ABK ARCHITECTS

PROPOSED DEVELOPMENT AT

ST. LAURENCE'S PARK, STILLORGAN, CO. DUBLIN

SITE SPECIFIC FLOOD RISK ASSESSMENT

IE CONSULTING

WATER-ENVIRONMENTAL-CIVIL

Integrated Engineering Consulting

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1 Introduction

IE Consulting was requested by ABK Architects, on behalf of Dun Laoghaire Rathdown Council, to undertake a Site Specific Flood Risk Assessment in support of a Part 8 planning application for a proposed residential development at St Laurence's Park, Stillorgan, Dublin.

The purpose of this SSFRA is to assess the potential flood risk to the proposed development site and to assess the impact that the development as proposed may or may not have on the hydrological regime of the area.

Quoted ground levels or estimated flood levels relate to Ordnance Datum Malin unless stated otherwise.

This flood risk assessment study has been undertaken in consideration of the following guidance and informative documents and policies:-

'The Planning System and Flood Risk Management – Guidelines for Planning Authorities' DOEHLG 2009.

'Dún Laoghaire-Rathdown County Development Plan 2016-2022 – Appendix 13 Strategic Flood Risk Assessment'

'Stillorgan Local Area Plan 2018-2024 – Appendix IV – Strategic Flood Risk Assessment'

2 Existing Site Description

2.1 General

The proposed development site is located at St. Laurence's Park, Stillorgan, Co. Dublin.
The site consists of unoccupied duplex houses and the existing Stillorgan Public Library. The area of the proposed site is approximately 0.65 Hectares.

The site is bound to the west by the Stillorgan Leisureplex facility, to the south by the Lower Kilmacud Road, to the east by the Stillorgan Road (N11) and to the north by the St. Laurence's Park residential estate.

A regional location map of the proposed development site is shown on *Drawing Number IE1938-001-A*, *Appendix A* and in *Figure 1* below:-

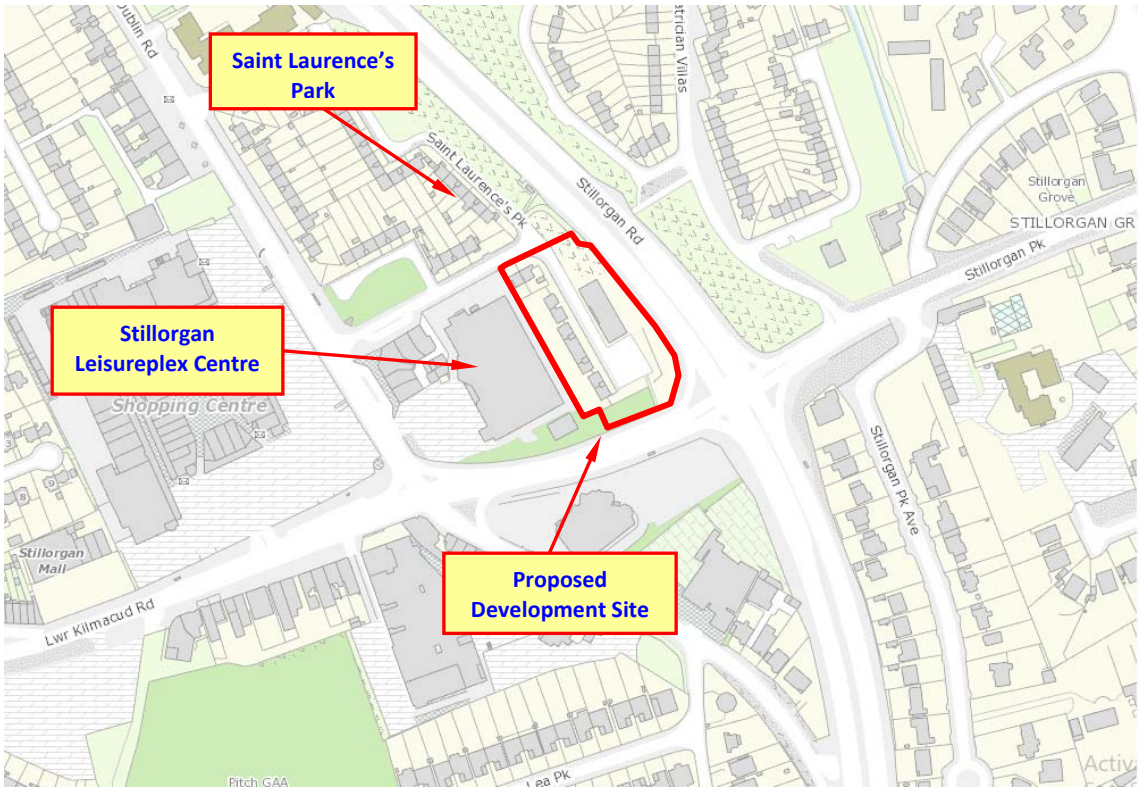

Figure 1 – Site Location

2.2 Existing Topography Levels at Site

The proposed development site slopes gently from north to south at a gradient of approximately 0.42% (1 in 238). At the East and South site boundaries, the site slopes steeply down to the bounding roads at an approximate gradient of 21.27% (1 in 4.7). Existing site elevations range from 50.99m OD in the north-western area of the site to 44.12m OD at the eastern boundary of the site.

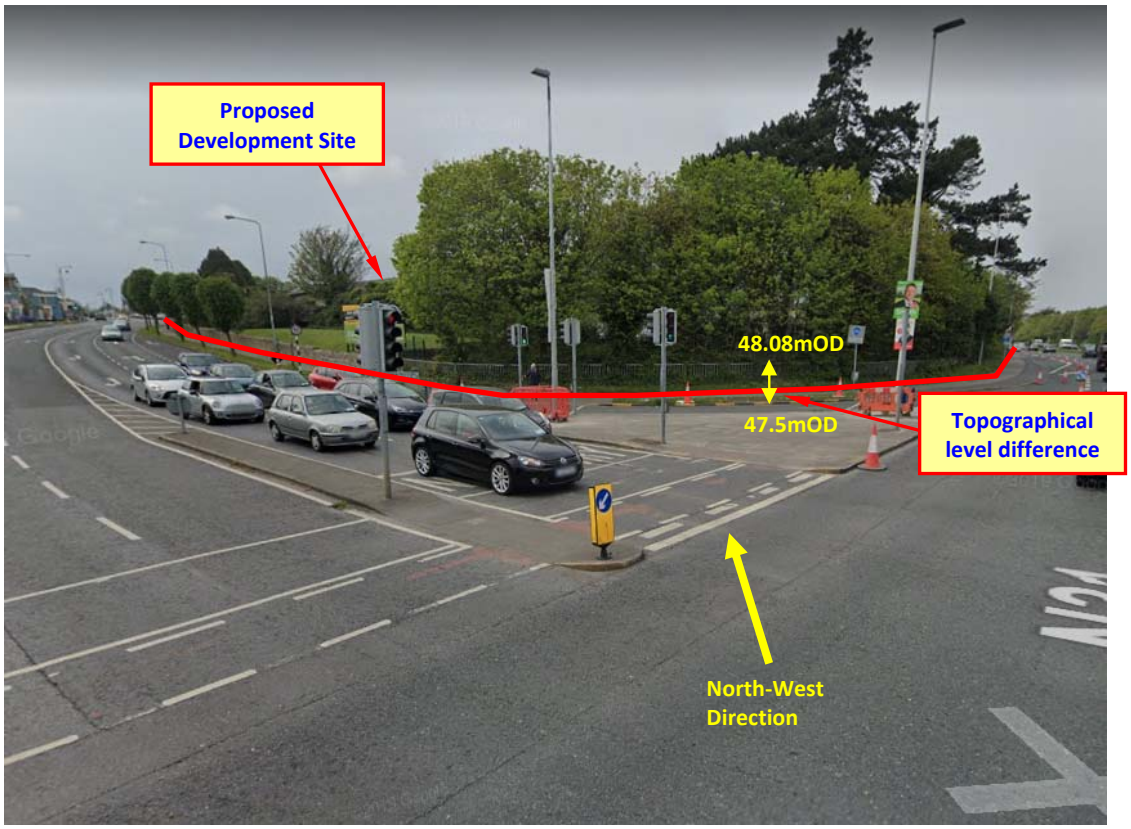

Figure 2 – Proposed Development Site – Looking North-west

As illustrated in *Figure 2* above, there is a noticeable topographical level difference between the site and Stillorgan road junction at the eastern boundary of the site.

2.3 Local Hydrology, Landuse & Existing Drainage

As illustrated in *Figure 3* below, the most significant hydrologic features in the vicinity of the proposed development site are the Brewery Stream (EPA Designation 09_1530) and the Priory Stream (EPA Designation 09_1896), located 380m and 168m beyond the eastern boundary of the site respectively.

The indicative catchment area of the Brewery Stream to a point downstream of the proposed development site is illustrated in *Figure 3* below.. An assessment of the upstream catchment area of the Brewery Stream indicates a mainly urban catchment area, with urban development accounting for approximately 85% of the total catchment area.

The indicative catchment area of the Priory Stream to a point downstream of the proposed development site is illustrated in *Figure 3* below. An assessment of the upstream catchment area of the Priory Stream indicates a mainly urban catchment area, with urban development accounting for approximately 92% of the total catchment area.

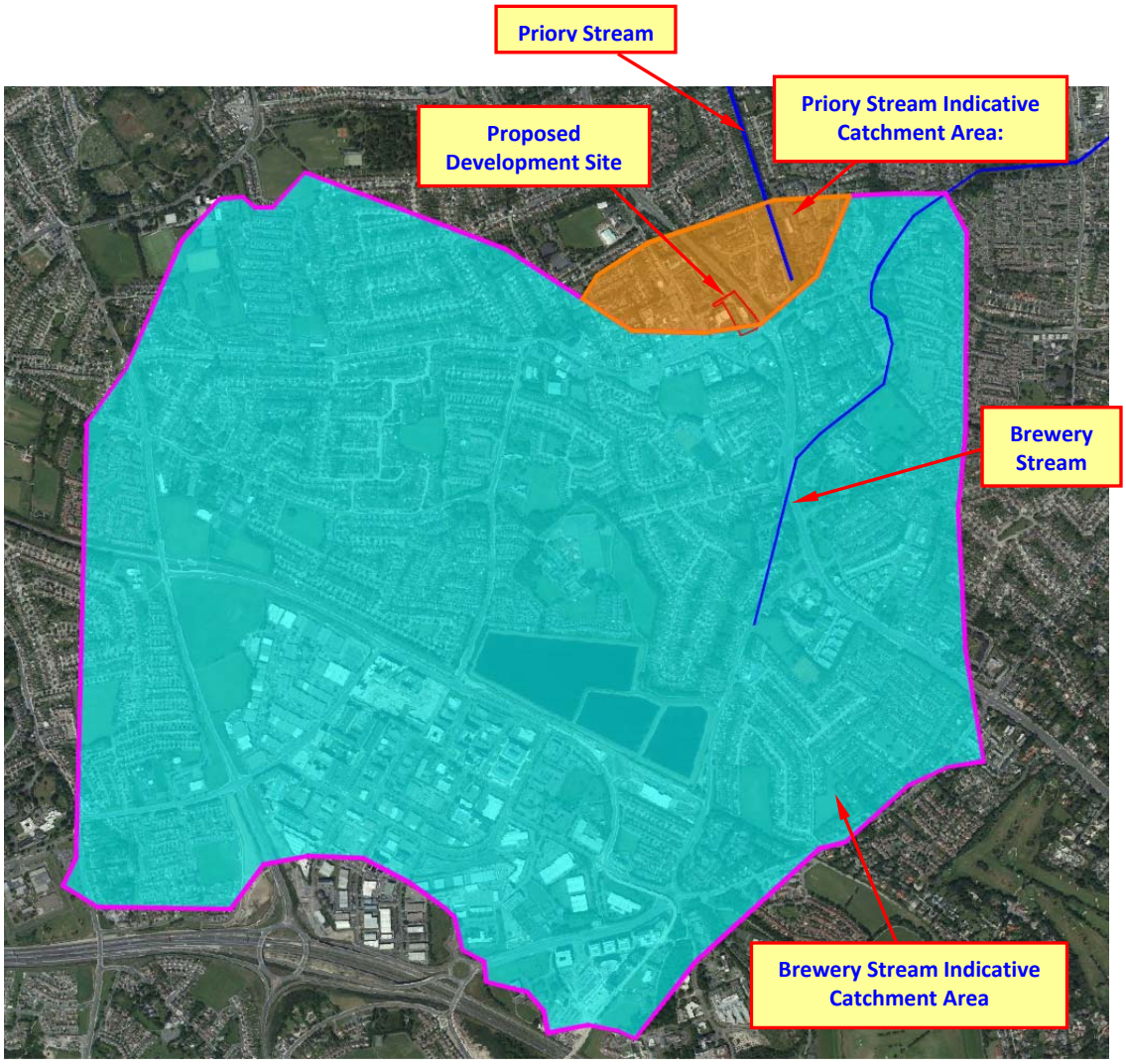

Figure 3 – Brewery Stream & Priory Stream Indicative Catchment Areas

3 Initial Flood Risk Assessment

The flood risk assessment for the proposed development site is undertaken in three principle stages, these being *'Step 1 – Screening', 'Step 2 – Scoping'* and *'Step 3 – Assessing'*.

