Cappaghfinn, Finglas, Dublin 11

Surface Water Management Plan (SWMP)

July 2019

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Comhairle Contae Fhine Gall
Fingal County Council

INTRODUCTION

This Surface Water Management Plan (SWMP) was commissioned by Fingal County Council and prepared by McCloy Consulting for lands at Cappaghfinn, Finglas, Dublin 11. The purpose of the SWMP is to determine flood risk at lands at Cappaghfinn and to develop a strategy for the sustainable management of surface water.

The SWMP consists of two parts:

- Strategic Flood Risk Assessment (SFRA)
- Sustainable Drainage Strategy (SDS)

Strategic Flood Risk Assessment (SFRA)

The SFRA is intended to produce a Stage 1 to 3 Flood Risk Assessment (FRA) as defined by the OPW Planning System and Flood Risk Management Guidelines to refine the existing SFRA for the Fingal Development Plan 2017-2023 and ensure that all relevant issues related to flooding are addressed.

The assessment will determine potential sources of flooding at the Plan Area and their associated risk to life and new development. The SFRA will determine the suitability of lands for development and set standards for flood protection material to the Plan Area.

Sustainable Drainage Strategy (SDS)

The purpose of the SDS is to set out a framework for the delivery of a drainage system which will integrate multi-functional SuDS components within the Plan Area to manage water at or near the surface, providing high quality blue / green infrastructure which enhances and improves biodiversity and brings significant community benefits within developed areas.

The SDS seeks to demonstrate that the objectives set out in Fingal Development Plan 2017 – 2023 and requirements set out in GDSDS (Volume 3) SuDS Requirements can be satisfied.

Health and Safety

The appointed Project Supervisor Design Process (PSDP) consultant has completed the required Health and Safety assessment which is provided under separate cover.

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McCloy Consulting

Strategic Flood Risk Assessment

Lands at Cappaghfinn, Finglas, Dublin 11

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CLIENT CONTACT	Daragh Sheedy
PROJECT MANAGER	Kyle Somerville
AUTHOR(S)	Victoria Ramsey, Paul Singleton
BRANCH	DUBLIN Unit 12, The BEaT Centre, Stephenstown Industrial Estate, Balbriggan T: +353 (0)1 5138963 | W: www.mccloyconsulting.ie

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1 INTRODUCTION

1.1 Terms of Reference

This Strategic Flood Risk Assessment (SFRA) was commissioned by Fingal County Council (hereafter *Fingal CC*) to form a Surface Water Management Plan (SWMP) in conjunction with a Sustainable Drainage Strategy (SDS) for lands at Cappaghfinn, Finglas, Dublin 11 (hereafter *Plan Area*).

1.2 Purpose

Flood risk management for development planning is guided by 'The Planning System and Flood Risk Management – Guidelines for Planning Authorities (Department of the Environment & Local Government, November 2009)' [hereafter *OPW Guidelines*].

This SFRA is intended to produce a Stage 1 to 3 Flood Risk Assessment (FRA) as defined by the OPW Guidelines to refine the existing SFRA for the Fingal Development Plan 2017-2023 (hereafter *Fingal SFRA*) and ensure that all relevant issues related to flooding are addressed.

The assessment will determine potential sources of flooding at the Plan Area and their associated risk to life and new development as well as determine the suitability of lands for development and set standards for flood protection.

This assessment is intended for 'plan making' and is not intended to assess the risk to development proposals. Risk to development would be assessed separately by Site-Specific Flood Risk Assessment(s) (SSFRA) submitted in support of planning application(s) and would be specific to development proposal(s). Any latter SSFRA may be informed by flood hazard information determined by this assessment.

1.3 Statement of Authority

This report and assessment has been prepared and reviewed by qualified professionals with appropriate experience in the fields of flood risk, drainage, wastewater, and hydraulic modelling studies. The key staff members involved in this project are as follows:

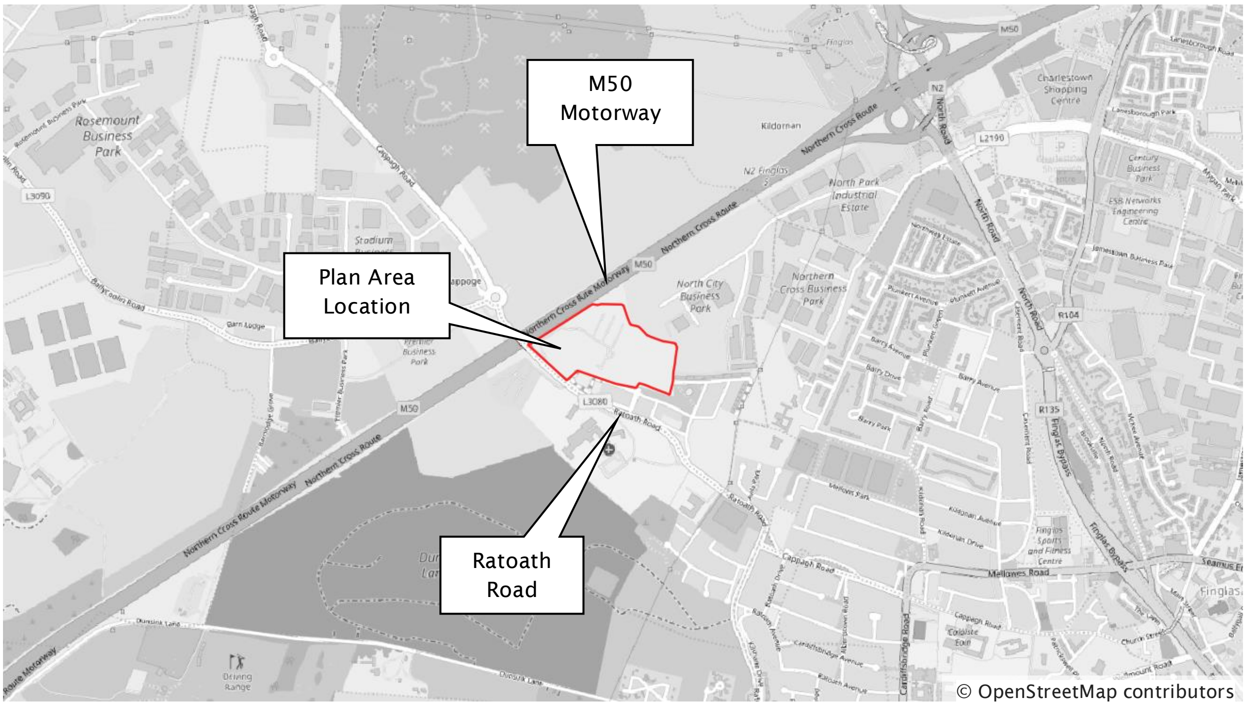
- Victoria Ramsey *BSc (Hons) MSc* – Environmental Consultant with experience in the fields of flood risk assessment, flood modelling, drainage and surface water management design and expertise in the application of climatology and climate change in relation to flood hydrology.
- Paul Singleton *BEng (Hons) MSc CEng MIEI* – Chartered Civil / Environmental Engineer with particular experience in drainage, SuDS and flood risk assessment, and a recognised industry professional having given industry training in these fields in Ireland and the UK.
- Kyle Somerville *BEng (Hons) CEng MIEI* – Associate and Chartered Engineer specializing in the fields of flood risk assessment, flood modelling, drainage and surface water management design for public and private sectors.

2 PLAN AREA DETAILS

2.1 Plan Area Location

The Plan Area is located in Cappagh, Dublin 11, west of Finglas, and lies north of the Ratoath Road and east of the M50 motorway between Junctions 5 and 6. The Heathfield development lies to the east of the Plan Area, Cappagh Hospital to the south and Dublin City Business Park to the north.

