Clifton Scannell Emerson Associates

Barnhill SHD
SuDS Strategy Report

Client: Alanna Homes and Alcove Ireland Four Limited

Date: 1st July 2022

Job Number: 16_053

Civil Engineering | Structural Engineering | Transport Engineering | Environmental Engineering | Project Management | Health and Safety

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1 Introduction

New development has the potential to exacerbate flood risk by increasing hardstanding areas and consequently increasing surface water runoff. Sustainable Urban Drainage Systems (SuDS) offer a comprehensive approach to the management of rainwater on a site, to delay and reduce runoff through infiltration, transpiration, evapotranspiration, and re-use whilst also providing improvements to water quality, amenity, and biodiversity.

It is an objective of Fingal County Council to incorporate SuDS in all new developments throughout the Fingal County Council area.

The Barnhill Strategic Housing Development (SHD) is a proposed residential development located approximately 3km west of Blanchardstown. The development is a joint venture between developers Alanna Homes and Alcove Ireland Four Limited. The SHD lands are situated directly south of the Dunboyne to Clonsilla Rail line and Hansfield Train Station, west of the Royal Canal and the Dublin to Maynooth Railway Line and east of the existing R149 Leixlip to Clonee Regional Road. It is the vision of the property developers and Fingal County Council to create a place to live that is appealing, distinctive and sustainable. The number of residential units supported on the SHD lands will be 1,243 units. The proposed development shall also include provision for commercial units and a crèche facility. Lands are also to be set aside for a future primary school within the Village Centre Character Area of the development. A detailed description of the proposed Barnhill SHD is included within Chapter 2 of the EIAR.

The future Ongar to Barnhill Distributor Road, to be delivered by Fingal County Council that shall be constructed prior to the Barnhill SHD and shall provide the main accesses to the development site (see section 2.2 of this report for further information).

Clifton Scannell Emerson Associates (CSEA) have been appointed by the Clients, Alanna Homes and Alcove Ireland Four Limited, to carry out the design of the civil engineering elements for the future residential development, including the proposed surface water layout and SuDS strategy. The following report outlines the SuDS design approach that was devised for the future Barnhill SHD.

2 Site Description & Constraints on Proposed SuDS Design

2.1 Site Description

The proposed development shall be located in existing rural agricultural lands in the Barnhill area South of Ongar Village. The site largely consists of arable lands with existing farm buildings located within the northern part of the site. These farm buildings are accessed from the existing Barberstown Lane North Road. The lands fall gradually from the existing Dunboyne to Clonsilla Railway Line, located to the north of the site, towards the existing Barberstown Lane South Road, located to the south of the site. Based on existing topographical surveys of the site, the ground levels vary between 61.5m AOD in the north-west of the site to 57.5m AOD in the south-east. The levels range from 61m AOD in the north-east of the site to 58.5m AOD in the south-west. The existing farm buildings / sheds and their associated yards are to be demolished / taken up as part of the proposed development.

An existing watercourse, the Barnhill Stream, enters the site from the west via an existing culvert under the existing R149 Regional Road. It then flows in an open channel in a south-easterly direction through the site before exiting the lands via a culvert / stream bridge under the existing Barberstown Lane South Road. The stream continues from here towards a long culvert that conveys the stream below the Royal Canal and the Dublin to Maynooth Railway Line. The Barnhill Stream continues from here through Luttrellstown Golf Course / Demesne and flows into the River Liffey. The section of stream open channel that passes through the lands is currently heavily overgrown.

2.2 Proposed Ongar to Barnhill Distributor Road

The future Ongar to Barnhill Distributor Road is to be constructed to provide access to the Barnhill SHD lands. The main section of this future road shall connect to the existing Ongar Distributor Road roundabout located to the north of the site. From here the proposed road shall run in a southerly direction
across the existing railway line, by means of a new railway overbridge, and connect to Barberstown Lane South and the existing R149 regional road by means of a newly constructed signalised junction.
This scheme will also include the full upgrade of the Barberstown Lane South Road, complete with two no. roundabout accesses that will provide future access to the proposed development lands.

The main road of the proposed Ongar to Barnhill Distributor Road shall run in a north-south direction through the western side of Barnhill SHD lands. The Barnhill SHD area to the west of the Distributor Road which will comprise an area of 3.3 hectares and the Barnhill SHD area to the east of the Distributor Road which will comprise an area of approximately 26.3 hectares.

The proposed Ongar to Barnhill Distributor Road shall fully accommodate for its surface water runoff by means of constructed detention basins that have been appropriately sized as part of the road design. The size of some of the detention basins associated with this road have been increased in order to allow surface water from this area of the development to be accounted for and adequately stored.

2.3 Site Investigation Findings

On the instruction of Clifton Scannell Emerson Associates (CSEA), Site Investigations Limited (SIL) were appointed to complete soakaway tests at numerous locations within the Barnhill SHD site. The soakaway tests were completed during July 2018 to ascertain the rate of infiltration of the soils within the site. From analysis of the soakaway test results it was found that the area is largely unsuitable for soakaway design with eight of the ten tests failing to meet the requirements of the BRE Special Digest 365. The BRE Digest stipulates that the pit should empty within 24 hours. The test analysis indicated that this condition could not be satisfied for most of all tests carried out. SIL also stated that the unsuitability of the site for soakaways was further suggested by the descriptions of the soils encountered at the locations where the soakaway tests were carried out, i.e., clay & silt soils.

2.4 Strategic Flood Risk Assessment

The Barnhill SHD lands were assessed for risk of flooding in accordance with the Planning System and Flood Risk management Guidelines for Planning Authorities 2009 issued by the Department of the Environment, Heritage, and Local Government (DoEHLG) and as updated by the Department Circular PL 02/2014. A Flood Risk Assessment was carried out for the Barnhill SHD site by Garland Consultancy on behalf of Fingal County Council.

Flooding within the area is associated with both Pluvial and Fluvial occurrences. The existing Barnhill Stream that passes through the lands was surveyed as part of the Liffey River catchment and for the Local Area Plan. Flood risk maps for stream were subsequently generated for the 1% (1 in 100 year) and 0.1% (1 in 1000 year) probabilities of flooding. These generated maps also included an allowance for climate change. The flood risk assessment analysis also took into consideration the future Ongar to Barnhill Distributor Road (see section 2.2) to determine its effect on the existing flood plain.

The flood modelling showed that there are large areas of low-lying lands located to the north and south of the existing stream that are liable to flooding. It was determined that this flooding is largely caused by the existing capacity of the culvert that conveys the stream under the Royal Canal and the Dublin to Maynooth Railway line, located to the south of the lands. It was discovered that this culvert caused the stream to back up during both the 1% and 0.1 % rainfall events. This, in turn, inundated the low-lying areas on both banks of the stream with flood waters.

Figure 1, shown below, displays mapping of the 1% (1 in 100 year) probability of flooding including allowances for climate change and the future Ongar to Barnhill Distributor Road.

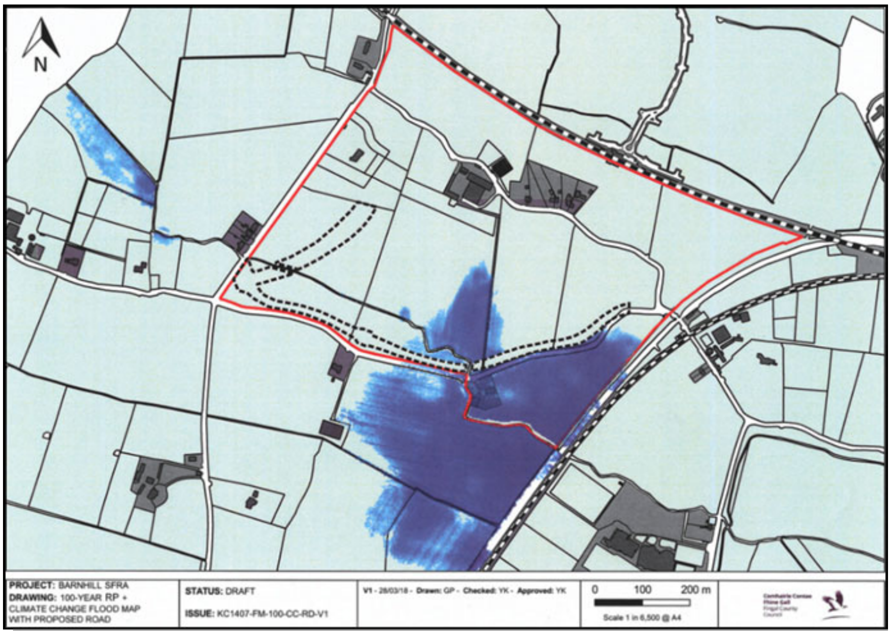

Figure 1: *1% (1 in 100 year) probability of flooding including climate change & future road allowances*

The highest predicted flood depths in the 1% (1 in 100 year) probability of flooding event including the allowances for climate change and the future Ongar to Barnhill Distributor Road are between 0.9 and 1.0 metres.

Figure 2, shown below, displays mapping of the 0.1% (1 in 1000 year) probability of flooding including allowances for climate change and the future Ongar to Barnhill Distributor Road.

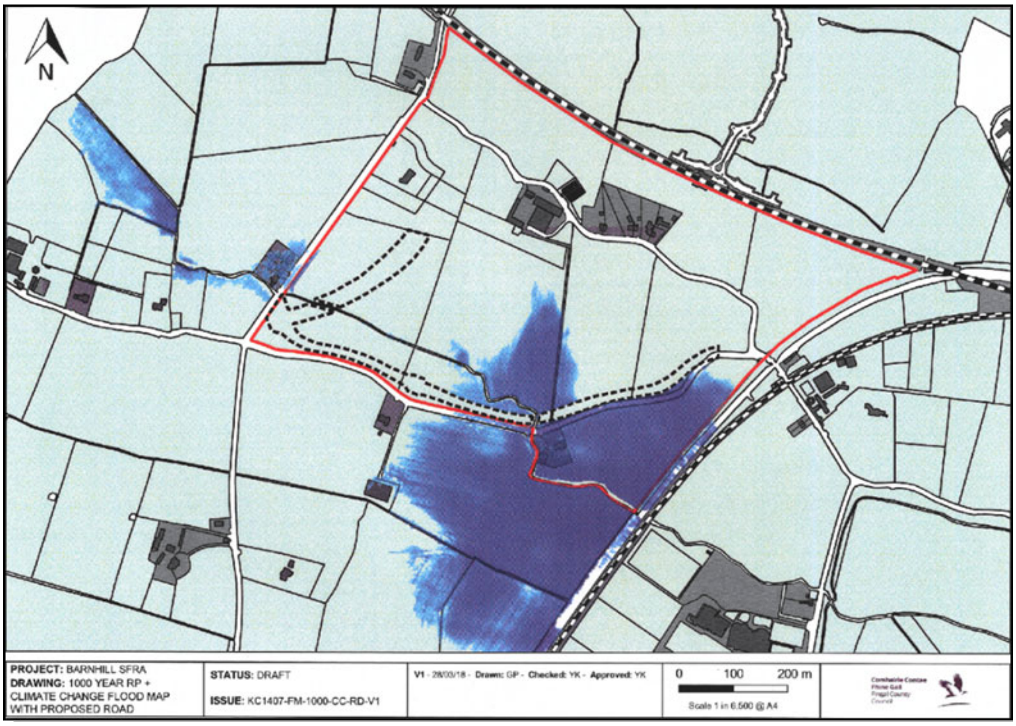

Figure 2: *0.1% (1 in 1000 year) probability of flooding Including climate change & future road allowances*

The highest predicted flood depths in the 0.1% (1 in 1000 year) probability of flooding event are between 1.1 and 1.3 metres including the allowances for climate change and the future Ongar to Barnhill Distributor Road.

2.4.1 Additional Strategic Flood Risk Assessment

An additional Flood Risk Assessment Report was carried out for the Barnhill SHD site by McCloys Consulting on behalf of the Clients, Alanna Homes and Alcove Ireland Four Limited.

"Flood Risk Assessment – Barnhill, Dublin 15" report (June 2022), prepared by McCloys Consulting, accompanies the Barnhill SHD Planning Application.

2.5 SuDS Constraints

The Flood Risk Assessment carried out by Garland Consultancy determined that flooding within the area is associated with both Pluvial and Fluvial occurrences. Pluvial flooding occurs when the infiltration capacity of the soil and existing drainage infrastructure of the area has been exceeded during periods of intense rainfall. The results of the site investigation (see section 2.3) carried out by Site Investigation Limited (SIL) would also prove this to be the case. This increases the amount of Sustainable Urban Drainage Systems (SuDS) storage capacity area required in the surface water network proposed as very little surface water runoff will dissipate as a result of soil infiltration / percolation.

The existing flooding that is experienced within the proposed parkland area provides an additional constraint in relation to SuDS as it is necessary to locate SuDS measures outside the predicted flood plain so that they may operate more efficiently during extreme storm events.

3 Proposed Barnhill Strategic Housing Development (SHD) SuDS Strategy

Sustainable Urban Drainage Systems (SUDS) objectives have been set out as part of the **Fingal Development Plan 2017-2023**. Fingal County Council stated that SuDS are to be implemented on all new developments throughout the County and to encourage where feasible the retrofit of sustainable drainage systems within existing developments.

The Greater Dublin Strategic Drainage Study (GDSDS) is the key guideline document used for the purpose of design of surface water drainage systems. GDSDS presents a regional strategic approach to sustainable drainage in consistency with the EU Water Framework Directive (WFD). It establishes key policies and standards which should be applied throughout the Dublin Region. The implementation of GDSDS guidelines in the context the Barnhill SHD will aim to prevent the adverse impacts of discharging the resulting development runoff, which includes discharging pollutants, into existing watercourses. The other objective of working in accordance with the GDSDS guidelines is to decrease the risk of flooding of the proposed development within the project's footprint.

Clifton Scannell Emerson Associates (CSEA) have been appointed by the developers, Alanna Homes and Alcove Ireland Four Limited, to carry out the Planning Stage design of the civil engineering elements for the future residential development, including the proposed surface water layout and Sustainable Urban Drainage Systems (SuDS) strategy.

In an effort to find an appropriate SuDS solution for the proposed development, the proposed SuDS strategy and the various site constraints have been the subject of numerous design team meetings and discussions with Fingal County Council (FCC).

CSEA, assisted by landscape architects, Gannon and Associates, have devised a SuDS strategy for the proposed development. Numerous design team meetings have helped inform the SuDS proposal outlined within this report. Due consideration of the SuDS constraints experienced at the subject site has also been necessary. The Barnhill Stormwater Management Plan prepared by Garland Consultancy, on behalf of FCC, has also been used as an important tool in the preparation of the SuDS strategy for the Barnhill SHD.

FCC have stipulated that no part of the development is to infringe any of the flood areas shown in Section 2.4 of this report, unless there are agreements made with FCC to do so. Proposed SuDS measures, excluding the pond / wetland area, have also been located outside of these flood areas.

It has been proposed by CSEA to create a SuDS train with differing SuDS methodologies used across the site. The following sections of this report outlines the SuDS strategy that is proposed.

Drawing 16_053_046 - Proposed Surface Water Network Layout and Main SuDS Storage Systems, accompanies the Barnhill SHD Planning Application.

Drawing 16_053_047 - Section A-A - SuDS Infiltration Basin and Outfall Details to Wetland Pond, accompanies the Barnhill SHD Planning Application. The location of Section A-A is indicated on Drawing 19_053_046 which accompanies the Barnhill SHD Planning Application.

3.1 SuDS Approach and Source Controls at Proposed Apartment Blocks

3.1.1 Rain Gardens

Rain Gardens are small, planted areas with stormwater controls that collect and treat stormwater runoff. Shallow landscaped basins make use of soils and vegetation in order to remove pollutants. This treated runoff shall be collected in these basins and form part of a wider SuDS approach for the areas at the Proposed Apartment blocks within the development.

Image 1, shown below, gives an example of a rain garden similar to that proposed as a SuDS measure at the apartment blocks within the Barnhill SHD site. Refer to Gannon and Associates Landscape Architects drawing 21154_LP-G_SuDS_01 for Rain Garden Locations. Refer to Gannon and Associates Landscape Architects drawing 21154_LP-G_SuDS_02 for Rain Garden Typical Construction Details.

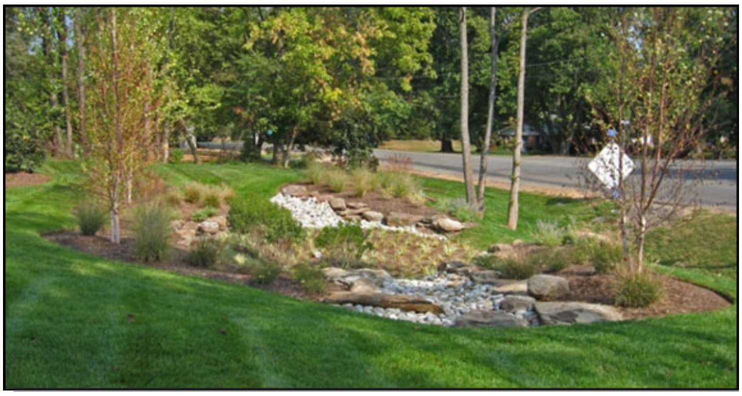

Image 1: *Rain Garden similar to that proposed as SuDS measure at Barnhill SHD apartment blocks*

3.1.2 Green / Sedum Roofs

Green and Sedum roofs involve covering a roof of a building with vegetation laid over a drainage layer and a waterproofing membrane. They are designed to intercept and store rainwater and therefore reduce surface water runoff. They are suited to the flat type of roof being proposed for the proposed apartment buildings of the Barnhill SHD. Green / Sedum roofs have ecological and aesthetic benefits and remove pollutants from rainwater. Disadvantages are that they are more expensive than conventional roof drainage systems and require maintenance of the roof vegetation.

See Image 2 below for a Sedum Roof similar to that proposed as a SuDS measure at the apartment blocks within the Barnhill SHD site. Refer to Gannon and Associates Landscape Architects drawing 21154_LP-G_SuDS_01 for Green Roof Locations. Refer to Gannon and Associates Landscape Architects drawing 21154_LP-G_SuDS_02 for Green Roof Typical Construction Details.

Image 2: *Sedum Roof similar to that proposed for the Barnhill SHD apartment blocks*

3.1.3 Underground Stormwater Arched Chamber Systems

Comprising of arched or boxed chambers laid in parallel, subsurface stormwater chambers, such as those produces by Triton^{TM} and Stormtech^{TM}, offer a cost-effective method to temporarily store stormwater for a period of time until the storm passes. The water is released into the surface water pipe network at a controlled rate using flow controls such as a hydrobrake manhole. They are simple and cost effective to construct and allow for the space above the tanks to be used for other purposes, i.e. parkland, play areas etc. Although they have no water quality benefits, they will be linked with other SuDS measures throughout the Barnhill site that will treat the water discharged from the underground stormwater chamber systems upon it is release. Untreated surface water runoff within the Barnhill Development shall not be directly discharged into any existing watercourse. Due to the poor infiltration and percolation characteristics of the soils present in the Barnhill SHD site, this type of underground storage system can be viewed as being a better SuDS option than others that rely on soil infiltration as it has a greater capacity and the space above the tanks may be used for other uses in the development site. This type of rainwater storage system allows suspended solids to be removed by means of an accessible isolator row chamber that can be de-sludged and easily maintained. It is proposed to install the underground stormwater arched chamber systems, where feasible, within the apartment block courtyard areas or in areas of green open space adjacent to the apartment block units.

Image 3, shown below, shows the installation of an Underground Stormwater Stormtech ^{TM} *Arched Chamber System.*

Image 3: *Installation of underground stormwater Stormtech^{TM} arched chamber system*

3.1.4 Raised Planters

It is proposed, as part of the landscaping of the development, to install raised planters within the courtyard areas at the proposed apartment block units within the Barnhill SHD as an additional SuDS source control. This allows a small volume of water to be stored within the planter and integrated within the proposed surface water network of the development. The planter will have an overflow outlet pipe in times of storm events. The raised planters are to be installed as a SuDS measure that will have ecological and aesthetic benefits.

3.2 SuDS Approach and Source Controls at Proposed Housing and Duplex Units

3.2.1 Rainwater Butts

Rainwater Butts are small, offline storage barrels designed to collect runoff from the roofs of units. They typically have a storage capacity of approximately 0.5m^3, are cheap and easy to install at all types of development. They are a good means of providing water for use in gardens & other non-potable means.

Image 4 gives an example of a rainwater butt similar to that proposed as a source control at the housing and duplex units within the Barnhill SHD site.

