.6	13.6	401.0	O K
4320 min Winter	19.264	0.764	0.0	13.6	13.6	295.6	O K
5760 min Winter	19.222	0.722	0.0	13.6	13.6	273.4	O K
7200 min Winter	19.198	0.698	0.0	13.6	13.6	261.5	O K
8640 min Winter	19.181	0.681	0.0	13.6	13.6	253.0	O K
10080 min Winter	19.168	0.668	0.0	13.6	13.6	246.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
30 min Winter	61.039	0.0	1142.6	1061
60 min Winter	41.247	0.0	1241.2	1068
120 min Winter	26.488	0.0	1302.8	1070
180 min Winter	20.263	0.0	1343.8	1066
240 min Winter	16.694	0.0	1375.2	1064
360 min Winter	12.665	0.0	1423.6	1064
480 min Winter	10.391	0.0	1461.1	1062
600 min Winter	8.905	0.0	1492.2	1060
720 min Winter	7.847	0.0	1519.0	1060
960 min Winter	6.422	0.0	1564.1	1058
1440 min Winter	4.838	0.0	1634.2	1088
2160 min Winter	3.645	0.0	1715.7	1244
2880 min Winter	2.979	0.0	1777.6	1508
4320 min Winter	2.237	0.0	1872.3	1076
5760 min Winter	1.824	0.0	1946.7	1072
7200 min Winter	1.556	0.0	2007.6	1064
8640 min Winter	1.366	0.0	2060.0	1064
10080 min Winter	1.223	0.0	2106.1	1064

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Model Details

Storage is Online Cover Level (m) 20.000

Infiltration Basin Structure

Invert Level (m) 18.500 Safety Factor 2.0
 Infiltration Coefficient Base (m/hr) 0.00000 Porosity 1.00
 Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	257.3	1.200	713.0	1.500	851.5
0.600	466.0	1.201	713.1		

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0160-1360-1500-1360
Design Head (m)	1.500
Design Flow (l/s)	13.6
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	160
Invert Level (m)	18.500
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	13.6
Flush-Flo™	0.441	13.6
Kick-Flo®	0.949	11.0
Mean Flow over Head Range	-	11.8

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	5.7	1.200	12.2	3.000	18.9	7.000	28.4
0.200	12.3	1.400	13.2	3.500	20.4	7.500	29.4
0.300	13.3	1.600	14.0	4.000	21.7	8.000	30.3
0.400	13.6	1.800	14.8	4.500	23.0	8.500	31.2
0.500	13.6	2.000	15.6	5.000	24.1	9.000	32.1
0.600	13.4	2.200	16.3	5.500	25.3	9.500	32.9
0.800	12.6	2.400	17.0	6.000	26.4		
1.000	11.2	2.600	17.7	6.500	27.4		

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[illegible]

Basin E, F, G, H, I, J, K, L, M
1 in 30yr + 30%CC
70% Hardstanding



Date	10/09/2018
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File STORAGE FROM E TO M.SRCX

Checked by

Innovyze

Source Control 2017.1.2

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

	Storm		Max	Max	Max	Max	Max	Max	Status
	Event		Level	Depth	Infiltration	Control	Σ	Outflow	
			(m)	(m)	(l/s)	(l/s)		(l/s)	(m³)
	30 min	Winter	18.956	0.456	0.0	52.2		52.2	984.3
	60 min	Winter	19.085	0.585	0.0	52.3		52.3	1289.9
	120 min	Winter	19.215	0.715	0.0	52.3		52.3	1612.7
	180 min	Winter	19.293	0.793	0.0	52.3		52.3	1814.2
	240 min	Winter	19.349	0.849	0.0	52.3		52.3	1958.6
	360 min	Winter	19.424	0.924	0.0	52.3		52.3	2161.2
	480 min	Winter	19.473	0.973	0.0	52.3		52.3	2292.5
	600 min	Winter	19.499	0.999	0.0	52.3		52.3	2365.1
	720 min	Winter	19.516	1.016	0.0	52.3		52.3	2412.1
	960 min	Winter	19.532	1.032	0.0	52.3		52.3	2457.1
	1440 min	Winter	19.526	1.026	0.0	52.3		52.3	2440.2
	2160 min	Winter	19.453	0.953	0.0	52.3		52.3	2238.7
	2880 min	Winter	19.357	0.857	0.0	52.3		52.3	1979.8
	4320 min	Winter	19.134	0.634	0.0	52.3		52.3	1411.0
	5760 min	Winter	18.790	0.290	0.0	49.1		49.1	606.4
	7200 min	Winter	18.751	0.251	0.0	41.9		41.9	522.7
	8640 min	Winter	18.730	0.230	0.0	37.4		37.4	476.6
	10080 min	Winter	18.715	0.215	0.0	33.8		33.8	443.8