3.1 Possible Flooding Mechanisms

Table 1 below summarises the possible flooding mechanisms in consideration of the proposed development site:-

Source/Pathway	Significant?	Comment/Reason
Tidal/Coastal	No	The proposed development site is not located in close proximity to a coastal or tidally influenced area.
Fluvial	Possible	The Brewery Stream & Priory Stream are located approximately 380m & 168m beyond the eastern boundary the proposed development site respectively.
Pluvial (urban drainage)	Possible	The proposed development site is located in an area of dense urban development. Existing and proposed urban drainage infrastructure in the area has the potential to become surcharged.
Pluvial (overland flow)	No	The site is not surrounded by significantly elevated lands and does not provide an important surface water discharge point to adjacent lands.
Surcharge/ Blockage	No	There are no significant or restrictive hydraulic structures located in the vicinity of the proposed development site.
Groundwater	No	There are no significant springs or groundwater discharges mapped or recorded in the immediate vicinity of the site

Table 1

The primary potential flood risk to the proposed development site can be attributed to the Brewery Stream and Priory Stream watercourses.

Secondary and residual flood risk can be attributed to the potential surcharge of existing and proposed urban drainage infrastructure in the vicinity of the proposed development site.

In accordance with '*The Planning System and Flood Risk Management – Guidelines for Planning Authorities -DOEHLG 2009'* these potential flood risks are analysed in the subsequent *'Screening Assessment'* and *'Assessment of Flood Risk'* section of this study report.

4 Screening Assessment

The purpose of the screening assessment is to establish the level of flooding risk that may or may not exist for a particular site and to collate and assess existing current or historical information and data which may indicate the level or extent of any flood risk.

If there is a potential flood risk issue then the flood risk assessment procedure should move to *'Step 2 – Scoping Assessment'* or if no potential flood risk is identified from the screening stage then the overall flood risk assessment can end at *'Step 1'*.

The following information and data was collated as part of the flood risk screening assessment for this particular site:-

4.1 OPW/EPA/Local Authority Hydrometric Data

Existing sources of OPW, EPA and local authority hydrometric data were investigated. This assessment has determined that there are no available sources of hydrometric data in the vicinity of the proposed development site.

4.2 OPW PFRA Indicative Flood Mapping

Preliminary Flood Risk Assessment (PFRA) Mapping for Ireland was produced by the OPW in 2011. OPW PFRA flood map number 2019/MAP/238/A illustrates indicative flood zones within this area of Dublin.

Figure 4 below illustrates an extract from the above indicative flood map in the vicinity of the proposed development site

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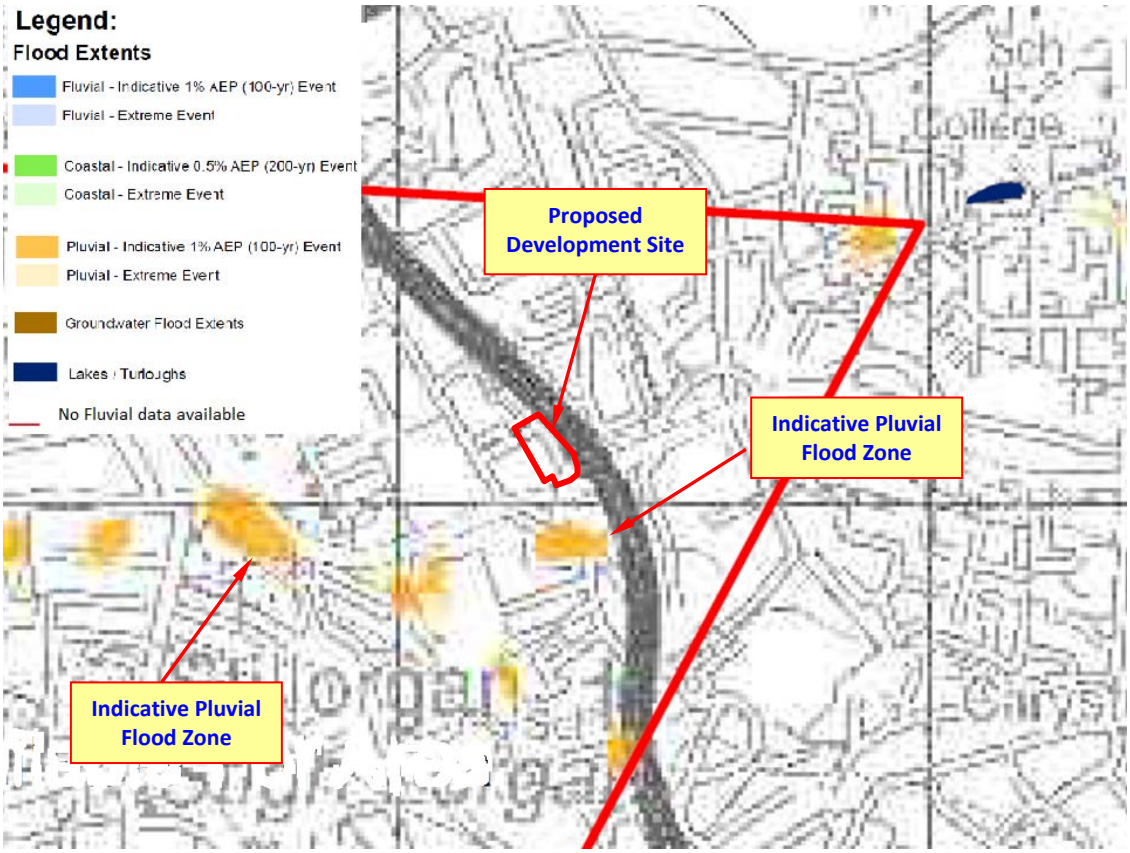


Figure 4 – PFRA Mapping

The PFRA flood mapping above does not provide any information or data in relation to indicative fluvial flood zone in the vicinity of the proposed development site.

An indicative pluvial (surface water) flood zone is mapped beyond the southern boundary of the proposed development site, however this does not encroach the boundary of the site.

Figure 5 below illustrates the PFRA predictive flood zone from *Figure 5* overlaid onto higher resolution background mapping.

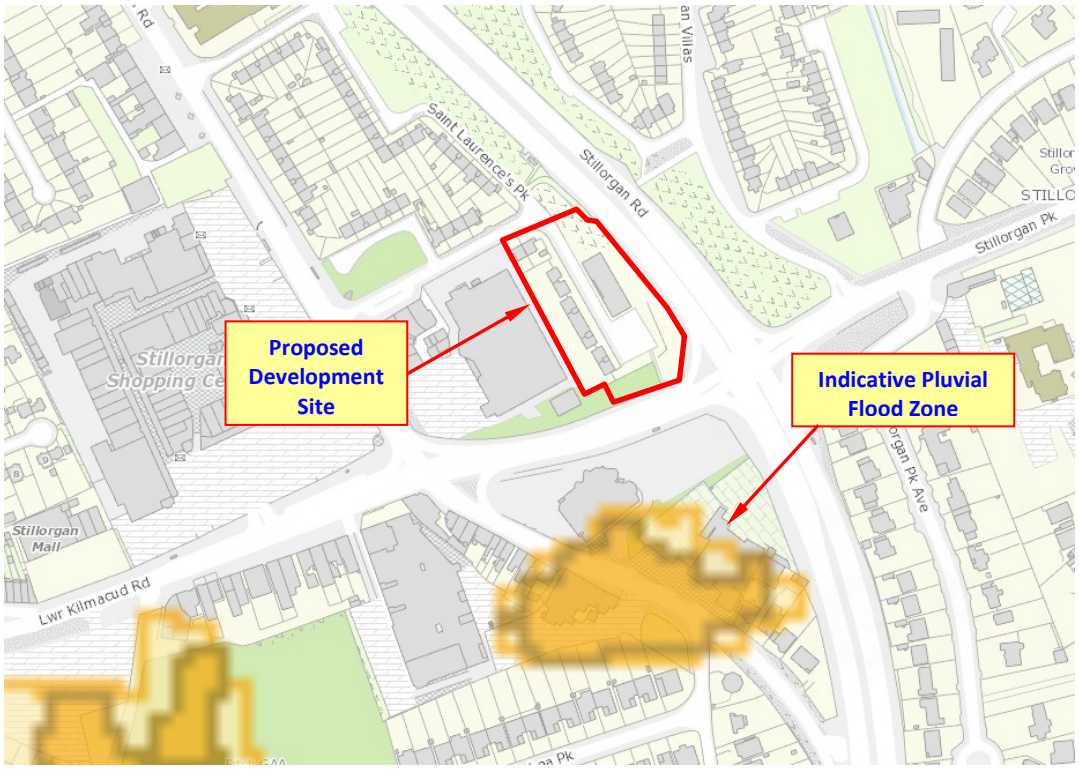


Figure 5 – PFRA Mapping

It should be noted that the predicted extent of flooding illustrated on the OPW PFRA was developed using a low resolution digital terrain model (DTM) and illustrated flood extents are intended to be indicative only. The flood extents mapped on the PFRA maps are not intended to be used on a site specific basis.

4.3 OPW Flood Maps Website

The OPW Flood Maps Website (www.floodmaps.ie) was consulted in relation to available historical or anecdotal information on any flooding incidences or occurrences in the vicinity of the proposed development site. *Figure 6* below illustrates mapping from the Flood Maps website in the vicinity of the site.