Image 4: *Rainwater Butt like that proposed within the Barnhill SHD*

3.2.2 Tree Pits

Tree pit systems are porous surfacing systems which are laid around the base of trees that are designed to take surface water runoff from adjacent impermeable areas within an urban environment. Using tree pits as a SuDS measure also allows water air and nutrients to reach the tree roots thus encouraging the trees' growth. Tree pits also have ecological and aesthetic benefits.

Refer to Gannon and Associates Landscape Architects drawing 21154_LP-G_SuDS_02 for Tree Pit Typical Construction Details.

3.2.3 Permeable Block Paving

Permeable block paving is to be used within the carparking areas of the housing units in order to reduce surface water runoff from hardstanding areas within the Barnhill SHD. This permeable block paving allows the rainwater to infiltrate through the surface and into the underlying layers where it is collected and conveyed to the proposed sealed drainage network. Permeable paving reduces peak surface water flow, is effective in removing urban pollutants, has low maintenance costs and requires no additional land space. However, if not properly maintained there is a risk that clogging and weed growth between the permeable paving blocks may occur. The permeable block paving runoff will discharge to a SuDS sealed system with perforated pipe (which can be potentially shared with the Street Tree Pit Arrangement as described in section 3.2.2 above) before discharging to the main surface water network for the proposed development.

Image 5, shown below, displays how the use of permeable block paving in driveways / carparking areas may be used as a SuDS approach within the areas of housing units of the Barnhill SHD.

Image 5: *Permeable block paving arrangement similar to that proposed for the housing units within the Barnhill SHD*

Refer to Gannon and Associates Landscape Architects drawing 21154_LP-G_SuDS_02 for Permeable Paving Typical Construction Details.

3.3 SuDS approach and Controls for Village Centre and Overall General Site

The surface water runoff collected from the SuDS approaches at the apartment block and the housing unit areas of the development shall be conveyed to larger proposed site controls by means of a closed surface water pipe network. These larger site controls shall provide greater storage for the overall site runoff during storm events before it is discharged to the existing Barnhill Stream at the south of the development at a controlled rate. This overall site storage volume will also allow for climate change.

This chapter of the report outlines the various SuDS approaches that are proposed to be adopted for the non-residential areas of the development as well as communal areas such as the proposed village centre, proposed train station plaza, parkland areas, future school, public carparks and the pedestrian and cycle green routes traversing the site.

3.3.1 Existing Ditches, Trees and Hedgerows Within Site

Where possible, existing ditches, trees and hedgerows are to be maintained throughout the site. Incorporating these existing drainage features into the proposed overall SuDS strategy would provide for greater storage volume capacity within the site and will assist in the conveyance and treatment of the generated surface water runoff. The retention of existing trees and hedgerows will also assist in the reduction of surface water runoff by evapotranspiration.

The existing ditches that are to be retained, particularly along the existing Barberstown Lane North Road which is to be largely retained as a green route, shall be cleaned out and assessed during the construction of the development. Retained ditches that are regarded as being too deep, and thus may present a risk of falling from height, will be reprofiled to reduce their depth. This shall mitigate against risk of injury to pedestrians and cyclists should they fall into them. All ditches and existing drainage features being retained shall be incorporated into the proposed overall surface water network for the overall site.

Image 6, shown below, shows an existing drainage ditch along one side of the existing Barberstown Lane North Road. This is an example of a ditch that may be changed to a swale type arrangement.

Image 6: *Existing drainage ditch along Barberstown Lane North, large sections of which are to be retained*

3.3.2 Infiltration Trenches

Where possible, Infiltration trenches shall be used to drain larger areas, such as the play areas within the open space area, within the proposed development site. Infiltration trenches are long narrow soakaways filled with a void forming material, typically stone. This allows water to be collected by the infiltration trench and exfiltrated into the surrounding soils from the bottom and sides of the trench. The top layer of the infiltration trenches may be stoned, similar to that shown in Image 6 below, or they may have a topsoil layer laid above the void forming stone of the infiltration trench. For large developments, similar to the Barnhill SHD, infiltration trenches can be constructed with incorporated geo-cellular units which would allow for increased storage capacity. The proposed infiltration trenches will discharge to the sealed surface water network system by means of a perforated pipe. Also, it is proposed that the rain gardens within the development will discharge to an infiltration trench which, in turn will, be connected to the sealed surface water pipe network by this means.

A typical Infiltration Trench is displayed in Image 7, shown below.

Image 7: *Typical Infiltration Trench similar to that proposed for the housing units within the Barnhill SHD*

3.3.3 Proposed Carpark at Public Open Space

It is proposed that a public carpark be provided adjacent to the primary access route to the east of the site. This carpark will cater for members of the public visiting the public open space, crèche, and future primary school. The area of this carpark will be in the region of 1800m^2.

Due to its large size, it is proposed that this carpark area be constructed using a porous surface solution, i.e., permeable asphalt, that would cater for the surface water runoff for the area. This permeable asphalt car park surfacing will allow the rainwater to infiltrate through the surface and into the underlying layers where it will be collected by means of perforated pipes and conveyed to the proposed main surface water drainage pipe network. This SuDS approach reduces peak surface water flow, is effective in removing urban pollutants, has low maintenance costs and requires no additional land space.

Image 8, shown below, shows a carpark constructed using permeable asphalt that may be used as a SuDS solution for the proposed carpark located near the Public Open Space within the Barnhill SHD.

Image 8: *Porous Asphalt Car Park as a SuDS solution*

3.3.4 Proposed Plaza Approaching Existing Hansfield Train Station

It is proposed to incorporate the surface water runoff for the northern section of the plaza near Hansfield Train Station into the proposed SuDS arrangement of the Railway Quarter Character Area apartment blocks (located north of the existing properties not included in the Barnhill SHD).

Surface SuDS features, in the form of a number of Rain Gardens and Permeable Green Areas have been proposed by Gannon and Associates Landscape Architects to collect, and treat, the surface water runoff at the Plaza. The Plaza area Surface SuDS features shall be connected with the overall surface water network for the site.

3.3.5 Pond / Wetland Area

It is proposed to provide a constructed pond / wetland area within the floodplain area of the Barnhill SHD public parkland (see section 2.4). This will form part of the overall SuDS network for the development and will be a regional site control to provide water quality and ecological benefits for the overall site catchment.

Ponds / wetlands are open basins which have a permanent depth of water and are generally recommended at the end of the SuDS Management Train. Runoff that enters the pond / wetland from the proposed surface water network shall be detained and treated by settlement and biological uptake. The Pond / Wetland shall be designed to have a constant turbulent flow passing through it and a constant adequate depth to prevent stagnation of the water. The primary objective of the pond / wetland proposed in the floodplain of the Barnhill SHD public parkland shall be to provide treatment of the collected surface water runoff. Once treated, the surface water passing through the pond shall be discharged, by means of an open channel, to the existing Barnhill Stream at a controlled flow rate. The pond / wetland area will also increase the aesthetics of the parkland area and provide amenity to the residents of the development. The pond / wetland area will also benefit from the variation in the types of planting that is proposed at its location.

The pond / wetland area within the floodplain shall be tiered / contoured with the intention of eliminating sheer drop-offs in depths within the pond that may pose a risk to public safety and is proposed to be planted in a manner that will discourage direct access to the pond and allow someone that falls in exit the pond with greater ease.

An example of a Pond / Wetland similar to that proposed within the floodplain of the Barnhill SHD public parkland is shown in Image 9 below.

Image 9: *Pond / Wetland SuDS solution similar to that proposed within the floodplain of the Barnhill SHD public parkland area.*

3.3.6 Proposed Infiltration Area Situated Under Proposed Playing Pitch

To cater for a more extreme flood event, it is proposed that the playing pitch to be constructed within the public parkland area be incorporated into the overall SuDS strategy for the site. This is due to the limited area within the Barnhill SHD lands that can accommodate the provision of a large detention / retention basin and the fact that as large amounts of the public parkland are taken up by the 0.1% floodplain (see section 2.4). As it is necessary to locate SuDS measures outside the predicted flood plain (so that they may operate efficiently during extreme storm events) it is also necessary to look at alternative solutions. It was concluded, during design team meetings, that the area of the playing pitch would be best suited to accommodate the more extreme rainfall events. The proposed infiltration area located under the proposed playing pitch will also serve the purpose of treating the surface water runoff for a very large area of the site.

It is proposed that the playing pitch be constructed on an underlying foundation layer of stone. This underlying stone shall be designed so that during storm events, surface water runoff for the overall development shall fill between the voids of the stone underlayer and be allowed pass through this stone medium below the pitch without creating damp areas on the pitch surface. This surface water runoff shall pass through the underlying material, be collected by perforated pipes, and then flow towards a hydrobrake manhole that will discharge the surface water runoff to the Barnhill Stream at a controlled rate of 40l/s. The stone layers beneath the proposed pitch will be wrapped in a needle punched filter geotextile to prevent over silting of the stone underlayer. The surface water inlets from the development will also have silt traps which will reduce the amount of silt infiltrating the pitch stone underlayer from the surface water network pipework.

Peak storm flows from the various catchment areas flowing into the proposed infiltration area situated under the playing pitch will be discharged to the existing stream at a rate of 2 l/s/Ha or Qbar, whichever is greater.

The use of the playing pitch as a SuDS measure within the proposed development can be seen as consistent with the land uses as defined by the Department of the Environment, Heritage and Local Government (DoEHLG) 2009 Guidelines for Planning Authorities document *"The Planning System and Flood Risk Management"*. The guidelines categorise amenity open space, outdoor sports and recreation and essential facilities such as changing rooms as "water-compatible development".

Drawing 16_053_046 - Proposed Surface Water Network Layout and Main SuDS Storage Systems, accompanies the Barnhill SHD Planning Application.

Drawing 16_053_047 - Section A-A - SuDS Infiltration Basin and Outfall Details to Wetland Pond, accompanies the Barnhill SHD Planning Application. The location of Section A-A is indicated on Drawing 19_053_046 which accompanies the Barnhill SHD Planning Application.

Refer to Appendix B for SuDS Calculations for Required Volume of Storage.

3.3.7 Proposals to Measure the Effectiveness of the SuDS and SuDS Maintenance during the Operational Stage of the Development

In order to measure the effectiveness of the SuDS measures proposed for the Barnhill SHD Fingal County Council (FCC) have requested that monitoring devices be installed at appropriate locations along the "SuDS train". This will allow for rates of flow to be measured and compared with previous measurements, thus giving an indication as to the overall effectiveness of the SuDS system within the site. The installation of a number of monitoring devices at focal locations along the SuDS network would allow for problem areas to be pinpointed with less difficulty and, as such, allow for greater ease of maintenance. The locations of the monitoring devices will be fully agreed with FCC prior to installation. Sampling by an appointed ecologist of the water discharging from the wetland pond to the existing stream will be undertaken and documented in a SuDS maintenance report that will be updated annually as per FCC requirements.

It is also proposed to install petrol interceptors and silt trap manholes at all of the discharge points to the detention basins and the infiltration area, beneath the proposed playing pitch, to filter out any remaining hydrocarbon pollutants and silt deposits from the proposed development site rainwater. During the operational stage of the development, it will be ensured that all surface SuDS features, petrol interceptors and silt trap manholes are regularly, maintained, cleaned of litter and debris, and that all inlets and outlets where water enters or leaves a SuDS feature are clear of obstructions. Maintenance of planting, such as grass cutting, within and adjacent to the SuDS features will be undertaken at regular intervals. The proposed SuDS features are to be regularly inspected for damage and remedial works carried out where necessary.

Maintenance of the Surface Water Network and SuDS features proposed as part of the scheme will be carried out in accordance with the Taking in Charge strategy for the development.

4 Conclusion

The development of the Sustainable Urban Drainage Strategy (SuDS) for the Barnhill Strategic Housing Development (SHD) has taken into consideration the views of all the various stakeholders associated with the project. One has also had to consider the numerous SuDS constraints that are present at the site of the proposed Barnhill SHD.

The measures for stormwater management outlined within this report have attempted to adhere to the recommendations of the Barnhill Local Area Plan Guidelines in relation to SuDS. This SuDS strategy has also attempted to follow, as closely as possible, the recommendations and conclusions of the Barnhill Strategic Flood Risk Assessment and the Barnhill Stormwater Management Plan carried out on behalf of Fingal County Council (FCC) by Garland Consultancy. The development of a SuDS management train has been the main objective when designing the stormwater management strategy for the development.

Source controls such as rainwater butts, rain gardens, green / sedum roofs, tree pits, permeable paving blocks / asphalt and infiltration trenches are proposed to collect and store surface water runoff at its source before discharging to the closed main surface water network traversing the site.

Site controls such as the retention of existing hedgerows, trees and ditches allows the site to naturally drain and will assist in conveying stormwater to the newly constructed surface water network elements. The provision of a pond / wetland in the floodplain area of the parkland will create an aesthetic and year-round amenity for the residents of the development to avail of. The proposed infiltration area situated under the proposed playing pitch is seen as a necessary component of the SuDS train as it will cater for the most extreme rainfall events. The design of the infiltration area beneath the proposed playing pitch will allow for the surface of the pitch to drain quickly once the storm event has passed and will allow treated water to be discharged to the existing stream at a controlled rate.

5 List of Appendices

Appendix A - Relevant Drawing References

Appendix B - SuDS Calculations for Required Volume of Storage

6 Appendix A – Relevant Drawing References

- 16_053_046 - Proposed Surface Water Network Layout and Main SuDS Storage Systems.
- 16_053_047 - Section A-A - SuDS Infiltration Basin and Outfall Details to Wetland Pond.

For additional information on the proposed SuDS Strategy for the Barnhill SHD, refer to Gannon and Associates Landscape Architects drawings 21154_LP-G_SuDS_01 and 21154_LP-G_SuDS_02, that accompanies the Barnhill SHD Planning Application.

7 Appendix B – SuDS Calculations for Required Volume of Storage

The impermeable area prior to attenuation has been calculated for each sub-catchment as being the total catchment area minus grassed areas within that catchment.
This Causeway Flow calculation gave a storage volume requirement of approximately 12900m³. This storage requirement is met by permeable paving of a total volume of 4566m³, underground geo-cellular systems, Stormtech (or equivalent), with a total volume of 1503m³, Proposed Playing Pitch with a total volume of 4800m³ and Detention basins with a volume of 1425m³.

7.1 Rainfall

The selection of rainfall frequency events (i.e., return period) often depends on the type of proposed drainage infrastructure. The development comprises various proposed drainage components including Rain Gardens, Green and Sedum roofs, Infiltration Trenches, Permeable Paving for Carpark, and an Attenuation system where required. The general rainfall characteristics for North Dublin Area are summarised in Table 5. below. Table 6 shows the design rainfall return period for each drainage infrastructure component.

Characteristic	Value
Mean Annual Rainfall SAAR mm	750
Ratio "r"	0.30
M5-60 mm	17.1
Soil SPR value % runoff	0.37 (SOIL TYPE 3)
Max. rainfall intensity depth for stormwater network design mm/hr	50

Table 1 Rainfall and Soil Characteristics (Adopted from GDSDS)

Drainage infrastructure	Rainfall Return period	Climate Change Allowance
Attenuation system	100 year	+20%

Table 2 Summary of design rainfall return period

7.2 Implementation of Sustainable Drainage Systems SuDS

7.2.1 Strategy

To comply with the guidelines outlined in Section 3 of this report, we propose to incorporate the following elements as part of the overall SuDS and surface water management strategy:

Source Control/Treatment:

- **Permeable Paving:**

  Permeable paving will be installed in the proposed parking area to promote infiltration to the underground storage void system. The outfall from underground storage will be controlled with flow controls in a manhole. It is proposed to connect surface water from roofs and gardens to this underground storage void system.

- **Rain Gardens**

  Rain Gardens are small, planted areas with stormwater controls that collect and treat stormwater runoff. Shallow landscaped basins make use of soils and vegetation in order to remove pollutants. This treated runoff shall be collected in these basins and form part of a wider SuDS approach for the areas at the Proposed Apartment blocks within the development.

- **Green / Sedum Roofs**

  Green and Sedum roofs involve covering a roof of a building with vegetation laid over a drainage layer and a waterproofing membrane. They are designed to intercept and store rainwater and therefore reduce surface water runoff. They are suited to the flat type of roof being proposed for the proposed apartment buildings of the Barnhill SHD. Green / Sedum roofs have ecological and aesthetic benefits and remove pollutants from rainwater. Disadvantages are that they are more expensive than conventional roof drainage systems and require maintenance of the roof vegetation.

- **Raised Planters**

  It is proposed, as part of the landscaping of the development, to install raised planters within the courtyard areas at the proposed apartment block units within the Barnhill SHD as an additional SuDS source control. This allows a small volume of water to be stored within the planter and integrated within the proposed surface water network of the development. The planter will have an overflow outlet pipe in times of storm events. The raised planters are to be installed as a SuDS measure that will have ecological and aesthetic benefits.

- **Infiltration Trenches**

  Where possible, Infiltration trenches shall be used to drain larger areas, such as the play areas within the open space area, within the proposed development site. Infiltration trenches are long narrow soakaways filled with a void-forming material, typically stone. This allows water to be collected by the infiltration trench and exfiltrated into the surrounding soils from the bottom and sides of the trench. The top layer of the infiltration trenches may be stoned, similar to that shown in Image 6 below, or they may have a topsoil layer laid above the void forming stone of the infiltration trench. For large developments, similar to the Barnhill SHD, infiltration trenches can be constructed with incorporated geo-cellular units which would allow for increased storage capacity. The proposed infiltration trenches will discharge to the sealed surface water network system by means of a perforated pipe. Also, it is proposed that the rain gardens within the development will discharge to an infiltration trench which, in turn will, be connected to the sealed surface water pipe network by this means.

- **Proposed Carpark at Public Open Space**

  It is proposed that a public carpark be provided adjacent to the primary access route to the east of the site. This carpark will cater for members of the public visiting the public open space, crèche, and future primary school. The area of this carpark will be in the region of 1800m^2.

- **Pond / Wetland Area**

  It is proposed to provide a constructed pond/wetland area within the floodplain area of the Barnhill SHD public parkland (see section 2.4). This will form part of the overall SuDS network for the development and will be a regional site control to provide water quality and ecological benefits for the overall site catchment.

- **Infiltration/Storage Under Proposed Playing Pitch:**

  Permeable paving with bottom layers of granular materials. Stone-fill underneath car parking areas is proposed to storage volume of attenuation storage required, typically up to 1 in 100 years of the storm event, in addition to delivering interception and contributing to water quality treatment.

<u>**Site Control/Storage:**</u>

- **Attenuation Storage:**

  Permeable paving will be installed in the proposed parking area to promote infiltration to the underground storage void system. The outfall from underground storage will be controlled with flow controls in a manhole.
  A geo-cellular storage system is proposed for the on-site attenuation storage required for extreme storm events in areas where not enough volume can be provided by an underground storage void system such as that under areas of permeable paving.
  A silt trap manhole and an oil separator are proposed in situations when there are no SuDS features for source control and treatment of surface water before tanks. These units will capture any solids and hydrocarbons, prevent them from entering the downstream network, and minimize the risk of blockages. The geo-cellular storage system has an isolator row arrangement to allow for maintenance.
  Storage under the proposed playing pitch is proposed for 1 in 100 years of the storm event. The outflow from the attenuation storage system is discharged at a reduced flow rate (30l/s) via a flow control structure (hydro brake) before discharge into the stream.

  Storage in the network, geo-cellular storage, drain material under the carpark and the proposed playing pitch will contribute as part of the total attenuation storage capacity requirement for up to a 1:100-year event since the network, in that case, will be surcharged as shown in Appendix B – Storm Drainage Calculations.

7.2.2 Surface Water Runoff and Storage Calculations:

Barnhill Strategic Housing Development was divided into 5 Sub-Catchment areas for Causeway Flow calculation based on discharge arrangement.

1) ***Barnhill Lower East***
2) ***Barnhill Lower West***
3) ***Barnhill Stream Lower***
4) ***Barnhill Upper West***
5) ***Main catchment area connected to the proposed infiltration basin with 4 Sub-Catchment areas:***
   5.1) ***Barnhill Stream and Crescent Area Catchment***
   5.2) ***Barnhill Stream and Central Area Catchment***
   5.3) ***Barnhill Upper and Station Area Catchment***
   5.4) ***Village Centre and Station Plaza Area Catchment***

The Causeway FLOW Storage Volume Requirement for these Catchments = 12295m³

7.2.3 Required Volume of Storage Breakdown

Barnhill Strategic Housing Development was divided into 5 Sub-Catchment areas for Causeway Flow calculation based on discharge arrangement.