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
30 min Winter	40.351	0.0	1989.3	39
60 min Winter	27.116	0.0	3444.9	66
120 min Winter	17.601	0.0	3866.5	124
180 min Winter	13.575	0.0	4154.5	182
240 min Winter	11.262	0.0	4379.8	238
360 min Winter	8.635	0.0	4732.6	354
480 min Winter	7.143	0.0	5010.5	464
600 min Winter	6.162	0.0	5243.8	572
720 min Winter	5.460	0.0	5446.8	678
960 min Winter	4.509	0.0	5791.4	780
1440 min Winter	3.441	0.0	6328.7	1086
2160 min Winter	2.625	0.0	7056.4	1520
2880 min Winter	2.166	0.0	7547.1	1964
4320 min Winter	1.650	0.0	8305.8	2536
5760 min Winter	1.359	0.0	8941.8	2992
7200 min Winter	1.169	0.0	9450.7	3752
8640 min Winter	1.034	0.0	9890.9	4480
10080 min Winter	0.931	0.0	10275.3	5152

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Innovyze	Source Control 2017.1.2	

Model Details

Storage is Online Cover Level (m) 20.000

Infiltration Basin Structure

Invert Level (m) 18.500 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	1988.2	1.200	2933.2	1.500	3191.9
0.600	2442.5	1.201	2933.3		

Hydro-Brake® Optimum Outflow Control

Unit Reference MD-SHE-0294-5230-1500-5230
Design Head (m) 1.500
Design Flow (l/s) 52.3
Flush-Flo™ Calculated
Objective Minimise upstream storage
Application Surface
Sump Available Yes
Diameter (mm) 294
Invert Level (m) 18.500
Minimum Outlet Pipe Diameter (mm) 375
Suggested Manhole Diameter (mm) 2100

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	52.3
Flush-Flo™	0.513	52.3
Kick-Flo®	1.075	44.6
Mean Flow over Head Range	-	44.1

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	9.1	1.200	47.0	3.000	73.1	7.000	110.4
0.200	30.3	1.400	50.6	3.500	78.8	7.500	114.2
0.300	49.8	1.600	54.0	4.000	84.1	8.000	117.9
0.400	51.7	1.800	57.1	4.500	89.0	8.500	121.4
0.500	52.3	2.000	60.1	5.000	93.7	9.000	124.9
0.600	52.1	2.200	62.9	5.500	98.2	9.500	128.2
0.800	50.7	2.400	65.6	6.000	102.4		
1.000	47.3	2.600	68.2	6.500	106.5		

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Summary of Results for 200 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	19.176	0.676	0.0	52.3	52.3	1514.4	O K
60 min Winter	19.370	0.870	0.0	52.3	52.3	2014.9	O K
120 min Winter	19.557	1.057	0.0	52.3	52.3	2526.8	O K
180 min Winter	19.669	1.169	0.0	52.3	52.3	2847.2	O K
240 min Winter	19.745	1.245	0.0	52.3	52.3	3070.7	Flood Risk
360 min Winter	19.847	1.347	0.0	52.3	52.3	3377.6	Flood Risk
480 min Winter	19.910	1.410	0.0	52.3	52.3	3571.7	Flood Risk
600 min Winter	19.946	1.446	0.0	52.3	52.3	3685.1	Flood Risk
720 min Winter	19.970	1.470	0.0	52.3	52.3	3761.0	Flood Risk
960 min Winter	19.993	1.493	0.0	52.3	52.3	3832.8	Flood Risk
1440 min Winter	19.996	1.496	0.0	52.3	52.3	3841.8	Flood Risk
2160 min Winter	19.953	1.453	0.0	52.3	52.3	3706.5	Flood Risk
2880 min Winter	19.893	1.393	0.0	52.3	52.3	3520.5	Flood Risk
4320 min Winter	19.638	1.138	0.0	52.3	52.3	2756.3	O K
5760 min Winter	19.127	0.627	0.0	52.3	52.3	1392.1	O K
7200 min Winter	18.866	0.366	0.0	51.3	51.3	776.8	O K
8640 min Winter	18.789	0.289	0.0	49.0	49.0	605.5	O K
10080 min Winter	18.763	0.263	0.0	44.2	44.2	547.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
30 min Winter	61.039	0.0	2528.1	39
60 min Winter	41.247	0.0	4181.7	68
120 min Winter	26.488	0.0	4793.3	126
180 min Winter	20.263	0.0	5200.6	184
240 min Winter	16.694	0.0	5512.5	242
360 min Winter	12.665	0.0	5992.7	358
480 min Winter	10.391	0.0	6363.7	472
600 min Winter	8.905	0.0	6669.4	584
720 min Winter	7.847	0.0	6928.9	694
960 min Winter	6.422	0.0	7342.6	904
1440 min Winter	4.838	0.0	7796.3	1126
2160 min Winter	3.645	0.0	8965.9	1584
2880 min Winter	2.979	0.0	9576.2	2080
4320 min Winter	2.237	0.0	10508.9	2776
5760 min Winter	1.824	0.0	11269.0	3400
7200 min Winter	1.556	0.0	11870.4	3968
8640 min Winter	1.366	0.0	12385.4	4496
10080 min Winter	1.223	0.0	12832.5	5240