Figure 2.1 Plan Area Location



2.2 Plan Area Description

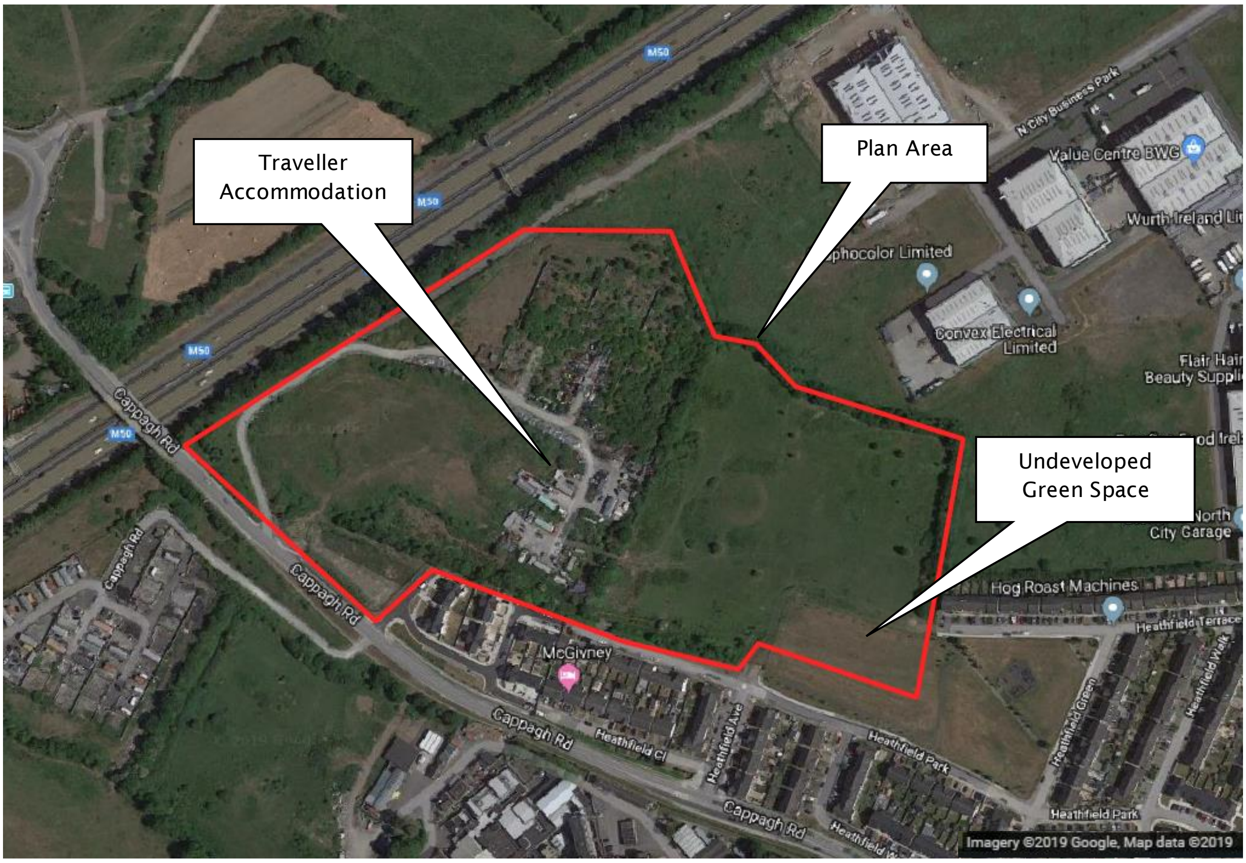
The Plan Area has an areal extent of 8.4 ha and currently comprises traveller accommodation in the west and undeveloped green space in the east. Figure 2.2 illustrates the current land usage.

Land within the Plan Area generally falls from west to east with ground levels varying between 73.44 meters Ordnance Datum (m OD) to 78.84 m OD.

Heathfield Terrace is contiguous with the Plan Area and provides access from the east. Access into the west is via the Ratoath Road

Existing levels used as the basis for this flood risk assessment are based on ground based topographical survey and included in Appendix A. Photographs of the existing Plan Area and its surroundings taken as part of a walkover survey are included in Appendix B.

Figure 2.2 Existing Land Use

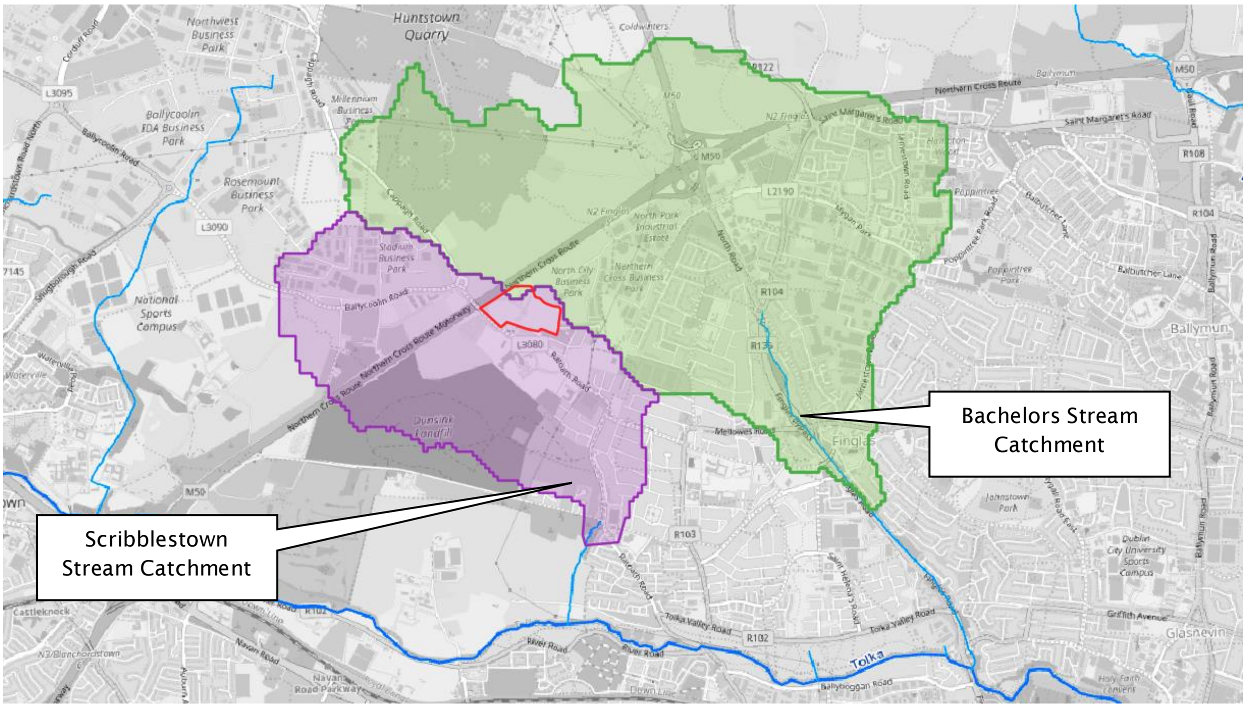


2.3 Existing Drainage

Analysis of 25 m DTM datasets indicates that the majority of the Plan Area lies within the wider catchment of a stream indicated on Environmental Protection Agency (EPA) datasets to be known as the Scribblestown Stream located 1.2 km to the south. The northern corner lies within the wider catchment of a stream known to the EPA as Bachelors Stream[1] located 1.3 km east of the Plan Area as shown in Figure 2.3.

[1] Greater Strategic Drainage Study also refers to this stream as the Finglas River