1) Barnhill Lower East

Node	Porosity	Invert Level (m)	Depth (m)	Area (m²)	Volume (m³)
Carpark					
US 9-1	0.30	57.318	0.000	330.0	128.7
			1.300	330.0	
			1.310	0.0	
US 9-2	0.30	56.967	0.000	330.0	138.6
			1.400	330.0	
			1.410	0.0	
UCS 9-3	1.00	56.752	0.000	250.0	375
			1.500	250.0	
			1.510	0.0	
Total Volume Carpark					642.3
Detention basin					
SWMH 9-6	1.00	55.875	0.000	300.0	450
			1.500	300.0	
			1.510	0.0	
Total Volume Detention basin					450
TOTAL VOLUME					**1092.3 m³**

2) Barnhill Lower West

Node	Porosity	Invert Level (m)	Depth (m)	Area (m²)	Volume (m³)
Carpark					
US 2-1	0.30	58.820	0.000	640.0	230.4
			1.200	640.0	
			1.210	0.0	
US 3-1	0.30	58.520	0.000	350.0	105
			1.000	350.0	
			1.010	0.0	
US 3-2	0.30	58.150	0.000	265.0	92.16
			1.200	256.0	
			1.210	0.0	
US 4-1	0.30	58.338	0.000	210.0	63
			1.000	210.0	
			1.010	0.0	
Total Volume Carpark					490.56
Detention basin					
3	1.00	57.348	0.000	800.0	480
			0.600	800.0	
			0.601	0.0	
Total Volume Detention basin					480
TOTAL VOLUME					**970.56 m³**

3) Barnhill Stream Lower

Node	Porosity	Invert Level (m)	Depth (m)	Area (m^2)	Volume (m^3)
Carpark					
US 1-1	0.30	57.266	0.000	150.0	63
			1.400	150.0	
			1.410	0.0	
US 1-2	0.30	57.121	0.000	210.0	81.9
			1.300	210.0	
			1.310	0.0	
US 1-3	0.30	56.974	0.000	225.0	77.625
			1.150	225.0	
			1.160	0.0	
Total Volume Carpark					222.525
Detention basin					
SWMH 1-10	1.00	56.610	0.000	550.0	495
			0.900	550.0	
			0.901	0.0	
Total Volume Detention basin					495
TOTAL VOLUME					**717.525m^3**

4) Barnhill Upper West

Node	Porosity	Invert Level (m)	Depth (m)	Area (m^2)	Volume (m^3)
Carpark					
US 10-1	0.30	59.757	0.000	150.0	67.5
			1.500	150.0	
			1.510	0.0	
US 10-2	0.30	59.765	0.000	150.0	65.25
			1.450	150.0	
			1.460	0.0	
US10-3	0.30	59.442	0.000	150.0	65.25
			1.450	150.0	
			1.460	0.0	
US10-4	0.30	59.496	0.000	260.0	89.7
			1.150	260.0	
			1.160	0.0	
US 10-5	0.30	59.657	0.000	210.0	66.15
			1.050	210.0	
			1.060	0.0	
Total Volume Carpark					353.85
TOTAL VOLUME					**353.85 m^3**

5) Main catchment area connected to the proposed infiltration basin with 4 Sub-Catchment areas:
5.1) Barnhill Stream and Crescent Area Catchment
5.2) Barnhill Stream and Central Area Catchment
5.3) Barnhill Upper and Station Area Catchment
5.4) Village Centre and Station Plaza Area Catchment

Node	Porosity	Invert Level (m)	Depth (m)	Area (m^2)	Volume (m^3)
Carpark					
US25	0.30	60.250	0.000	60.0	12.6
			0.700	60.0	
			0.701	0.0	
US26	0.30	60.069	0.000	25.0	7.5
			1.000	25.0	
			1.010	0.0	
US27	0.30	59.928	0.000	170.0	43.35
			0.850	170.0	
			0.860	0.0	
US28	0.30	59.745	0.000	155.0	53.475
			1.150	155.0	
			1.160	0.0	
US31	0.30	59.822	0.000	380.0	85.5
			0.750	380.0	
			0.760	0.0	
US34	0.30	59.585	0.000	65.0	32.175
			1.650	65.0	
			1.660	0.0	
US37	0.30	59.338	0.000	100.0	57
			1.900	100.0	
			1.910	0.0	
US38	0.30	59.260	0.000	100.0	55.5
			1.850	100.0	
			1.860	0.0	
US30	0.30	60.032	0.000	290.0	52.2
			0.600	290.0	
			0.610	0.0	
US32	0.30	60.370	0.000	325.0	136.5
			1.400	325.0	
			1.410	0.0	

US40	0.30	59.699	0.000	255.0	126.225
			1.650	255.0	
			1.660	0.0	
US39	0.30	59.281	0.000	290.0	217.5
			2.500	290.0	
			2.510	0.0	
US41	0.30	59.188	0.000	245.0	147
			2.000	245.0	
			2.010	0.0	
US24	0.30	57.744	0.000	80.0	36
			1.500	80.0	
			1.510	0.0	
US3	0.30	57.579	0.000	255.0	38.25
			0.500	255.0	
			0.510	0.0	
US1	0.30	57.479	0.000	335.0	90.45
			0.900	335.0	
			0.910	0.0	
US5	0.30	57.790	0.000	130.0	39
			1.000	130.0	
			1.010	0.0	
US6	0.30	57.500	0.000	130.0	35.1
			0.900	130.0	
			0.910	0.0	
US8	0.30	57.092	0.000	210.0	56.7
			0.900	210.0	
			0.910	0.0	
US9	0.30	56.995	0.000	210.0	63
			1.000	210.0	
			1.010	0.0	
US10	0.30	56.850	0.000	210.0	56.7
			0.900	210.0	
			0.910	0.0	
US11	0.30	56.750	0.000	210.0	63
			1.000	210.0	
			1.010	0.0	
US43	0.30	57.382	0.000	265.0	111.3
			1.400	265.0	
			1.410	0.0	
US42	0.30	57.187	0.000	200.0	129
			2.150	200.0	
			2.160	0.0	

US4	0.30	57.510	0.000	235.0	63.45
			0.900	235.0	
			0.910	0.0	
US12	0.30	59.812	0.000	135.0	56.7
			1.400	135.0	
			1.410	0.0	
US13	0.30	59.909	0.000	165.0	66.825
			1.350	165.0	
			1.360	0.0	
US17	0.30	58.427	0.000	150.0	78.75
			1.750	150.0	
			1.760	0.0	
US18	0.30	58.436	0.000	150.0	78.75
			1.750	150.0	
			1.760	0.0	
US20	0.30	58.328	0.000	210.0	72.45
			1.150	210.0	
			1.160	0.0	
US21	0.30	58.333	0.000	110.0	37.95
			1.150	110.0	
			1.160	0.0	
US16	0.30	58.335	0.000	265.0	123.225
			1.550	265.0	
			1.560	0.0	
US19	0.30	57.127	0.000	265.0	99.375
			1.250	265.0	
			1.260	0.0	
US22	0.30	56.920	0.000	125.0	35.625
			0.950	125.0	
			0.960	0.0	
US14	0.30	57.954	0.000	265.0	159
			2.000	265.0	
			2.010	0.0	
US15	0.30	57.965	0.000	250.0	150
			2.000	250.0	
			2.010	0.0	
US23	0.30	57.551	0.000	240.0	90
			1.250	240.0	
			1.260	0.0	
Total Volume Carpark					2857.13

Underground Geo-cellular (Stormtech)					
UCS 1	1.00	58.530	0.000	95.0	109.25
			1.150	95.0	
			1.160	0.0	
UCS 2	1.00	58.450	0.000	145.0	188.5
			1.300	145.0	
			1.310	0.0	
UCS 3	1.00	58.250	0.000	160.0	368
			2.300	160.0	
			2.310	0.0	
UCS 4	1.00	57.200	0.000	85.0	178.5
			2.100	85.0	
			2.110	0.0	
UCS 5	1.00	56.750	0.000	150.0	225
			1.500	150.0	
			1.510	0.0	
UCS 6	1.00	59.450	0.000	135.0	290.25
			2.150	135.0	
			2.160	0.0	
UCS 7	1.00	59.650	0.000	115.0	143.75
			1.250	115.0	
			1.260	0.0	
Total Underground Geo-cellular (Stormtech)					1503.25
Proposed Playing Pitch					
SWMH 6-11	0.30	55.650	0.000	8000.0	4800
			2.000	8000.0	
			2.010	0.0	
Total Proposed Playing Pitch					4800
TOTAL VOLUME					**9160.38 m^3**

Drainage Design Report

Flow+

v8.1

Network	Flow Path
Filename	Q:\2016 Jobs\16_053 Barnhill Lands LAP\InfoDrainage Design\New Network\Barnhill Lower East.pfd
Username	Tomislav Bozinovic (Tomislav.Bozinovic@csea.ie)
Last analysed	30/06/2022 08:00:33
Report produced on	30/06/2022 08:03:35

Rainfall Methodology	FSR
Return Period (years)	100
Additional Flow (%)	0
FSR Region	Scotland and Ireland
M5-60 (mm)	17.100
Ratio-R	0.300
CV	0.750
Time of Entry (mins)	5.00
Maximum Time of Concentration (mins)	30.00
Maximum Rainfall (mm/hr)	50.0
Minimum Velocity (m/s)	1.00
Connection Type	Level Soffits
Minimum Backdrop Height (m)	0.200
Preferred Cover Depth (m)	1.200
Include Intermediate Ground	
Enforce best practice design rules	x

Name	Area (ha)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
SWMH 9-0	0.082	59.093	1200	703613.191	738329.808	2.063
US 9-2	0.157	58.786	1200	703596.691	738275.285	1.819
SWMH 9-1	0.070	58.748	1200	703604.186	738280.075	1.886
UCS 9-3	0.469	58.800	1200	703654.279	738248.234	2.048
SWMH 9-2	0.050	58.299	1200	703593.247	738219.655	1.922
SWMH 9-3	0.058	58.687	1200	703551.534	738226.840	2.431
SWMH 9A-0	0.067	59.550	1200	703538.654	738325.614	1.500
US 9-1	0.157	59.027	1200	703534.611	738264.692	1.709
SWMH 9A-1	0.035	58.749	1200	703524.383	738246.787	1.500
SWMH9-4	0.076	58.478	1200	703524.311	738224.801	2.375
SWMH 9B-0	0.020	57.612	1200	703405.409	738186.954	1.127
SWMH 9B-1	0.060	57.600	1200	703417.453	738201.359	1.178
SWMH 9-5	0.090	57.697	1200	703481.699	738215.828	1.794
SWMH 9-6	0.000	58.045	1200	703483.708	738206.287	2.170

Name	US Node	DS Node	Length (m)	US IL (m)	DS IL (m)	Slope (1:X)	Dia (mm)
1.000	SWMH 9-0	SWMH 9-1	50.541	57.030	56.862	300.8	300
2.000	US 9-2	SWMH 9-1	8.895	56.967	56.937	296.5	225
1.001	SWMH 9-1	SWMH 9-2	61.402	56.862	56.452	149.8	300
3.000	UCS 9-3	SWMH 9-2	67.392	56.752	56.527	299.5	225
1.002	SWMH 9-2	SWMH 9-3	42.327	56.377	56.256	349.8	375
1.003	SWMH 9-3	SWMH9-4	27.300	56.256	56.178	350.0	375
4.000	SWMH 9A-0	SWMH 9A-1	80.108	58.050	57.249	100.0	225
5.000	US 9-1	SWMH 9A-1	20.621	57.318	57.249	298.9	225
4.001	SWMH 9A-1	SWMH9-4	21.987	57.249	57.029	99.9	225
1.004	SWMH9-4	SWMH 9-5	43.546	56.103	55.978	348.4	450
6.000	SWMH 9B-0	SWMH 9B-1	18.777	56.485	56.422	298.0	225
6.001	SWMH 9B-1	SWMH 9-5	65.855	56.422	56.203	300.7	225
1.005	SWMH 9-5	SWMH 9-6	9.750	55.903	55.875	348.2	525

			Return Period (years)	Climate Change (%)
Rainfall Methodology	FSR			
FSR Region	Scotland and Ireland		100	20
M5-60 (mm)	17.100			
Ratio-R	0.300			
Summer CV	1.000			
Winter CV	1.000			
Analysis Speed	Normal			
Skip Steady State	x			
Drain Down Time (mins)	240			
Additional Storage (m³/ha)	20.0			
Storm Durations (mins)	15			
	30			
	60			
	120			
	180			
	240			
	360			
	480			
	600			
	720			
	960			
	1440			
Check Discharge Rate(s)	x			
1 year (l/s)				
30 year (l/s)				
100 year (l/s)				
Check Discharge Volume	x			
100 year 360 minute (m³)				

Orifice

Node	Flap Valve	Online / Offline	Downstream Link	Replaces Downstream Link	Loop to Node	Invert Level (m)	Design Depth (m)	Design Flow (l/s)	Diameter (m)	Discharge Coefficient
US 9-1	x	Online				57.318	1.300	0.5	0.014	0.600
US 9-2	x	Online				56.967	1.400	0.5	0.014	0.600

Hydro-Brake®

Node	Flap Valve	Online / Offline	Downstream Link	Replaces Downstream Link	Loop to Node	Invert Level (m)	Design Depth (m)	Design Flow (l/s)	Objective	Sump Available	Product Number	Min Outlet Diameter (m)	Min Node Diameter (mm)
UCS 9-3	x	Online				56.752	1.500	2.0	(HE) Minimise upstream storage		CTL-SHE-0061-2000-1500-2000	0.075	1200
SWMH 9-6	x	Online				55.875	1.500	5.0	(HE) Minimise upstream storage		CTL-SHE-0098-5000-1500-5000	0.150	1200

Depth/Area/Inf Area									
Node	Base Inf Coefficient (m/hr)	Side Inf Coefficient (m/hr)	Safety Factor	Porosity	Invert Level (m)	Time to half empty (mins)	Depth (m)	Area (m²)	Inf. Area (m²)
US 9-1	0.00000	0.00000	2.0	0.30	57.318		0.000	330.0	0.0
							1.300	330.0	0.0
							1.310	0.0	0.0
US 9-2	0.00000	0.00000	2.0	0.30	56.967		0.000	330.0	0.0
							1.400	330.0	0.0
							1.410	0.0	0.0
UCS 9-3	0.00000	0.00000	2.0	1.00	56.752		0.000	250.0	0.0
							1.500	250.0	0.0
							1.510	0.0	0.0
SWMH 9-6	0.00000	0.00000	2.0	1.00	55.875		0.000	300.0	0.0
							1.500	300.0	0.0
							1.510	0.0	0.0

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
100 year +20% 15 minute summer	327.141	92.570
100 year +20% 15 minute winter	229.573	92.570
100 year +20% 30 minute summer	222.672	63.008
100 year +20% 30 minute winter	156.261	63.008
100 year +20% 60 minute summer	152.168	40.214
100 year +20% 60 minute winter	101.097	40.214
100 year +20% 120 minute summer	94.736	25.036
100 year +20% 120 minute winter	62.940	25.036
100 year +20% 180 minute summer	73.107	18.813
100 year +20% 180 minute winter	47.522	18.813
100 year +20% 240 minute summer	58.050	15.341
100 year +20% 240 minute winter	38.567	15.341
100 year +20% 360 minute summer	44.575	11.471
100 year +20% 360 minute winter	28.975	11.471
100 year +20% 480 minute summer	35.270	9.321
100 year +20% 480 minute winter	23.432	9.321
100 year +20% 600 minute summer	28.993	7.930
100 year +20% 600 minute winter	19.810	7.930
100 year +20% 720 minute summer	25.923	6.948
100 year +20% 720 minute winter	17.422	6.948
100 year +20% 960 minute summer	21.405	5.637
100 year +20% 960 minute winter	14.179	5.637
100 year +20% 1440 minute summer	15.657	4.196
100 year +20% 1440 minute winter	10.523	4.196

Results for 100 year +20% Critical Storm Duration. Lowest mass balance: 99.78%															
Event	US Node ID	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status	Link ID	DS Node ID	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	SWMH 9-0	10	57.227	0.197	43.8	0.3799	0.0000	OK	1.000	SWMH 9-1	42.6	0.821	0.764	2.8457	
1440 minute winter	US 9-2	1410	58.275	1.308	4.6	133.2483	0.0000	SURCHARGED	Orifice	SWMH 9-1	0.4				
1440 minute winter	SWMH 9-1	1380	57.223	0.361	4.8	0.6755	0.0000	SURCHARGED	1.001	SWMH 9-2	4.8	0.609	0.060	4.3239	
1440 minute winter	UCS 9-3	1410	58.144	1.392	13.7	355.8569	0.0000	SURCHARGED	Hydro-Brake®	SWMH 9-2	1.6				
1440 minute winter	SWMH 9-2	1380	57.223	0.846	7.7	1.3961	0.0000	SURCHARGED	1.002	SWMH 9-3	7.1	0.457	0.076	4.6685	
1440 minute winter	SWMH 9-3	1380	57.222	0.966	8.7	1.5541	0.0000	SURCHARGED	1.003	SWMH9-4	8.5	0.546	0.090	3.0111	
15 minute summer	SWMH 9A-0	11	58.199	0.149	35.8	0.3009	0.0000	OK	4.000	SWMH 9A-1	34.7	1.067	0.772	2.7070	
1440 minute winter	US 9-1	1410	58.614	1.296	4.6	132.1961	0.0000	SURCHARGED	Orifice	SWMH 9A-1	0.5				
15 minute summer	SWMH 9A-1	11	57.475	0.226	53.4	0.3616	0.0000	SURCHARGED	4.001	SWMH9-4	49.6	1.329	1.105	0.8218	
1440 minute winter	SWMH9-4	1380	57.222	1.119	13.8	1.9824	0.0000	SURCHARGED	1.004	SWMH 9-5	13.7	0.494	0.090	6.8996	
1440 minute winter	SWMH 9B-0	1380	57.222	0.737	0.6	1.0956	0.0000	SURCHARGED	6.000	SWMH 9B-1	0.6	0.155	0.023	0.7468	
1440 minute winter	SWMH 9B-1	1380	57.222	0.800	2.3	1.7207	0.0000	SURCHARGED	6.001	SWMH 9-5	2.3	0.386	0.088	2.6191	
1440 minute winter	SWMH 9-5	1380	57.222	1.319	18.3	2.8153	0.0000	SURCHARGED	1.005	SWMH 9-6	18.2	0.683	0.079	2.1063	
1440 minute winter	SWMH 9-6	1380	57.222	1.347	18.2	405.7045	0.0000	OK	Hydro-Brake®		4.9				400.5

Drainage Design Report

Flow+

v8.1

Network	Ongar Road _ South From Bridge
Filename	C:\Users\tomislav.bozinovic\Desktop\SW 16_053\Barnhill Lower West June 2022.pfd
Username	Tomislav Bozinovic (Tomislav.Bozinovic@csea.ie)
Last analysed	06/07/2022 11:35:06
Report produced on	06/07/2022 12:21:58

Rainfall Methodology	FSR
Return Period (years)	100
Additional Flow (%)	0
FSR Region	Scotland and Ireland
M5-60 (mm)	17.100
Ratio-R	0.300
CV	0.750
Time of Entry (mins)	5.00
Maximum Time of Concentration (mins)	30.00
Maximum Rainfall (mm/hr)	50.0
Minimum Velocity (m/s)	1.00
Connection Type	Level Soffits
Minimum Backdrop Height (m)	0.200
Preferred Cover Depth (m)	1.200
Include Intermediate Ground	
Enforce best practice design rules	