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Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)																																																																																																				
0.100	9.1	1.200	47.0	3.000	73.1	7.000	110.4																																																																																																				
0.200	30.3	1.400	50.6	3.500	78.8	7.500	114.2																																																																																																				
0.300	49.8	1.600	54.0	4.000	84.1	8.000	117.9																																																																																																				
0.400	51.7	1.800	57.1	4.500	89.0	8.500	121.4																																																																																																				
0.500	52.3	2.000	60.1	5.000	93.7	9.000	124.9																																																																																																				
0.600	52.1	2.200	62.9	5.500	98.2	9.500	128.2																																																																																																				
0.800	50.7	2.400	65.6	6.000	102.4																																																																																																						
1.000	47.3	2.600	68.2	6.500	106.5																																																																																																						
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Basin N and O
1 in 30yr + 30% CC
70% Hardstanding



Date	10/09/2018
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Checked by

Innovyze

Source Control 2017.1.2

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

	Storm	Max	Max	Max	Max	Max	Max	Status
	Event	Level	Depth	Infiltration	Control	Σ	Outflow	Volume
		(m)	(m)	(l/s)	(l/s)		(l/s)	(m³)
	30 min Winter	19.114	0.614	0.0	4.3		4.3	156.3
	60 min Winter	19.246	0.746	0.0	4.3		4.3	206.9
	120 min Winter	19.372	0.872	0.0	4.3		4.3	261.4
	180 min Winter	19.442	0.942	0.0	4.3		4.3	294.3
	240 min Winter	19.488	0.988	0.0	4.3		4.3	317.2
	360 min Winter	19.546	1.046	0.0	4.3		4.3	347.3
	480 min Winter	19.581	1.081	0.0	4.3		4.3	365.6
	600 min Winter	19.602	1.102	0.0	4.3		4.3	377.1
	720 min Winter	19.615	1.115	0.0	4.3		4.3	384.2
	960 min Winter	19.625	1.125	0.0	4.3		4.3	389.9
	1440 min Winter	19.623	1.123	0.0	4.3		4.3	389.0
	2160 min Winter	19.605	1.105	0.0	4.3		4.3	379.0
	2880 min Winter	19.574	1.074	0.0	4.3		4.3	361.7
	4320 min Winter	19.487	0.987	0.0	4.3		4.3	316.7
	5760 min Winter	19.377	0.877	0.0	4.3		4.3	263.7
	7200 min Winter	19.215	0.715	0.0	4.3		4.3	194.7
	8640 min Winter	19.071	0.571	0.0	4.3		4.3	140.9
	10080 min Winter	18.945	0.445	0.0	4.3		4.3	100.4

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
30 min Winter	40.351	0.0	162.8	40
60 min Winter	27.116	0.0	219.7	68
120 min Winter	17.601	0.0	285.2	126
180 min Winter	13.575	0.0	329.9	184
240 min Winter	11.262	0.0	365.0	242
360 min Winter	8.635	0.0	419.7	358
480 min Winter	7.143	0.0	462.8	472
600 min Winter	6.162	0.0	498.9	584
720 min Winter	5.460	0.0	530.3	694
960 min Winter	4.509	0.0	582.9	904
1440 min Winter	3.441	0.0	632.7	1138
2160 min Winter	2.625	0.0	766.5	1608
2880 min Winter	2.166	0.0	843.0	2080
4320 min Winter	1.650	0.0	962.8	2988
5760 min Winter	1.359	0.0	1058.6	3864
7200 min Winter	1.169	0.0	1138.2	4608
8640 min Winter	1.034	0.0	1207.5	5200
10080 min Winter	0.931	0.0	1269.1	5848

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Date 10/09/2018 File STORAGE N AND O.SRCX	Designed by CVB Checked by	
Innovyze	Source Control 2017.1.2	

Model Details

Storage is Online Cover Level (m) 20.000

Infiltration Basin Structure

Invert Level (m) 18.500 Safety Factor 2.0
 Infiltration Coefficient Base (m/hr) 0.00000 Porosity 1.00
 Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	159.6	1.200	591.6	1.500	722.2
0.600	357.6	1.201	591.7		

Hydro-Brake® Optimum Outflow Control

Unit Reference MD-SHE-0093-4500-1500-4500
 Design Head (m) 1.500
 Design Flow (l/s) 4.5
 Flush-Flo™ Calculated
 Objective Minimise upstream storage
 Application Surface
 Sump Available Yes
 Diameter (mm) 93
 Invert Level (m) 18.500
 Minimum Outlet Pipe Diameter (mm) 150
 Suggested Manhole Diameter (mm) 1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	4.5
Flush-Flo™	0.407	4.3
Kick-Flo®	0.828	3.4
Mean Flow over Head Range	-	3.8

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	2.9	1.200	4.1	3.000	6.2	7.000	9.3
0.200	3.9	1.400	4.4	3.500	6.7	7.500	9.6
0.300	4.2	1.600	4.6	4.000	7.1	8.000	9.9
0.400	4.3	1.800	4.9	4.500	7.5	8.500	10.2
0.500	4.2	2.000	5.1	5.000	7.9	9.000	10.5
0.600	4.1	2.200	5.4	5.500	8.3	9.500	10.7
0.800	3.6	2.400	5.6	6.000	8.6		
1.000	3.7	2.600	5.8	6.500	9.0		