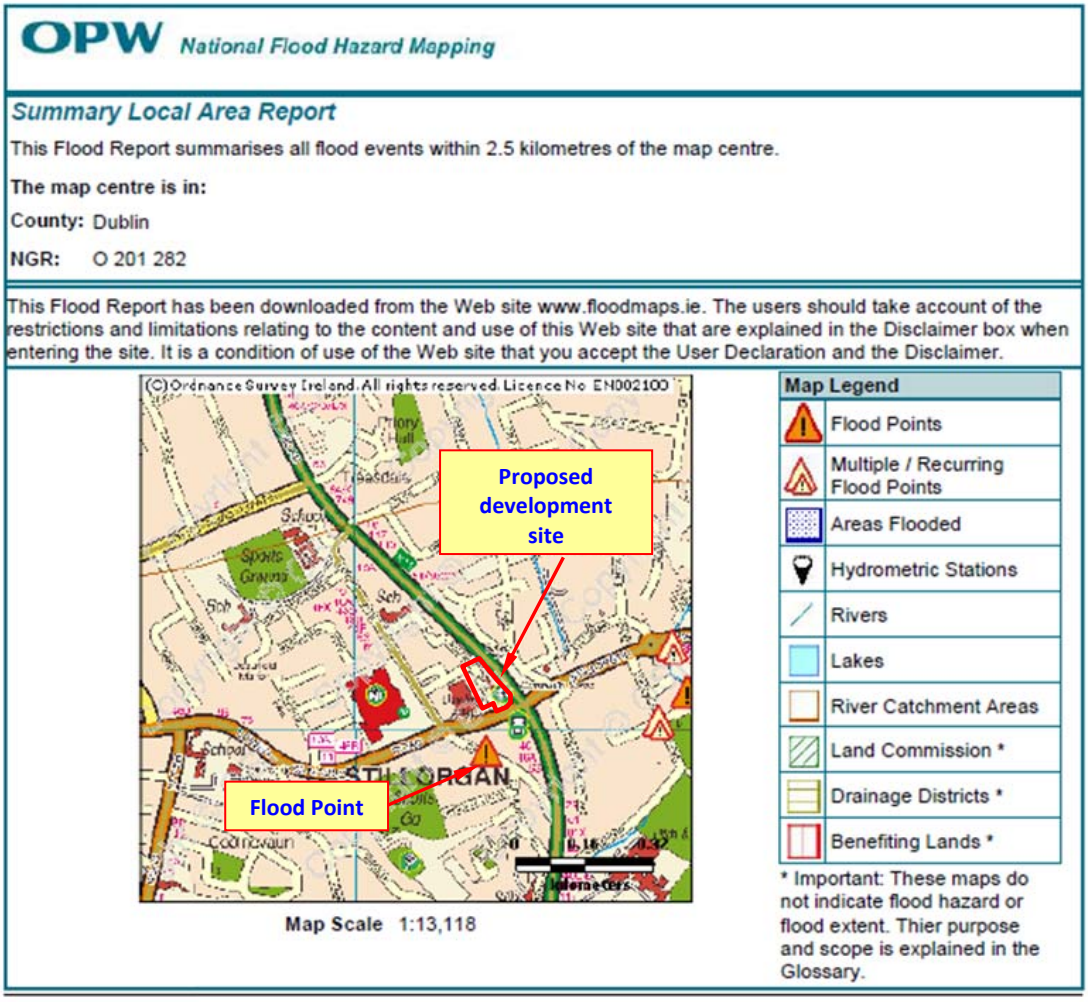


Figure 6 – OPW Flood Maps

Figure 6 above indicates that no historical incidents of flooding have been recorded in the vicinity of the proposed development site, however there is a recorded instance of flooding located beyond the southern boundary of the site in Stillorgan. The recorded flood point is associated with a flood event that occurred in November 2002 due to a blockage in a deep culvert at the location.

There is no information or data to indicate that this flood event impacted the area of the proposed development site.

4.4 Ordnance Survey Historic Mapping

Available historic mapping for the area was consulted, as this can provide evidence of historical flooding incidences or occurrences. The maps that were consulted were the historical maps (pre-1900), and the 25-inch map series.

Figure 7 and *Figure 8* below illustrate the historic mapping for the area of the proposed development site.

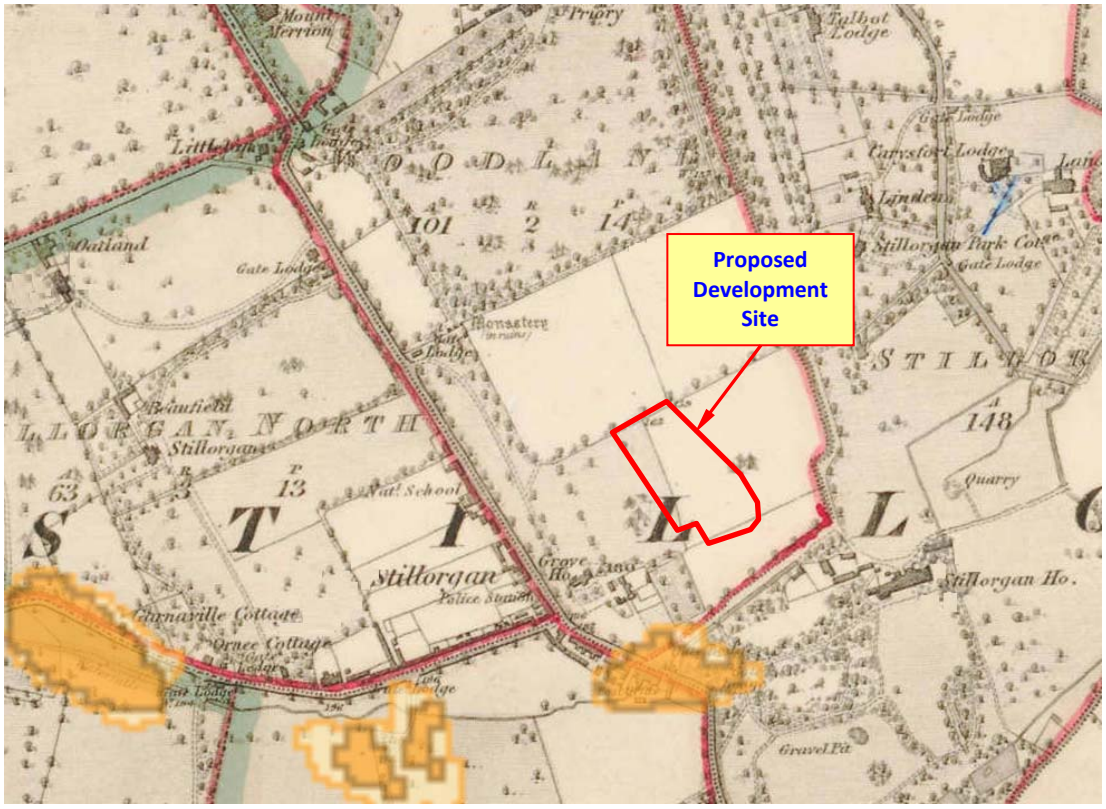


Figure 7 – Historic 6 inch Mapping

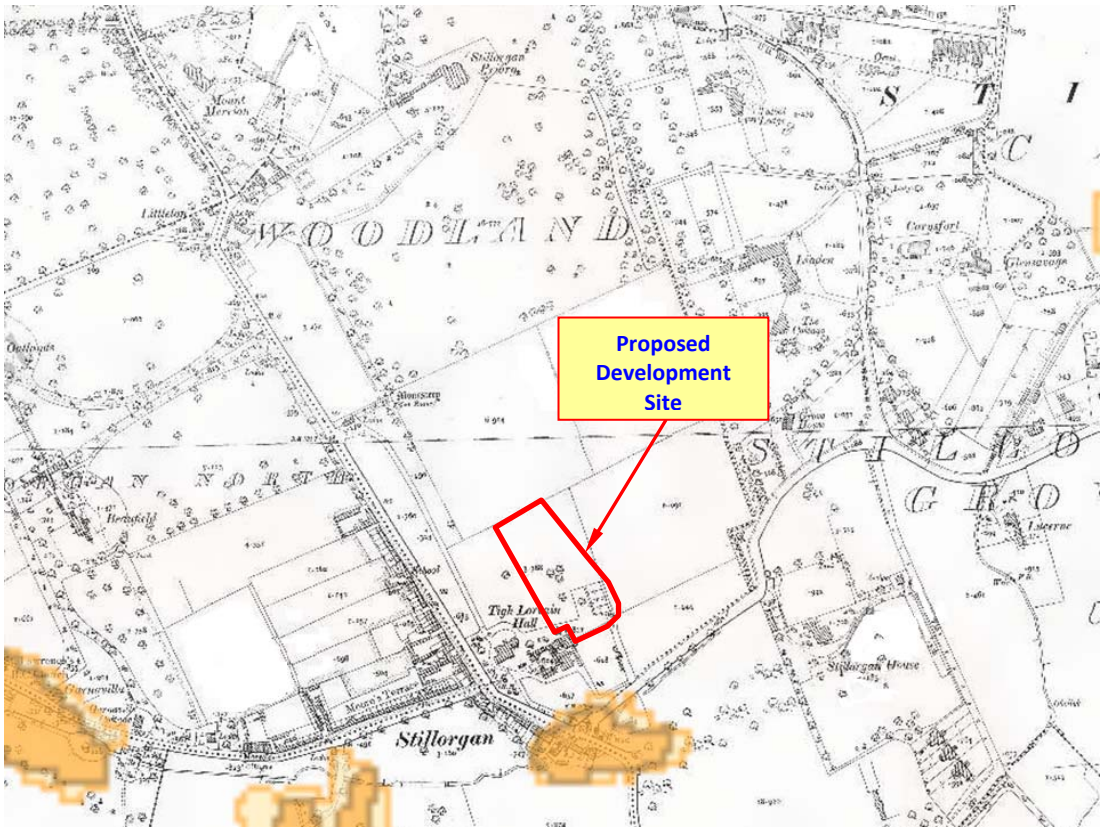


Figure 8 – Historic 25 inch Mapping

The historic 6 and 25 inch mapping does not indicate any historical or anecdotal instances of flooding at or in the immediate vicinity of the proposed development site.

4.5 Geological Survey of Ireland Mapping

The alluvium deposit maps of the Geological Survey of Ireland (GSI) were consulted to assess the extent of alluvium deposits in the vicinity of the proposed development site. Alluvium deposits can be an indicator of areas that have flooded in the recent geological past. *Figure 9* below illustrates the GSI River Basin District sub-soils mapping for the general area of the site.