Name	Area (ha)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
9		58.790		703097.624	738463.904	0.904
8		58.750		702992.396	738375.212	1.002
7		58.830		702964.460	738362.360	1.116
3		58.995	1200	702900.472	738351.452	1.647
2		58.700	2100	702897.428	738343.826	1.649
1		58.700	1200	702894.385	738336.201	1.676
31		58.750		703042.854	738407.759	0.942
SWMH 3-3	0.045	60.125	1200	702933.799	738443.807	1.913
SWMH 3-4	0.066	59.700	1500	702958.885	738389.014	1.896
SWMH 3A-1	0.035	59.354	1200	702990.534	738404.582	1.225
SWMH 4A-0	0.016	59.765	1200	703027.167	738429.487	1.332
SWMH 4-1	0.050	59.670	1200	703045.898	738446.371	1.443
SWMH 4-2	0.025	59.336	1200	703057.438	738434.563	1.311
SWMH 4-0	0.021	59.618	1200	703061.901	738462.520	1.185
SWMH 2-0	0.080	60.822	1200	702992.105	738512.829	1.531
SWMH 2-1	0.060	60.316	1200	703036.784	738489.427	1.607
SWMH 2-2	0.026	59.782	1200	703084.182	738466.564	1.343
SWMH 3B-0	0.050	59.158	1200	702998.390	738391.181	0.977
SWMH 3A-0	0.046	59.378	1200	703011.689	738418.326	1.165
SWMH 3-0	0.020	60.309	1350	702993.121	738494.258	1.576
SWMH 3-1	0.025	59.793	1200	702973.055	738478.002	1.316
SWMH 3-2	0.010	60.000	1350	702945.501	738459.117	1.691
US 4-1	0.134	59.763	1200	703040.768	738450.667	1.425
US 2-1	0.189	60.416	1350	703039.629	738495.891	1.596
US 3-1	0.103	59.893	1200	702978.562	738473.782	1.373
US 3-2	0.077	59.800	1350	702962.451	738399.728	1.650

Name	US Node	DS Node	Length (m)	US IL (m)	DS IL (m)	Slope (1:X)	Dia (mm)
1.003	9	31	78.435	57.886	57.808	1005.6	600
1.009	8	7	30.770	57.748	57.714	900.0	600
1.010	7	3	64.911	57.714	57.423	223.1	375
1.011	3	2	8.211	57.348	57.321	300.0	450
1.012	2	1	8.210	57.051	57.024	300.0	450
1.004	31	8	60.044	57.808	57.748	1000.7	600
6.003	SWMH 3-3	SWMH 3-4	60.263	58.212	58.011	300.0	225
6.004	SWMH 3-4	3	69.448	57.804	57.640	423.5	375
8.001	SWMH 3A-1	SWMH 3-4	35.271	58.129	57.954	201.5	225
3.000	SWMH 4A-0	SWMH 4-1	25.217	58.433	58.353	315.2	225
3.001	SWMH 4-1	SWMH 4-2	16.511	58.227	58.025	81.7	225
3.002	SWMH 4-2	31	30.515	58.025	57.872	200.0	225
4.000	SWMH 4-0	SWMH 4-1	22.735	58.433	58.353	284.2	225
1.000	SWMH 2-0	SWMH 2-1	50.437	59.291	58.784	99.5	225
1.001	SWMH 2-1	SWMH 2-2	52.624	58.709	58.439	194.9	300
1.002	SWMH 2-2	9	13.703	58.439	58.186	54.2	300
6.000	SWMH 3-0	SWMH 3-1	25.824	58.733	58.477	100.9	225
6.001	SWMH 3-1	SWMH 3-2	33.405	58.477	58.309	198.8	225
6.002	SWMH 3-2	SWMH 3-3	19.270	58.309	58.212	198.7	225
10.000	US 3-2	SWMH 3-4	11.292	58.150	58.094	200.0	225
5.000	US 4-1	SWMH 4-1	6.691	58.338	58.227	60.3	225
2.000	US 2-1	SWMH 2-1	7.062	58.820	58.785	200.0	225
7.000	US 3-1	SWMH 3-1	6.938	58.520	58.485	200.0	225
9.000	SWMH 3B-0	SWMH 3A-1	15.534	58.181	58.129	300.0	225
8.000	SWMH 3A-0	SWMH 3A-1	25.228	58.213	58.129	300.0	225

Rainfall Methodology	FSR		**Return Period (years)**	**Climate Change (%)**
FSR Region	England and Wales		100	20
M5-60 (mm)	17.100			
Ratio-R	0.300			
Summer CV	0.750			
Winter CV	0.840			
Analysis Speed	Normal			
Skip Steady State	x			
Drain Down Time (mins)	240			
Additional Storage (m³/ha)	20.0			
Storm Durations (mins)	15			
	30			
	60			
	120			
	180			
	240			
	360			
	480			
	600			
	720			
	960			
	1440			
Check Discharge Rate(s)	x			
1 year (l/s)				
30 year (l/s)				
100 year (l/s)				
Check Discharge Volume	x			
100 year 360 minute (m³)				

Orifice										
Node	Flap Valve	Online / Offline	Downstream Link	Replaces Downstream Link	Loop to Node	Invert Level (m)	Design Depth (m)	Design Flow (l/s)	Diameter (m)	Discharge Coefficient
3	x	Online		x		57.348	0.600	3.6	0.047	0.600
US 2-1	x	Online		x		58.820	1.200	0.2	0.009	0.600
US 3-1	x	Online		x		58.520	1.000	0.2	0.009	0.600
US 3-2	x	Online		x		58.150	1.200	0.2	0.009	0.600
US 4-1	x	Online		x		58.338	1.000	5.0	0.049	0.600

Depth/Area/Inf Area									
Node	**Base Inf Coefficient (m/hr)**	**Side Inf Coefficient (m/hr)**	**Safety Factor**	**Porosity**	**Invert Level (m)**	**Time to half empty (mins)**	**Depth (m)**	**Area (m²)**	**Inf. Area (m²)**
3	0.00000	0.00000	2.0	1.00	57.348		0.000	800.0	0.0
							0.600	800.0	0.0
							0.601	0.0	0.0
US 2-1	0.00000	0.00000	2.0	0.30	58.820		0.000	640.0	0.0
							1.200	640.0	0.0
							1.210	0.0	0.0
US 3-1	0.00000	0.00000	2.0	0.30	58.520		0.000	350.0	0.0
							1.000	350.0	0.0
							1.010	0.0	0.0
US 3-2	0.00000	0.00000	2.0	0.30	58.150		0.000	265.0	0.0
							1.200	256.0	0.0
							1.210	0.0	0.0
US 4-1	0.00000	0.00000	2.0	0.30	58.338	80	0.000	210.0	0.0
							1.000	210.0	0.0
							1.010	0.0	0.0

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
100 year +20% 15 minute summer	318.306	90.070
100 year +20% 15 minute winter	223.372	90.070
100 year +20% 30 minute summer	220.065	62.271
100 year +20% 30 minute winter	154.432	62.271
100 year +20% 60 minute summer	156.077	41.246
100 year +20% 60 minute winter	103.694	41.246
100 year +20% 120 minute summer	100.090	26.451
100 year +20% 120 minute winter	66.497	26.451
100 year +20% 180 minute summer	78.107	20.100
100 year +20% 180 minute winter	50.772	20.100
100 year +20% 240 minute summer	62.121	16.417
100 year +20% 240 minute winter	41.272	16.417
100 year +20% 360 minute summer	47.533	12.232
100 year +20% 360 minute winter	30.897	12.232
100 year +20% 480 minute summer	37.575	9.930
100 year +20% 480 minute winter	24.964	9.930
100 year +20% 600 minute summer	30.852	8.439
100 year +20% 600 minute winter	21.080	8.439
100 year +20% 720 minute summer	27.548	7.383
100 year +20% 720 minute winter	18.514	7.383
100 year +20% 960 minute summer	22.683	5.973
100 year +20% 960 minute winter	15.026	5.973
100 year +20% 1440 minute summer	16.492	4.420
100 year +20% 1440 minute winter	11.084	4.420

Results for 100 year +20% Critical Storm Duration. Lowest mass balance: 99.90%

Event	US Node ID	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status	Link ID	DS Node ID	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	9	12	58.038	0.152	66.2	0.0000	0.0000	OK	1.003	31	63.4	0.491	0.073	10.4161	
15 minute winter	8	15	57.942	0.194	103.9	0.0000	0.0000	OK	1.009	7	91.5	0.685	0.099	5.6005	
15 minute winter	7	15	57.934	0.220	91.5	0.0000	0.0000	OK	1.010	3	86.0	1.302	0.644	4.2903	
1440 minute winter	3	1380	57.916	0.568	17.7	455.0309	0.0000	SURCHARGED	1.011	2	3.3	0.469	0.018	0.0586	
1440 minute winter	2	1380	57.094	0.043	3.3	0.1497	0.0000	OK	1.012	1	3.3	0.469	0.018	0.0586	221.7
1440 minute winter	1	1380	57.063	0.039	3.3	0.0000	0.0000	OK							
15 minute winter	31	13	57.995	0.187	107.8	0.0000	0.0000	OK	1.004	8	103.9	0.698	0.119	9.2960	
15 minute winter	SWMH 3-3	12	58.449	0.237	37.5	0.3802	0.0000	SURCHARGED	6.003	SWMH 3-4	34.3	0.940	1.151	2.0784	
15 minute winter	SWMH 3-4	12	58.128	0.324	105.1	0.7972	0.0000	OK	6.004	3	101.6	1.157	1.053	6.0296	
15 minute winter	SWMH 3A-1	11	58.439	0.310	48.4	0.5273	0.0000	SURCHARGED	8.001	SWMH 3-4	46.6	1.194	1.279	1.3029	
15 minute winter	SWMH 4A-0	11	58.506	0.073	6.6	0.1007	0.0000	OK	3.000	SWMH 4-1	6.4	0.619	0.220	0.2606	
15 minute winter	SWMH 4-1	11	58.369	0.142	36.9	0.2591	0.0000	OK	3.001	SWMH 4-2	36.8	1.074	0.639	0.5463	
15 minute winter	SWMH 4-2	11	58.289	0.264	47.0	0.3985	0.0000	SURCHARGED	3.002	31	45.4	1.167	1.241	1.1215	
15 minute winter	SWMH 4-0	10	58.516	0.083	8.6	0.1227	0.0000	OK	4.000	SWMH 4-1	8.3	0.680	0.272	0.2790	
15 minute winter	SWMH 2-0	10	59.421	0.130	32.8	0.2831	0.0000	OK	1.000	SWMH 2-1	31.8	1.368	0.610	1.1722	
15 minute winter	SWMH 2-1	11	58.900	0.191	56.0	0.3590	0.0000	OK	1.001	SWMH 2-2	55.9	1.373	0.705	2.1406	
15 minute winter	SWMH 2-2	11	58.585	0.146	65.9	0.2215	0.0000	OK	1.002	9	66.2	2.023	0.437	0.4484	
15 minute winter	SWMH 3B-0	11	58.464	0.283	20.5	0.6088	0.0000	SURCHARGED	9.000	SWMH 3A-1	17.8	0.508	0.598	0.6178	
15 minute winter	SWMH 3A-0	11	58.471	0.258	18.9	0.4953	0.0000	SURCHARGED	8.000	SWMH 3A-1	17.1	0.520	0.573	1.0033	
15 minute winter	SWMH 3-0	10	58.793	0.060	8.2	0.1007	0.0000	OK	6.000	SWMH 3-1	8.1	0.583	0.156	0.3613	
15 minute winter	SWMH 3-1	10	58.588	0.111	18.2	0.1681	0.0000	OK	6.001	SWMH 3-2	18.1	0.820	0.494	0.8245	
15 minute winter	SWMH 3-2	12	58.475	0.166	22.0	0.2578	0.0000	OK	6.002	SWMH 3-3	19.7	0.646	0.536	0.6865	
180 minute winter	US 4-1	140	59.003	0.665	15.7	43.9067	0.0000	SURCHARGED	5.000	SWMH 4-1	4.0	0.839	0.059	0.0508	
1440 minute winter	US 2-1	1440	59.639	0.819	4.9	160.3752	0.0000	SURCHARGED	2.000	SWMH 2-1	0.2	0.238	0.004	0.0046	
1440 minute winter	US 3-1	1440	59.304	0.784	2.7	84.3521	0.0000	SURCHARGED	7.000	SWMH 3-1	0.1	0.237	0.004	0.0079	
1440 minute winter	US 3-2	1440	58.904	0.754	2.0	61.0859	0.0000	SURCHARGED	10.000	SWMH 3-4	0.1	0.237	0.004	0.0070	

Drainage Design Report

Flow+

v8.1

Network	Flow Path
Filename	Q:\2016 Jobs\16_053 Barnhill Lands LAP\InfoDrainage Design\New Network\Barnhill Stream Lower June 2022.pfd
Username	Tomislav Bozinovic (Tomislav.Bozinovic@csea.ie)
Last analysed	30/06/2022 08:39:56
Report produced on	30/06/2022 08:41:10

Rainfall Methodology	FSR
Return Period (years)	100
Additional Flow (%)	0
FSR Region	England and Wales
M5-60 (mm)	17.100
Ratio-R	0.300
CV	0.750
Time of Entry (mins)	5.00
Maximum Time of Concentration (mins)	30.00
Maximum Rainfall (mm/hr)	50.0
Minimum Velocity (m/s)	1.00
Connection Type	Level Soffits
Minimum Backdrop Height (m)	0.200
Preferred Cover Depth (m)	1.200
Include Intermediate Ground	
Enforce best practice design rules	x

Name	Area (ha)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
SWMH 1-0	0.030	58.750	1200	702948.153	738261.801	1.182
SWMH 1-1	0.102	58.600	1200	702936.418	738293.296	1.144
SWMH 1-2	0.025	58.803	1200	702948.818	738297.201	1.390
SWMH 1-3	0.007	59.030	1200	702961.750	738298.529	1.660
SWMH 1-4	0.020	59.177	1200	702974.671	738297.098	1.850
SWMH 1-5	0.018	59.088	1200	702986.999	738292.973	1.804
US 1-1	0.090	59.087	1200	702992.734	738278.935	1.821
SWMH 1-6	0.019	58.987	1200	702999.873	738285.273	1.828
US 1-2	0.090	58.836	1200	703029.225	738263.182	1.715
SWMH 1-7	0.037	58.736	1200	703032.245	738265.820	1.703
SWMH 1A-0	0.097	58.450	1200	703067.544	738208.220	1.389
US 1-3	0.020	58.534	1200	703068.562	738247.141	1.560
SWMH 1-8	0.089	58.345	1200	703082.361	738245.184	1.492
SWMH 1-9	0.182	58.450	1200	703130.853	738224.954	1.772
SWMH 1-10	0.000	58.450	1200	703134.075	738204.797	1.840

Name	US Node	DS Node	Length (m)	US IL (m)	DS IL (m)	Slope (1:X)	Dia (mm)
1.000	SWMH 1-0	SWMH 1-1	33.611	57.568	57.456	300.1	225
1.001	SWMH 1-1	SWMH 1-2	13.000	57.456	57.413	302.3	300
1.002	SWMH 1-2	SWMH 1-3	13.000	57.413	57.370	302.3	300
1.003	SWMH 1-3	SWMH 1-4	13.000	57.370	57.327	302.3	300
1.004	SWMH 1-4	SWMH 1-5	13.000	57.327	57.284	302.3	300
1.005	SWMH 1-5	SWMH 1-6	15.000	57.284	57.234	300.0	300
2.000	US 1-1	SWMH 1-6	9.546	57.266	57.234	298.3	225
1.006	SWMH 1-6	SWMH 1-7	37.768	57.159	57.033	299.7	375
3.000	US 1-2	SWMH 1-7	4.010	57.121	57.108	308.5	225
1.007	SWMH 1-7	SWMH 1-8	54.199	57.033	56.853	301.1	375
4.000	SWMH 1A-0	SWMH 1-8	39.823	57.061	56.928	299.4	225
5.000	US 1-3	SWMH 1-8	13.938	56.974	56.928	303.0	225
1.008	SWMH 1-8	SWMH 1-9	52.543	56.853	56.678	300.2	375
1.009	SWMH 1-9	SWMH 1-10	20.413	56.678	56.610	300.2	375

Rainfall Methodology	FSR		**Return Period (years)**	**Climate Change (%)**
FSR Region	Scotland and Ireland		100	20
M5-60 (mm)	17.100			
Ratio-R	0.300			
Summer CV	1.000			
Winter CV	1.000			
Analysis Speed	Normal			
Skip Steady State	x			
Drain Down Time (mins)	240			
Additional Storage (m³/ha)	20.0			
Storm Durations (mins)	15			
	30			
	60			
	120			
	180			
	240			
	360			
	480			
	600			
	720			
	960			
	1440			
Check Discharge Rate(s)	x			
1 year (l/s)				
30 year (l/s)				
100 year (l/s)				
Check Discharge Volume	x			
100 year 360 minute (m³)				

Orifice

Node	Flap Valve	Online / Offline	Downstream Link	Replaces Downstream Link	Loop to Node	Invert Level (m)	Design Depth (m)	Design Flow (l/s)	Diameter (m)	Discharge Coefficient
US 1-1	x	Online		x		57.266	1.400	1.0	0.020	0.600
US 1-2	x	Online		x		57.121	1.300	0.4	0.012	0.600
US 1-3	x	Online		x		56.974	1.150	0.5	0.014	0.600

Hydro-Brake®

Node	Flap Valve	Online / Offline	Downstream Link	Replaces Downstream Link	Loop to Node	Invert Level (m)	Design Depth (m)	Design Flow (l/s)	Objective	Sump Available	Product Number	Min Outlet Diameter (m)	Min Node Diameter (mm)
SWMH 1-10	x	Online		x		56.610	1.000	2.5	(HE) Minimise upstream storage		CTL-SHE-0075-2500-1000-2500	0.100	1200

Depth/Area/Inf Area									
Node	**Base Inf Coefficient (m/hr)**	**Side Inf Coefficient (m/hr)**	**Safety Factor**	**Porosity**	**Invert Level (m)**	**Time to half empty (mins)**	**Depth (m)**	**Area (m²)**	**Inf. Area (m²)**
US 1-1	0.00000	0.00000	2.0	0.30	57.266		0.000	150.0	0.0
							1.400	150.0	0.0
							1.410	0.0	0.0
US 1-2	0.00000	0.00000	2.0	0.30	57.121		0.000	210.0	0.0
							1.300	210.0	0.0
							1.310	0.0	0.0
US 1-3	0.00000	0.00000	2.0	0.30	56.974		0.000	225.0	0.0
							1.150	225.0	0.0
							1.160	0.0	0.0
SWMH 1-10	0.00000	0.00000	2.0	1.00	56.610		0.000	550.0	0.0
							0.900	550.0	0.0
							0.901	0.0	0.0

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
100 year +20% 15 minute summer	327.141	92.570
100 year +20% 15 minute winter	229.573	92.570
100 year +20% 30 minute summer	222.672	63.008
100 year +20% 30 minute winter	156.261	63.008
100 year +20% 60 minute summer	152.168	40.214
100 year +20% 60 minute winter	101.097	40.214
100 year +20% 120 minute summer	94.736	25.036
100 year +20% 120 minute winter	62.940	25.036
100 year +20% 180 minute summer	73.107	18.813
100 year +20% 180 minute winter	47.522	18.813
100 year +20% 240 minute summer	58.050	15.341
100 year +20% 240 minute winter	38.567	15.341
100 year +20% 360 minute summer	44.575	11.471
100 year +20% 360 minute winter	28.975	11.471
100 year +20% 480 minute summer	35.270	9.321
100 year +20% 480 minute winter	23.432	9.321
100 year +20% 600 minute summer	28.993	7.930
100 year +20% 600 minute winter	19.810	7.930
100 year +20% 720 minute summer	25.923	6.948
100 year +20% 720 minute winter	17.422	6.948
100 year +20% 960 minute summer	21.405	5.637
100 year +20% 960 minute winter	14.179	5.637
100 year +20% 1440 minute summer	15.657	4.196
100 year +20% 1440 minute winter	10.523	4.196