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File STORAGE P.SRCX

Basin P

1 in 30 yr + 30% CC

70% Hardstanding

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Summary of Results for 30 year Return Period (+30%)							
Half Drain Time : 749 minutes.							
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	18.947	0.447	0.0	4.1	4.1	90.0	O K
30 min Summer	19.073	0.573	0.0	4.1	4.1	125.4	O K
60 min Summer	19.199	0.699	0.0	4.1	4.1	165.5	O K
120 min Summer	19.317	0.817	0.0	4.1	4.1	207.7	O K
180 min Summer	19.380	0.880	0.0	4.1	4.1	232.1	O K
240 min Summer	19.420	0.920	0.0	4.1	4.1	248.4	O K
360 min Summer	19.467	0.967	0.0	4.1	4.1	268.4	O K
480 min Summer	19.492	0.992	0.0	4.1	4.1	279.0	O K
600 min Summer	19.504	1.004	0.0	4.1	4.1	284.2	O K
720 min Summer	19.510	1.010	0.0	4.1	4.1	287.2	O K
960 min Summer	19.517	1.017	0.0	4.1	4.1	290.3	O K
1440 min Summer	19.519	1.019	0.0	4.1	4.1	290.9	O K
2160 min Summer	19.507	1.007	0.0	4.1	4.1	285.7	O K
2880 min Summer	19.486	0.986	0.0	4.1	4.1	276.4	O K
4320 min Summer	19.429	0.929	0.0	4.1	4.1	252.1	O K
5760 min Summer	19.361	0.861	0.0	4.1	4.1	224.6	O K
7200 min Summer	19.282	0.782	0.0	4.1	4.1	194.8	O K
8640 min Summer	19.172	0.672	0.0	4.1	4.1	156.6	O K
10080 min Summer	19.074	0.574	0.0	4.1	4.1	125.5	O K
15 min Winter	18.989	0.489	0.0	4.1	4.1	101.3	O K
Storm Event	Rain (mm/hr)		Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)		
15 min Summer	57.549		0.0	93.8	26		
30 min Summer	40.351		0.0	131.7	40		
60 min Summer	27.116		0.0	177.7	70		
120 min Summer	17.601		0.0	230.7	128		
180 min Summer	13.575		0.0	266.9	186		
240 min Summer	11.262		0.0	295.2	246		
360 min Summer	8.635		0.0	339.5	364		
480 min Summer	7.143		0.0	374.5	482		
600 min Summer	6.162		0.0	403.8	586		
720 min Summer	5.460		0.0	429.2	638		
960 min Summer	4.509		0.0	472.5	768		
1440 min Summer	3.441		0.0	539.8	1038		
2160 min Summer	2.625		0.0	619.9	1456		
2880 min Summer	2.166		0.0	681.9	1880		
4320 min Summer	1.650		0.0	778.9	2724		
5760 min Summer	1.359		0.0	856.1	3520		
7200 min Summer	1.169		0.0	920.5	4328		
8640 min Summer	1.034		0.0	976.5	5024		
10080 min Summer	0.931		0.0	1026.3	5656		
15 min Winter	57.549		0.0	105.1	26		

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. . .	Basin P 1 in 30 yr + 30% CC 70% Hardstanding																																											
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Innovyze	Source Control 2017.1.2	

Model Details

Storage is Online Cover Level (m) 20.000

Infiltration Basin Structure

Invert Level (m) 18.500 Safety Factor 2.0
 Infiltration Coefficient Base (m/hr) 0.00000 Porosity 1.00
 Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	147.4	1.200	518.2	1.500	637.2
0.600	307.5	1.201	518.3		

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0093-4100-1200-4100
Design Head (m)	1.200
Design Flow (l/s)	4.1
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	93
Invert Level (m)	18.500
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	4.1
Flush-Flo™	0.358	4.1
Kick-Flo®	0.743	3.3
Mean Flow over Head Range	-	3.6

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	3.0	1.200	4.1	3.000	6.3	7.000	9.4
0.200	3.9	1.400	4.4	3.500	6.8	7.500	9.7
0.300	4.1	1.600	4.7	4.000	7.2	8.000	10.0
0.400	4.1	1.800	4.9	4.500	7.6	8.500	10.3
0.500	4.0	2.000	5.2	5.000	8.0	9.000	10.6
0.600	3.9	2.200	5.4	5.500	8.4	9.500	10.8
0.800	3.4	2.400	5.7	6.000	8.7		
1.000	3.8	2.600	5.9	6.500	9.0		

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1 in 200 yr + 30% CC
70% Hardstanding