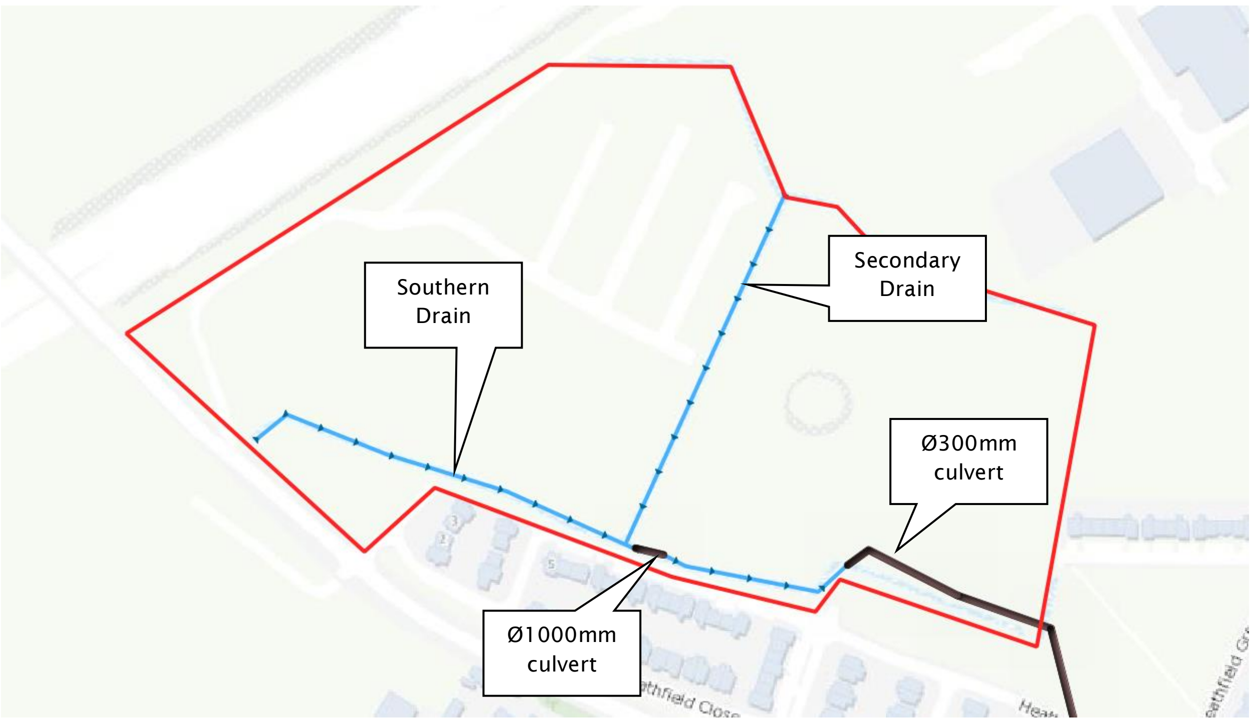
Figure 2.3 Wider Catchment Area



A drainage ditch, hereafter referred to as the 'southern drain', is located adjacent to the southern boundary and is culverted beneath Heathfield Park by a by a Ø1000 mm concrete circular pipe and sinks beneath the south-east of the Plan Area via a Ø300 mm PVC pipe.

Another ditch, hereafter referred to as the 'secondary drain', flows from north to south and discharges to the southern drain as shown in Figure 2.4. Surface water sewerage asset information is described further in Section 4.4.1.

Figure 2.4 Drainage Features



2.4 Environment

While not material to the assessment of flood likelihood or flood risk, it is pertinent to determine water-environment linkages to sites of designated environmental importance, in order to inform the Strategic Environmental Assessment (SEA) for the Plan Area.

There are no Natura 2000 sites within the Plan Area. However, the South Dublin Bay and River Tolka Estuary SPA and South Dublin Bay SAC are located approximately 8 km south-east and are hydrologically linked (downstream of) the Plan Area.

Under Article 6 (3) of the EU Habitats Directive, an 'appropriate assessment' is required where any plan or project, either alone or in combination with other plans or projects, could have an adverse effect of the integrity of a Natura 2000 site.

Natural Heritage Areas (NHAs) are sites of national importance for nature conservation and are afforded protection under planning policy and the Wildlife Acts 1976-2012. Proposed NHAs (pNHAs) are published sites identified as of similar conservation interest but have not been statutorily proposed or designated. The nearest NHA/pNHAs to the Plan Area are The Royal Canal pNHA located 2.2 km to the south and Santry Demesne pNHA located 4.8 km to the east, neither of which are hydrologically linked to the Plan Area.

2.5 Proposed Development

Notwithstanding particular objectives of the Plan Area that this assessment is intended to inform, Zoning objectives contained within the Fingal Development Plan 2017 – 2023 are shown in Figure 2.5 and summarised in Table 2.1.

Figure 2.5 Fingal CC Zoning Objectives

Table 2.1 Fingal CC Zoning Objectives

Objective	Description
RA – Residential Area (R1)	Provide for new residential communities subject to the necessary social and physical infrastructure.

3 APPROACH AND METHODOLOGY

3.1 Introduction

This Flood Risk Assessment report has been prepared in accordance with the OPW Guidelines. The OPW Guidelines have been implemented and embedded within the context of the Fingal Development Plan 2017 – 2023 through informing the approach adopted by the Fingal SFRA.

This SFRA further refines the general requirements of the OPW Guidelines and particular requirements of the Fingal SFRA.

3.2 Definition of Flood Risk

Flood risk is a combination of the likelihood of the occurrence of a flood event and the potential consequences arising from that flood evet, expressed as the following:

Flood Risk = Likelihood of Flooding x Consequences of Flooding

3.2.1 Likelihood of Flooding

The likelihood of flooding is defined in the OPW Guidelines as the percentage probability of a flood of a given magnitude or severity, occurring or being exceeded in any given year. It is generally expressed as a return period or annual exceedance probability (AEP). For example, a 1% AEP indicates the severity of a flood that has a 1 in 100 (1%) chance of occurring in any one year. Annual exceedance probability is the inverse of return period as shown in Table 3.1 below.

Table 3.1 Return Periods and AEP

Return Period (Years)	Annual Exceedance Probability (%)
1	100
10	10
50	2
100	1
200	0.5
1000	0.1

3.2.2 Consequences of Flooding

The consequences of flooding are determined by the hazards associated with the flooding (e.g. depth of water, speed flow, rate of onset, duration, wave action, water quality), and the vulnerability of people, property and the environment potentially affected by a flood (e.g. age profile of the population, type of development, presence and reliability of mitigation measures).

3.3 Objectives and Principles of the OPW Guidelines

The Fingal SFRA recognises the core objectives of the OPW Guidelines which are designed to:

- Avoid inappropriate development in areas at risk of flooding.
- Avoid new developments increasing flood risk elsewhere, including that which may arise from surface water run-off.
- Ensure effective management of residual risks for development permitted in floodplains.
- Avoid unnecessary restriction of national, regional or local economic and social growth.

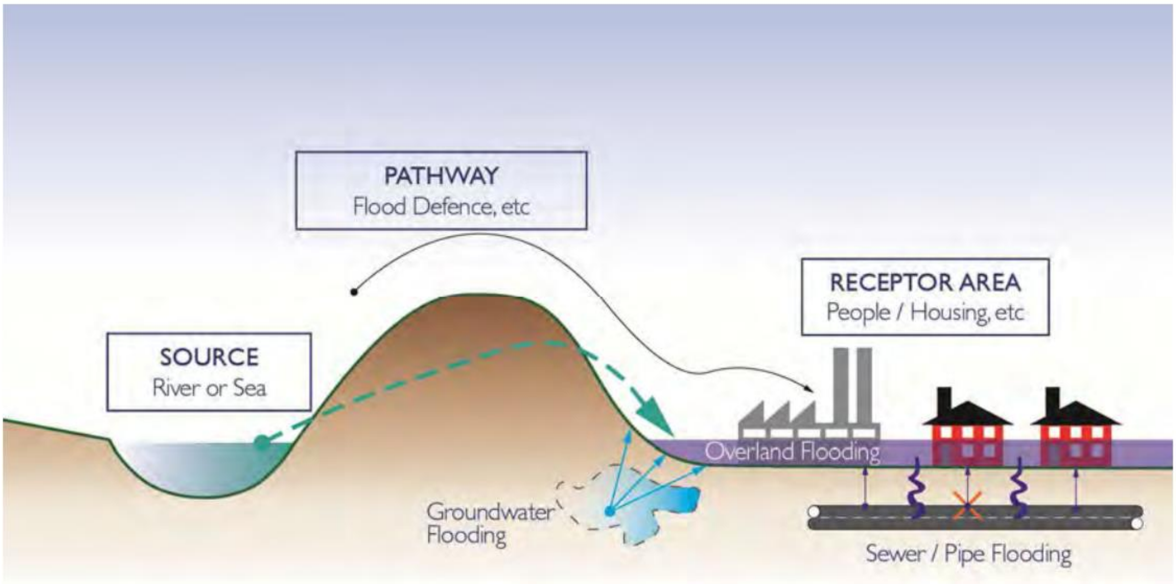
- Improve the understanding of flood risk among relevant stakeholders; and
- Ensure that the requirements of EU and national law in relation to the natural environment
- and nature conservation are complied with at all stages of flood risk management.

The OPW Guidelines recommend that Flood Risk Assessments be carried out to identify the risk of flooding to land, property and people.

3.4 Flood Risk Assessment

The Fingal SFRA, in line with the OPW Guidelines, advocates the use of the Source – Pathway – Receptor model in Flood Risk Assessments (FRA) to identify the sources of flooding (e.g. high sea levels, intense or prolonged rainfall leading to increased runoff and increased flow in rivers and sewers), the people and assets impacted by flooding (receptors) and the pathways by which the flood water reaches those receptors (e.g. overland flow, river and coastal floodplains, river channels and sewers). Figure 3.1 shows the source-pathway-receptor model from the Fingal SFRA.

Figure 3.1 Sources, pathways and receptors of flooding from the Fingal SFRA



3.5 Flood Zones

Flood Zones are geographical areas within which the likelihood of flooding is in a particular range. The Fingal SFRA in conjunction with the OPW Guidelines defines three Flood Zones for **flooding from rivers and sea only** as indicated in Table 3.2.