Results for 100 year +20% Critical Storm Duration. Lowest mass balance: 99.78%

Event	US Node ID	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status	Link ID	DS Node ID	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
30 minute summer	SWMH 1-0	20	58.312	0.744	15.0	1.2199	0.0000	SURCHARGED	1.000	SWMH 1-1	12.6	0.384	0.487	1.3367	
30 minute summer	SWMH 1-1	20	58.292	0.836	58.4	2.4352	0.0000	SURCHARGED	1.001	SWMH 1-2	52.0	0.785	0.934	0.9155	
30 minute summer	SWMH 1-2	20	58.259	0.846	64.5	1.2609	0.0000	SURCHARGED	1.002	SWMH 1-3	60.9	0.881	1.096	0.9155	
15 minute summer	SWMH 1-3	12	58.213	0.843	72.1	1.0238	0.0000	SURCHARGED	1.003	SWMH 1-4	69.6	0.988	1.251	0.9155	
15 minute summer	SWMH 1-4	12	58.163	0.836	80.2	1.1264	0.0000	SURCHARGED	1.004	SWMH 1-5	77.7	1.104	1.398	0.9155	
15 minute summer	SWMH 1-5	12	58.100	0.816	87.3	1.0866	0.0000	SURCHARGED	1.005	SWMH 1-6	84.9	1.263	1.521	1.0563	
960 minute summer	US 1-1	705	58.391	1.125	5.4	53.0041	0.0000	SURCHARGED	2.000	SWMH 1-6	0.8	0.332	0.033	0.3532	
15 minute summer	SWMH 1-6	12	58.013	0.854	95.1	1.1431	0.0000	SURCHARGED	1.006	SWMH 1-7	85.0	0.983	0.840	4.1657	
1440 minute winter	US 1-2	1410	58.281	1.160	2.6	75.5982	0.0000	SURCHARGED	3.000	SWMH 1-7	0.3	0.237	0.010	0.1595	
15 minute summer	SWMH 1-7	12	57.937	0.904	94.5	1.4152	0.0000	SURCHARGED	1.007	SWMH 1-8	100.2	0.909	0.992	5.9780	
15 minute summer	SWMH 1A-0	12	58.146	1.085	51.8	2.7429	0.0000	SURCHARGED	4.000	SWMH 1-8	41.1	1.035	1.586	1.5838	
1440 minute summer	US 1-3	1680	57.367	0.393	0.9	27.0925	0.0000	SURCHARGED	5.000	SWMH 1-8	-0.2	0.187	-0.007	0.5543	
15 minute summer	SWMH 1-8	12	57.784	0.931	163.5	2.1647	0.0000	SURCHARGED	1.008	SWMH 1-9	165.9	1.504	1.640	5.7953	
1440 minute winter	SWMH 1-9	1410	57.500	0.822	18.4	2.6182	0.0000	SURCHARGED	1.009	SWMH 1-10	18.2	0.743	0.180	2.2515	
1440 minute winter	SWMH 1-10	1410	57.500	0.890	18.2	490.4956	0.0000	OK	Hydro-Brake®		2.5				197.3

Drainage Design Report

Flow+

v8.1

Network	Flow Path
Filename	Q:\2016 Jobs\16_053 Barnhill Lands LAP\InfoDrainage Design\New Network\Barnhill Upper West_Final.pfd
Username	Tomislav Bozinovic (Tomislav.Bozinovic@csea.ie)
Last analysed	29/06/2022 15:55:42
Report produced on	29/06/2022 15:56:44

Rainfall Methodology	FSR
Return Period (years)	100
Additional Flow (%)	0
FSR Region	Scotland and Ireland
M5-60 (mm)	17.100
Ratio-R	0.300
CV	0.750
Time of Entry (mins)	5.00
Maximum Time of Concentration (mins)	30.00
Maximum Rainfall (mm/hr)	50.0
Minimum Velocity (m/s)	1.00
Connection Type	Level Soffits
Minimum Backdrop Height (m)	0.200
Preferred Cover Depth (m)	1.200
Include Intermediate Ground	
Enforce best practice design rules	x

Name	Area (ha)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
SWMH 10-0	0.098	60.999	1200	703206.014	738802.914	1.297
US 10-1	0.068	61.725	1200	703155.603	738777.257	1.968
US 10-2	0.068	61.625	1200	703151.791	738768.511	1.860
SWMH 10A-0	0.023	61.625	1200	703155.901	738773.325	1.881
SWMH 10-1	0.057	61.295	1200	703189.330	738760.252	1.746
SWMH 10B-0	0.012	61.019	1200	703131.749	738711.301	1.498
US10-3	0.068	61.375	1200	703157.941	738708.019	1.933
SWMH 10-2	0.122	61.275	1200	703165.085	738698.257	1.948
SWMH 10C-0	0.014	60.750	1200	703119.513	738707.405	1.170
SWMH 10C-1	0.030	60.712	1200	703128.029	738699.713	1.170
SWMH 10D-0	0.031	60.744	1200	703105.839	738682.388	1.202
US10-4	0.127	61.054	1200	703125.197	738673.447	1.558
SWMH 10C-2	0.053	60.954	1200	703125.824	738679.839	1.479
US 10-5	0.085	61.143	1200	703147.250	738602.001	1.486
SWMH 10E-0	0.050	61.043	1200	703153.274	738594.771	1.492
SWMH 10C-3	0.104	61.300	1200	703161.251	738675.320	2.019
SWMH 10-3	0.068	61.250	1200	703163.972	738679.474	1.986
SWMH 10-4		61.250	1200	703254.396	738662.584	2.293

Name	US Node	DS Node	Length (m)	US IL (m)	DS IL (m)	Slope (1:X)	Dia (mm)
1.000	SWMH 10-0	SWMH 10-1	45.809	59.702	59.549	299.4	375
2.000	US 10-1	SWMH 10A-0	3.943	59.757	59.744	303.3	225
3.000	US 10-2	SWMH 10A-0	6.330	59.765	59.744	301.4	225
2.001	SWMH 10A-0	SWMH 10-1	35.895	59.744	59.624	299.1	225
1.001	SWMH 10-1	SWMH 10-2	66.567	59.549	59.327	299.9	375
4.000	SWMH 10B-0	SWMH 10-2	35.797	59.521	59.402	300.8	225
5.000	US10-3	SWMH 10-2	12.096	59.442	59.402	302.4	225
1.002	SWMH 10-2	SWMH 10-3	18.816	59.327	59.264	298.7	375
6.000	SWMH 10C-0	SWMH 10C-1	11.476	59.580	59.542	302.0	300
6.001	SWMH 10C-1	SWMH 10C-2	19.996	59.542	59.475	298.4	300
7.000	SWMH 10D-0	SWMH 10C-2	20.147	59.542	59.475	300.7	225
8.000	US10-4	SWMH 10C-2	6.413	59.496	59.475	305.4	225
6.002	SWMH 10C-2	SWMH 10C-3	35.714	59.475	59.356	300.1	300
9.000	US 10-5	SWMH 10E-0	9.411	59.657	59.626	303.6	225
9.001	SWMH 10E-0	SWMH 10C-3	80.944	59.551	59.281	299.8	300
6.003	SWMH 10C-3	SWMH 10-3	4.966	59.281	59.264	292.1	375
1.003	SWMH 10-3	SWMH 10-4	91.987	59.264	58.957	299.6	375

			Return Period (years)	Climate Change (%)
Rainfall Methodology	FSR			
FSR Region	Scotland and Ireland		100	0
M5-60 (mm)	17.100			
Ratio-R	0.300			
Summer CV	1.000			
Winter CV	1.000			
Analysis Speed	Normal			
Skip Steady State	x			
Drain Down Time (mins)	240			
Additional Storage (m³/ha)	20.0			
Storm Durations (mins)	15			
	30			
	60			
	120			
	180			
	240			
	360			
	480			
	600			
	720			
	960			
	1440			
Check Discharge Rate(s)	x			
1 year (l/s)				
30 year (l/s)				
100 year (l/s)				
Check Discharge Volume	x			
100 year 360 minute (m³)				

Orifice										
Node	**Flap Valve**	**Online / Offline**	**Downstream Link**	**Replaces Downstream Link**	**Loop to Node**	**Invert Level (m)**	**Design Depth (m)**	**Design Flow (l/s)**	**Diameter (m)**	**Discharge Coefficient**
US 10-1	x	Online		x		59.757	1.500	0.3	0.010	0.600
US 10-2	x	Online		x		59.765	1.450	0.3	0.010	0.600
US10-3	x	Online		x		59.442	1.450	0.3	0.010	0.600
US10-4	x	Online		x		59.496	1.150	0.3	0.011	0.600
US 10-5	x	Online		x		59.657	1.050	0.3	0.011	0.600

Depth/Area/Inf Area									
Node	Base Inf Coefficient (m/hr)	Side Inf Coefficient (m/hr)	Safety Factor	Porosity	Invert Level (m)	Time to half empty (mins)	Depth (m)	Area (m²)	Inf. Area (m²)
US 10-1	0.00000	0.00000	2.0	0.30	59.757		0.000	150.0	0.0
							1.500	150.0	0.0
							1.510	0.0	0.0
US 10-2	0.00000	0.00000	2.0	0.30	59.765		0.000	150.0	0.0
							1.450	150.0	0.0
							1.460	0.0	0.0
US10-3	0.00000	0.00000	2.0	0.30	59.442		0.000	150.0	0.0
							1.450	150.0	0.0
							1.460	0.0	0.0
US10-4	0.00000	0.00000	2.0	0.30	59.496		0.000	260.0	0.0
							1.150	260.0	0.0
							1.160	0.0	0.0
US 10-5	0.00000	0.00000	2.0	0.30	59.657		0.000	210.0	0.0
							1.050	210.0	0.0
							1.060	0.0	0.0

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
100 year 15 minute summer	272.618	77.141
100 year 15 minute winter	191.311	77.141
100 year 30 minute summer	185.560	52.507
100 year 30 minute winter	130.217	52.507
100 year 60 minute summer	126.807	33.511
100 year 60 minute winter	84.247	33.511
100 year 120 minute summer	78.947	20.863
100 year 120 minute winter	52.450	20.863
100 year 180 minute summer	60.923	15.678
100 year 180 minute winter	39.601	15.678
100 year 240 minute summer	48.375	12.784
100 year 240 minute winter	32.139	12.784
100 year 360 minute summer	37.146	9.559
100 year 360 minute winter	24.146	9.559
100 year 480 minute summer	29.392	7.767
100 year 480 minute winter	19.527	7.767
100 year 600 minute summer	24.161	6.609
100 year 600 minute winter	16.508	6.609
100 year 720 minute summer	21.602	5.790
100 year 720 minute winter	14.518	5.790
100 year 960 minute summer	17.838	4.697
100 year 960 minute winter	11.816	4.697
100 year 1440 minute summer	13.048	3.497
100 year 1440 minute winter	8.769	3.497

Results for 100 year Critical Storm Duration. Lowest mass balance: 99.68%

Event	US Node ID	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status	Link ID	DS Node ID	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
30 minute summer	SWMH 10-0	20	60.238	0.536	40.7	1.4156	0.0000	SURCHARGED	1.000	SWMH 10-1	39.0	0.706	0.385	5.0526	
1440 minute winter	US 10-1	1380	60.731	0.974	1.7	45.5956	0.0000	SURCHARGED	2.000	SWMH 10A-0	0.2	0.137	0.008	0.0095	
1440 minute winter	US 10-2	1380	60.738	0.973	1.7	45.5864	0.0000	SURCHARGED	3.000	SWMH 10A-0	0.2	0.137	0.008	0.0132	
30 minute summer	SWMH 10A-0	20	60.309	0.565	18.1	0.7776	0.0000	SURCHARGED	2.001	SWMH 10-1	11.9	0.464	0.459	1.4276	
30 minute summer	SWMH 10-1	20	60.246	0.697	71.2	1.2438	0.0000	SURCHARGED	1.001	SWMH 10-2	56.9	0.588	0.562	7.3421	
30 minute summer	SWMH 10B-0	20	60.207	0.686	13.7	0.8855	0.0000	SURCHARGED	4.000	SWMH 10-2	11.1	0.284	0.428	1.4237	
1440 minute winter	US10-3	1380	60.416	0.974	1.7	45.6026	0.0000	SURCHARGED	5.000	SWMH 10-2	0.2	0.214	0.008	0.0117	
30 minute summer	SWMH 10-2	20	60.177	0.850	95.2	2.0271	0.0000	SURCHARGED	1.002	SWMH 10-3	88.9	0.806	0.876	2.0753	
30 minute summer	SWMH 10C-0	21	60.186	0.606	11.1	0.8300	0.0000	SURCHARGED	6.000	SWMH 10C-1	-5.3	0.265	-0.096	0.8081	
30 minute summer	SWMH 10C-1	21	60.185	0.643	22.9	1.0576	0.0000	SURCHARGED	6.001	SWMH 10C-2	15.9	0.390	0.284	1.4081	
30 minute summer	SWMH 10D-0	21	60.190	0.648	12.9	1.0675	0.0000	SURCHARGED	7.000	SWMH 10C-2	9.3	0.354	0.358	0.8013	
1440 minute winter	US10-4	1410	60.634	1.138	3.1	91.9117	0.0000	SURCHARGED	8.000	SWMH 10C-2	0.3	0.201	0.010	0.0324	
30 minute summer	SWMH 10C-2	21	60.181	0.706	45.9	1.3052	0.0000	SURCHARGED	6.002	SWMH 10C-3	42.9	0.614	0.768	2.5150	
1440 minute winter	US 10-5	1410	60.571	0.914	2.1	59.6584	0.0000	SURCHARGED	9.000	SWMH 10E-0	0.2	0.229	0.009	0.0100	
30 minute summer	SWMH 10E-0	21	60.162	0.611	25.8	1.1003	0.0000	SURCHARGED	9.001	SWMH 10C-3	22.5	0.320	0.403	5.7000	
30 minute summer	SWMH 10C-3	21	60.133	0.852	94.4	1.8403	0.0000	SURCHARGED	6.003	SWMH 10-3	92.1	0.835	0.897	0.5477	
30 minute summer	SWMH 10-3	21	60.123	0.859	179.1	1.5600	0.0000	SURCHARGED	1.003	SWMH 10-4	174.9	1.609	1.727	9.5103	182.1
30 minute summer	SWMH 10-4	21	59.264	0.307	174.9	0.0000	0.0000	OK							

Drainage Design Report

Flow+

v8.1

Network	Flow Path
Filename	Q:\2016 Jobs\16_053 Barnhill Lands LAP\InfoDrainage Design\New Network\Main Network June 2022_Final.pfd
Username	Tomislav Bozinovic (Tomislav.Bozinovic@csea.ie)
Last analysed	28/06/2022 11:18:47
Report produced on	28/06/2022 11:44:02

Rainfall Methodology	FSR
Return Period (years)	100
Additional Flow (%)	0
FSR Region	Scotland and Ireland
M5-60 (mm)	17.100
Ratio-R	0.300
CV	0.750
Time of Entry (mins)	5.00
Maximum Time of Concentration (mins)	30.00
Maximum Rainfall (mm/hr)	50.0
Minimum Velocity (m/s)	1.00
Connection Type	Level Soffits
Minimum Backdrop Height (m)	0.200
Preferred Cover Depth (m)	1.200
Include Intermediate Ground	
Enforce best practice design rules	x

Name	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
SWMH 7D-0	61.975	1200	703517.409	738595.896	1.450
US30	60.990	1200	703321.153	738673.153	0.958
SWMH 7B-0	60.894	1200	703325.334	738672.193	0.876
SWMH 7B-1	61.174	1200	703346.601	738704.702	1.285
US32	62.170	1200	703377.102	738640.461	1.800
SWMH 7C-0	62.071	1200	703385.446	738638.918	1.730
US40	61.710	1200	703405.131	738658.036	2.011
SWMH 7B-2	61.618	1200	703402.885	738667.882	2.028
SWMH 7B-3	63.209	1200	703457.812	738631.950	3.913
SWMH 7B-4	63.062	1200	703436.251	738598.992	3.879
SWMH 7F-0	61.026	1200	703578.741	738518.475	1.293
SWMH 7F-1	61.425	1200	703522.767	738539.386	1.966
SWMH 7F-2	61.823	1200	703466.793	738560.297	2.638
US39	62.250	1200	703417.713	738577.789	2.969
SWMH 7B-5	62.151	1200	703424.193	738576.212	3.117
US25	61.320	1200	703325.337	738707.949	1.070
SWMH 7-0	61.221	1200	703326.222	738714.916	1.016
SWMH 7-1	61.381	1200	703301.968	738716.976	1.257
US26	61.430	1200	703283.726	738705.117	1.361
SWMH 7-2	61.335	1200	703279.877	738710.615	1.299
SWMH 7-3	61.195	1200	703262.144	738698.821	1.219
US27	61.160	1200	703255.690	738679.148	1.232
SWMH 7-4	61.056	1200	703249.475	738681.810	1.226
SWMH 7-5	61.007	1200	703245.370	738667.728	1.226
SWMH 7-6	61.071	1200	703250.398	738658.728	1.324
US28	61.300	1200	703265.090	738639.153	1.555
US29	62.020	1200	703275.840	738631.506	2.315
SWMH 7-7	61.924	1200	703280.539	738632.411	2.385
US31	60.980	1200	703327.108	738662.393	1.158
SWMH 7A-0	61.080	1200	703323.817	738663.208	1.269
SWMH 7-8	61.458	1200	703292.135	738619.571	1.977
US34	61.670	1200	703298.369	738601.880	2.085
SWMH 7-9	61.573	1200	703301.005	738604.437	2.150
US35	62.420	1200	703320.892	738585.472	2.913
US44	62.420	1200	703322.905	738595.809	2.907
SWMH 7-10	62.321	1200	703320.659	738590.080	2.979
US33	62.320	1200	703384.815	738629.845	1.636

SWMH 7E-0	62.224	1200	703380.556	738631.346	1.555
SWMH 7E-1	61.957	1200	703359.503	738602.198	1.528
US36	61.820	1200	703349.245	738577.235	2.425
SWMH 7-11	61.715	1200	703352.974	738580.091	2.561
US37	61.660	1200	703373.158	738561.892	2.322
SWMH 7-12	61.563	1200	703371.882	738568.483	2.472
US38	61.500	1200	703390.677	738550.577	2.240
SWMH 7-13	61.401	1200	703392.046	738554.421	2.380
US41	61.390	1200	703420.215	738546.929	2.202
SWMH 7-14	61.293	1200	703416.197	738547.500	2.419
SWMH 7G-0	59.707	1200	703438.328	738455.143	1.672
US24	59.680	1200	703394.271	738463.109	1.936
SWMH 7-15	59.611	1200	703400.294	738461.994	2.262
SWMH 7H-0	59.625	1200	703476.935	738382.268	2.686
SWMH 7-16	58.557	1200	703390.639	738397.811	2.281
SWMH 6-0	58.867	1200	703079.035	738367.156	1.084
US4	58.820	1200	703104.886	738356.465	1.310
SWMH 6-1	58.703	1200	703099.119	738360.446	1.216
SWMH 6-2	58.925	1200	703113.964	738404.885	1.444
SWMH 6A-0	58.706	1200	703146.787	738348.115	1.160
SWMH 6-3	58.941	1200	703159.170	738390.689	1.618
SWMH 6-4	59.071	1200	703174.782	738418.461	1.929
SWMH 6B-0	61.483	1200	703285.404	738557.916	1.596
US13	61.660	1200	703240.377	738538.986	1.751
SWMH 6C-0	61.562	1200	703243.727	738544.758	1.675
US12	61.650	1200	703267.093	738542.442	1.838
SWMH 6B-1	61.670	1200	703278.625	738534.607	2.054
SWMH 6E-0	59.567	1200	703307.164	738457.431	1.108
US16	60.300	1200	703255.938	738482.036	1.965
SWMH 6D-1	60.506	1200	703226.883	738480.782	2.095
US20	59.900	1200	703269.809	738472.442	1.572
US21	59.900	1200	703266.684	738462.172	1.567
SWMH 6B-2	60.506	1200	703260.154	738471.104	2.510
US19	58.790	1200	703237.338	738418.005	1.663
SWMH 6-5	58.549	1200	703239.574	738400.349	1.856
SWMH 6F-0	61.693	1200	703283.426	738533.211	2.445
US14	60.380	1200	703340.584	738521.002	2.426
US15	60.410	1200	703335.280	738511.324	2.445
SWMH 6F-1	60.325	1200	703347.006	738514.718	2.476
US23	59.230	1200	703335.754	738461.180	1.679