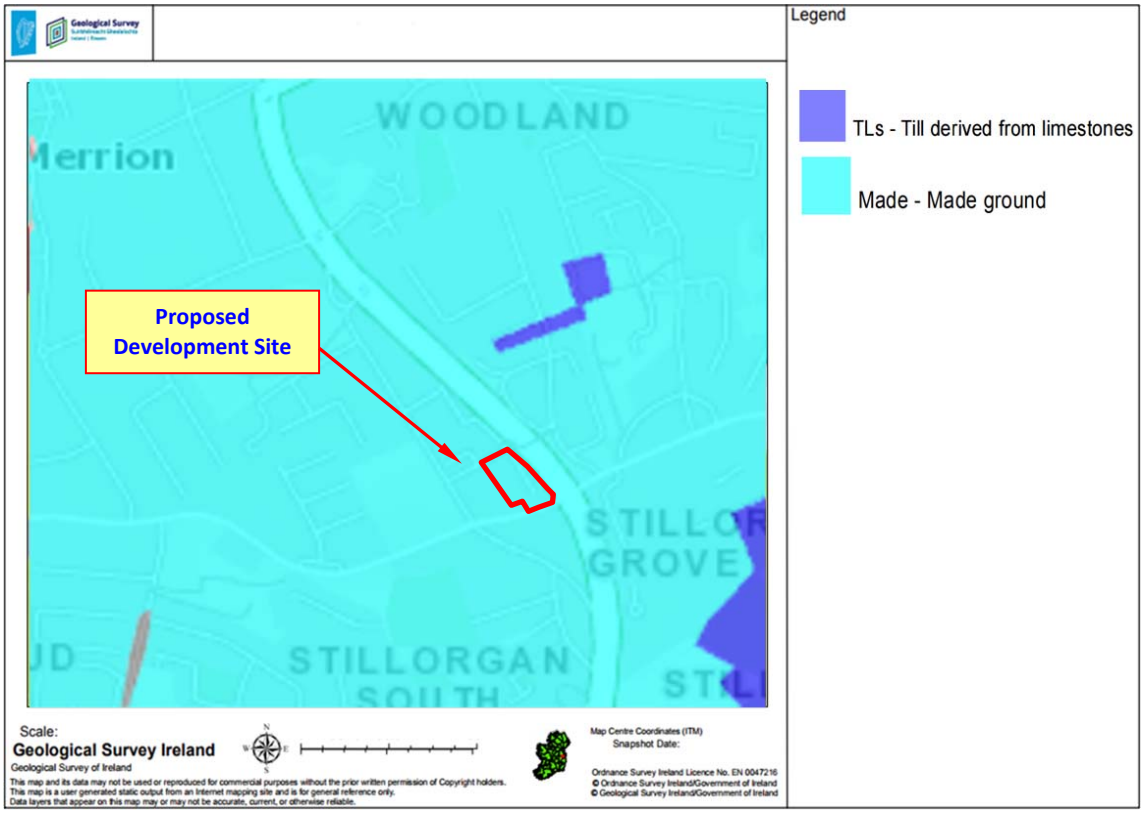


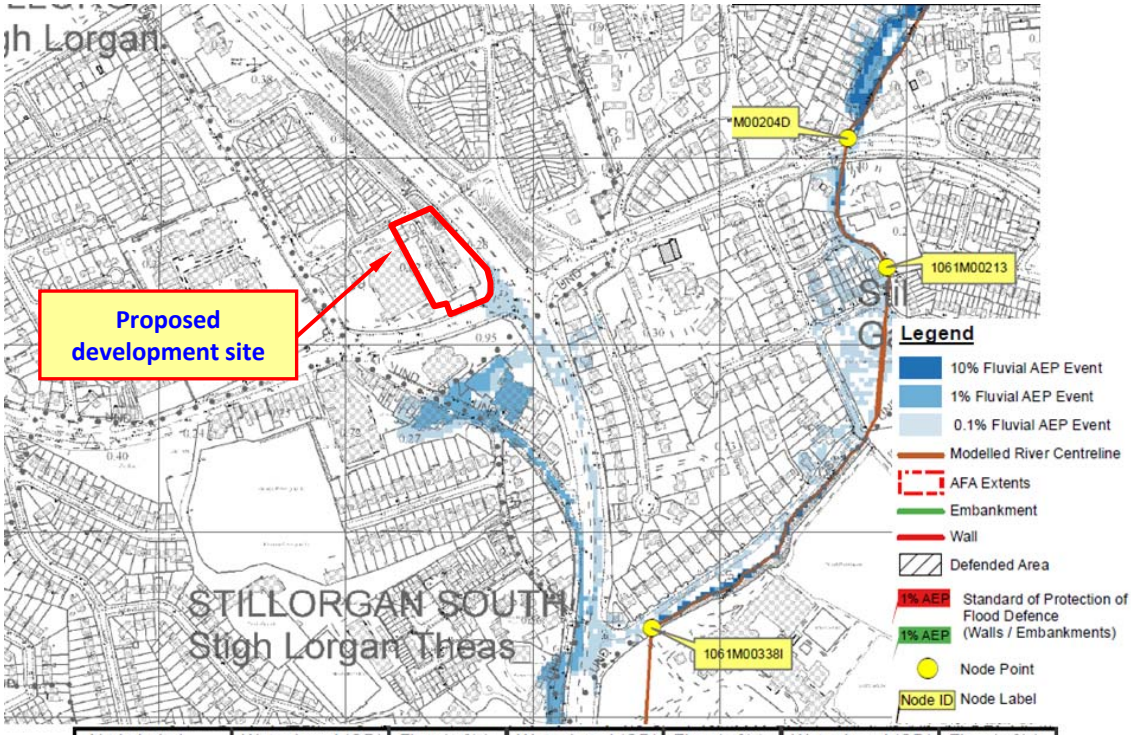
Figure 9 – GSI Subsoil Mapping

Figure 9 above indicates that the proposed development site is entirely underlain by made ground. Alluvium deposits are not mapped within or adjacent to the site boundary.

4.6 Eastern CFRAM Study

The Eastern Catchment Flood Risk & Management Study (CFRAMS) has been undertaken by the OPW and the Final version of the flood maps were issued in July 2016. Flood risk extent and depth maps for further assessment areas within Dublin have also been produced. OPW CFRAMS predictive flood map number E09CAR_EXFCD_F2_06 illustrates extreme predictive fluvial flood zones associated in the vicinity of the proposed development site.

Figure 10 below (extracted from CFRAMS flood map E09RAH_EXCCD_F1_01 illustrate the predicted extreme 10% AEP (1 in 10 year), 1% AEP (1 in 200 year) or 0.1% AEP (1 in 1000 year) fluvial flood extents in the vicinity of the proposed development site.



Node Label	Water Level (OD) 10% AEP	Flow (m³/s) 10% AEP	Water Level (OD) 1% AEP	Flow (m³/s) 1% AEP	Water Level (OD) 0.1% AEP	Flow (m³/s) 0.1% AEP
1061M00338I	51.34	4.12	51.55	6.33	51.65	8.16
1061M00213	37.16	N/A	37.4	N/A	37.53	N/A
1061M00204D	33.01	N/A	33.22	N/A	33.36	N/A

Figure 10 – CFRAMS Fluvial Flood Extents

The CFRAMS flood map also provides information on predicted flood water levels & flood volumes for 10% AEP, 1% AEP and 0.1% AEP flood events at various node points. The node point most relevant to the proposed development site is referenced as node point *1061M003381,* as illustrated in *Figure 10* above. Details of the predicted extreme tidal flood levels for the CFRAMS node point in the general vicinity of the proposed development site is listed in *Table 2* below, which has been extracted from CFRAMS flood map reference E09CAR_EXFCD_F2_06.

Node Label	Water Level (mOD) 10% AEP	Water Level (mOD) 1% AEP	Water Level (mOD) 0.1% AEP
0936C0001	51.39	51.55	51.65

Table 2 –CFRAMS Fluvial Map - Predicted Flood Levels

The South Eastern Region Catchment Flood Risk & Management Study (CFRAMS) also provides information and data on predicted flood depths in the general area of the proposed development site in consideration of extreme 10% AEP (1 in 10 year), 1% AEP (1 in 100 year) and 0.1% AEP (1 in 1000 year) fluvial flood events.

Figure 11 below (extracted from Final CFRAMS flood map E09CAR_DPFCD100_F2_06) illustrates the predicted 10% AEP (1 in 10 year) fluvial flood depth in the general vicinity of the proposed development site.

Figure 12 below (extracted from Final CFRAMS flood map E09CAR_DPFCD010_F2_06) illustrates the predicted 1% AEP (1 in 100 year) fluvial flood depth in the general vicinity of the proposed development site.

Figure 13 below (extracted from Final CFRAMS flood map E09CAR_DPFCD001_F2_06) illustrates the predicted 0.1% AEP (1 in 1000 year) fluvial flood depth in the general vicinity of the proposed development site.