Table 3.2 Flood Zones

Flood Zone	Description	Probability (Rivers)	Probability (Coastal)
A	Probability of flooding from rivers and sea is highest	Greater than 1% or 1 in 100	Greater than 0.5% or 1 in 200
B	Probability of flooding from rivers and sea is moderate	Between 0.1% or 1 in 1000 and 1% or 1 in 100	Between 0.1% or 1 in 1000 and 0.5% or 1 in 200
C	Probability of flooding from rivers and sea is low. Covers all Plan Areas which are not in zones A or B	Less than 0.1% or 1 in 1000	Less than 0.1% or 1 in 1000

Flood Zones are generated without the inclusion of climate change factors. When determining Flood Zones, the presence of flood protection structures should be ignored as areas protected by flood defences still carry a residual risk from overtopping or breach of defences.

3.6 Climate Change

Climate change is expected to increase flood risk, in terms of more frequent flooding and increasing the depth and extent of flooding. Due to the uncertainty of the potential effects of climate change, the Fingal SFRA sets out recommendations in line with the precautionary approach adopted by the OPW Guidelines in managing the effects of climate change:

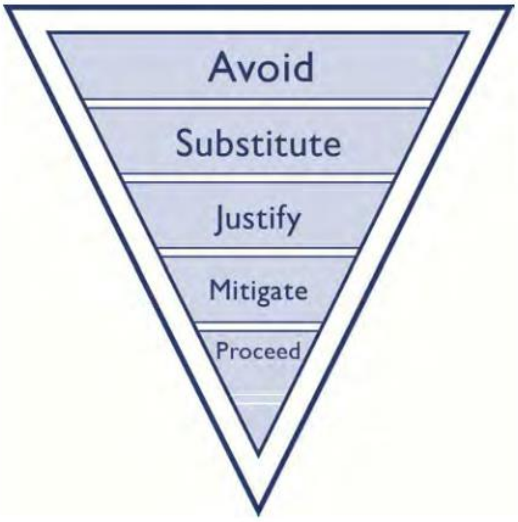
- Recognise that significant changes in the flood extent may result from an increase in rainfall or tide events and accordingly adopt a cautious approach to zoning land in transitional areas.
- Ensure that the levels of structures designed to protect against flooding, such as flood defences, land-raising or raised floor levels are sufficient to cope with the effects of climate change over the lifetime of the development.
- Ensure that structures to protect against flooding and the protected development are capable of adaptation to the effects of climate change when there is more certainty about the effects and still time for such adaptation to be effective.

3.7 The Sequential Approach and Justification Test

The Fingal SFRA, in line with the OPW Guidelines recommend a sequential approach to planning to ensure the core objectives outlined in section 3.3 are implemented. It is of particular importance at the plan making stage but is also applicable in the layout and design of development at the development management stage. The broad philosophy of the sequential approach in flood risk management from the Fingal SFRA / OPW Guidelines is shown in Figure 3.2.

In general, most types of development would be considered inappropriate in Flood Zone A. In Flood Zone B highly vulnerable development (e.g. hospitals, dwelling houses and primary infrastructure) would be considered inappropriate but less vulnerable development (e.g. retail, commercial and industrial uses) might be considered appropriate. Development within Flood Zone C is appropriate from a flood risk perspective.

Figure 3.2 The Sequential Approach



The Justification Test has been designed to rigorously assess the appropriateness, or otherwise, of particular developments that, for the reasons outlined above, are being considered in areas of moderate or high flood risk. The test is comprised of two processes:

- **Plan Making Justification Test** – used at the plan preparation and adoption stage where it is intended to zone or otherwise designated land which is at moderate or high risk of flooding.
- **Development Management Justification Test** – used at the planning application state where it is intended to develop land at moderate or high risk of flooding for uses or development vulnerable to flooding that would generally be inappropriate for that land.

Table 3.3 below indicates the types of development that would be required to meet the Justification Test.

Table 3.3 Vulnerability and Flood Zone Matrix for Justification Test

Development Vulnerability[2]	Flood Zone A	Flood Zone B	Flood Zone C
Highly Vulnerable (including essential infrastructure)	Justification Test	Justification Test	Appropriate
Less Vulnerable	Justification Test	Appropriate	Appropriate
Water-compatible	Appropriate	Appropriate	Appropriate

[2] Full descriptions and examples of development vulnerability can be found in Section 3.6 of the Fingal SFRA

4 STAGE 1 – FLOOD RISK IDENTIFICATION

As part of the Stage 1 flood risk identification phase, a number of available sources of information generally as set out in the Fingal SFRA and OPW Guidelines was investigated in order to build an understanding of the potential risk of flooding to the Plan Area.

The following review highlights the key findings of the Stage 1 FRA to identify any flooding issues that may warrant further investigation.

Stage 1 data gathering informs the screening of potentially significant flood mechanisms (Stage 2 FRA) described in subsequent Section 5 of this assessment.

4.1 Information Sources Summary

The following table summarises the data sources consulted as part of the flood risk identification process. Pertinent data obtained from these sources is described and screened in the following sections.

Table 4.1 Flood Data Sources

Source	Relevant?	Described in Section
Topographic Data		
OSI close-scale mapping	Close scale OSI mapping indicates water features on and adjacent to the Plan Area. OSI datasets for flooding, marsh, and seasonal lakes indicate no features on and adjacent to the Plan Area.	4.2.1
OSI Historical Maps	OSI 6" and 25" mapping have been reviewed.	0
OSI Height Data	OSI 25 m DTM has been used to inform macro-level catchment assessments. 2 m Grid Urban LiDAR height data has been used to inform the Plan Area assessment.	4.2.2
Land Survey	Survey data provided by Fingal CC from a 3rd party surveyor and additional survey instructed as part of this SFRA conducted by a 3rd party surveyor has been reviewed.	4.2.2
Flood Data (Predictive and Flood Records)		
OPW National Flood Hazard Mapping	Review of flood records confirms no recorded flooding relevant to the assessment within 1.8 km of the area of interest.	N/A
OPW Preliminary Flood Risk Assessment Maps (PFRA)	Fluvial, pluvial, coastal and ground water flooding datasets have been reviewed.	4.3.1
Fingal and East Meath Flood Risk Assessment and Management Study (FEM-FRAM)	No FEM-FRAM mapping (in lieu of CFRAM detailed mapping) is available for the Plan Area.	N/A
Dublin Pluvial Study	Pluvial flooding mapping has been reviewed.	4.3.2
Greater Dublin Strategic Drainage Strategy (GDSDS)	Content relevant to the Plan Area has been reviewed.	4.3.3

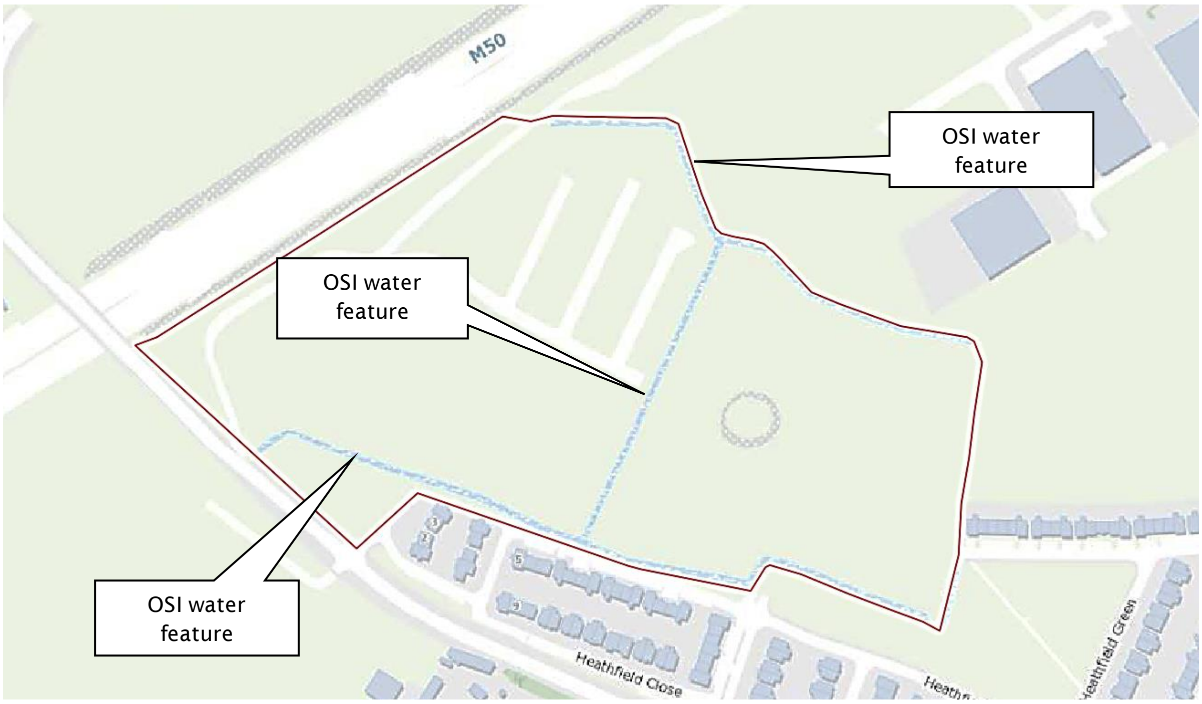
Source	Relevant?	Described in Section
SFRA for Fingal Development Plan 2017-2013	Review of the SFRA in relation to predictive or historic flood data indicates no further information over and above that established from original sources already described.	N/A
Media Search	A media search has provided photographic confirmation of flooding on part of the Plan Area.	4.3.4
Drainage Data		
Irish Water / Fingal CC Drainage Records	Sewerage records have been made available. No information on culverted watercourses is available.	4.4.1
EPA Datasets	No lakes, rivers, streams or canals mapped on EPA datasets were identified within 1 km of the Plan Area.	N/A
OPW Arterial Drainage Datasets	No drainage district, channel, embankment, or benefitting land affects the Plan Area.	N/A
Drainage Surveys	Additional drainage tracing to close data gaps has been undertaken and informs the assessment.	4.4.2
Ground Conditions		
Geological Survey of Ireland (GSI) Maps	Bedrock and superficial geology datasets have been reviewed.	4.5
Site Investigation Report (Causeway Geotech)	A trial pit and borehole survey has been undertaken on the Plan Area confirming ground conditions.	4.5
Plan Area Observations		
Walk Over Survey – March 2019	Ground truthing topographical information and drainage data.	4.6