SWMH 6F-2	59.107	1200	703330.571	738458.213	1.726
SWMH 6F-3	58.080	1200	703314.318	738393.170	1.371
US22	58.300	1200	703290.600	738401.624	1.380
SWMH 6-6	57.965	1200	703311.248	738379.501	1.671
SWMH 6-7	58.500	1200	703380.748	738359.286	2.563
SWMH 6-8	58.250	1200	703406.679	738325.993	2.434
SWMH 6-9	58.250	1800	703405.682	738320.484	2.450
SWMH 8C-0	59.825	1200	703493.912	738379.210	1.832
SWMH 8D-0	61.250	1200	703621.099	738539.629	1.600
SWMH 8D-1	60.750	1200	703594.706	738484.643	1.785
SWMH 8D-2	60.175	1200	703570.209	738423.921	1.940
SWMH 8D-3	60.250	1200	703565.033	738393.755	2.219
SWMH 8C-1	60.041	1200	703544.437	738370.109	2.219
SWMH 8-0	60.400	1200	703664.671	738446.657	1.704
SWMH 8-1	60.500	1200	703714.308	738427.245	2.070
SWMH 8-2	59.634	1200	703705.658	738380.440	1.521
SWMH 8A-0	60.050	1200	703594.167	738408.210	1.740
SWMH 8A-1	60.050	1200	703634.316	738392.507	1.884
SWMH 8-3	59.515	1200	703702.172	738365.968	1.592
SWMH 8-4	59.450	1200	703691.637	738324.443	1.939
SWMH 8B-0	59.555	1200	703619.304	738362.872	1.918
US43	59.190	1200	703624.523	738343.369	1.808
SWMH 8-5	59.174	1200	703614.863	738338.344	2.053
US42	59.750	1200	703557.551	738355.490	2.563
SWMH 8-6	59.801	1200	703543.305	738351.299	3.038
SWMH 8-7	59.681	1200	703541.327	738340.374	2.950
SWMH 8-8	59.251	1200	703523.865	738343.535	2.579
SWMH 8-9	58.950	1200	703505.169	738346.920	2.341
SWMH 8-10	58.750	1200	703500.404	738320.598	2.863
SWMH 8-11	58.475	1200	703493.386	738304.647	2.675
SWMH 6-10	58.100	1800	703442.112	738274.762	2.419
SWMH 5-0	58.539	1200	703112.396	738334.863	0.944
US3	58.430	1200	703095.423	738327.306	0.851
SWMH 5-1	58.463	1200	703095.372	738340.550	0.928
SWMH 5-2	58.590	1200	703077.456	738286.919	1.243
SWMH 5A-0	58.503	1200	703015.729	738320.465	0.936
US1	58.780	1200	703040.512	738302.343	1.301
SWMH 5A-1	58.708	1200	703037.675	738299.668	1.242
SWMH 5A-2	58.814	1200	703059.559	738284.931	1.436
SWMH 5-3	58.825	1200	703076.528	738277.982	1.658

SWMH 5-4	58.395	1200	703115.668	738264.424	1.366
SWMH 5-5	58.424	1200	703126.433	738267.507	1.507
SWMH 5B-0	58.501	1200	703143.637	738337.285	1.298
SWMH 5-6	58.014	1200	703131.305	738293.888	1.261
SWMH 5C-0	59.218	1200	703233.102	738372.927	1.362
SWMH 5C-1	59.067	1200	703228.440	738357.083	1.294
SWMH 5D-0	59.200	1200	703187.284	738353.042	1.386
SWMH 5D-1	58.988	1200	703216.939	738344.414	1.277
SWMH 5C-2	58.857	1200	703222.267	738341.807	1.241
SWMH 5C-3	58.694	1200	703211.750	738324.383	1.282
SWMH 5C-4	58.487	1200	703198.244	738308.948	1.355
SWMH 5C-5	58.295	1200	703184.020	738296.027	1.355
SWMH 5-7	58.212	1200	703172.612	738282.110	1.677
SWMH 5-8	58.380	1200	703211.630	738250.126	1.989
SWMH 5E-0	58.075	1200	703308.368	738368.941	0.943
SWMH 5E-1	58.309	1200	703304.559	738353.506	1.233
SWMH 5E-2	58.332	1200	703294.925	738324.201	1.356
SWMH 5E-3	58.069	1200	703276.244	738289.221	1.300
SWMH 5E-4	58.104	1200	703251.179	738258.538	1.468
SWMH 5-9	57.715	1200	703254.308	738236.431	1.527
SWMH 5-10	57.575	1200	703298.708	738247.218	1.518
SWMH 5-11	57.650	1200	703381.756	738250.121	1.831
SWMH 5-12	57.650	1200	703388.152	738248.963	1.850
SWMH 6-11	58.100	1800	703408.794	738240.654	2.450
SWMH 6-12	57.760	1800	703407.828	738235.829	2.120
SWMH 6-13	56.955	1200	703305.858	738221.674	1.475
US17	60.600	1200	703224.551	738485.642	2.173
US18	60.600	1200	703223.007	738475.735	2.164
US5	59.160	1200	703232.480	738357.759	1.370
US6	58.794	1200	703214.813	738324.174	1.294
US7	58.587	1200	703202.063	738308.701	1.302
US8	58.409	1200	703301.861	738355.208	1.317
US9	58.432	1200	703292.153	738325.813	1.437
US10	58.169	1200	703273.530	738291.012	1.319
US11	58.204	1200	703248.720	738260.276	1.454
UCS 1	60.150	1200	703601.690	738412.047	1.620
UCS 2	60.150	1200	703639.495	738397.507	1.700
UCS 3	59.925	1200	703495.780	738385.246	1.675
UCS 4	59.725	1200	703478.239	738387.223	2.525
UCS 5	58.657	1200	703399.865	738401.356	1.907

	UCS 6	62.000	1200	703472.354	738572.230	2.550
	UCS 7	61.300	1200	703527.833	738553.928	1.650

Name	US Node	DS Node	US IL (m)	DS IL (m)	Slope (1:X)	Dia (mm)
1.000	SWMH 7D-0	SWMH 7B-3	60.525	60.293	300.2	225
2.000	US30	SWMH 7B-0	60.032	60.018	306.4	225
2.001	SWMH 7B-0	SWMH 7B-1	60.018	59.889	301.1	225
2.002	SWMH 7B-1	SWMH 7B-2	59.889	59.665	300.3	450
3.000	US32	SWMH 7C-0	60.370	60.341	295.3	225
3.001	SWMH 7C-0	SWMH 7B-2	60.341	59.665	50.0	225
4.000	US40	SWMH 7B-2	59.699	59.665	297.0	225
2.003	SWMH 7B-2	SWMH 7B-3	59.590	59.371	299.7	450
1.001	SWMH 7B-3	SWMH 7B-4	59.296	59.183	348.5	450
1.002	SWMH 7B-4	SWMH 7B-5	59.183	59.109	348.3	450
5.000	SWMH 7F-0	SWMH 7F-1	59.733	59.534	300.3	300
5.001	SWMH 7F-1	SWMH 7F-2	59.459	59.260	300.3	375
5.002	SWMH 7F-2	SWMH 7B-5	59.185	59.034	301.2	450
6.000	US39	SWMH 7B-5	59.281	59.259	303.1	225
1.003	SWMH 7B-5	SWMH 7-14	59.034	58.949	350.6	525
7.000	US25	SWMH 7-0	60.250	60.215	200.7	225
7.001	SWMH 7-0	SWMH 7-1	60.205	60.124	300.5	225
7.002	SWMH 7-1	SWMH 7-2	60.124	60.047	298.6	225
8.000	US26	SWMH 7-2	60.069	60.036	201.6	225
7.003	SWMH 7-2	SWMH 7-3	60.047	59.976	300.0	225
7.004	SWMH 7-3	SWMH 7-4	59.976	59.905	298.7	225
9.000	US27	SWMH 7-4	59.928	59.894	198.8	225
7.005	SWMH 7-4	SWMH 7-5	59.830	59.781	299.3	300
7.006	SWMH 7-5	SWMH 7-6	59.781	59.747	303.2	300
7.007	SWMH 7-6	SWMH 7-7	59.747	59.614	300.8	300
10.000	US28	SWMH 7-7	59.745	59.689	301.0	225
11.000	US29	SWMH 7-7	59.705	59.689	299.1	225
7.008	SWMH 7-7	SWMH 7-8	59.539	59.481	298.3	375
12.000	US31	SWMH 7A-0	59.822	59.811	308.2	225
12.001	SWMH 7A-0	SWMH 7-8	59.811	59.631	299.6	225
7.009	SWMH 7-8	SWMH 7-9	59.481	59.423	302.4	375
13.000	US34	SWMH 7-9	59.585	59.573	306.0	225
7.010	SWMH 7-9	SWMH 7-10	59.423	59.342	300.5	375
14.000	US35	SWMH 7-10	59.507	59.492	307.6	225
15.000	US44	SWMH 7-10	59.513	59.492	293.0	225
7.011	SWMH 7-10	SWMH 7-11	59.342	59.229	299.3	375
16.000	US33	SWMH 7E-0	60.684	60.669	301.1	225

16.001	SWMH 7E-0	SWMH 7E-1	60.669	60.429	149.8	225
16.002	SWMH 7E-1	SWMH 7-11	60.429	60.276	150.7	225
17.000	US36	SWMH 7-11	59.395	59.379	293.6	225
7.012	SWMH 7-11	SWMH 7-12	59.154	59.091	352.2	450
18.000	US37	SWMH 7-12	59.338	59.316	305.1	225
7.013	SWMH 7-12	SWMH 7-13	59.091	59.021	351.2	450
19.000	US38	SWMH 7-13	59.260	59.246	291.4	225
7.014	SWMH 7-13	SWMH 7-14	59.021	58.949	348.9	450
20.000	US41	SWMH 7-14	59.188	59.174	289.9	225
1.004	SWMH 7-14	SWMH 7-15	58.874	57.424	60.0	525
21.000	SWMH 7G-0	SWMH 7-15	58.035	57.649	100.1	300
22.000	US24	SWMH 7-15	57.744	57.724	306.3	225
1.005	SWMH 7-15	SWMH 7-16	57.349	56.351	65.0	600
23.000	SWMH 7H-0	SWMH 7-16	56.939	56.501	200.2	450
1.006	SWMH 7-16	SWMH 6-7	56.276	56.162	348.9	675
24.000	SWMH 6-0	SWMH 6-1	57.783	57.712	298.2	300
25.000	US4	SWMH 6-1	57.510	57.487	304.7	225
24.001	SWMH 6-1	SWMH 6-2	57.712	57.556	300.3	300
24.002	SWMH 6-2	SWMH 6-3	57.481	57.323	299.9	300
26.000	SWMH 6A-0	SWMH 6-3	57.546	57.398	299.6	225
24.003	SWMH 6-3	SWMH 6-4	57.323	57.217	300.6	450
24.004	SWMH 6-4	SWMH 6-5	57.142	56.918	300.3	450
27.000	SWMH 6B-0	SWMH 6B-1	59.887	59.766	200.6	225
28.000	US13	SWMH 6C-0	59.909	59.887	303.4	225
28.001	SWMH 6C-0	SWMH 6B-1	59.887	59.766	300.4	225
29.000	US12	SWMH 6B-1	59.812	59.766	303.1	225
27.001	SWMH 6B-1	SWMH 6B-2	59.616	58.146	45.0	375
30.000	SWMH 6E-0	SWMH 6B-2	58.459	58.296	300.4	225
31.000	US16	SWMH 6B-2	58.335	58.296	300.4	225
35.000_1	US17	SWMH 6D-1	58.427	58.413	385.0	225
33.000	US20	SWMH 6B-2	58.328	58.296	304.6	225
34.000	US21	SWMH 6B-2	58.333	58.296	299.1	225
27.002	SWMH 6B-2	SWMH 6-5	57.996	56.768	60.0	525
35.000	US19	SWMH 6-5	57.127	57.068	301.6	225
24.005	SWMH 6-5	SWMH 6-6	56.693	56.444	299.8	600
36.000	SWMH 6F-0	SWMH 6F-1	59.248	57.924	50.0	225
37.000	US14	SWMH 6F-1	57.954	57.924	295.6	225
38.000	US15	SWMH 6F-1	57.965	57.924	297.7	225
36.001	SWMH 6F-1	SWMH 6F-2	57.849	57.456	149.7	300
39.000	US23	SWMH 6F-2	57.551	57.531	298.6	225

	36.002	SWMH 6F-2	SWMH 6F-3	57.381	56.709	99.9	375
	36.003	SWMH 6F-3	SWMH 6-6	56.709	56.669	347.2	375
	40.000	US22	SWMH 6-6	56.920	56.819	299.6	225
	24.006	SWMH 6-6	SWMH 6-7	56.294	56.087	349.7	750
	1.007	SWMH 6-7	SWMH 6-8	55.937	55.816	348.8	900
	1.008	SWMH 6-8	SWMH 6-9	55.816	55.800	349.9	900
	1.009	SWMH 6-9	SWMH 6-10	55.800	55.683	499.7	900
	41.000	SWMH 8C-0	SWMH 8C-1	57.993	57.822	300.2	450
	42.000	SWMH 8D-0	SWMH 8D-1	59.650	59.040	100.0	300
	42.001	SWMH 8D-1	SWMH 8D-2	58.965	58.310	100.0	375
	42.002	SWMH 8D-2	SWMH 8D-3	58.235	58.031	150.0	450
	42.003	SWMH 8D-3	SWMH 8C-1	58.031	57.822	150.0	450
	41.001	SWMH 8C-1	SWMH 8-6	57.822	57.759	299.1	450
	43.000	SWMH 8-0	SWMH 8-1	58.696	58.430	200.4	375
	43.001	SWMH 8-1	SWMH 8-2	58.430	58.113	150.2	375
	43.002	SWMH 8-2	SWMH 8-3	58.113	58.014	150.4	375
	44.000	SWMH 8A-0	SWMH 8A-1	58.310	58.166	299.4	450
	44.001	SWMH 8A-1	SWMH 8-3	58.166	57.923	299.8	450
	43.003	SWMH 8-3	SWMH 8-4	57.923	57.511	104.0	450
	43.004	SWMH 8-4	SWMH 8-5	57.511	57.121	200.1	450
	45.000	SWMH 8B-0	SWMH 8-5	57.637	57.138	50.0	225
	46.000	US43	SWMH 8-5	57.382	57.346	302.5	225
	43.005	SWMH 8-5	SWMH 8-6	57.121	56.913	349.6	450
	47.000	US42	SWMH 8-6	57.187	57.138	303.0	225
	41.002	SWMH 8-6	SWMH 8-7	56.763	56.731	347.0	600
	41.003	SWMH 8-7	SWMH 8-8	56.731	56.672	300.8	600
	41.004	SWMH 8-8	SWMH 8-9	56.672	56.609	301.6	600
	41.005	SWMH 8-9	SWMH 8-10	56.609	56.520	300.6	600
	41.006	SWMH 8-10	SWMH 8-11	55.887	55.800	200.3	600
	41.007	SWMH 8-11	SWMH 6-10	55.800	55.681	498.7	600
	1.010	SWMH 6-10	SWMH 6-11	55.683	55.650	1444.8	900
	48.000	SWMH 5-0	SWMH 5-1	57.595	57.535	299.2	225
	49.000	US3	SWMH 5-1	57.579	57.535	301.0	225
	48.001	SWMH 5-1	SWMH 5-2	57.535	57.347	300.8	225
	48.002	SWMH 5-2	SWMH 5-3	57.347	57.317	299.5	225
	50.000	SWMH 5A-0	SWMH 5A-1	57.567	57.466	299.3	225
	51.000	US1	SWMH 5A-1	57.479	57.466	299.9	225
	50.001	SWMH 5A-1	SWMH 5A-2	57.466	57.378	299.8	225
	50.002	SWMH 5A-2	SWMH 5-3	57.378	57.317	300.6	225
	48.003	SWMH 5-3	SWMH 5-4	57.167	57.029	300.2	375

48.004	SWMH 5-4	SWMH 5-5	57.029	56.992	302.6	375
48.005	SWMH 5-5	SWMH 5-6	56.917	56.828	301.4	450
52.000	SWMH 5B-0	SWMH 5-6	57.203	57.053	300.8	225
48.006	SWMH 5-6	SWMH 5-7	56.753	56.610	300.4	525
53.000	SWMH 5C-0	SWMH 5C-1	57.856	57.773	199.0	300
53.001	SWMH 5C-1	SWMH 5C-2	57.773	57.691	200.9	300
54.000	SWMH 5D-0	SWMH 5D-1	57.814	57.711	299.9	225
54.001	SWMH 5D-1	SWMH 5C-2	57.711	57.691	296.6	225
53.002	SWMH 5C-2	SWMH 5C-3	57.616	57.412	99.8	375
53.003	SWMH 5C-3	SWMH 5C-4	57.412	57.207	100.0	375
53.004	SWMH 5C-4	SWMH 5C-5	57.132	56.940	100.1	375
53.005	SWMH 5C-5	SWMH 5-7	56.940	56.760	100.0	375
48.007	SWMH 5-7	SWMH 5-8	56.535	56.391	350.4	600
48.008	SWMH 5-8	SWMH 5-9	56.391	56.263	350.2	600
55.000	SWMH 5E-0	SWMH 5E-1	57.132	57.079	300.0	225
55.001	SWMH 5E-1	SWMH 5E-2	57.079	56.976	299.5	225
55.002	SWMH 5E-2	SWMH 5E-3	56.976	56.844	300.4	225
55.003	SWMH 5E-3	SWMH 5E-4	56.769	56.636	299.8	300
55.004	SWMH 5E-4	SWMH 5-9	56.636	56.563	301.5	300
48.009	SWMH 5-9	SWMH 5-10	56.188	56.057	348.8	675
48.010	SWMH 5-10	SWMH 5-11	56.057	55.819	349.2	675
48.011	SWMH 5-11	SWMH 5-12	55.819	55.800	342.1	675
45.012	SWMH 5-12	SWMH 6-10	55.800	55.700	600.0	675
1.011	SWMH 6-11	SWMH 6-12	55.650	55.640	492.2	900
1.012	SWMH 6-12	SWMH 6-13	55.640	55.480	643.4	900
34.001	SWMH 6D-1	SWMH 6B-2	58.411	58.296	301.3	225
34.000_1	US18	SWMH 6D-1	58.436	58.413	276.7	225
52.000_1	US5	SWMH 5C-1	57.790	57.773	241.0	225
53.000_1	US6	SWMH 5C-3	57.500	57.485	200.0	225
54.000_1	US7	SWMH 5C-4	57.285	57.266	200.0	225
59.000	US11	SWMH 5E-4	56.750	56.735	200.0	225
58.000	US10	SWMH 5E-3	56.850	56.834	200.0	225
57.000	US9	SWMH 5E-2	56.995	56.979	200.0	225
56.000	US8	SWMH 5E-1	57.092	57.076	200.0	225
60.000	UCS 1	SWMH 8A-0	58.530	58.488	200.0	300
61.000	UCS 2	SWMH 8A-1	58.450	58.414	200.0	225
66.000	UCS 3	SWMH 8C-0	58.250	58.218	200.0	225
25.000_1	UCS 4	SWMH 7H-0	57.200	57.174	200.0	225
26.000_1	UCS 5	SWMH 7-16	56.750	56.701	200.0	225
20.000_1	UCS 6	SWMH 7F-2	59.450	59.384	199.5	225

	19.000_1	UCS 7	SWMH 7F-1	59.650	59.573	200.0	225

			Return Period (years)	Climate Change (%)
Rainfall Methodology	FSR			
FSR Region	Scotland and Ireland		100	10
M5-60 (mm)	17.100			
Ratio-R	0.300			
Summer CV	0.750			
Winter CV	0.840			
Analysis Speed	Normal			
Skip Steady State	x			
Drain Down Time (mins)	240			
Additional Storage (m³/ha)	20.0			
Storm Durations (mins)	15			
	30			
	60			
	120			
	180			
	240			
	360			
	480			
	600			
	720			
	960			
	1440			
Check Discharge Rate(s)	x			
1 year (l/s)				
30 year (l/s)				
100 year (l/s)				
Check Discharge Volume	x			
100 year 360 minute (m³)				

Orifice

Node	Flap Valve	Online / Offline	Downstream Link	Replaces Downstream Link	Loop to Node	Invert Level (m)	Design Depth (m)	Design Flow (l/s)	Diameter (m)	Discharge Coefficient
US25	x	Online		x		60.250	0.650	0.5	0.017	0.600
US26	x	Online		x		60.069	0.950	1.0	0.022	0.600
US27	x	Online		x		59.928	0.850	1.0	0.022	0.600
US28	x	Online		x		59.745	1.150	0.3	0.011	0.600
US31	x	Online		x		59.822	0.750	0.3	0.012	0.600
US34	x	Online		x		59.585	1.650	0.3	0.010	0.600
US37	x	Online		x		59.338	1.900	0.5	0.013	0.600
US38	x	Online		x		59.260	1.850	0.3	0.010	0.600
US30	x	Online		x		60.032	0.550	0.8	0.022	0.600
US32	x	Online		x		60.370	1.400	0.3	0.011	0.600
US40	x	Online		x		59.699	1.600	0.3	0.010	0.600
US39	x	Online		x		59.281	2.550	0.3	0.009	0.600
US41	x	Online		x		59.188	2.050	0.3	0.010	0.600
US24	x	Online		x		57.744	1.950	0.3	0.010	0.600
US3	x	Online		x		57.579	0.450	20.0	0.124	0.600
US1	x	Online		x		57.479	0.900	4.0	0.045	0.600
US5	x	Online		x		57.790	0.950	0.3	0.012	0.600
US6	x	Online		x		57.500	0.900	0.3	0.012	0.600
US8	x	Online		x		57.092	0.900	1.5	0.027	0.600
US9	x	Online		x		56.995	1.000	0.3	0.012	0.600
US10	x	Online		x		56.850	0.900	0.3	0.012	0.600
US11	x	Online		x		56.750	1.000	0.3	0.012	0.600
US43	x	Online		x		57.382	1.400	0.3	0.011	0.600
US42	x	Online		x		57.187	2.150	0.3	0.009	0.600
US4	x	Online		x		57.510	0.900	2.0	0.031	0.600
US12	x	Online		x		59.812	1.450	1.5	0.024	0.600
US13	x	Online		x		59.909	1.350	0.3	0.011	0.600
US17	x	Online		x		58.427	1.750	1.0	0.019	0.600
US18	x	Online		x		58.436	1.750	1.0	0.019	0.600
US20	x	Online		x		58.328	1.150	0.5	0.014	0.600
US21	x	Online		x		58.333	1.150	1.5	0.025	0.600
US16	x	Online		x		58.335	1.550	0.3	0.010	0.600
US19	x	Online		x		57.127	1.250	0.5	0.014	0.600
US22	x	Online		x		56.920	1.000	2.0	0.031	0.600
US14	x	Online		x		57.954	2.000	0.3	0.010	0.600
US15	x	Online		x		57.965	2.000	0.3	0.010	0.600
US23	x	Online		x		57.551	1.300	0.3	0.011	0.600