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	Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
	30 min Winter	19.342	0.842	0.0	4.1	4.1	217.3	O K
	60 min Winter	19.517	1.017	0.0	4.1	4.1	290.1	O K
	120 min Winter	19.671	1.171	0.0	4.1	4.1	363.6	O K
	180 min Winter	19.756	1.256	0.0	4.2	4.2	407.9	Flood Risk
	240 min Winter	19.811	1.311	0.0	4.3	4.3	438.5	Flood Risk
	360 min Winter	19.882	1.382	0.0	4.4	4.4	479.3	Flood Risk
	480 min Winter	19.924	1.424	0.0	4.4	4.4	504.5	Flood Risk
	600 min Winter	19.951	1.451	0.0	4.5	4.5	520.9	Flood Risk
	720 min Winter	19.968	1.468	0.0	4.5	4.5	531.4	Flood Risk
	960 min Winter	19.984	1.484	0.0	4.5	4.5	541.3	Flood Risk
	1440 min Winter	19.980	1.480	0.0	4.5	4.5	538.9	Flood Risk
	2160 min Winter	19.962	1.462	0.0	4.5	4.5	527.4	Flood Risk
	2880 min Winter	19.932	1.432	0.0	4.4	4.4	508.9	Flood Risk
	4320 min Winter	19.851	1.351	0.0	4.3	4.3	461.4	Flood Risk
	5760 min Winter	19.759	1.259	0.0	4.2	4.2	409.7	Flood Risk
	7200 min Winter	19.661	1.161	0.0	4.1	4.1	358.6	O K
	8640 min Winter	19.559	1.059	0.0	4.1	4.1	309.5	O K
	10080 min Winter	19.453	0.953	0.0	4.1	4.1	262.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
30 min Winter	61.039	0.0	223.0	40
60 min Winter	41.247	0.0	302.7	70
120 min Winter	26.488	0.0	388.8	126
180 min Winter	20.263	0.0	446.1	184
240 min Winter	16.694	0.0	490.0	242
360 min Winter	12.665	0.0	557.2	358
480 min Winter	10.391	0.0	608.8	474
600 min Winter	8.905	0.0	649.7	588
720 min Winter	7.847	0.0	671.1	700
960 min Winter	6.422	0.0	670.5	918
1440 min Winter	4.838	0.0	669.1	1184
2160 min Winter	3.645	0.0	964.0	1640
2880 min Winter	2.979	0.0	1050.4	2108
4320 min Winter	2.237	0.0	1179.6	3024
5760 min Winter	1.824	0.0	1286.9	3872
7200 min Winter	1.556	0.0	1372.1	4752
8640 min Winter	1.366	0.0	1445.4	5552
10080 min Winter	1.223	0.0	1510.2	6448

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Model Details

Storage is Online Cover Level (m) 20.000

Infiltration Basin Structure

Invert Level (m) 18.500 Safety Factor 2.0
 Infiltration Coefficient Base (m/hr) 0.00000 Porosity 1.00
 Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	147.4	1.200	518.2	1.500	637.2
0.600	307.5	1.201	518.3		

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0093-4100-1200-4100
Design Head (m)	1.200
Design Flow (l/s)	4.1
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	93
Invert Level (m)	18.500
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	4.1
Flush-Flo™	0.358	4.1
Kick-Flo®	0.743	3.3
Mean Flow over Head Range	-	3.6

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	3.0	1.200	4.1	3.000	6.3	7.000	9.4
0.200	3.9	1.400	4.4	3.500	6.8	7.500	9.7
0.300	4.1	1.600	4.7	4.000	7.2	8.000	10.0
0.400	4.1	1.800	4.9	4.500	7.6	8.500	10.3
0.500	4.0	2.000	5.2	5.000	8.0	9.000	10.6
0.600	3.9	2.200	5.4	5.500	8.4	9.500	10.8
0.800	3.4	2.400	5.7	6.000	8.7		
1.000	3.8	2.600	5.9	6.500	9.0		

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70% Hardstanding



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

Storm Event		Max	Max	Max	Max	Max	Max	Status
		Level (m)	Depth (m)	Infiltration (l/s)	Control (l/s)	Σ Outflow (l/s)	Volume (m³)	
30 min	Winter	19.080	0.580	0.0	8.1	8.1	278.4	O K
60 min	Winter	19.211	0.711	0.0	8.1	8.1	368.6	O K
120 min	Winter	19.341	0.841	0.0	8.1	8.1	464.7	O K
180 min	Winter	19.413	0.913	0.0	8.1	8.1	522.1	O K
240 min	Winter	19.461	0.961	0.0	8.1	8.1	561.4	O K
360 min	Winter	19.521	1.021	0.0	8.1	8.1	612.3	O K
480 min	Winter	19.555	1.055	0.0	8.1	8.1	642.1	O K
600 min	Winter	19.575	1.075	0.0	8.1	8.1	659.9	O K
720 min	Winter	19.586	1.086	0.0	8.1	8.1	669.9	O K
960 min	Winter	19.593	1.093	0.0	8.1	8.1	675.8	O K
1440 min	Winter	19.591	1.091	0.0	8.1	8.1	674.1	O K
2160 min	Winter	19.564	1.064	0.0	8.1	8.1	650.4	O K
2880 min	Winter	19.523	1.023	0.0	8.1	8.1	614.1	O K
4320 min	Winter	19.418	0.918	0.0	8.1	8.1	525.9	O K
5760 min	Winter	19.286	0.786	0.0	8.1	8.1	422.8	O K
7200 min	Winter	19.107	0.607	0.0	8.1	8.1	296.6	O K
8640 min	Winter	18.961	0.461	0.0	8.1	8.1	205.8	O K
10080 min	Winter	18.840	0.340	0.0	8.1	8.1	140.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
30 min Winter	40.351	0.0	288.7	40
60 min Winter	27.116	0.0	390.9	68
120 min Winter	17.601	0.0	507.7	126
180 min Winter	13.575	0.0	587.4	184
240 min Winter	11.262	0.0	649.7	242
360 min Winter	8.635	0.0	747.2	356
480 min Winter	7.143	0.0	824.0	470
600 min Winter	6.162	0.0	888.2	580
720 min Winter	5.460	0.0	944.0	688
960 min Winter	4.509	0.0	1038.2	884
1440 min Winter	3.441	0.0	1175.4	1112
2160 min Winter	2.625	0.0	1365.8	1584
2880 min Winter	2.166	0.0	1502.2	2048
4320 min Winter	1.650	0.0	1715.4	2944
5760 min Winter	1.359	0.0	1886.7	3816
7200 min Winter	1.169	0.0	2028.6	4472
8640 min Winter	1.034	0.0	2152.0	5104
10080 min Winter	0.931	0.0	2261.5	5664