4.2 Topography

4.2.1 OSI Mapping

OSI mapping has been reviewed as part of this assessment. Currently available data showing relevant water features is included in Figure 4.1. OSI historical map data has also been reviewed via the online portal[3] and is confirmed to provide no further indication of watercourses or drainage features that may have been diverted or culverted.

Figure 4.1 OSI Close Scale Mapping

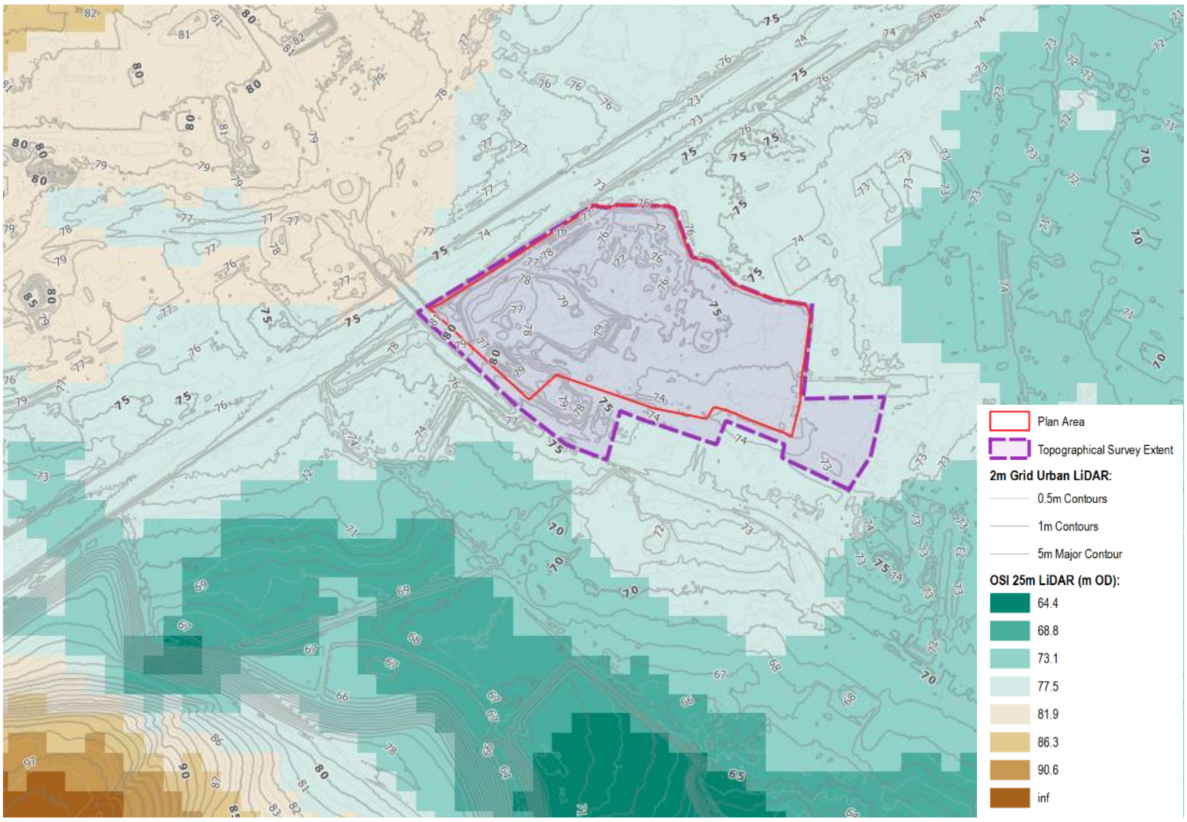


[3] http://map.geohive.ie/mapviewer.html [accessed 23rd July 2019]

4.2.2 Height Data

Review of LiDAR datasets indicates that the natural hydrological catchment upstream of the Plan Area has been broken by the lower lying M50. No other lands drain towards the Plan Area with surrounding lands falling to the north-east and south-west, away from the Plan Area.

Figure 4.2 OSI Topographical Information



4.3 Flood Data

4.3.1 OPW Preliminary Flood Risk Assessment (PFRA) Maps

The Office of Public Works (OPW) has developed Preliminary Flood Maps as part of the Catchment Flood Risk Assessment and Management (CFRAM) Programme.

The first stage of the CFRAM process was to produce a Preliminary Flood Risk Assessment (PFRA) that included flood mapping for the entire country. The PFRA is a preliminary assessment only, based on available or readily-derivable information. The analysis was undertaken to identify areas prone to flooding but the analysis is purely indicative[4] and mapping is considered to be coarse and is designed to inform further stages in the CFRAM process.

The PFRA flood mapping indicates that part of the Plan Area:

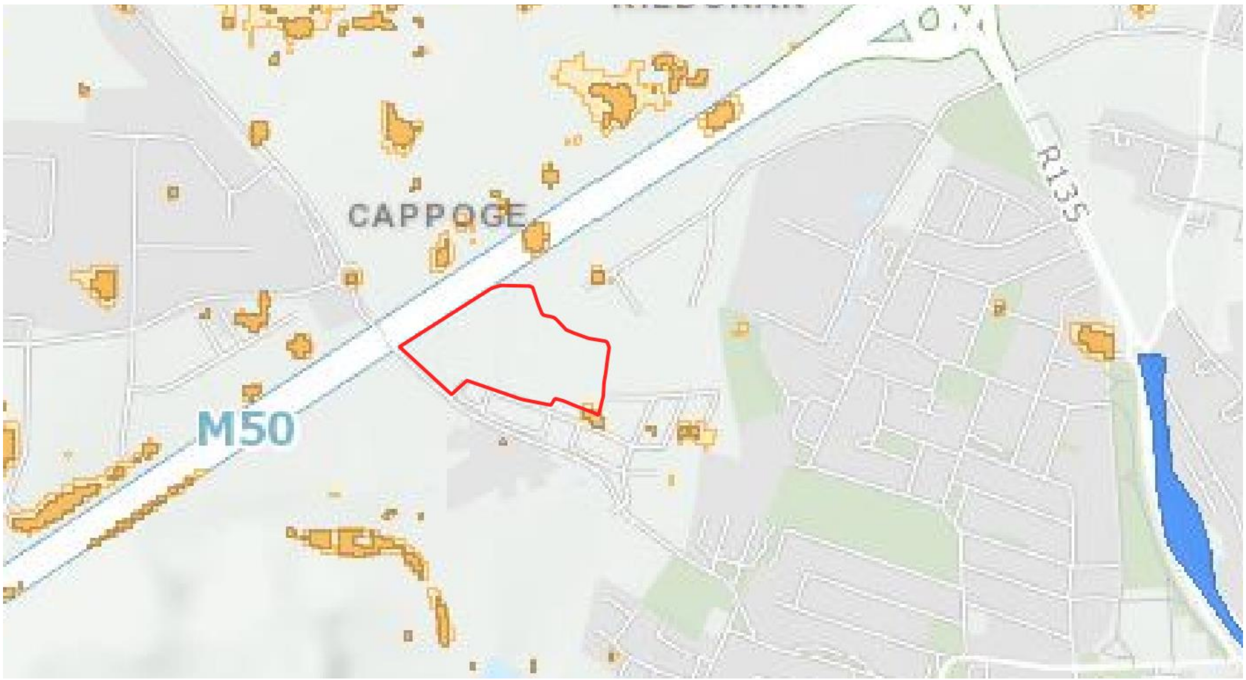
- is anticipated to be affected by pluvial (surface water) flooding
- is not considered to be at risk from fluvial or groundwater flooding.