Hydro-Brake®

Node	Flap Valve	Online / Offline	Downstream Link	Replaces Downstream Link	Loop to Node	Invert Level (m)	Design Depth (m)	Design Flow (l/s)	Objective	Sump Available	Product Number	Min Outlet Diameter (m)	Min Node Diameter (mm)
UCS 7	x	Online		x		59.650	1.250	2.5	(HE) Minimise upstream storage		CTL-SHE-0072-2500-1250-2500	0.100	1200
UCS 6	x	Online		x		59.450	2.150	0.3	(HE) Minimise upstream storage		CTL-SHE-0021-3000-2150-3000	0.075	1200
UCS 4	x	Online		x		57.200	2.100	0.5	(HE) Minimise upstream storage		CTL-SHE-0027-5000-2100-5000	0.075	1200
UCS 5	x	Online		x		56.750	1.500	0.5	(HE) Minimise upstream storage		CTL-SHE-0029-5000-1500-5000	0.075	1200
UCS 1	x	Online		x		58.530	1.200	7.0	(HE) Minimise upstream storage		CTL-SHE-0121-7000-1200-7000	0.150	1200
UCS 2	x	Online		x		58.450	1.300	1.5	(HE) Minimise upstream storage		CTL-SHE-0054-1500-1300-1500	0.075	1200
UCS 3	x	Online		x		58.250	2.350	0.5	(HE) Minimise upstream storage		CTL-SHE-0026-5000-2350-5000	0.075	1200
SWMH 6-11	x	Online		x		55.650	2.000	30.0	(HE) Minimise upstream storage		CTL-SHE-0223-3000-2000-3000	0.300	1800

Depth/Area/Inf Area									
Node	Base Inf Coefficient (m/hr)	Side Inf Coefficient (m/hr)	Safety Factor	Porosity	Invert Level (m)	Time to half empty (mins)	Depth (m)	Area (m²)	Inf. Area (m²)
US25	0.00000	0.00000	2.0	0.30	60.250	264	0.000	60.0	0.0
							0.700	60.0	0.0
							0.701	0.0	0.0
US26	0.00000	0.00000	2.0	0.30	60.069	108	0.000	25.0	0.0
							1.000	25.0	0.0
							1.010	0.0	0.0
US27	0.00000	0.00000	2.0	0.30	59.928		0.000	170.0	0.0
							0.850	170.0	0.0
							0.860	0.0	0.0
US28	0.00000	0.00000	2.0	0.30	59.745	210	0.000	155.0	0.0
							1.150	155.0	0.0
							1.160	0.0	0.0
US31	0.00000	0.00000	2.0	0.30	59.822		0.000	380.0	0.0
							0.750	380.0	0.0
							0.760	0.0	0.0
US34	0.00000	0.00000	2.0	0.30	59.585		0.000	65.0	0.0
							1.650	65.0	0.0
							1.660	0.0	0.0
US37	0.00000	0.00000	2.0	0.30	59.338	0	0.000	100.0	0.0
							1.900	100.0	0.0
							1.910	0.0	0.0
US38	0.00000	0.00000	2.0	0.30	59.260		0.000	100.0	0.0
							1.850	100.0	0.0
							1.860	0.0	0.0
US30	0.00000	0.00000	2.0	0.30	60.032		0.000	290.0	0.0
							0.600	290.0	0.0
							0.610	0.0	0.0
US32	0.00000	0.00000	2.0	0.30	60.370	150	0.000	325.0	0.0
							1.400	325.0	0.0
							1.410	0.0	0.0
US40	0.00000	0.00000	2.0	0.30	59.699	0	0.000	255.0	0.0
							1.650	255.0	0.0
							1.660	0.0	0.0
UCS 7	0.00000	0.00000	2.0	1.00	59.650		0.000	115.0	0.0
							1.250	115.0	0.0

							1.260	0.0	0.0
UCS 6	0.00000	0.00000	2.0	1.00	59.450		0.000	135.0	0.0
							2.150	135.0	0.0
							2.160	0.0	0.0
US39	0.00000	0.00000	2.0	0.30	59.281	0	0.000	290.0	0.0
							2.500	290.0	0.0
							2.510	0.0	0.0
US41	0.00000	0.00000	2.0	0.30	59.188	0	0.000	245.0	0.0
							2.000	245.0	0.0
							2.010	0.0	0.0
US24	0.00000	0.00000	2.0	0.30	57.744		0.000	80.0	0.0
							1.500	80.0	0.0
							1.510	0.0	0.0
UCS 4	0.00000	0.00000	2.0	1.00	57.200	0	0.000	85.0	0.0
							2.100	85.0	0.0
							2.110	0.0	0.0
UCS 5	0.00000	0.00000	2.0	1.00	56.750	0	0.000	150.0	0.0
							1.500	150.0	0.0
							1.510	0.0	0.0
US3	0.00000	0.00000	2.0	0.30	57.579	35	0.000	255.0	0.0
							0.500	255.0	0.0
							0.510	0.0	0.0
US1	0.00000	0.00000	2.0	0.30	57.479	0	0.000	335.0	0.0
							0.900	335.0	0.0
							0.910	0.0	0.0
US5	0.00000	0.00000	2.0	0.30	57.790	0	0.000	130.0	0.0
							1.000	130.0	0.0
							1.010	0.0	0.0
US6	0.00000	0.00000	2.0	0.30	57.500		0.000	130.0	0.0
							0.900	130.0	0.0
							0.910	0.0	0.0
US8	0.00000	0.00000	2.0	0.30	57.092	0	0.000	210.0	0.0
							0.900	210.0	0.0
							0.910	0.0	0.0
US9	0.00000	0.00000	2.0	0.30	56.995	0	0.000	210.0	0.0
							1.000	210.0	0.0
							1.010	0.0	0.0
US10	0.00000	0.00000	2.0	0.30	56.850		0.000	210.0	0.0
							0.900	210.0	0.0
							0.910	0.0	0.0

US11	0.00000	0.00000	2.0	0.30	56.750		0.000	210.0	0.0
							1.000	210.0	0.0
							1.010	0.0	0.0
UCS 1	0.00000	0.00000	2.0	1.00	58.530	204	0.000	95.0	0.0
							1.150	95.0	0.0
							1.160	0.0	0.0
UCS 2	0.00000	0.00000	2.0	1.00	58.450		0.000	145.0	0.0
							1.300	145.0	0.0
							1.310	0.0	0.0
US43	0.00000	0.00000	2.0	0.30	57.382		0.000	265.0	0.0
							1.400	265.0	0.0
							1.410	0.0	0.0
US42	0.00000	0.00000	2.0	0.30	57.187	150	0.000	200.0	0.0
							2.150	200.0	0.0
							2.160	0.0	0.0
UCS 3	0.00000	0.00000	2.0	1.00	58.250	0	0.000	160.0	0.0
							2.300	160.0	0.0
							2.310	0.0	0.0
US4	0.00000	0.00000	2.0	0.30	57.510		0.000	235.0	0.0
							0.900	235.0	0.0
							0.910	0.0	0.0
US12	0.00000	0.00000	2.0	0.30	59.812		0.000	135.0	0.0
							1.400	135.0	0.0
							1.410	0.0	0.0
US13	0.00000	0.00000	2.0	0.30	59.909	0	0.000	165.0	0.0
							1.350	165.0	0.0
							1.360	0.0	0.0
US17	0.00000	0.00000	2.0	0.30	58.427	0	0.000	150.0	0.0
							1.750	150.0	0.0
							1.760	0.0	0.0
US18	0.00000	0.00000	2.0	0.30	58.436	0	0.000	150.0	0.0
							1.750	150.0	0.0
							1.760	0.0	0.0
US20	0.00000	0.00000	2.0	0.30	58.328		0.000	210.0	0.0
							1.150	210.0	0.0
							1.160	0.0	0.0
US21	0.00000	0.00000	2.0	0.30	58.333	328	0.000	110.0	0.0
							1.150	110.0	0.0
							1.160	0.0	0.0
US16	0.00000	0.00000	2.0	0.30	58.335	0	0.000	265.0	0.0

							1.550	265.0	0.0
							1.560	0.0	0.0
US19	0.00000	0.00000	2.0	0.30	57.127		0.000	265.0	0.0
							1.250	265.0	0.0
							1.260	0.0	0.0
US22	0.00000	0.00000	2.0	0.30	56.920	232	0.000	125.0	0.0
							0.950	125.0	0.0
							0.960	0.0	0.0
US14	0.00000	0.00000	2.0	0.30	57.954	270	0.000	265.0	0.0
							2.000	265.0	0.0
							2.010	0.0	0.0
US15	0.00000	0.00000	2.0	0.30	57.965	210	0.000	250.0	0.0
							2.000	250.0	0.0
							2.010	0.0	0.0
US23	0.00000	0.00000	2.0	0.30	57.551		0.000	240.0	0.0
							1.250	240.0	0.0
							1.260	0.0	0.0
SWMH 6-11	0.00000	0.00000	2.0	0.30	55.650	510	0.000	8000.0	0.0
							2.000	8000.0	0.0
							2.010	0.0	0.0

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
100 year +10% 15 minute summer	299.880	84.856
100 year +10% 15 minute winter	210.442	84.856
100 year +10% 30 minute summer	204.116	57.758
100 year +10% 30 minute winter	143.239	57.758
100 year +10% 60 minute summer	139.487	36.862
100 year +10% 60 minute winter	92.672	36.862
100 year +10% 120 minute summer	86.841	22.950
100 year +10% 120 minute winter	57.695	22.950
100 year +10% 180 minute summer	67.015	17.245
100 year +10% 180 minute winter	43.562	17.245
100 year +10% 240 minute summer	53.213	14.063
100 year +10% 240 minute winter	35.353	14.063
100 year +10% 360 minute summer	40.861	10.515
100 year +10% 360 minute winter	26.561	10.515
100 year +10% 480 minute summer	32.331	8.544
100 year +10% 480 minute winter	21.480	8.544
100 year +10% 600 minute summer	26.577	7.269
100 year +10% 600 minute winter	18.159	7.269
100 year +10% 720 minute summer	23.763	6.369
100 year +10% 720 minute winter	15.970	6.369
100 year +10% 960 minute summer	19.622	5.167
100 year +10% 960 minute winter	12.998	5.167
100 year +10% 1440 minute summer	14.352	3.847
100 year +10% 1440 minute winter	9.646	3.847

Results for 100 year +10% Critical Storm Duration. Lowest mass balance: 79.85%

Event	US Node ID	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status	Link ID	DS Node ID	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	SWMH 7D-0	12	60.595	0.070	5.8	0.0936	0.0000	OK	1.000	SWMH 7B-3	4.9	0.540	0.191	0.6385	
960 minute winter	US30	735	60.611	0.579	3.4	52.3495	0.0000	SURCHARGED	2.000	SWMH 7B-0	0.8	0.286	0.029	0.0117	
15 minute winter	SWMH 7B-0	11	60.061	0.043	2.1	0.0532	0.0000	OK	2.001	SWMH 7B-1	2.0	0.248	0.078	0.4970	
15 minute winter	SWMH 7B-1	11	60.004	0.115	24.2	0.2335	0.0000	OK	2.002	SWMH 7B-2	23.3	0.674	0.141	2.4376	
1440 minute winter	US32	1410	61.085	0.715	2.4	71.3638	0.0000	SURCHARGED	3.000	SWMH 7C-0	0.2	0.238	0.008	0.0083	
15 minute winter	SWMH 7C-0	11	60.380	0.039	4.2	0.0493	0.0000	OK	3.001	SWMH 7B-2	4.2	0.615	0.066	0.5049	
1440 minute winter	US40	1410	60.187	0.488	1.4	38.1635	0.0000	SURCHARGED	4.000	SWMH 7B-2	0.1	0.192	0.006	0.0076	
15 minute winter	SWMH 7B-2	11	59.802	0.212	76.3	0.5089	0.0000	OK	2.003	SWMH 7B-3	73.4	1.011	0.445	4.8139	
15 minute winter	SWMH 7B-3	12	59.586	0.290	108.4	0.4511	0.0000	OK	1.001	SWMH 7B-4	103.5	0.890	0.678	4.7326	
15 minute winter	SWMH 7B-4	12	59.533	0.350	115.5	0.4554	0.0000	OK	1.002	SWMH 7B-5	113.3	0.843	0.742	3.5798	
15 minute winter	SWMH 7F-0	11	59.902	0.169	35.1	0.4291	0.0000	OK	5.000	SWMH 7F-1	33.8	0.685	0.605	3.2616	
15 minute winter	SWMH 7F-1	11	59.813	0.354	123.5	1.2397	0.0000	OK	5.001	SWMH 7F-2	117.0	1.184	1.156	6.2549	
15 minute winter	SWMH 7F-2	12	59.592	0.407	149.6	0.7386	0.0000	OK	5.002	SWMH 7B-5	140.6	0.896	0.856	7.0339	
1440 minute winter	US39	1440	60.240	0.959	2.7	85.3048	0.0000	SURCHARGED	6.000	SWMH 7B-5	0.2	0.200	0.006	0.0055	
15 minute winter	SWMH 7B-5	12	59.497	0.463	303.4	1.0117	0.0000	OK	1.003	SWMH 7-14	305.0	1.650	1.328	5.4647	
360 minute winter	US25	280	60.841	0.591	2.0	11.6749	0.0000	SURCHARGED	7.000	SWMH 7-0	0.5	0.310	0.014	0.0159	
15 minute winter	SWMH 7-0	11	60.296	0.091	9.0	0.1434	0.0000	OK	7.001	SWMH 7-1	8.8	0.452	0.339	0.4787	
15 minute winter	SWMH 7-1	11	60.257	0.133	17.1	0.1969	0.0000	OK	7.002	SWMH 7-2	16.7	0.608	0.643	0.6421	
180 minute winter	US26	136	60.992	0.923	3.2	8.4002	0.0000	SURCHARGED	8.000	SWMH 7-2	1.0	0.215	0.031	0.0801	
15 minute winter	SWMH 7-2	11	60.213	0.177	23.5	0.2496	0.0000	OK	7.003	SWMH 7-3	22.9	0.719	0.885	0.6814	
15 minute winter	SWMH 7-3	12	60.149	0.173	26.5	0.2242	0.0000	OK	7.004	SWMH 7-4	26.2	0.904	1.008	0.6113	
720 minute winter	US27	555	60.645	0.717	3.4	38.4639	0.0000	SURCHARGED	9.000	SWMH 7-4	0.8	0.369	0.026	0.0154	
15 minute winter	SWMH 7-4	12	59.991	0.161	29.6	0.2077	0.0000	OK	7.005	SWMH 7-5	29.8	0.741	0.533	0.5891	
15 minute winter	SWMH 7-5	12	59.954	0.173	33.4	0.2291	0.0000	OK	7.006	SWMH 7-6	33.5	0.782	0.602	0.4411	
15 minute winter	SWMH 7-6	12	59.925	0.178	36.8	0.2312	0.0000	OK	7.007	SWMH 7-7	36.7	0.826	0.658	2.0542	
1440 minute winter	US28	1380	60.363	0.618	1.2	29.8623	0.0000	SURCHARGED	10.000	SWMH 7-7	0.2	0.209	0.008	0.0160	
15 minute winter	US29	13	59.854	0.149	13.5	0.2130	0.0000	OK	11.000	SWMH 7-7	13.4	0.788	0.515	0.1411	
15 minute winter	SWMH 7-7	13	59.854	0.315	65.1	0.4852	0.0000	OK	7.008	SWMH 7-8	58.8	0.765	0.579	1.7883	
1440 minute winter	US31	1410	60.371	0.549	2.2	64.1560	0.0000	SURCHARGED	12.000	SWMH 7A-0	0.2	0.179	0.009	0.0112	
15 minute winter	SWMH 7A-0	11	59.955	0.144	19.7	0.2783	0.0000	OK	12.001	SWMH 7-8	19.1	0.752	0.736	1.6325	
15 minute winter	SWMH 7-8	13	59.836	0.355	83.0	0.4516	0.0000	OK	7.009	SWMH 7-9	80.3	0.881	0.797	1.9144	
1440 minute winter	US34	1140	60.853	1.268	1.1	26.7603	0.0000	SURCHARGED	13.000	SWMH 7-9	0.2	0.236	0.009	0.0037	
15 minute winter	SWMH 7-9	12	59.806	0.383	85.6	0.5185	0.0000	SURCHARGED	7.010	SWMH 7-10	90.8	0.870	0.898	2.6845	
15 minute winter	US35	12	59.758	0.251	14.7	0.3491	0.0000	SURCHARGED	14.000	SWMH 7-10	13.1	0.735	0.511	0.1835	
15 minute winter	US44	12	59.761	0.248	19.3	0.3651	0.0000	SURCHARGED	15.000	SWMH 7-10	17.7	0.793	0.676	0.2448	
15 minute winter	SWMH 7-10	12	59.756	0.414	111.2	0.5182	0.0000	SURCHARGED	7.011	SWMH 7-11	112.6	1.081	1.112	3.7307	
15 minute winter	US33	12	61.464	0.780	46.7	2.0371	0.0000	SURCHARGED	16.000	SWMH 7E-0	40.0	1.005	1.545	0.1796	
15 minute winter	SWMH 7E-0	12	61.428	0.759	53.8	1.2295	0.0000	SURCHARGED	16.001	SWMH 7E-1	51.9	1.304	1.413	1.4300	