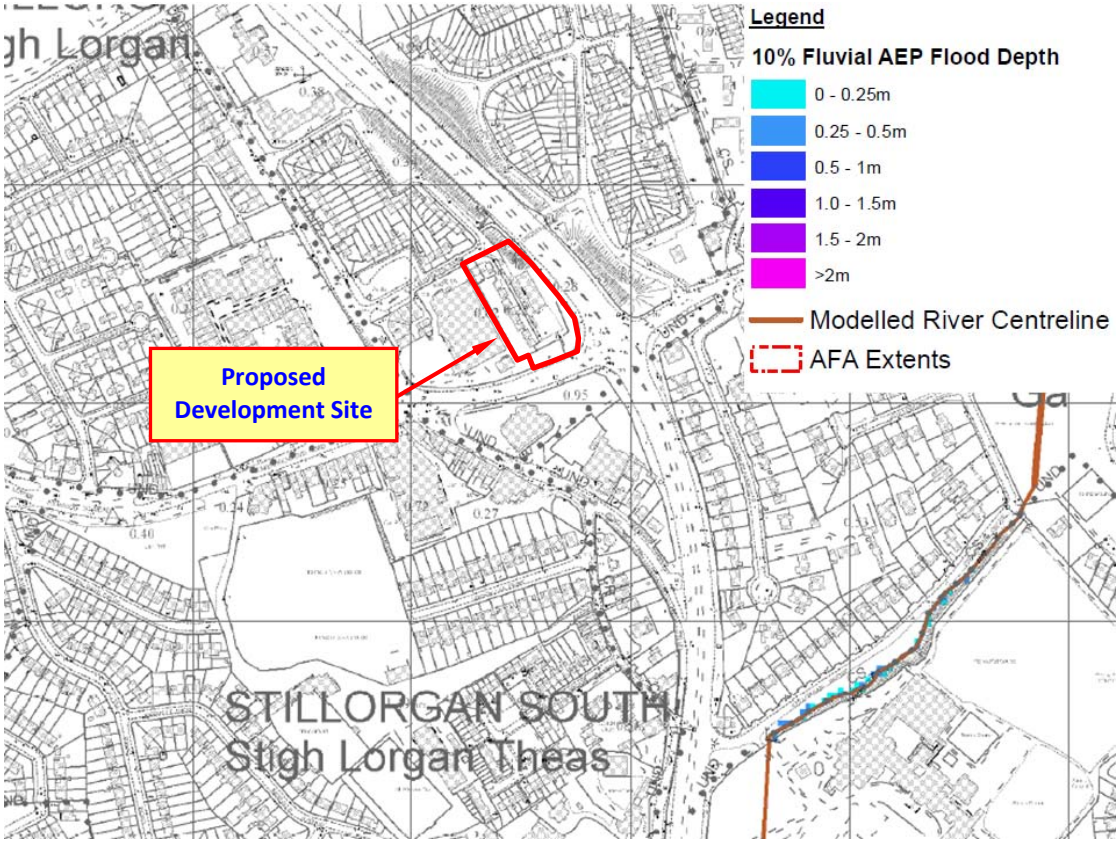


Figure 11 – 10% AEP (1 in 10 Year)Fluvial Flood Depth

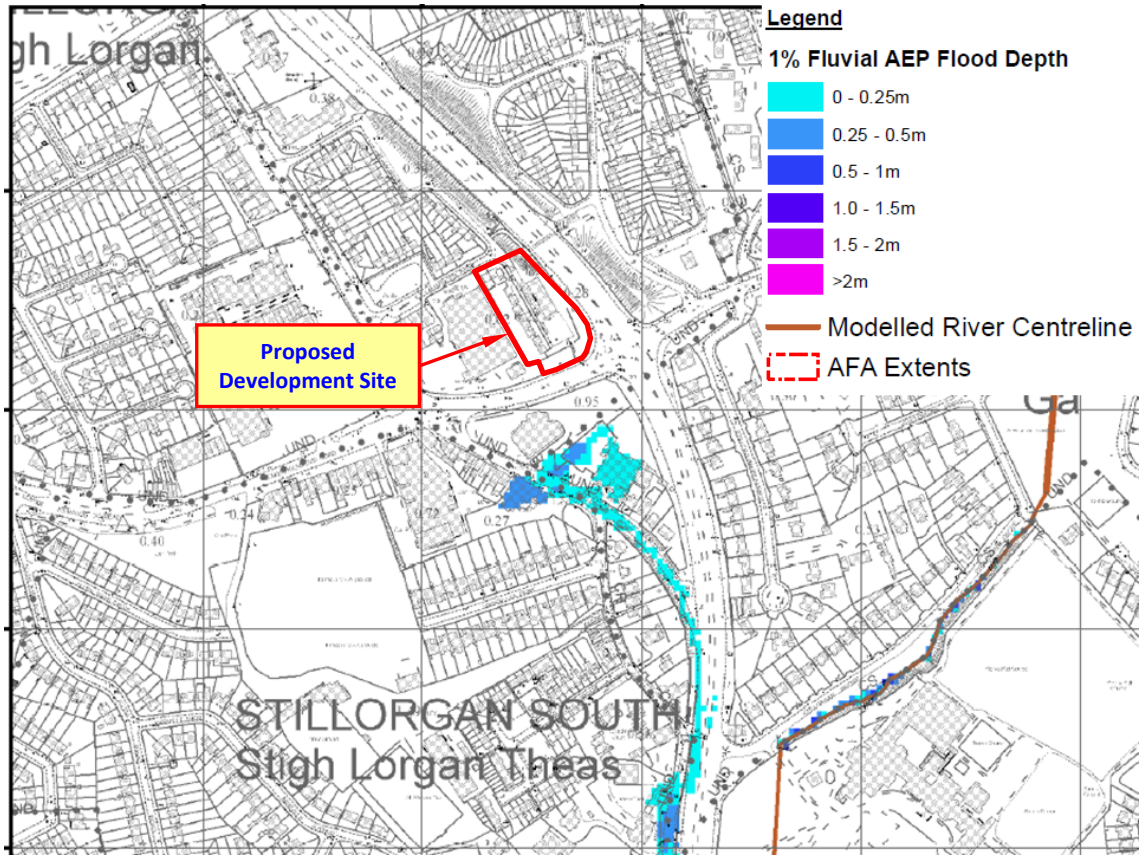


Figure 12 – 1% AEP (1 in 100 Year) Fluvial Flood Depth

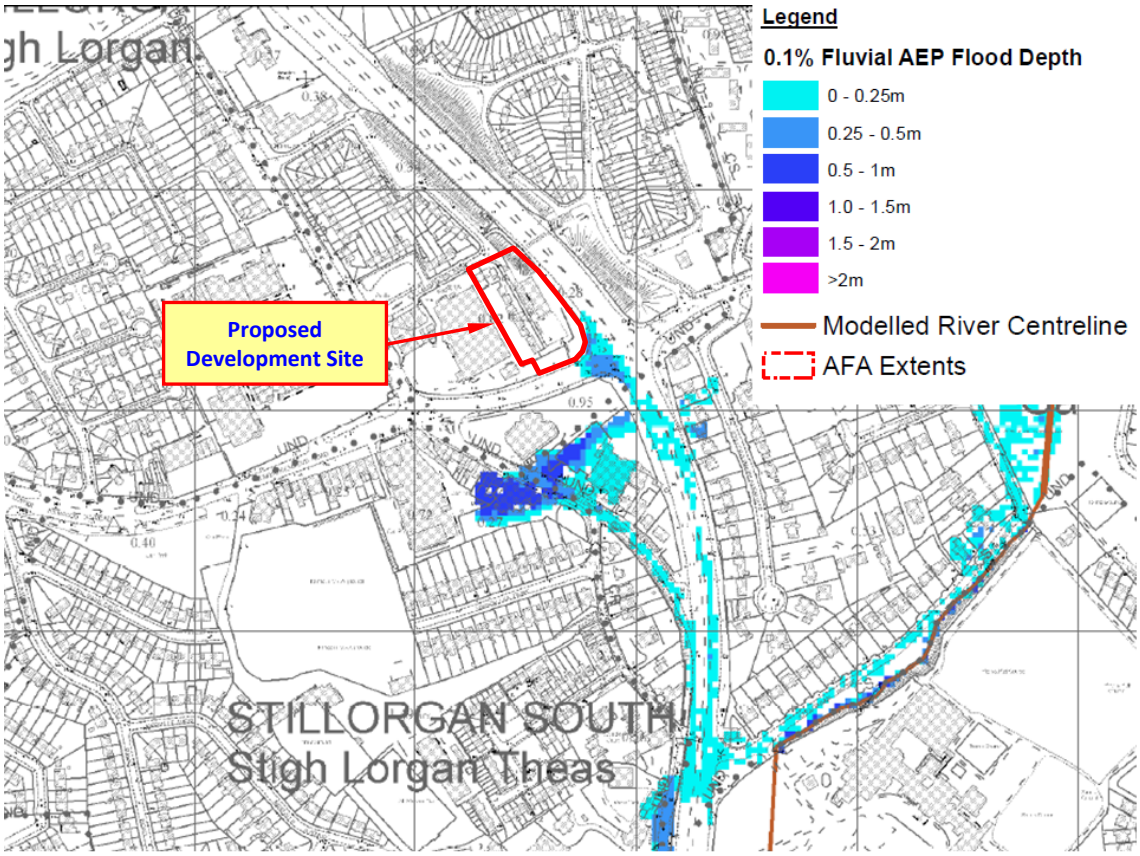


Figure 13 – 0.1% AEP (1 in 1000 Year) Fluvial Flood Depth

Figure 11, Figure 12 and *Figure 13* above indicates that the area of the proposed development site does not fall within a predictive 10% AEP (10 in 100 year), 1% AEP (1 in 100 year) or a 0.1% AEP (1 in 1000 year) fluvial flood zone.

A predictive 0.1% AEP (1 in 1000 year) fluvial flood zone is mapped adjacent to the south-east corner of the proposed development site, however this does not encroach the boundary of the site.

4.7 Dublin Pluvial Flood Study

The Dublin Pluvial Flood study does not extend to the area of the proposed development site.

5 Scoping Assessment

The purpose of the scoping stage is to identify possible flood risks and to implement the necessary level of detail and assessment to assess these possible risks, and to ensure these can be adequately addressed in the flood risk assessment. The scoping exercise should also identify that sufficient quantitative information is already available to complete a flood risk assessment appropriate to the scale and nature of the development proposed.

The above screening assessment indicates that the proposed development site is not at risk of primary and direct fluvial, pluvial or groundwater flooding. The site has not been identified as being at risk of fluvial (river) flooding in either the OPW Eastern CFRAMS maps or the council's own flood risk maps. As indicated on these maps the site is immediately adjacent to a localised predictive 0.1% AEP fluvial flood zone at the N11/Kilmacud Road junction. Existing ground levels at the location of this localised flood zone are of the order of 47.5m OD, whereas the existing ground levels within the boundary of the proposed development site are circa 49.0m OD, thereby indicating that the site would not be directly impacted by this predictive flood zone.

The final fluvial flood maps for the area produced as part of the Eastern CFRAM study are based on the results of detailed hydraulic modelling undertaken and therefore provide a reasonably accurate delineation of flood zones and prediction of flood depths in the general vicinity of the proposed development site. Primary and direct fluvial and pluvial flood risk is therefore not considered further as part of this Site Specific Flood Risk Assessment.

The initial flood risk assessment and screening assessment indicates that the existing and proposed urban drainage infrastructure at and in the vicinity of the proposed development site has the potential to present a secondary or residual pluvial flood risk to the site.

The specific secondary or residual pluvial flood risk to the proposed development site is assessed in the subsequent 'Assessing Flood Risk' stage of this study report.

6 Assessing Flood Risk

6.1 Assessment of Secondary & Residual Pluvial Flood Risk

Existing Urban Drainage & Water Supply Infrastructure

Secondary and residual flood risk can be attributed to a potential surcharge of the urban drainage and/or failure of the water supply network in the general vicinity of the property site. An existing drainage water supply infrastructure map for the area was obtained from Irish Water, an extract of which is illustrated in *Figure 14* below. The following infrastructure has been identified at and in the vicinity of the proposed development

- Water-main located through the site at the location illustrated below.
- Foul water sewer located though the site at the location illustrated below.

Figure 14 – Urban Drainage/Water Supply Records

As illustrated in *Figure 15* below, It is anticipated that any potential pluvial flooding due to a surcharge of the foul water manholes or damage to the water-main would likely cause surcharge waters to spill out and flow towards the south-east and eastern boundaries of the site and onto the adjacent Stillorgan Road.

There are no identifiable significant topographically depressed areas within the boundary of the site that would permit collection and ponding of any pluvial surcharge waters.

Figure 15 –Overland Flow Paths

Overall the secondary and residual flood risk to the proposed development site is considered to be **LOW**.

Proposed Stormwater Management System

A stormwater management system for the proposed development has been prepared by Hayes Higgins Partnership.

The proposed stormwater management system is illustrated on Hayes Higgins Partnership *Drawing Number 17D102-01-P6, Appendix B*.

In general, the proposed development storm water management system has been designed in accordance with the requirements of the Greater Dublin Strategic Drainage Study (GDSDS) and shall comprise the following elements:-

- *Main storm water drainage to roof and hardstanding areas provided by traditional techniques such as gullies, manholes and storm water drains.*
- *Stormcell attenuation system to provide attenuation storage up to the 1% AEP (1 in 100 year) rainfall event.*
- *Discharge flow control system.*
- *Discharge to existing stormwater drainage network.*

It is proposed to utilise traditional drainage techniques, in accordance with BS EN 752:2008, in order to provide adequate storm water management to the roof and hardstanding areas within the boundary of the proposed development site.

The proposed stormwater management system shall therefore provide a robust and sustainable means of managing stormwater runoff from the proposed development site.

6.2 Proposed Storm Water Management System – Exceedence Checks

Utilising the Micro-Drainage WinDes software package a hydraulic surcharge simulation analysis was undertaken to demonstrate the following:-

- Analysis to demonstrate that the proposed site storm water drainage and management system has been designed not to flood any part of the site in a 1 in 30 year return period design storm event and to ensure a free-board of 300mm.
- Analysis to check for exceedence up to the 1 in 100 year return period design storm event.

The surcharge analysis was undertaken utilising summer and winter rainfall profiles for a range of storm duration periods (15 minutes to >7200 minutes) and for storm return periods 1 in 30 year and 1 in 100 year return periods.

As summarised in the Micro-Drainage output analysis presented in *Appendix C*, in consideration of a 1 in 30 year return period design storm event a minimum freeboard of 300mm is maintained within the storm water drainage system (Page 9 of Micro-Drainage calculations).

In consideration of a 1 in 100 year return period design storm event maximum water levels within the storm water drainage system would not exceed proposed manhole cover levels and therefore would not present a flood risk to the proposed development site (Page 11 of Micro-Drainage calculations).

In summary, the hydraulic surcharge analysis indicates that in the event of the occurrence of a 1 in 30 year and/or a 1 in 100 year rainfall event the maximum hydraulic capacity of the proposed stormwater management system is not expected to be exceeded and no significant manhole surcharging and cover level exceedence is expected to occur.

The proposed storm water management system is therefore not expected to present a secondary and residual pluvial flood risk to the proposed development site.

With respect to the proposed stormwater management system the secondary and residual pluvial flood risk to the proposed development site is therefore considered to be **LOW**.

6.3 Proposed Storm Water Management System – Blockage Analysis

An additional analysis was undertaken in order to simulate a potential blockage within the proposed storm water drainage system and to assess the potential for blockage to result in a pluvial flood risk to the proposed development site.

As presented on the details and information provided by Hayes Higgins Partnership the proposed storm water management system shall limit storm water discharge from the development site to a maximum discharge rate of 1.4 l/s via Hydrobrake flow restrictor located at manhole number S01.

In order to simulate the potential pluvial flood risk due to a blockage or restriction within the storm water drainage system the hydraulic simulation model was re-run in consideration of a maximum discharge rate of 0.7 l/s - i.e. in consideration of a 50% blockage scenario at the Hydrobrake flow restrictor manhole.

The output of the hydraulic simulation analysis indicates that, in consideration of a 50% blockage scenario, a maximum surcharge depth of 0.766m may result within the storm water drainage system, however any surcharging would not exceed the cover levels of the proposed manholes or the attenuation system up to the 1 in 100 year rainfall event.

Therefore, a 50% blockage scenario is not considered to present a pluvial flood risk to the proposed development site.

Summary output details of the 50% blockage scenario are presented in *Appendix D*.

In consideration of the unlikely event of a total blockage or failure of the storm water drainage system then in this scenario manholes any surcharging has the potential to exceed manhole cover levels.

Reference to the Hayes Higgins Partnership proposed drainage layout drawing indicates that the cover levels of proposed manhole numbers S01, S02, S03, S03, S04, S05 and S11 shall be lower than the ground floor levels of Block A, Blocks B and C and the Library. Any exceedence of the cover levels of these manholes due to total blockage surcharge is not expected to impact the proposed development Blocks and Library as any surcharge waters would be contained within the access roadway and would generally be conveyed in a northerly and easterly direction away from the development Blocks and Library.

7 Proposed Development in the Context of the Guidelines

In the context of the *'Planning System and Flood Risk Management Guidelines, DOEHLG, 2009'* three flood zones are designated in consideration of flood risk to a particular development site.

Flood Zone 'A' – where the probability of flooding from rivers and watercourses is the highest (greater than 1% or 1 in 100 year for river and watercourse flooding and 0.5% or 1 on 200 for coastal or tidal flooding).

Flood Zone 'B' – where the probability of flooding from rivers and watercourses is moderate (between 0.1% or 1 in 1000 year for river and watercourse flooding and 0.5% or 1 on 200 for coastal or tidal flooding).

Flood Zone 'C' – where the probability of flooding from rivers and watercourses is low or negligible (less than 0.1% of 1 in 1000 year for both river and watercourse and coastal flooding). *Flood Zone 'C'* covers all areas that are not in *Zones 'A'* or '*B*'.

The *'Planning System and Flood Risk Management Guidelines'* list the planning implications for each flood zone, as summarised below:-

Zone A – High Probability of Flooding. Most types of development would not be considered in this zone. Development in this zone should be only be considered in exceptional circumstances, such as in city and town centres, or in the case of essential infrastructure that cannot be located elsewhere, and where the *'Planning System and Flood Risk Management Guidelines'* justification test has been applied. Only water-compatible development, such as docks and marinas, dockside activities that require a waterside location, amenity open space and outdoor sports and reaction would be considered appropriate in this zone.

Zone B – Moderate Probability of Flooding. Highly vulnerable development such as hospitals, residential care homes, Garda, fire and ambulance stations, dwelling houses, strategic transport and essential utilities infrastructure would generally be considered inappropriate in this zone, unless the requirements of the justification test can be met. Less vulnerable development such as retail, commercial and industrial uses and recreational facilities might be considered appropriate in this zone. In general however, less vulnerable development should only be considered in this zone if adequate lands or sites are not available in *Zone 'C'* and subject to a flood risk assessment to the appropriate level of detail to demonstrate that flood risk to the development can be adequately managed and that development in this zone will not adversely affect adjacent lands and properties.