An extract from the PFRA flood map is shown in

[4] http://www.cfram.ie/wordpress/wp-content/uploads/2011/08/PFRASummary-Pamphlet110815.pdf [accessed 22nd November 2017]

Figure 4.3.

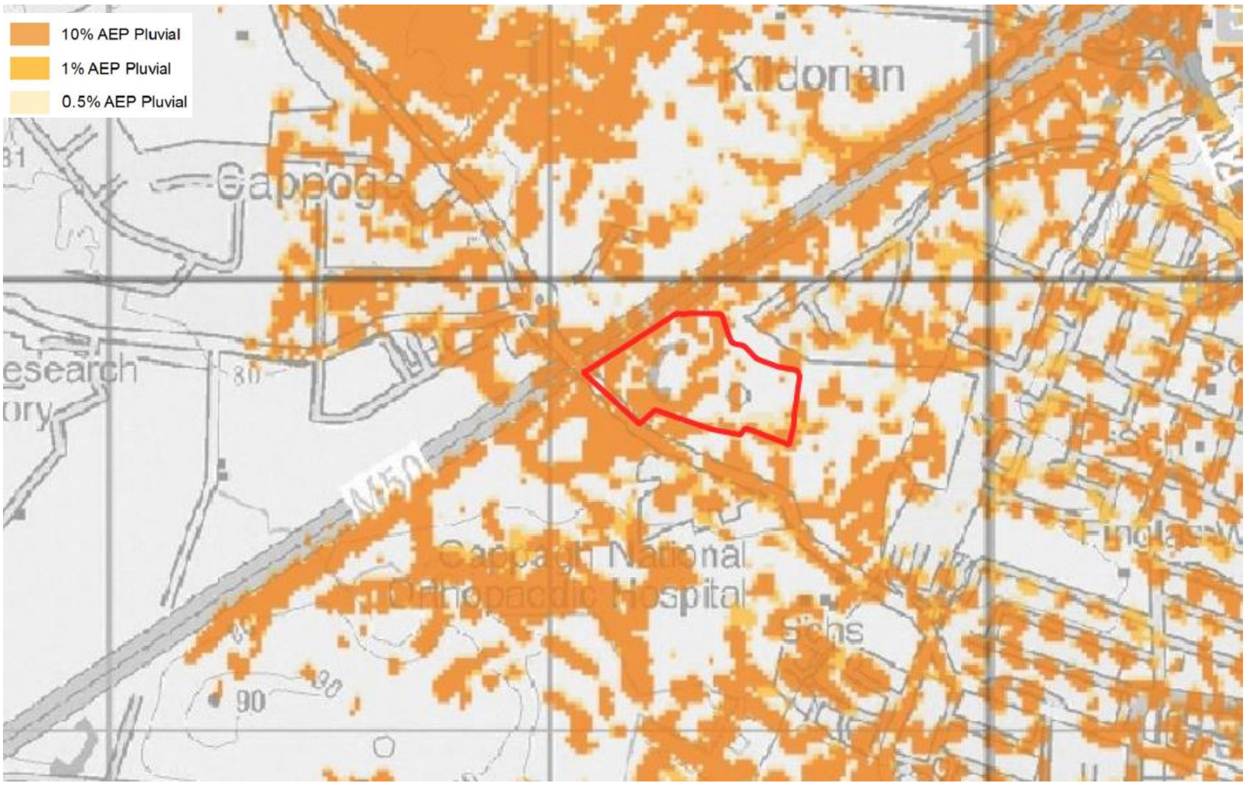
Figure 4.3 OPW PFRA Indicative Extents and Outcomes



4.3.2 Dublin Pluvial Study

The Dublin Pluvial Study (DPS) was undertaken between 2012 - 2016 and is a regional scale assessment of pluvial flood risk based on a coarse 25 m terrain model. The DPS indicates that the Plan Area is affected by surface water flooding from 10%, 1% and 0.5% AEP events as shown in Figure 4.4.

Figure 4.4 Dublin Pluvial Study Flood Map



4.3.3 Greater Dublin Strategic Drainage Study

The Greater Dublin Strategic Drainage Study (GDSDS) was commissioned in 2001 to carry out a strategic analysis of the existing foul and surface water systems in the local authority areas of Dublin (including Fingal CC) and adjacent catchments. The objectives of the Study were to identify policies, strategies and projects for the development of a sustainable drainage system for the Greater Dublin region.

The GDSDS report includes information relating to the areas surrounding the Plan Area:

- The Plan Area and neighbouring Heathfield development are located within the Finglas River Storm Level 1 Catchment S1003 which discharges to the Tolka River near Glasnevin Woods.
- No historic flooding has been reported from the piped network or from the river system.

No further details relating to the Plan Area and its environs are covered.

4.3.4 Internet / Media / Background Search

A brief media search found no historic records of flooding in the vicinity of the Plan Area.

Images from Google Street View captured in April 2009 indicate ponding of water within the east of the Plan Area adjacent to Heathfield Terrace as shown in the figure below.

Figure 4.5 Ponding of Water within Plan Area – April 2009

4.4 Drainage Data

4.4.1 Fingal CC – Water Services Drainage Records

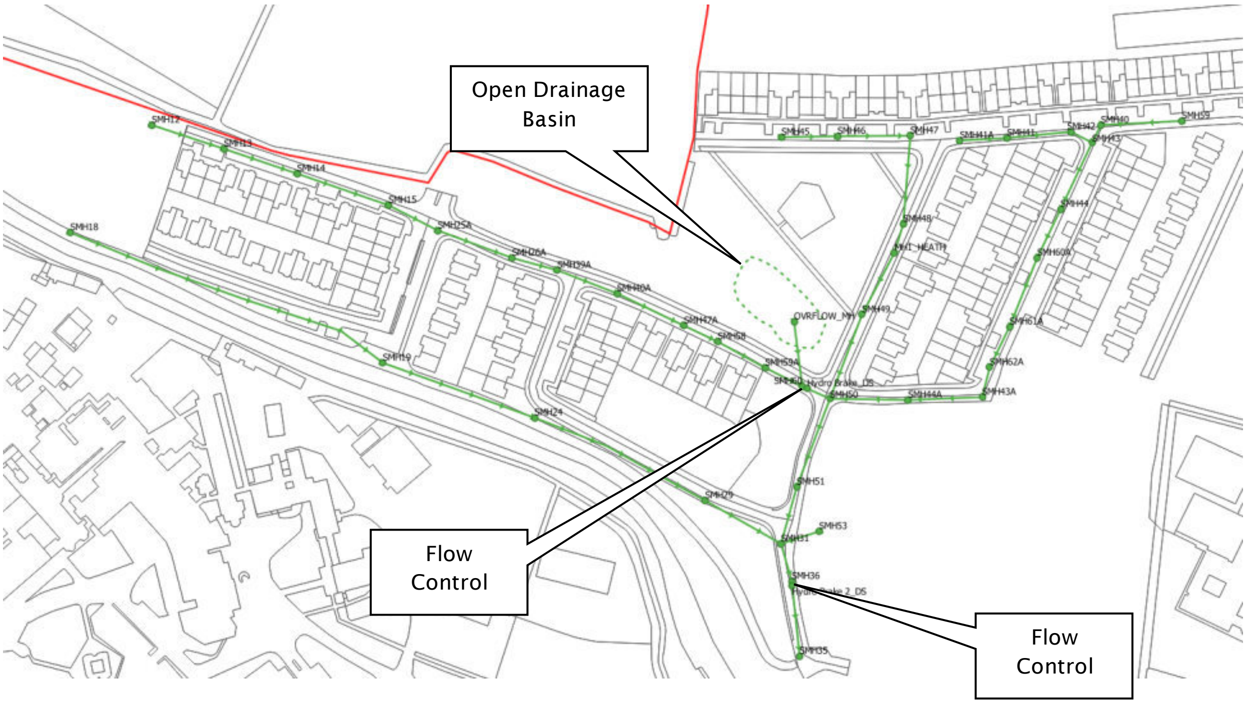
Drainage records for the Plan Area and wider environs were gathered to identify potential linkages to or from open drains within the Plan Area. Drainage asset data was provided for the Heathfield development to the east, and for Cappagh Road and the M50 motorway to the south and west respectively.