15 minute winter	SWMH 7E-1	12	60.908	0.479	62.6	0.7369	0.0000	SURCHARGED	16.002	SWMH 7-11	61.9	1.558	1.692	0.8916	
15 minute winter	US36	12	59.630	0.235	16.2	0.3478	0.0000	SURCHARGED	17.000	SWMH 7-11	14.9	0.760	0.567	0.1868	
15 minute winter	SWMH 7-11	12	59.627	0.473	189.8	0.6536	0.0000	SURCHARGED	7.012	SWMH 7-12	188.4	1.191	1.240	3.5031	
720 minute winter	US37	660	59.934	0.596	1.5	18.7584	0.0000	SURCHARGED	18.000	SWMH 7-12	0.3	0.242	0.010	0.0076	
15 minute winter	SWMH 7-12	12	59.529	0.438	196.4	0.5702	0.0000	OK	7.013	SWMH 7-13	194.8	1.273	1.280	3.7615	
1440 minute winter	US38	1380	60.609	1.349	1.6	42.8534	0.0000	SURCHARGED	19.000	SWMH 7-13	0.2	0.240	0.009	0.0041	
15 minute winter	SWMH 7-13	12	59.420	0.399	202.0	0.5323	0.0000	OK	7.014	SWMH 7-14	201.5	1.486	1.320	3.4185	
1440 minute winter	US41	1410	59.919	0.731	1.9	55.1054	0.0000	SURCHARGED	20.000	SWMH 7-14	0.2	0.212	0.007	0.0034	
15 minute winter	SWMH 7-14	12	59.276	0.402	518.5	0.5879	0.0000	OK	1.004	SWMH 7-15	513.7	2.914	0.925	15.4001	
15 minute winter	SWMH 7G-0	10	58.180	0.145	46.3	0.3726	0.0000	OK	21.000	SWMH 7-15	45.1	1.343	0.466	1.3015	
1440 minute winter	US24	1200	59.046	1.302	1.4	33.5372	0.0000	SURCHARGED	22.000	SWMH 7-15	0.2	0.231	0.009	0.0064	
15 minute winter	SWMH 7-15	12	57.750	0.401	585.2	0.8303	0.0000	OK	1.005	SWMH 7-16	578.8	2.195	0.760	15.6448	
720 minute winter	SWMH 7H-0	720	57.648	0.709	23.8	0.9975	0.0000	SURCHARGED	23.000	SWMH 7-16	35.8	0.405	0.178	13.8931	
720 minute winter	SWMH 7-16	720	57.659	1.383	217.3	7.9329	0.0000	SURCHARGED	1.006	SWMH 6-7	-207.3	1.072	-0.461	14.1984	
15 minute winter	SWMH 6-0	10	57.830	0.047	3.1	0.0605	0.0000	OK	24.000	SWMH 6-1	3.0	0.345	0.053	0.3073	
720 minute winter	US4	525	58.317	0.807	5.0	59.4515	0.0000	SURCHARGED	25.000	SWMH 6-1	1.5	-0.041	0.059	0.2787	
15 minute winter	SWMH 6-1	11	57.817	0.330	16.1	0.5577	0.0000	OK	24.001	SWMH 6-2	13.8	0.709	0.248	0.9228	
720 minute winter	SWMH 6-2	720	57.692	0.211	3.6	0.3054	0.0000	OK	24.002	SWMH 6-3	3.6	0.338	0.065	2.9206	
720 minute winter	SWMH 6A-0	720	57.691	0.145	1.9	0.2891	0.0000	OK	26.000	SWMH 6-3	1.9	0.412	0.073	1.4816	
720 minute winter	SWMH 6-3	720	57.691	0.368	10.7	1.0543	0.0000	OK	24.003	SWMH 6-4	10.7	0.627	0.065	4.7366	
720 minute winter	SWMH 6-4	720	57.689	0.547	17.8	1.0378	0.0000	SURCHARGED	24.004	SWMH 6-5	25.2	0.662	0.153	10.6594	
15 minute winter	SWMH 6B-0	10	60.040	0.153	26.3	0.3028	0.0000	OK	27.000	SWMH 6B-1	25.4	0.963	0.803	0.6445	
1440 minute winter	US13	1380	60.527	0.618	1.3	31.6792	0.0000	SURCHARGED	28.000	SWMH 6C-0	0.2	0.174	0.008	0.0184	
15 minute winter	SWMH 6C-0	11	60.038	0.151	21.2	0.2707	0.0000	OK	28.001	SWMH 6B-1	20.1	0.813	0.776	0.8976	
600 minute winter	US12	465	60.996	1.184	5.4	50.9179	0.0000	SURCHARGED	29.000	SWMH 6B-1	1.3	0.373	0.050	0.0483	
15 minute winter	SWMH 6B-1	11	59.748	0.132	68.9	0.2289	0.0000	OK	27.001	SWMH 6B-2	69.1	1.997	0.264	2.2872	
15 minute winter	SWMH 6E-0	12	58.500	0.041	1.9	0.0495	0.0000	OK	30.000	SWMH 6B-2	1.6	0.391	0.062	0.2025	
1440 minute winter	US16	1410	59.060	0.725	2.0	59.1172	0.0000	SURCHARGED	31.000	SWMH 6B-2	0.2	0.202	0.007	0.0102	
15 minute winter	SWMH 6D-1	11	58.467	0.056	4.2	0.0686	0.0000	OK	34.001	SWMH 6B-2	4.0	0.555	0.134	0.2490	
1440 minute winter	US20	1350	59.233	0.905	2.3	59.2548	0.0000	SURCHARGED	33.000	SWMH 6B-2	0.4	0.265	0.015	0.0142	
480 minute winter	US21	360	59.380	1.047	5.1	37.0934	0.0000	SURCHARGED	34.000	SWMH 6B-2	1.3	0.378	0.051	0.0385	
15 minute winter	SWMH 6B-2	11	58.163	0.167	120.8	0.3555	0.0000	OK	27.002	SWMH 6-5	121.1	1.308	0.218	8.0459	
1440 minute winter	US19	1380	57.870	0.743	2.3	60.8482	0.0000	SURCHARGED	35.000	SWMH 6-5	8.2	0.365	0.319	0.6932	
720 minute winter	SWMH 6-5	720	57.686	0.993	52.7	4.2137	0.0000	SURCHARGED	24.005	SWMH 6-6	84.4	0.875	0.238	21.0255	
15 minute winter	SWMH 6F-0	11	59.283	0.035	3.5	0.0426	0.0000	OK	36.000	SWMH 6F-1	3.4	0.650	0.053	0.4392	
1440 minute winter	US14	1410	58.990	1.036	2.8	84.5721	0.0000	SURCHARGED	37.000	SWMH 6F-1	0.2	0.220	0.008	0.0086	
1440 minute winter	US15	1410	58.992	1.027	2.6	79.1964	0.0000	SURCHARGED	38.000	SWMH 6F-1	0.2	0.217	0.008	0.0119	
15 minute winter	SWMH 6F-1	11	57.988	0.139	36.5	0.2539	0.0000	OK	36.001	SWMH 6F-2	34.3	1.077	0.435	1.8771	
1440 minute winter	US23	1410	58.531	0.980	2.5	72.9678	0.0000	SURCHARGED	39.000	SWMH 6F-2	0.2	0.237	0.010	0.0063	
720 minute winter	SWMH 6F-2	720	57.670	0.289	5.9	0.4984	0.0000	OK	36.002	SWMH 6F-3	5.9	0.518	0.033	6.7697	
720 minute winter	SWMH 6F-3	720	57.684	0.975	114.2	1.8140	0.0000	SURCHARGED	36.003	SWMH 6-6	-113.6	-1.030	-1.208	1.5319	
360 minute winter	US22	272	57.791	0.871	6.6	34.9909	0.0000	SURCHARGED	40.000	SWMH 6-6	2.4	0.409	0.093	0.7710	
720 minute winter	SWMH 6-6	720	57.686	1.392	168.8	4.0904	0.0000	FLOOD RISK	24.006	SWMH 6-7	115.0	0.844	0.193	31.8559	

720 minute winter	SWMH 6-7	720	57.654	1.717	247.7	3.4571	0.0000	SURCHARGED	1.007	SWMH 6-8	301.9	0.818	0.311	26.7459
1440 minute winter	SWMH 6-8	1230	58.214	2.398	803.8	2.7125	0.0000	FLOOD RISK	1.008	SWMH 6-9	2520.4	4.265	2.604	3.5485
600 minute winter	SWMH 6-9	675	57.671	1.871	603.3	4.7605	0.0000	SURCHARGED	1.009	SWMH 6-10	266.3	0.544	0.329	37.0504
15 minute winter	SWMH 8C-0	11	58.104	0.111	9.9	0.1553	0.0000	OK	41.000	SWMH 8C-1	11.9	0.193	0.072	3.3228
15 minute winter	SWMH 8D-0	11	59.690	0.040	3.9	0.0497	0.0000	OK	42.000	SWMH 8D-1	3.5	0.649	0.037	0.3330
15 minute winter	SWMH 8D-1	11	59.076	0.111	34.2	0.2246	0.0000	OK	42.001	SWMH 8D-2	33.2	1.220	0.189	1.7801
15 minute winter	SWMH 8D-2	10	58.401	0.166	66.6	0.3421	0.0000	OK	42.002	SWMH 8D-3	66.4	1.126	0.285	1.8057
15 minute winter	SWMH 8D-3	11	58.224	0.193	88.7	0.3233	0.0000	OK	42.003	SWMH 8C-1	88.8	1.080	0.381	2.5769
15 minute winter	SWMH 8C-1	11	58.092	0.270	124.9	0.4999	0.0000	OK	41.001	SWMH 8-6	122.7	1.314	0.745	1.7626
15 minute winter	SWMH 8-0	11	58.778	0.082	13.5	0.1269	0.0000	OK	43.000	SWMH 8-1	13.0	0.602	0.105	1.1748
15 minute winter	SWMH 8-1	11	58.538	0.108	26.4	0.1587	0.0000	OK	43.001	SWMH 8-2	25.7	0.769	0.180	1.6007
15 minute winter	SWMH 8-2	11	58.263	0.150	47.7	0.2875	0.0000	OK	43.002	SWMH 8-3	47.8	1.165	0.334	0.6108
15 minute winter	SWMH 8A-0	11	58.388	0.078	10.8	0.0972	0.0000	OK	44.000	SWMH 8A-1	10.7	0.568	0.065	0.8736
15 minute winter	SWMH 8A-1	12	58.257	0.091	15.6	0.1120	0.0000	OK	44.001	SWMH 8-3	14.5	0.618	0.088	2.6091
15 minute winter	SWMH 8-3	11	58.080	0.157	74.4	0.2465	0.0000	OK	43.003	SWMH 8-4	72.5	1.228	0.259	2.5703
15 minute winter	SWMH 8-4	12	57.718	0.207	88.9	0.3299	0.0000	OK	43.004	SWMH 8-5	86.6	0.841	0.430	8.0003
15 minute winter	SWMH 8B-0	10	57.702	0.065	11.6	0.0938	0.0000	OK	45.000	SWMH 8-5	11.5	0.547	0.180	0.6137
1440 minute winter	US43	1410	58.435	1.053	2.9	86.4551	0.0000	SURCHARGED	46.000	SWMH 8-5	0.3	0.235	0.010	0.0122
15 minute winter	SWMH 8-5	12	57.476	0.355	163.4	1.0573	0.0000	OK	43.005	SWMH 8-6	148.8	1.273	0.976	8.4941
1440 minute winter	US42	1410	58.283	1.096	2.3	67.8304	0.0000	SURCHARGED	47.000	SWMH 8-6	-4.7	-0.247	-0.181	0.3299
1440 minute winter	SWMH 8-6	1170	57.283	0.520	41.7	0.6743	0.0000	OK	41.002	SWMH 8-7	77.7	0.724	0.236	2.9562
1440 minute winter	SWMH 8-7	1170	57.290	0.559	77.7	0.6698	0.0000	OK	41.003	SWMH 8-8	92.7	0.738	0.262	4.9200
1440 minute winter	SWMH 8-8	1140	57.301	0.629	115.3	0.7609	0.0000	SURCHARGED	41.004	SWMH 8-9	-56.5	0.709	-0.160	5.3519
1440 minute winter	SWMH 8-9	1170	57.297	0.688	96.8	1.8239	0.0000	SURCHARGED	41.005	SWMH 8-10	-96.1	0.825	-0.271	7.5349
1440 minute winter	SWMH 8-10	1170	57.298	1.411	50.7	1.7940	0.0000	SURCHARGED	41.006	SWMH 8-11	-50.6	0.487	-0.117	4.9088
1440 minute winter	SWMH 8-11	1170	57.300	1.500	44.7	1.6969	0.0000	SURCHARGED	41.007	SWMH 6-10	44.8	0.184	0.163	16.7170
1440 minute winter	SWMH 6-10	1260	57.319	1.638	368.7	4.1677	0.0000	SURCHARGED	1.010	SWMH 6-11	361.2	1.037	0.758	30.2183
30 minute winter	SWMH 5-0	21	57.729	0.134	9.3	0.2369	0.0000	OK	48.000	SWMH 5-1	8.7	0.381	0.335	0.5445
60 minute winter	US3	44	58.166	0.587	51.3	42.6458	0.0000	FLOOD RISK	49.000	SWMH 5-1	20.9	0.668	0.807	0.4230
30 minute winter	SWMH 5-1	21	57.726	0.191	26.5	0.2661	0.0000	OK	48.001	SWMH 5-2	26.3	0.739	1.015	2.1116
15 minute winter	SWMH 5-2	11	57.576	0.229	42.4	0.4435	0.0000	SURCHARGED	48.002	SWMH 5-3	41.4	1.110	1.595	0.3417
15 minute winter	SWMH 5A-0	11	57.630	0.063	4.6	0.0879	0.0000	OK	50.000	SWMH 5A-1	4.5	0.304	0.172	0.5067
240 minute winter	US1	184	57.822	0.343	9.2	35.4274	0.0000	SURCHARGED	51.000	SWMH 5A-1	2.3	0.394	0.089	0.0343
15 minute winter	SWMH 5A-1	11	57.599	0.133	15.2	0.2100	0.0000	OK	50.001	SWMH 5A-2	14.3	0.488	0.551	0.8070
15 minute winter	SWMH 5A-2	11	57.575	0.197	31.7	0.3591	0.0000	OK	50.002	SWMH 5-3	31.2	0.956	1.204	0.6503
15 minute winter	SWMH 5-3	13	57.516	0.349	94.4	0.6473	0.0000	OK	48.003	SWMH 5-4	93.5	1.040	0.924	4.4984
15 minute winter	SWMH 5-4	13	57.443	0.414	117.1	0.8626	0.0000	SURCHARGED	48.004	SWMH 5-5	116.2	1.381	1.153	1.2350
15 minute winter	SWMH 5-5	14	57.396	0.479	138.0	0.9222	0.0000	SURCHARGED	48.005	SWMH 5-6	135.8	1.246	0.827	4.2506
15 minute winter	SWMH 5B-0	13	57.400	0.197	11.9	0.2534	0.0000	OK	52.000	SWMH 5-6	-9.7	0.472	-0.374	1.7296
15 minute winter	SWMH 5-6	12	57.374	0.621	154.0	1.0956	0.0000	SURCHARGED	48.006	SWMH 5-7	133.7	0.851	0.539	9.2793
15 minute winter	SWMH 5C-0	12	58.706	0.850	103.9	4.3201	0.0000	SURCHARGED	53.000	SWMH 5C-1	85.1	1.209	1.242	1.1630
15 minute winter	SWMH 5C-1	12	58.581	0.808	92.7	1.1766	0.0000	SURCHARGED	53.001	SWMH 5C-2	87.8	1.310	1.287	1.1602
15 minute winter	SWMH 5D-0	12	58.997	1.183	55.2	3.7792	0.0000	FLOOD RISK	54.000	SWMH 5D-1	43.4	1.091	1.674	1.2283

15 minute winter	SWMH 5D-1	12	58.686	0.975	99.2	3.4227	0.0000	SURCHARGED	54.001	SWMH 5C-2	89.2	2.244	3.423	0.2359	
15 minute winter	SWMH 5C-2	12	58.442	0.826	179.4	1.0668	0.0000	SURCHARGED	53.002	SWMH 5C-3	176.9	1.739	1.007	2.2448	
15 minute winter	SWMH 5C-3	12	58.224	0.812	186.7	1.2596	0.0000	SURCHARGED	53.003	SWMH 5C-4	181.6	1.716	1.036	2.2622	
15 minute winter	SWMH 5C-4	13	57.990	0.858	222.4	1.3116	0.0000	SURCHARGED	53.004	SWMH 5C-5	220.4	1.999	1.258	2.1195	
15 minute winter	SWMH 5C-5	13	57.698	0.758	263.6	2.1878	0.0000	SURCHARGED	53.005	SWMH 5-7	260.1	2.358	1.483	1.9848	
15 minute winter	SWMH 5-7	13	57.332	0.797	409.3	1.3572	0.0000	SURCHARGED	48.007	SWMH 5-8	397.6	1.433	1.212	14.2112	
960 minute winter	SWMH 5-8	855	57.314	0.923	51.1	1.5541	0.0000	SURCHARGED	48.008	SWMH 5-9	51.1	0.900	0.156	12.6251	
1440 minute winter	SWMH 5E-0	1110	57.278	0.146	3.0	0.1931	0.0000	OK	55.000	SWMH 5E-1	-2.9	-0.123	-0.114	0.5004	
1440 minute winter	SWMH 5E-1	1170	57.272	0.196	2.5	0.2854	0.0000	OK	55.001	SWMH 5E-2	3.8	0.279	0.148	1.1731	
1440 minute winter	SWMH 5E-2	1170	57.279	0.303	9.2	0.4773	0.0000	SURCHARGED	55.002	SWMH 5E-3	-6.8	0.426	-0.264	1.5772	
1440 minute winter	SWMH 5E-3	1140	57.344	0.575	15.1	0.9863	0.0000	SURCHARGED	55.003	SWMH 5E-4	16.6	0.355	0.297	2.8074	
1440 minute winter	SWMH 5E-4	1170	57.307	0.671	57.9	1.4441	0.0000	SURCHARGED	55.004	SWMH 5-9	-41.0	-0.582	-0.735	1.5499	
960 minute winter	SWMH 5-9	915	57.295	1.107	58.4	1.6874	0.0000	SURCHARGED	48.009	SWMH 5-10	56.2	0.799	0.125	16.3110	
720 minute winter	SWMH 5-10	840	57.350	1.293	69.5	1.4628	0.0000	FLOOD RISK	48.010	SWMH 5-11	64.1	0.573	0.142	29.6645	
1440 minute winter	SWMH 5-11	1290	57.519	1.700	278.1	1.9224	0.0000	FLOOD RISK	48.011	SWMH 5-12	-172.7	-0.484	-0.380	2.3204	
1440 minute winter	SWMH 5-12	1230	57.500	1.700	229.7	1.9226	0.0000	FLOOD RISK	45.012	SWMH 6-10	-101.8	-0.285	-0.297	21.3509	
1440 minute winter	SWMH 6-11	1170	57.271	1.621	361.2	3894.1950	0.0000	SURCHARGED	1.011	SWMH 6-12	29.9	0.514	0.037	0.2869	
60 minute winter	SWMH 6-12	57	55.776	0.136	30.0	0.3459	0.0000	OK	1.012	SWMH 6-13	30.0	0.630	0.042	4.9445	478.4
60 minute winter	SWMH 6-13	57	55.576	0.096	30.0	0.0000	0.0000	OK							
720 minute winter	US17	570	59.193	0.766	3.1	35.8915	0.0000	SURCHARGED	35.000_1	SWMH 6D-1	0.6	0.235	0.025	0.0156	
600 minute winter	US18	495	59.181	0.745	3.4	34.9218	0.0000	SURCHARGED	34.000_1	SWMH 6D-1	0.6	0.246	0.021	0.0175	
960 minute winter	US5	900	58.249	0.459	1.1	18.6501	0.0000	SURCHARGED	52.000_1	SWMH 5C-1	0.2	0.224	0.006	0.0391	
960 minute winter	US6	900	58.213	0.713	1.7	29.2257	0.0000	SURCHARGED	53.000_1	SWMH 5C-3	0.3	0.284	0.007	0.0027	
15 minute winter	US7	12	58.005	0.720	36.7	1.8650	0.0000	SURCHARGED	54.000_1	SWMH 5C-4	30.9	0.944	0.845	0.1522	
360 minute winter	US8	280	57.388	0.296	3.3	19.2282	0.0000	SURCHARGED	56.000	SWMH 5E-1	0.8	0.299	0.022	0.0159	
1440 minute winter	US9	1380	57.455	0.460	1.1	29.8050	0.0000	SURCHARGED	57.000	SWMH 5E-2	-2.7	0.152	-0.073	0.1275	
1440 minute winter	US10	1380	57.526	0.676	1.6	44.0610	0.0000	SURCHARGED	58.000	SWMH 5E-3	5.1	0.280	0.140	0.1293	
1440 minute winter	US11	1410	57.666	0.916	2.1	59.9131	0.0000	SURCHARGED	59.000	SWMH 5E-4	-21.7	-0.544	-0.592	0.1198	
180 minute winter	UCS 1	148	60.026	1.496	40.1	118.8050	0.0000	FLOOD RISK	60.000	SWMH 8A-0	7.6	0.716	0.097	0.0898	
960 minute winter	UCS 2	915	59.667	1.217	10.6	182.8276	0.0000	SURCHARGED	61.000	SWMH 8A-1	1.4	0.439	0.042	0.0236	
1440 minute winter	UCS 3	1410	58.767	0.517	2.9	84.1320	0.0000	SURCHARGED	66.000	SWMH 8C-0	0.3	0.286	0.007	0.0057	
1440 minute winter	UCS 4	1200	57.567	0.367	1.4	31.7574	0.0000	SURCHARGED	25.000_1	SWMH 7H-0	4.9	0.536	0.135	0.1590	
1440 minute winter	UCS 5	1380	57.178	0.428	2.0	65.0448	0.0000	SURCHARGED	26.000_1	SWMH 7-16	10.3	0.298	0.282	0.3931	
1440 minute winter	UCS 6	1440	61.332	1.882	8.1	261.5542	0.0000	SURCHARGED	20.000_1	SWMH 7F-2	0.3	0.293	0.008	0.0128	
480 minute winter	UCS 7	456	61.174	1.524	18.0	152.7021	0.0000	FLOOD RISK	19.000_1	SWMH 7F-1	2.7	0.547	0.074	0.0762	

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