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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)	13.700	Shortest Storm (mins)	15
Ratio R	0.250	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 1.722

Time (mins)	Area	Time (mins)	Area	Time (mins)	Area
From: To:	(ha)	From: To:	(ha)	From: To:	(ha)
0 4	0.574	4 8	0.574	8 12	0.574

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.	1 in 30yr + 30% CC	
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Model Details

Storage is Online Cover Level (m) 20.000

Infiltration Basin Structure

Invert Level (m) 18.500 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	327.3	1.200	956.8	1.500	1116.2
0.600	664.8	1.201	956.9		

Hydro-Brake® Optimum Outflow Control

Unit Reference MD-SHE-0129-8100-1200-8100
Design Head (m) 1.200
Design Flow (l/s) 8.1
Flush-Flo™ Calculated
Objective Minimise upstream storage
Application Surface
Sump Available Yes
Diameter (mm) 129
Invert Level (m) 18.500
Minimum Outlet Pipe Diameter (mm) 150
Suggested Manhole Diameter (mm) 1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	8.1
Flush-Flo™	0.353	8.1
Kick-Flo®	0.764	6.6
Mean Flow over Head Range	-	7.0

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	4.6	1.200	8.1	3.000	12.5	7.000	18.7
0.200	7.7	1.400	8.7	3.500	13.4	7.500	19.3
0.300	8.1	1.600	9.3	4.000	14.3	8.000	19.9
0.400	8.1	1.800	9.8	4.500	15.1	8.500	20.5
0.500	7.9	2.000	10.3	5.000	15.9	9.000	21.1
0.600	7.7	2.200	10.8	5.500	16.7	9.500	21.7
0.800	6.7	2.400	11.2	6.000	17.4		
1.000	7.4	2.600	11.7	6.500	18.0		

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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)	13.700	Shortest Storm (mins)	15
Ratio R	0.250	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 1.722

Time (mins)	Area	Time (mins)	Area	Time (mins)	Area
From: To:	(ha)	From: To:	(ha)	From: To:	(ha)
0 4	0.574	4 8	0.574	8 12	0.574

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Model Details

Storage is Online Cover Level (m) 20.000

Infiltration Basin Structure

Invert Level (m) 18.500 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	327.3	1.200	956.8	1.500	1116.2
0.600	664.8	1.201	956.9		

Hydro-Brake® Optimum Outflow Control

Unit Reference MD-SHE-0129-8100-1200-8100
Design Head (m) 1.200
Design Flow (l/s) 8.1
Flush-Flo™ Calculated
Objective Minimise upstream storage
Application Surface
Sump Available Yes
Diameter (mm) 129
Invert Level (m) 18.500
Minimum Outlet Pipe Diameter (mm) 150
Suggested Manhole Diameter (mm) 1200