Zone C – Low to Negligible Probability of Flooding. Development in this zone is appropriate from a flood risk perspective. Developments in this zone are generally not considered at risk of fluvial flooding and would not adversely affect adjacent lands and properties from a flood risk perspective.

In the context of the *'Planning System and Flood Risk Management Guidelines, DOEHLG, 2009'* this Site Specific Flood Risk Assessment indicates that the proposed development site falls within Flood Zone 'C'.

In accordance with the *'Planning System & Flood Risk Management Guidelines, DOEGLG, 2009'* the development as proposed is not subject to the requirements of the Justification Test.

8 Climate Change

The screening assessment undertaken as part of this Site Specific Flood Risk Assessment indicates that the proposed development site does not fall within a delineated 1% AEP (1 in 100 year – Flood Zone 'A') or a 0.1% AEP (1 in 1000 year – Flood Zone 'B').

With reference to *Section 4.9* of the*'Dún Laoghaire-Rathdown County Development Plan 2016-2022 – Appendix 13 Strategic Flood Risk Assessment'* and to *'The Planning System and Flood Risk Management – Guidelines for Planning Authorities' DOEHLG 2009 Technical Appendix A, Section 1.6* recommends that, where mathematical models are not available climate change flood extents can be assessed by using the Flood Zone B outline as a surrogate for Flood Zone A with allowance for the possible impacts of climate change.

In additional the indicative mid-range future scenario and high-end future scenario flood maps for the area as illustrated on the OPW Floodinfo.ie flood maps for the area indicate that the area of the proposed development site does not fall within a future climate change scenario fluvial flood zone.

The future climate change scenario fluvial flood risk to the area of the proposed development site is therefore considered to be **LOW**.

9 Summary Conclusions & Recommendations

In consideration of the findings of this site specific flood risk assessment and analysis the following conclusions and recommendations are made in respect of the proposed development site:-

- *A Site Specific Flood Risk (SSFRA) assessment, appropriate to the type and scale of development proposed, and in accordance with 'The Planning System and Flood Risk Management Guidelines – DoEHLG-2009' has been undertaken.*
- *The proposed development site has been screened, scoped and assessed for flood risk in accordance with the above guidelines and in consideration of the 'Dún Laoghaire-Rathdown County Development Plan 2016-2022 – Appendix 13 Strategic Flood Risk Assessment'*
- *The screening assessment undertaken as part of this SSFRA indicates that the proposed development site is not at risk of primary and direct fluvial or pluvial flooding.*
- *In particular, the site has not been identified as being at risk of fluvial (river) flooding in either the OPW Eastern CFRAMS maps or the council's own flood risk maps. The site is adjacent to a localised predictive 0.1% AEP fluvial flood zone at the N11/Kilmacud Road junction. Existing ground levels at the location of this localised flood zone are of the order of 47.5m OD, whereas the existing ground levels within the boundary of the proposed development site are circa 49.0m OD, thereby indicating that the site would not be directly impacted by this predictive flood zone.*
- *In the context of 'The Planning System and Flood Risk Management Guidelines – DoEHLG-2009' the proposed development site falls within Flood Zone 'C'. The development as proposed is therefore not subject to the requirements of 'The Justification Test' as per the above guidelines.*
- *In consideration of Section 4.5 of the 'Dún Laoghaire-Rathdown County Development Plan 2016-2022 – Appendix 13 Strategic Flood Risk Assessment' potential secondary and residual fluvial and pluvial flood risk to the proposed development site has been considered.*
- *The assessment and analysis undertaken as part of this SSFRA indicates that the future climate change scenario fluvial flood risk to the area of the proposed development site is low.*
- *The assessment and analysis undertaken as part of this SSFRA indicates that the secondary and residual fluvial and pluvial flood risk to the proposed development site is considered to be low.*
- *A hydraulic surcharge simulation analysis was undertaken to demonstrate that the proposed site storm water drainage and management system has been designed not to flood any part of the site in a 1 in 30 year return period design storm event and to ensure a free-board of 300mm and to check for exceedence up to the 1 in 100 year return period design storm event.*

- *The output of the hydraulic surcharge simulation analysis indicates that the proposed stormwater management system does not present a secondary or residual pluvial flood risk to the proposed development site.*
- *An additional hydraulic analysis was undertaken in order to simulate a potential 50% blockage at the Hydrobrake flow restrictor manhole. This additional simulation analysis indicates that any surcharging due to a 50% blockage scenario would not exceed the cover levels of the proposed manholes or the attenuation system up to the 1 in 100 year rainfall event.*
- *In consideration of a total blockage or failure of the storm water drainage system any exceedence of the cover levels of proposed manhole numbers S01, S02, S03, S04, S05 and S11 is not expected to impact the proposed development Blocks and Library as any surcharge waters would be contained within the access roadway and would generally be conveyed in a northerly and easterly direction away from the development Blocks and Library.*
- *It is recommended that the proposed surface water management system is constructed in accordance with the requirements of the GDSDS and any local authority drainage policy.*
- *It is recommended that an on-going maintenance and management regime is implemented for the proposed stormwater management system in order to ensure that the system operates as designed and is regularly inspected for damage or defects and that any debris or deleterious materials are removed from the system on a regular basis, especially following any significant precipitation events.*
- *In summary, and in consideration of the findings and recommendations of this Site Specific Flood Risk Assessment, the flood risk to the development as proposed is considered to be* ***LOW****.*
- *The development as proposed is not expected to result in an adverse impact to the existing hydrological regime of the area and is therefore considered to be appropriate from a flood risk perspective.*

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APPENDIX A

Drawing Number IE1938-001-A

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IE CONSULTING
WATER-ENVIRONMENTAL-CIVIL

Project Title:	FLOOD RISK ASSESSMENT
Project Address:	ST. LAURENCE'S PARK, STILLORGAN, CO. DUBLIN
Client:	ABK ARCHITECTS
Drg. Title:	SITE LOCATION MAP

Dwg.Scale:	Date:	Dwg.No:	Job No:	Revision:	Dwg.By:
1:50,000	21/08/19	IE1938-001	IE1938	A	GK

IE CONSULTING
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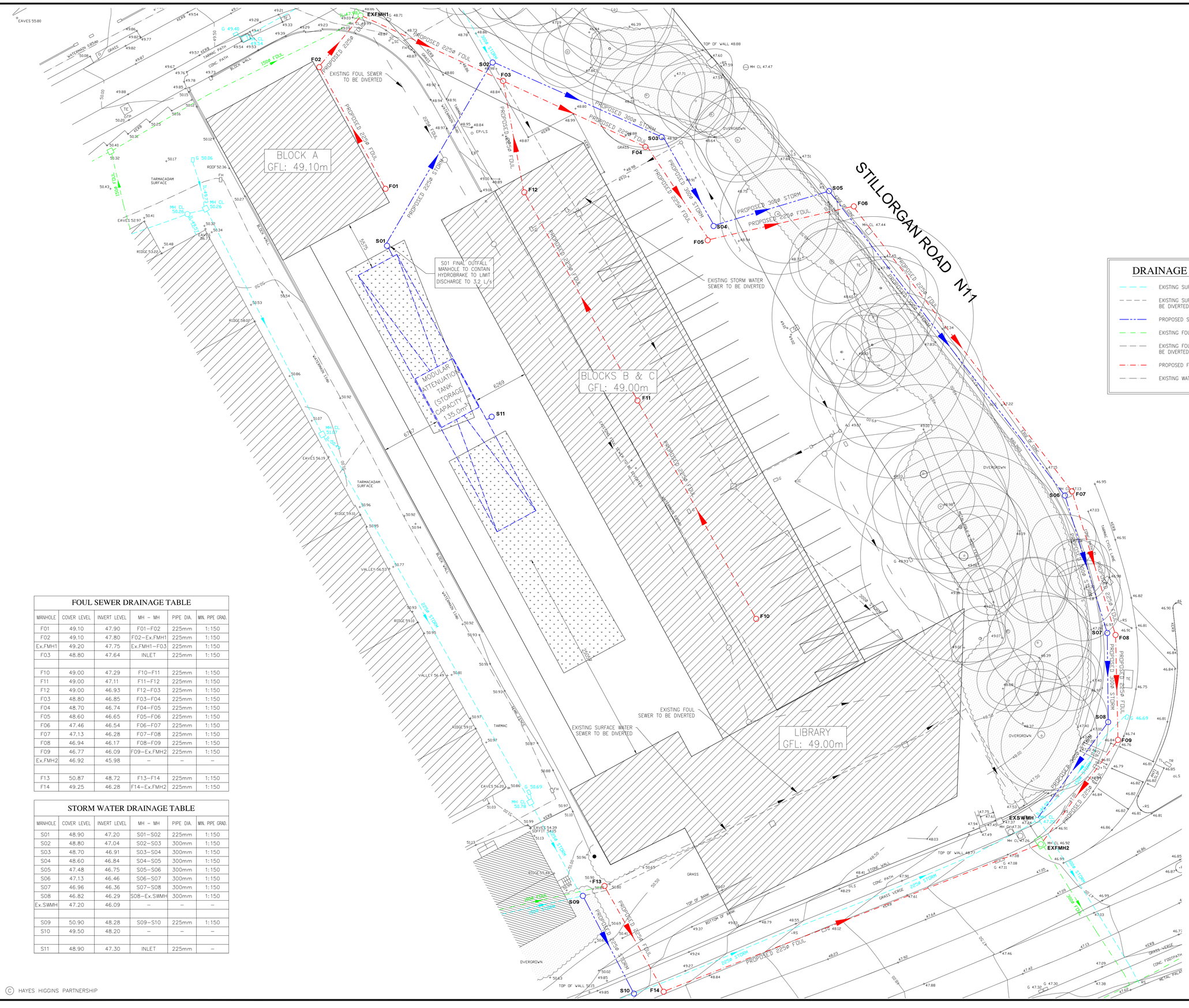
APPENDIX B

Hayes Higgins Partnership

Proposed Drainage Layout



NOTES

GENERAL

1.) THESE DRAWINGS TO BE READ IN CONJUNCTION WITH ALL RELEVANT HAYES HIGGINS ENGINEERING DRAWINGS AND SPECIFICATIONS.

2.) DO NOT SCALE. USE FIGURED DIMENSIONS ONLY.

3.) SURFACE WATER TO DÚN LAOGHAIRE–RATHDOWN COUNTY COUNCILS SPECIFICATION (GREATER DUBLIN REGIONAL CODE OF PRACTICE FOR DRAINAGE WORKS)

4.) FOUL WATER TO IRISH WATER SPECIFICATION (IW-CDS-5030-01 & 03)

5.) WATERMAIN TO IRISH WATER SPECIFICATION (IW-CDS-5020-01 & 03)

DRAINAGE LEGEND

- EXISTING SURFACE WATER SEWER
- EXISTING SURFACE WATER TO BE DIVERTED
- PROPOSED SURFACE WATER SEWER
- EXISTING FOUL SEWER
- EXISTING FOUL SEWER TO BE DIVERTED
- PROPOSED FOUL SEWER
- EXISTING WATERMAIN

FOUL SEWER DRAINAGE TABLE

MANHOLE	COVER LEVEL	INVERT LEVEL	MH – MH	PIPE DIA.	MIN. PIPE GRAD.
F01	49.10	47.90	F01–F02	225mm	1:150
F02	49.10	47.80	F02–Ex.FMH1	225mm	1:150
Ex.FMH1	49.20	47.75	Ex.FMH1–F03	225mm	1:150
F03	48.80	47.64	INLET	225mm	1:150
F10	49.00	47.29	F10–F11	225mm	1:150
F11	49.00	47.11	F11–F12	225mm	1:150
F12	49.00	46.93	F12–F03	225mm	1:150
F03	48.80	46.85	F03–F04	225mm	1:150
F04	48.70	46.74	F04–F05	225mm	1:150
F05	48.60	46.65	F05–F06	225mm	1:150
F06	47.46	46.54	F06–F07	225mm	1:150
F07	47.13	46.28	F07–F08	225mm	1:150
F08	46.94	46.17	F08–F09	225mm	1:150
F09	46.77	46.09	F09–Ex.FMH2	225mm	1:150
Ex.FMH2	46.92	45.98	–	–	–
F13	50.87	48.72	F13–F14	225mm	1:150
F14	49.25	46.28	F14–Ex.FMH2	225mm	1:150