No drainage assets were identified that flow into the Plan Area outside of the topographic surface water catchment.

Drainage asset information indicates the Heathfield development is served by a separate drainage system that flows south-east to the Cappagh Road. Prior to this discharge point the surface water sewer network is controlled by two flow control devices beneath Heathfield Park, and beneath lands linking Heathfield Drive and Heathfield Way. The flow control device in Heathfield Park is immediately downstream of an attenuation basin within green space north and west of Heathfield Park and Heathfield Green, respectively.

Figure 4.6 indicates the surface water sewer network within the Heathfield development that may have hydraulic connectivity with the Plan Area.

Figure 4.6 Surface Water Sewer Network

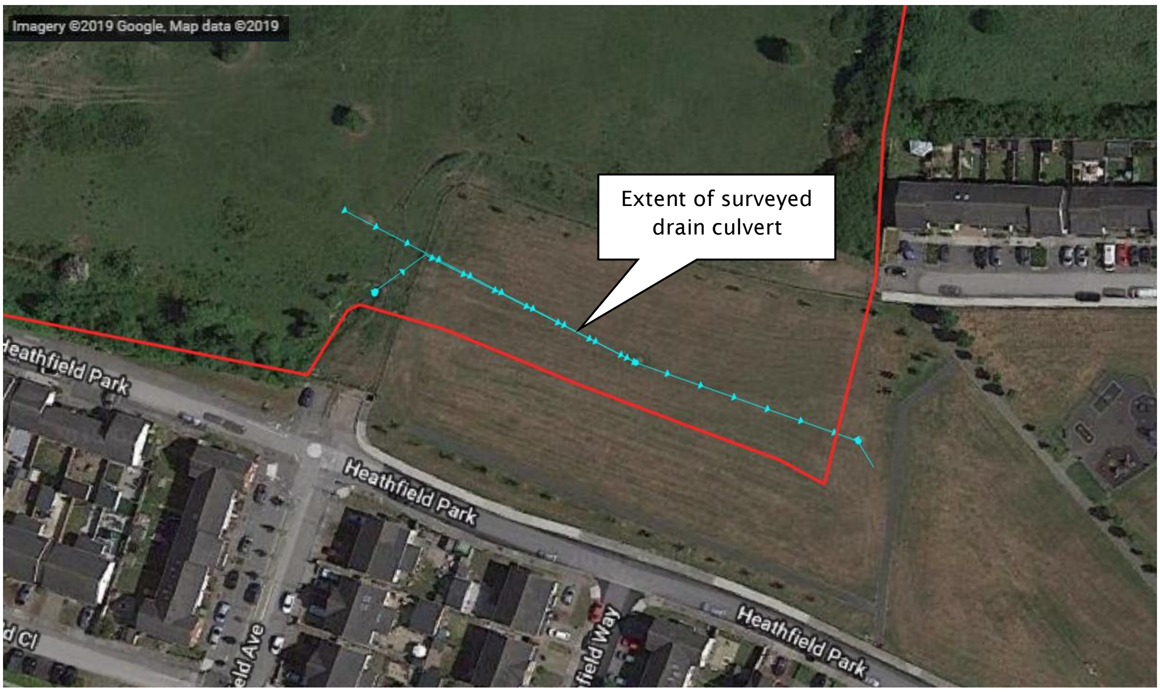


4.4.2 Surveyed Drainage Assets

Due to the proximity of the open drainage basin and flow control devices, it is possible that the open drain within the Plan Area discharges to the Heathfield surface water sewer network.

Visual inspection of the manhole chamber within the basin did not provide evidence of connectivity with the Ø300 mm drain culvert. Additional survey/tracing completed on the drain culvert provided no further evidence of connectivity, however once the culvert leaves the Plan Area it flows south-east in the direction of the downstream surface water sewer network.

Figure 4.7 Surveyed Drainage Assets



4.5 Ground Conditions

Geological Survey of Ireland mapping and Site Investigation (SI) undertaken by Causeway Geotech were analysed to determine ground conditions within the Plan Area.

Geological mapping indicates that the Plan Area is underlain by a bedrock of calcareous shale and limestone conglomerate with superficial deposits of till derived from limestone.

During the SI, made ground comprising of sandy gravelly clay with general fill of construction and demolition waste interspersed throughout, extended to between 3-4 m below existing ground level. Glacial till comprising sandy gravelly silty clay becoming very stiff with increasing depth was found to extend to the maximum borehole depth of 6.5 m.

Groundwater was encountered at 1.20-3.20 m in 3no. boreholes and 4.40-5.40 m in 2no. boreholes generated in the west of the Plan Area.

4.6 Walkover Survey

A walk over survey of the Plan Area and adjacent lands was conducted by McCloy Consulting Ltd. on 5th March 2019 during which a photographic survey of the Plan Area and adjacent areas was undertaken; photos are included within Appendix B. The purpose of the inspection was to ground-truth desktop study outcomes, and to verify data-gaps and identify the need for any further survey.

The western extent was noted to be undulating in topography with several stockpiles of earth located around the traveller accommodation. The eastern extent is relatively flat and falls towards the south-east.

The presence of mapped drains and culverts were verified as shown on Figure 4.8. OSI mapped water features along the northern boundary were found to be an embankment separating the Plan Area from lands to the north. No water feature was identified at this location. The southern drain was confirmed to serve the Plan Area only with no further inflows from outside of the Plan Area identified. The drain contained standing water on the day of the inspection.

The secondary drain was noted to be dry in the upstream extents. The drain was noted to be partially infilled upstream of its confluence with the southern drain. Water was present in the lower reaches and coincided with an area of ponding surface water adjacent to the confluence with the southern drain.

Figure 4.8 Verified Water Features

5 STAGE 2 – INITIAL FLOOD RISK ASSESSMENT

5.1 Preamble

Further to the Stage 1 assessment, the following Stage 2 assessment summarises the potential sources of flood risk that have a potential pathway to affect the Plan Area, and identifies those sources of flooding that require further detailed analysis as part of a Stage 3 assessment.

5.2 Initial Assessment

The following is a record of the screening assessment of the Plan Area for potential flooding mechanisms requiring subsequent detailed assessment, based on the information obtained from the background information review and consultations.

Table 5.1 Possible Flooding Mechanisms

<table>
<tr><th colspan="2">Source/Pathway</th><th>Significant / Assess Further?</th><th>Reason</th></tr>
<tr><td rowspan="2">Fluvial Flooding</td><td>Floodplain</td><td>No</td><td>There are no watercourses in the vicinity of the Plan Area.
OPW flood mapping indicates that there is no fluvial flooding at or on lands proximal to the Plan Area.</td></tr>
<tr><td>Flood Defence / Failure</td><td>No</td><td>The Plan Area is undefended.</td></tr>
<tr><td colspan="2">Coastal Flooding</td><td>No</td><td>The Plan Area lies at sufficient elevation relative to coastal flooding that it can be discounted.</td></tr>
<tr><td rowspan="2">Surface Water Flooding</td><td>Surface water flooding</td><td>Yes</td><td>Dublin Pluvial Study and OPW PFRA mapping indicates areas of potential surface water flooding on and adjacent to the Plan Area.
An open drain that would convey surface water flows adjacent to the southern Plan Area boundary.</td></tr>
<tr><td>Culvert Blockage</td><td>Yes</td><td>An open drain is culverted at its downstream extent within the Plan Area.</td></tr>
<tr><td colspan="2">Urban Drainage</td><td>Yes</td><td>The Plan Area is undeveloped, and adjacent developments tend to primarily fall away from the Plan Area.
Existing drains within the Plan Area are potentially hydraulically connected to downstream urban drainage networks. Fingal CC drainage asset information indicate an attenuation basin downstream of the Plan Area that may be hydraulically connected and therefore influence water levels within the Plan Area.</td></tr>
</table>

Source/Pathway	Significant / Assess Further?	Reason
Groundwater	No	Superficial geology within the Plan Area established from GSI and SI information tends to indicate that land cover is clay increasing in stiffness with depth that would tend to act as an aquitard. Topography on the Plan Area and wider environs is not characteristic of a relatively depressed 'bowl' where clear water flooding would feasibly be experienced.
Reservoirs / Canals / Artificial Sources	No	A screening assessment based on OSI and EPA mapping relative to the topographic catchment draining toward the area confirms that there are no lakes, reservoirs, or other impoundments with potential to affect the Plan Area.