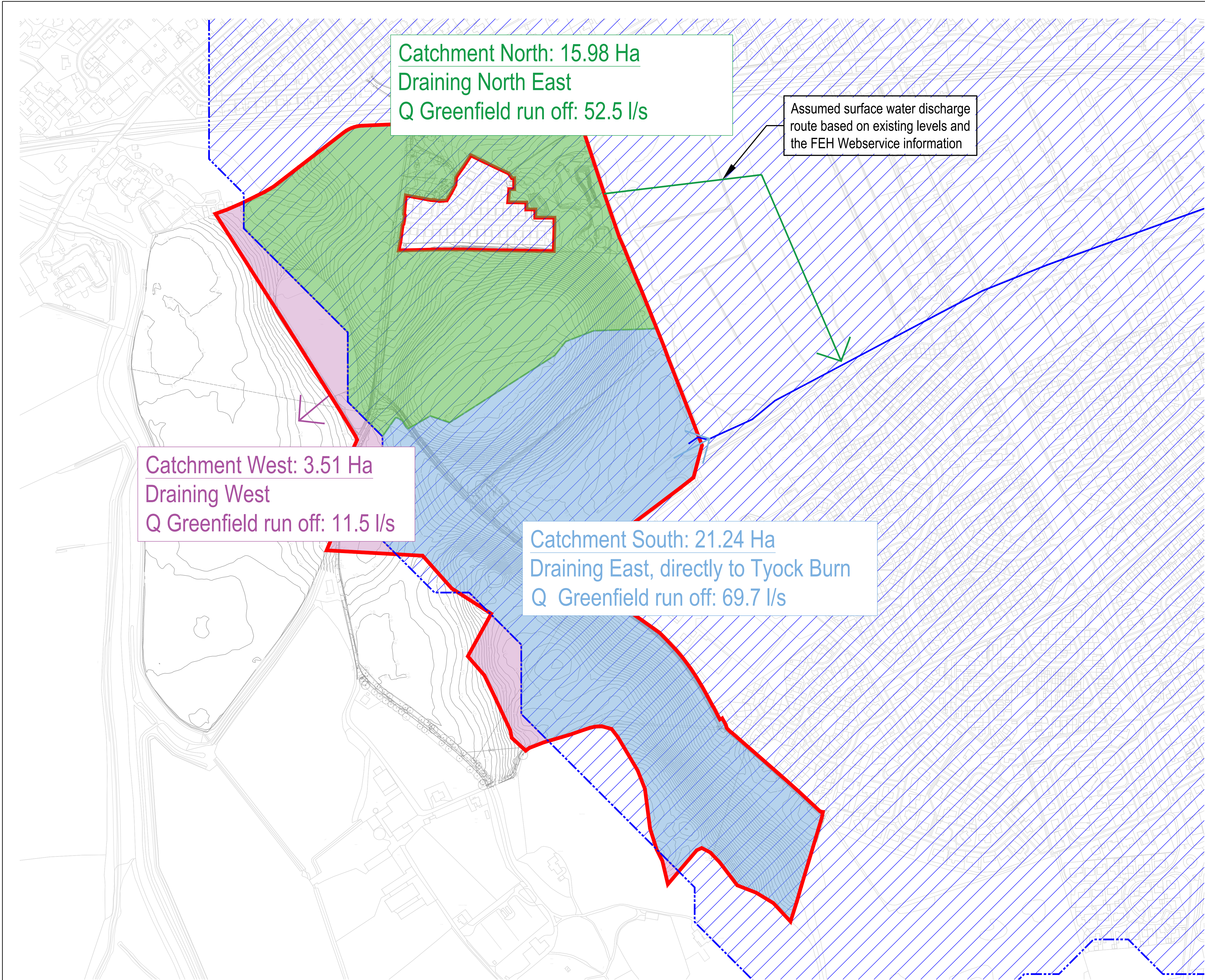
Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	8.1
Flush-Flo™	0.353	8.1
Kick-Flo®	0.764	6.6
Mean Flow over Head Range	-	7.0

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	4.6	1.200	8.1	3.000	12.5	7.000	18.7
0.200	7.7	1.400	8.7	3.500	13.4	7.500	19.3
0.300	8.1	1.600	9.3	4.000	14.3	8.000	19.9
0.400	8.1	1.800	9.8	4.500	15.1	8.500	20.5
0.500	7.9	2.000	10.3	5.000	15.9	9.000	21.1
0.600	7.7	2.200	10.8	5.500	16.7	9.500	21.7
0.800	6.7	2.400	11.2	6.000	17.4		
1.000	7.4	2.600	11.7	6.500	18.0		

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Appendix F – Drainage Strategy. Pre Development Scenario



Catchment North: 15.98 Ha
Draining North East
Q Greenfield run off: 52.5 l/s

Assumed surface water discharge
route based on existing levels and
the FEH Webservice information

Catchment West: 3.51 Ha
Draining West
Q Greenfield run off: 11.5 l/s

Catchment South: 21.24 Ha
Draining East, directly to Tyock Burn
Q Greenfield run off: 69.7 l/s

GENERAL NOTES:

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS AND ENGINEERS DRAWINGS AND SPECIFICATIONS.
2. DO NOT SCALE THIS DRAWING. ANY AMBIGUITIES, OMISSIONS AND ERRORS ON DRAWINGS SHALL BE BROUGHT TO THE ENGINEERS ATTENTION IMMEDIATELY. ALL DIMENSIONS MUST BE CHECKED / VERIFIED ON SITE.
3. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.
4. FOR GENERAL NOTES REFER TO DRAWING.
5. FEH CATCHMENT BOUNDARY TAKEN FROM THE FLOOD ESTIMATION HANDBOOK WEB SERVICE.
6. CATCHMENT AREA 1 SURFACE WATER DISCHARGING ROUTE HAS BEEN ASSUMED BASED ON TOPOGRAPHICAL SURVEY LEVELS UNDERTAKEN BY PROPERTY AND LAND SURVEYS (HIGHLANDS) LTD IN CONJUNCTION WITH SCOTTISH WATER PLANS ALONG WITH A SITE WALKOVER.

KEY:

- Application Boundary
- FEH Tyock Burn Catchment Boundary
- Catchment North, discharging North East
- Catchment South, discharging East
- Catchment West, discharging West
- Tyock Burn

REV	ISSUED	00/00/00	XXX	XXX
Rev:	Description:	Date:	By:	Chkd:



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Status:

PRELIMINARY

Project:

Bilbohall, Masterplan

Dwg Title:

Drainage Strategy -
Pre Development
Scenario

Size:	Date:	Drawn By:	Designed By:	Checked By:		
A1	17/07/18	CVB	CVB	PP		
Scale: 1:2500						
Project No:	Originator:	Zone:	Level:	Type:	Discipline: Category / Number:	Rev:
063268	- CUR	- XX	- XX	- DR	- C - 92002	-P01

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Appendix G – Drainage Strategy. Post Development Scenario

Appendix H – Drainage Strategy. Infiltration Considerations

Appendix I – Summary of Planning Application Requirements

- 7.2.6 It is intended that the masterplan site be divided into development sites, which will be progressed individually.