STORM WATER DRAINAGE TABLE

MANHOLE	COVER LEVEL	INVERT LEVEL	MH – MH	PIPE DIA.	MIN. PIPE GRAD.
S01	48.90	47.20	S01–S02	225mm	1:150
S02	48.80	47.04	S02–S03	300mm	1:150
S03	48.70	46.91	S03–S04	300mm	1:150
S04	48.60	46.84	S04–S05	300mm	1:150
S05	47.48	46.75	S05–S06	300mm	1:150
S06	47.13	46.46	S06–S07	300mm	1:150
S07	46.96	46.36	S07–S08	300mm	1:150
S08	46.82	46.29	S08–Ex.SWMH	300mm	1:150
Ex.SWMH	47.20	46.09	–	–	–
S09	50.90	48.28	S09–S10	225mm	1:150
S10	49.50	48.20	–	–	–
S11	48.90	47.30	INLET	225mm	–

REV	DATE	DESCRIPTION	DWG BY	APPR. BY
P8	07.05.20	REVISED ATTENUATION TANK	DW	LM
P7	18.10.19	CL AMENDED FOR S01 & S11	DW	DH
P6	09.04.19	ADDED S11	DW	DH
P5	01.02.19	GENERAL REVISION	DW	DH
P4	30.11.18	REVISED STORM WATER LEVELS	DW	DH

ISSUED
PLANNING

CLIENT
DUN LAOGHAIRE - RATHDOWN COUNTY COUNCIL

PROJECT NAME
APARTMENTS AT ST LAURENCE'S PARK

DRAWING NAME
PROPOSED DRAINAGE LAYOUT

PROJECT No.
17D102

DRAWING No.	REVISION
01	P8
SCALE: 1:200	DRAWN DATE: 08.10.2018
CAD DRAWN BY: D.W.	CHECKED BY: K.H.
APPROVED BY: D.H.	

HAYES HIGGINS PARTNERSHIP
The Glass House, 11 Coke Lane
Smithfield, Dublin 7. Tel: 01 6612321
E-mail: admin@hayeshiggins.ie
Gas House Lane, Kilkenny. Tel: (056) 7764710
Email: info@hhp.ie

A1

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APPENDIX C

Micro-Drainage Hydraulic Simulation Analysis

Summary Output

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	16.000	Add Flow / Climate Change (%)	10
Ratio R	0.280	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.079	4-8	0.208

Total Area Contributing (ha) = 0.287

Total Pipe Volume (m³) = 7.017

Network Design Table for Storm

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.000	22.696	0.300	75.6	0.287	5.00	0.0	0.600	o	225	Pipe/Conduit	
S1.001	23.945	0.160	149.6	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.002	20.944	0.130	161.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.000	50.00	5.25	47.500	0.287	0.0	0.0	3.9	1.51	59.9	42.8
S1.001	50.00	5.63	47.200	0.287	0.0	0.0	3.9	1.07	42.4«	42.8
S1.002	50.00	5.97	47.040	0.287	0.0	0.0	3.9	1.03	40.9«	42.8

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.003	11.596	0.070	165.6	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.004	13.649	0.090	151.6	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.005	43.573	0.290	150.2	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.006	16.332	0.100	163.3	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.007	10.022	0.070	143.2	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.008	13.713	0.200	68.6	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.003	50.00	6.16	46.910	0.287	0.0	0.0	3.9	1.01	40.3«	42.8
S1.004	50.00	6.37	46.840	0.287	0.0	0.0	3.9	1.06	42.1«	42.8
S1.005	50.00	7.05	46.750	0.287	0.0	0.0	3.9	1.06	42.3«	42.8
S1.006	50.00	7.32	46.460	0.287	0.0	0.0	3.9	1.02	40.6«	42.8
S1.007	50.00	7.47	46.360	0.287	0.0	0.0	3.9	1.09	43.4	42.8
S1.008	50.00	7.62	46.290	0.287	0.0	0.0	3.9	1.58	62.9	42.8

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.000	o	225	S1	48.900	47.500	1.175	Open Manhole	1200
S1.001	o	225	S2	48.900	47.200	1.475	Open Manhole	1200
S1.002	o	225	S3	48.800	47.040	1.535	Open Manhole	1200
S1.003	o	225	S4	48.700	46.910	1.565	Open Manhole	1200
S1.004	o	225	S5	48.600	46.840	1.535	Open Manhole	1200
S1.005	o	225	S6	47.480	46.750	0.505	Open Manhole	1200
S1.006	o	225	S7	47.130	46.460	0.445	Open Manhole	1200
S1.007	o	225	S8	46.960	46.360	0.375	Open Manhole	1200
S1.008	o	225	S9	46.820	46.290	0.305	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.000	22.696	75.6	S2	48.900	47.200	1.475	Open Manhole	1200
S1.001	23.945	149.6	S3	48.800	47.040	1.535	Open Manhole	1200
S1.002	20.944	161.0	S4	48.700	46.910	1.565	Open Manhole	1200
S1.003	11.596	165.6	S5	48.600	46.840	1.535	Open Manhole	1200
S1.004	13.649	151.6	S6	47.480	46.750	0.505	Open Manhole	1200
S1.005	43.573	150.2	S7	47.130	46.460	0.445	Open Manhole	1200
S1.006	16.332	163.3	S8	46.960	46.360	0.375	Open Manhole	1200
S1.007	10.022	143.2	S9	46.820	46.290	0.305	Open Manhole	1200
S1.008	13.713	68.6	S	47.200	46.090	0.885	Open Manhole	0

Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	Classification	Roof	90	0.319	0.287	0.287
1.001	-	-	100	0.000	0.000	0.000
1.002	-	-	100	0.000	0.000	0.000
1.003	-	-	100	0.000	0.000	0.000
1.004	-	-	100	0.000	0.000	0.000
1.005	-	-	100	0.000	0.000	0.000
1.006	-	-	100	0.000	0.000	0.000
1.007	-	-	100	0.000	0.000	0.000
1.008	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.319	0.287	0.287

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S1.008	S	47.200	46.090	46.090	0	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	10.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs 0	Number of Offline Controls 0	Number of Time/Area Diagrams 0
Number of Online Controls 1	Number of Storage Structures 1	Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	16.000	Storm Duration (mins)	30
Ratio R	0.280		

Online Controls for Storm

Hydro-Brake® Optimum Manhole: S2, DS/PN: S1.001, Volume (m³): 2.8

Unit Reference	MD-SHE-0053-1400-1200-1400
Design Head (m)	1.200
Design Flow (l/s)	1.4
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface Sump Available
Yes Diameter (mm)	53
Invert Level (m)	47.200
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	1.4	Kick-Flo®	0.474	0.9
Flush-Flo™	0.235	1.1	Mean Flow over Head Range	-	1.1

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.0	1.200	1.4	3.000	2.1	7.000	3.1
0.200	1.1	1.400	1.5	3.500	2.3	7.500	3.2
0.300	1.1	1.600	1.6	4.000	2.4	8.000	3.3
0.400	1.1	1.800	1.7	4.500	2.6	8.500	3.4
0.500	0.9	2.000	1.8	5.000	2.7	9.000	3.5
0.600	1.0	2.200	1.8	5.500	2.8	9.500	3.6
0.800	1.2	2.400	1.9	6.000	2.9		
1.000	1.3	2.600	2.0	6.500	3.0		

Storage Structures for Storm

Cellular Storage Manhole: S2, DS/PN: S1.001

Invert Level (m) 47.200 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	193.0	0.0	1.300	0.0	0.0
0.100	193.0	0.0	1.400	0.0	0.0
0.200	193.0	0.0	1.500	0.0	0.0
0.300	193.0	0.0	1.600	0.0	0.0
0.400	193.0	0.0	1.700	0.0	0.0
0.500	193.0	0.0	1.800	0.0	0.0
0.600	193.0	0.0	1.900	0.0	0.0
0.700	193.0	0.0	2.000	0.0	0.0
0.800	193.0	0.0	2.100	0.0	0.0
0.900	193.0	0.0	2.200	0.0	0.0
1.000	193.0	0.0	2.300	0.0	0.0
1.100	0.0	0.0	2.400	0.0	0.0
1.200	0.0	0.0	2.500	0.0	0.0

Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	10.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.280
Region	Scotland and Ireland	Cv (Summer)	0.750
M5-60 (mm)	16.000	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Coarse Inertia Status OFF
DTS Status ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1
Climate Change (%)	0

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.000	S1	15 Winter	1	+0%					47.632
S1.001	S2	720 Winter	1	+0%	1/360 Winter				47.441
S1.002	S3	360 Winter	1	+0%					47.066
S1.003	S4	480 Winter	1	+0%					46.939
S1.004	S5	360 Winter	1	+0%					46.867
S1.005	S6	2160 Winter	1	+0%					46.775
S1.006	S7	480 Summer	1	+0%					46.487
S1.007	S8	360 Winter	1	+0%					46.388
S1.008	S9	480 Summer	1	+0%					46.312

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	-0.093	0.000	0.62		34.1	OK	

Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.001	S2	0.016	0.000	0.03		1.1	SURCHARGED	
S1.002	S3	-0.199	0.000	0.03		1.1	OK	
S1.003	S4	-0.196	0.000	0.03		1.1	OK	
S1.004	S5	-0.198	0.000	0.03		1.1	OK	
S1.005	S6	-0.200	0.000	0.03		1.1	OK	
S1.006	S7	-0.198	0.000	0.03		1.1	OK	
S1.007	S8	-0.197	0.000	0.03		1.1	OK	
S1.008	S9	-0.203	0.000	0.02		1.1	OK	

Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	10.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.280
Region	Scotland and Ireland	Cv (Summer)	0.750
M5-60 (mm)	16.000	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Coarse Inertia Status OFF
DTS Status ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	30
Climate Change (%)	0

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.000	S1	15 Winter	30	+0%	30/15 Summer				47.944
S1.001	S2	960 Winter	30	+0%	30/30 Summer				47.787
S1.002	S3	120 Summer	30	+0%					47.066
S1.003	S4	120 Winter	30	+0%					46.939
S1.004	S5	120 Summer	30	+0%					46.867
S1.005	S6	5760 Summer	30	+0%					46.775
S1.006	S7	120 Winter	30	+0%					46.487
S1.007	S8	360 Summer	30	+0%					46.388
S1.008	S9	120 Winter	30	+0%					46.312

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	0.219	0.000	1.31		71.9	SURCHARGED	

Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.001	S2	0.362	0.000	0.03		1.1	SURCHARGED	
S1.002	S3	-0.199	0.000	0.03		1.1	OK	
S1.003	S4	-0.196	0.000	0.03		1.1	OK	
S1.004	S5	-0.198	0.000	0.03		1.1	OK	
S1.005	S6	-0.200	0.000	0.03		1.1	OK	
S1.006	S7	-0.198	0.000	0.03		1.1	OK	
S1.007	S8	-0.197	0.000	0.03		1.1	OK	
S1.008	S9	-0.203	0.000	0.02		1.1	OK	

Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	10.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.280
Region	Scotland and Ireland	Cv (Summer)	0.750
M5-60 (mm)	16.000	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Coarse Inertia Status OFF
DTS Status ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	100
Climate Change (%)	0

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.000	S1	15 Winter	100	+0%	100/15 Summer				48.260
S1.001	S2	960 Winter	100	+0%	100/15 Winter				47.967
S1.002	S3	960 Winter	100	+0%					47.066
S1.003	S4	480 Summer	100	+0%					46.939
S1.004	S5	120 Winter	100	+0%					46.867
S1.005	S6	960 Winter	100	+0%					46.775
S1.006	S7	240 Summer	100	+0%					46.487
S1.007	S8	360 Summer	100	+0%					46.388
S1.008	S9	180 Winter	100	+0%					46.312

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	0.535	0.000	1.64		89.9	SURCHARGED	

Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.001	S2	0.542	0.000	0.03		1.1	SURCHARGED	
S1.002	S3	-0.199	0.000	0.03		1.1	OK	
S1.003	S4	-0.196	0.000	0.03		1.1	OK	
S1.004	S5	-0.198	0.000	0.03		1.1	OK	
S1.005	S6	-0.200	0.000	0.03		1.1	OK	
S1.006	S7	-0.198	0.000	0.03		1.1	OK	
S1.007	S8	-0.197	0.000	0.03		1.1	OK	
S1.008	S9	-0.203	0.000	0.02		1.1	OK	

Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	10.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.280
Region	Scotland and Ireland	Cv (Summer)	0.750
M5-60 (mm)	16.000	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Coarse Inertia Status OFF
DTS Status ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 0

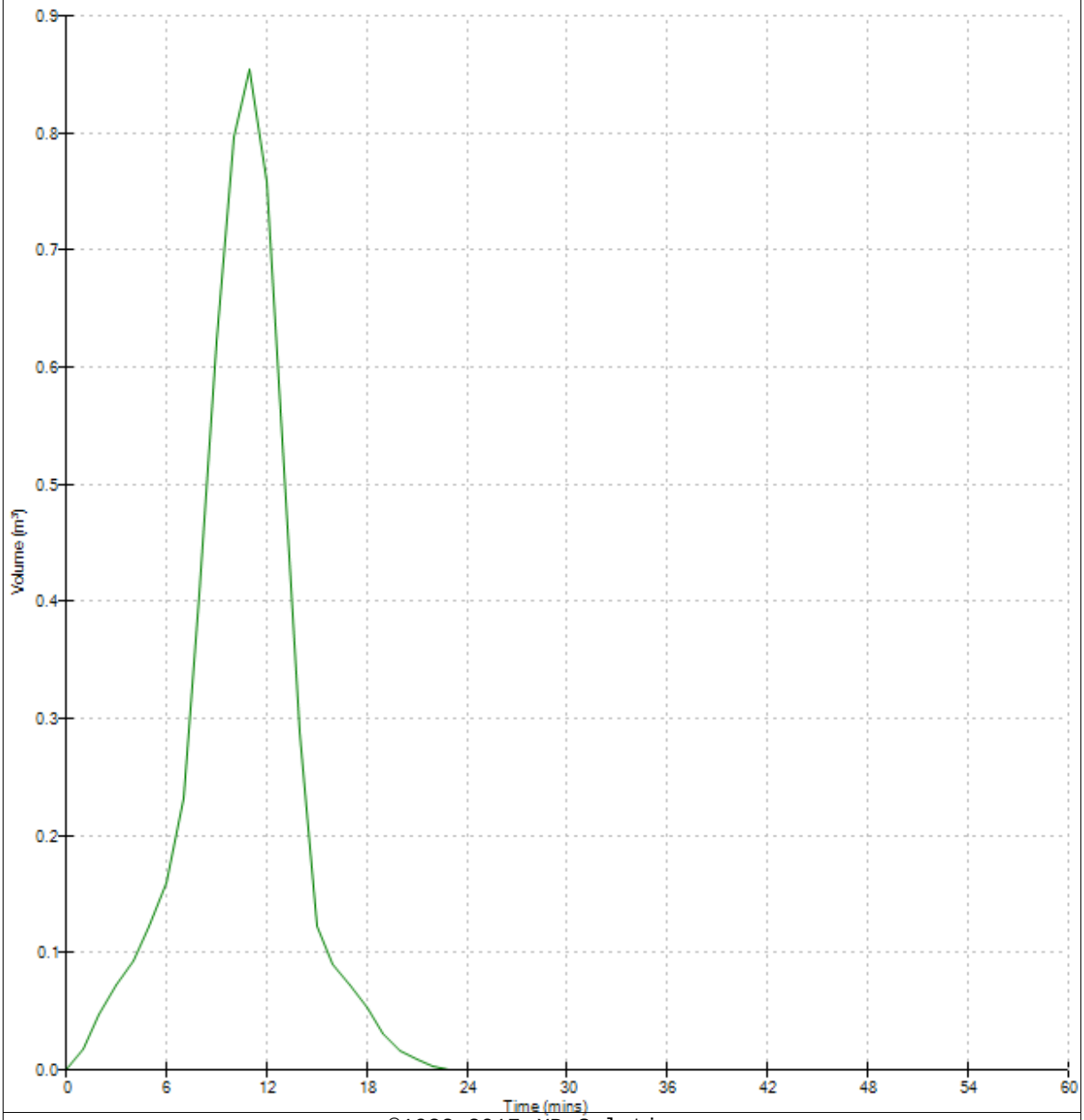
PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.000	S1	15 Winter	100	+0%	30/15 Summer				48.260
S1.001	S2	960 Winter	100	+0%	1/360 Winter				47.967
S1.002	S3	960 Winter	100	+0%					47.066
S1.003	S4	120 Winter	30	+0%					46.939
S1.004	S5	120 Winter	100	+0%					46.867
S1.005	S6	960 Winter	100	+0%					46.775
S1.006	S7	120 Winter	30	+0%					46.487
S1.007	S8	360 Summer	100	+0%					46.388
S1.008	S9	120 Winter	30	+0%					46.312

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	0.535	0.000	1.64		89.9	SURCHARGED	

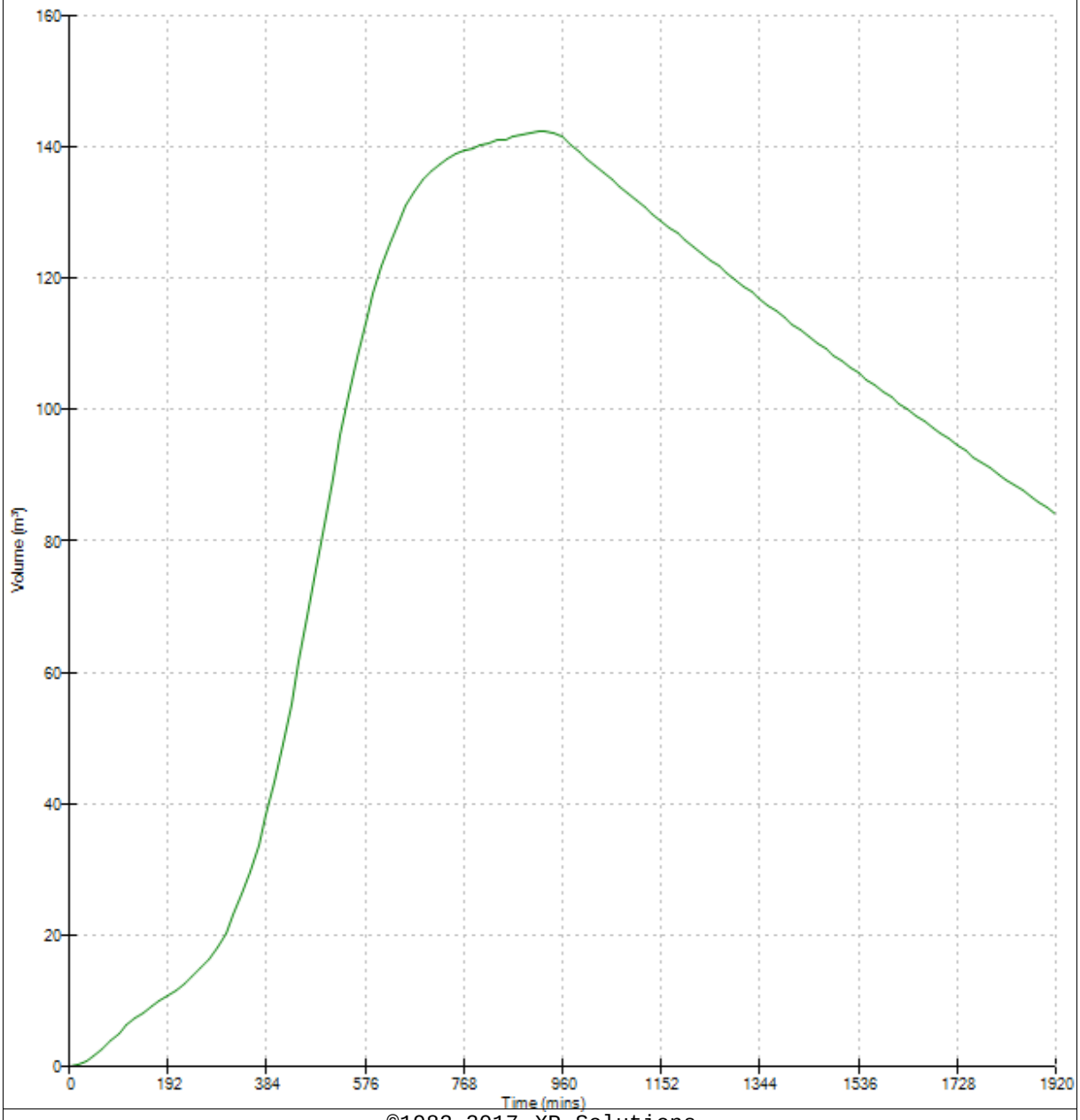
Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.001	S2	0.542	0.000	0.03		1.1	SURCHARGED	
S1.002	S3	-0.199	0.000	0.03		1.1	OK	
S1.003	S4	-0.196	0.000	0.03		1.1	OK	
S1.004	S5	-0.198	0.000	0.03		1.1	OK	
S1.005	S6	-0.200	0.000	0.03		1.1	OK	
S1.006	S7	-0.198	0.000	0.03		1.1	OK	
S1.007	S8	-0.197	0.000	0.03		1.1	OK	
S1.008	S9	-0.203	0.000	0.02		1.1	OK	

Graphs for Pipe S1.000 US/MH S1 (Storm)
15 minute 100 year Winter I+0%
Status: SURCHARGED



Graphs for Pipe S1.001 US/MH S2 (Storm)
960 minute 100 year Winter I+0%
Status: SURCHARGED



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APPENDIX D

Micro-Drainage Hydraulic Simulation Analysis

Blocked Scenario Output

Online Controls for Storm

Hydro-Brake® Optimum Manhole: S2, DS/PN: S1.001, Volume (m³): 2.8

Unit Reference	MD-SHE-0037-7000-1200-7000
Design Head (m)	1.200
Design Flow (l/s)	0.7
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface Sump Available
Yes Diameter (mm)	37
Invert Level (m)	47.200
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	0.7	Kick-Flo®	0.331	0.4
Flush-Flo™	0.165	0.5	Mean Flow over Head Range	-	0.5

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.5	1.200	0.7	3.000	1.1	7.000	1.6
0.200	0.5	1.400	0.7	3.500	1.1	7.500	1.6
0.300	0.4	1.600	0.8	4.000	1.2	8.000	1.6
0.400	0.4	1.800	0.8	4.500	1.3	8.500	1.7
0.500	0.5	2.000	0.9	5.000	1.3	9.000	1.7
0.600	0.5	2.200	0.9	5.500	1.4	9.500	1.8
0.800	0.6	2.400	1.0	6.000	1.4		
1.000	0.6	2.600	1.0	6.500	1.5		

Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	10.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.280
Region	Scotland and Ireland	Cv (Summer)	0.750
M5-60 (mm)	16.000	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Coarse Inertia Status OFF
DTS Status ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 0

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.000	S1	15 Winter	100	+0%	30/15 Summer				48.260
S1.001	S2	2880 Winter	100	+0%	1/240 Winter				48.191
S1.002	S3	2880 Winter	100	+0%					47.058
S1.003	S4	480 Winter	30	+0%					46.933
S1.004	S5	2880 Winter	100	+0%					46.859
S1.005	S6	2880 Winter	100	+0%					46.767
S1.006	S7	2880 Winter	100	+0%					46.479
S1.007	S8	2880 Winter	100	+0%					46.379
S1.008	S9	2880 Winter	100	+0%					46.303

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	0.535	0.000	1.64		89.9	SURCHARGED	

Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.001	S2	0.766	0.000	0.02		0.6	SURCHARGED	
S1.002	S3	-0.207	0.000	0.02		0.6	OK	
S1.003	S4	-0.202	0.000	0.01		0.5	OK	
S1.004	S5	-0.206	0.000	0.02		0.6	OK	
S1.005	S6	-0.208	0.000	0.02		0.6	OK	
S1.006	S7	-0.206	0.000	0.02		0.6	OK	
S1.007	S8	-0.206	0.000	0.02		0.6	OK	
S1.008	S9	-0.212	0.000	0.01		0.6	OK	