Item	Description
Detailed drainage strategy	Future planning applications must include development site-specific drainage strategies. These will demonstrate how the proposed development will incorporate SUDS and restrict drainage discharge to the design limits. A drainage impact assessment (DIA) must be undertaken for each future planning application. The DIA should demonstrate, that the post-development runoff rate does not exceed the pre-development runoff rate or increase flood risk through discharge to a receiving watercourse. The DIA will also demonstrate how the proposed development will restrict drainage discharge to the design limits. The requirements for drainage should be taken into account when determining the overall layout of the development. The capacity of the drainage system including attenuation measures such as SuDS features should be designed to withstand a 1:30 year event (+30 CC), without surcharging. Exceedance events up to and including the 1 in 200 year (+30 CC) event should be contained and managed on site, such that they do not increase flood risk. Details of the method used to manage this flow should be provided in the DIA. This method should also be shown on the general arrangement drawing. A schedule detailing inspection and maintenance arrangements for the entire drainage system should be submitted at the same time as the design. The body responsible for overall management of the SuDS system should be identified in the DIA and a letter of agreement with the responsible body should be included. If the overall management of the system is to be undertaken by a property manager employed jointly by the property owners, this arrangement should be made clear in the title deeds.
Flood Risk Assessment	A Flood Risk Assessment (FRA) shall be provided for each future planning application detailing the proposed development, flood risk, results of hydrological and hydraulic studies and proposed mitigation. The FRA should demonstrate that the development is not at risk of flooding during a 1:200 year flood event (+ 30 CC). A key requirement of the FRA is that it must consider all sources of flooding and demonstrate

	how mitigation methods will be managed. The FRA will be required to demonstrate that any flood risk associated with the development can be managed now and for the lifetime of the development, taking into account the potential effects of climate change (30%). It should also demonstrate that the development will not increase the risk of flooding elsewhere.
Groundwater abstraction locations	Searches should be carried out to identify local groundwater abstraction points.
Groundwater monitoring	Existing site investigation data indicates high groundwater levels around the Burn of Tyock and its associated land drains, to the east of the masterplan area. Groundwater levels to the north appear much lower. Future planning applications to provide groundwater monitoring results to confirm seasonal groundwater levels within their boundaries via on-site monitoring in wells. Confirm that the maximum likely groundwater levels are >1 m below the base of the proposed infiltration device.
Soakaway testing	Future planning applications to provide Soakaway testing results to BRE 365 standards, to determine the potential for surface water infiltration systems at each sites. Provide infiltration test results, along with trial pit records with soil/rock descriptions of the materials in which the test has been completed in accordance with BS EN ISO 14688-1:2002+A1:2013 or BS EN ISO 14689-1:2003. Confirm that the infiltration tests have been undertaken at the location, depth and with a head of water that replicates the proposed design.

Our Locations

Birmingham

2 The Wharf
Bridge Street
Birmingham
B1 2JS
T. 0121 643 4694
birmingham@curtins.com

Bristol

Quayside
40-58 Hotwell Road
Bristol
BS8 4UQ
T. 0117 302 7560
bristol@curtins.com

Cambridge

50 Cambridge Place
Cambridge
CB2 1NS
T. 01223 631 799
cambridge@curtins.com

Cardiff

3 Cwrt-y-Parc
Earlswood Road
Cardiff
CF14 5GH
T. 029 2068 0900
cardiff@curtins.com

Douglas

Varley House
29-31 Duke Street
Douglas
Isle of Man
IM1 2AZ
T. 01624 624 585
douglas@curtins.com

Dublin

39 Fitzwilliam Square
Dublin 2
Ireland
T. 00353 1 507 9447
dublin@curtins.com

Edinburgh

1a Belford Road
Edinburgh
EH4 3BL
T. 0131 225 2175
edinburgh@curtins.com

Glasgow

Queens House
29 St Vincent Place
Glasgow
G1 2DT
T. 0141 319 8777
glasgow@curtins.com

Kendal

28 Lowther Street
Kendal
Cumbria
LA9 4DH
T. 01539 724 823
kendal@curtins.com

Leeds

Rose Wharf
Ground Floor
Leeds
L29 8EE
T. 0113 274 8509
leeds@curtins.com

Liverpool

Curtin House
Columbus Quay
Riverside Drive
Liverpool
L3 4DB
T. 0151 726 2000
liverpool@curtins.com

London

40 Compton Street
London
EC1V 0BD
T. 020 7324 2240
london@curtins.com

Manchester

Merchant Exchange
17-19 Whitworth Street West
Manchester
M1 5WG
T. 0161 236 2394
manchester@curtins.com

Nottingham

56 The Ropewalk
Nottingham
NG1 5DW
T. 0115 941 5551
nottingham@curtins.com