Those flood mechanisms screened as being potentially significant and requiring Stage 3 assessment have been assessed in further detail, the findings of which are detailed in the following sections.

6 STAGE 3 – DETAILED FLOOD RISK ASSESSMENT

6.1 Preamble

The Stage 2 assessment has determined that surface water flooding, flooding from or influenced by the effect of urban drainage infrastructure, and culvert blockage have potential to be significant at the Plan Area.

Due to the potential interconnectivity between surface water flooding at the Plan Area and downstream surface water sewerage networks, and potential influence of such networks and culverts on flooding at the Plan Area, it is prudent to consider these flood mechanisms in combination as a single integrated urban drainage analysis.

No existing modelled or other predictive data is available to inform the assessment. In order to provide a more accurate and up-to-date (present day) assessment of flood risk in the vicinity of the area of interest, a location-specific detailed 1D-2D integrated urban drainage model has been developed for the Plan Area using InfoWorks ICM software (version 9.5).

ICM solves full two-dimensional depth averaged shallow water equations to produce a virtual representation of flow paths, velocities, volumes and depths.

The modelling approach is summarised as follows:

- Open drain sections have been modelled as 1D elements using detailed cross section survey data derived from ground based topographical survey.
- Culverts have been included in the model with geometry based on topographic survey information.
- Urban drainage (sewerage) assets have been included in the model based on Fingal CC design drawings (supplied on the basis that they are as-built) from the neighbouring Heathfield development, with asset information locally verified by additional survey.
- The wider terrain is modelled as a 2D meshed ground model, to allow the accurate representation of overland surface water flood routing. Terrain is based on OSI LiDAR data updated with ground-based topographic survey in areas of greatest interest.
- Design rainfall for the 1/3/6 hr duration for 1% AEP and 0.1% AEP rainfall events have been calculated using OPW FSU methodologies for the appropriate hydrological catchment. Rainfall is applied directly to the undeveloped 2D zone, or to subcatchments within the 1D sewer network. Detailed appraisal of the flood model hydrology is included in Section 4.3.

The following sections provide detail on the modelling methodology and the hydrological assessment.

6.2 Model Coverage

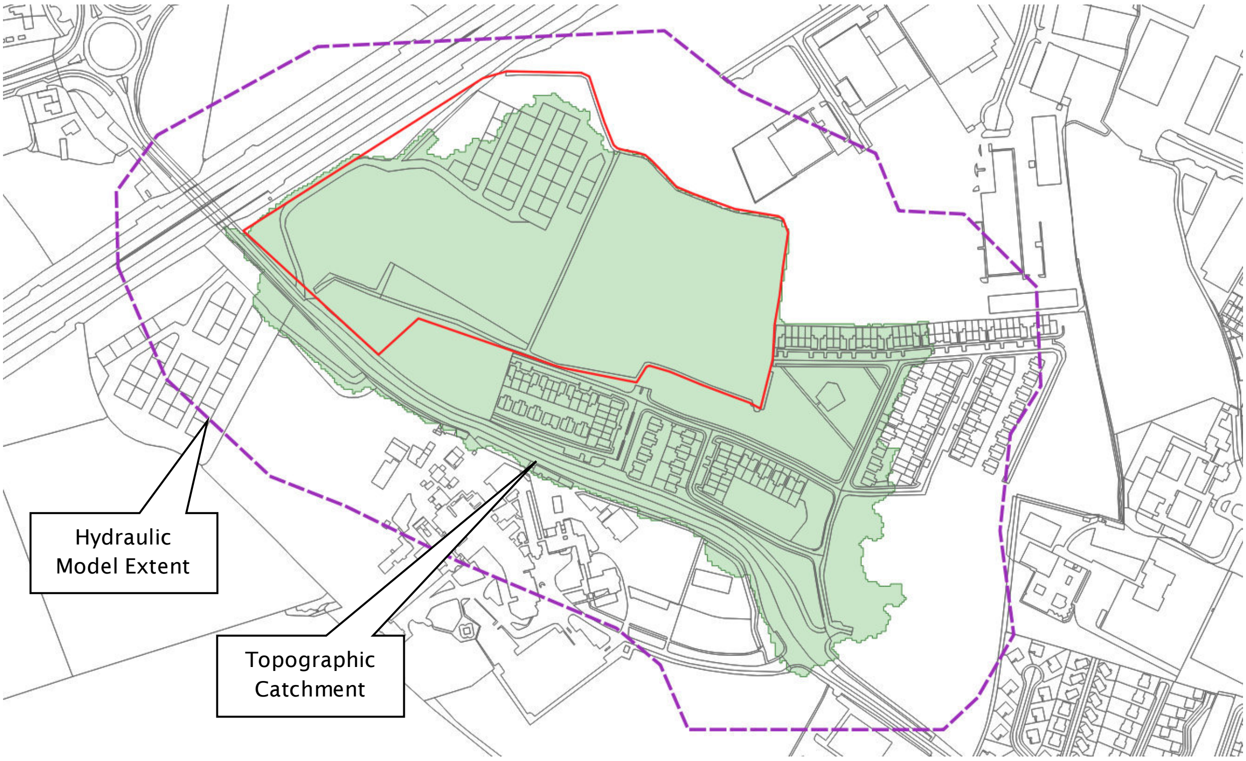
The area of assessment for the model has been determined using Geographical Information Systems (GIS) analysis of a LiDAR based terrain model, utilising the software to determine flow direction and accumulation for each cell to delineate the natural catchment.

The outlet point for the model has been located sufficiently downstream of the Plan Area to ensure predicted water levels in the area of interest are not susceptible to any backwater effect as a result of the boundary condition, and to ensure that the backwater effect of the flow controls are included as they may have potential to influence flood levels at the Plan Area. The upstream catchment is limited in extent due to the lower lying M50 immediately north of the Plan Area which acts as a hydrological break with no drainage assets crossing the motorway corridor into the Plan Area.

Lands of the North City Business Park immediately to the north-east are of a lower elevation falling away from the Plan Area. The surface water catchment is therefore constrained to the Plan Area itself and comprises a surface water catchment area of 0.15 km^2.

The topographic hydrological catchment was assessed in conjunction with the catchment of the surface water sewer network draining lands adjacent to and downstream of the Plan Area, to ensure that sewer flows (and any out of sewer flooding) is collected and represented within the model. The surface water catchment was buffered by 100 m to comprise the entire contributing catchment and ensure no missing areas that would result in underestimation of flows reaching the study area. For extent refer to model boundary on Figure 6.1.

Figure 6.1 Model Extent



6.3 Model Hydrology (Rainfall Analysis)

Model hydrology is via the application of rainfall direct to the 2D surface. Rainfall has been derived from the OPW Flood Studies Update (FSU) Rainfall Depth Duration Frequency (DDF) module. Due to the small (<5km^2) and ungauged nature of the catchment, the rainfall DDF module uses the nearest 2 km grid point for analysis. Rainfall is therefore calculated using the Northern Cross Business Park approximately 700 m north east of the Plan Area.

Rainfall profiles for the 1/3/6 hour storm durations for the 1% event have been calculated from the FSU Rainfall DDF module and converted from rainfall depth to intensity for use in the ICM model. Due to the urban nature of the catchment the summer rainfall profile was used in line with (England and Wales) Environment Agency Flood Maps for Surface Water updated guidance[5]. The summer rainfall profile is more peaked than the winter profile and representative of the prevalence of intense convective storms during summer which is more critical for surface water flooding.

The FSU methodology does not extend to allow estimation of 0.1% AEP rainfall directly. Rainfall for the 1/3/6 hour storm durations for the 0.1% AEP event were therefore estimated by plotting a range of total rainfall depths against the associated return periods up to the 0.4% AEP (250 year) event. The rainfall curves were plotted on a logarithmic scale and the 0.1% AEP total rainfall estimated from the trendline equation. Rainfall profiles for each storm duration were derived through scaling the total rainfall depth to the 1% AEP hyetograph.

6.3.1 Critical Duration Analysis

The critical duration rainfall was determined for each storm event probability from the analysis of model simulation results, by measurement of peak volume of surface water (coinciding with peak flood extent) enclosed within the Plan Area.

[5] Environment Agency (2013) What is the updated Flood Map for Surface Water? Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/297432/LIT_8988_0bf634.pdf Accessed on 17/05/2019.

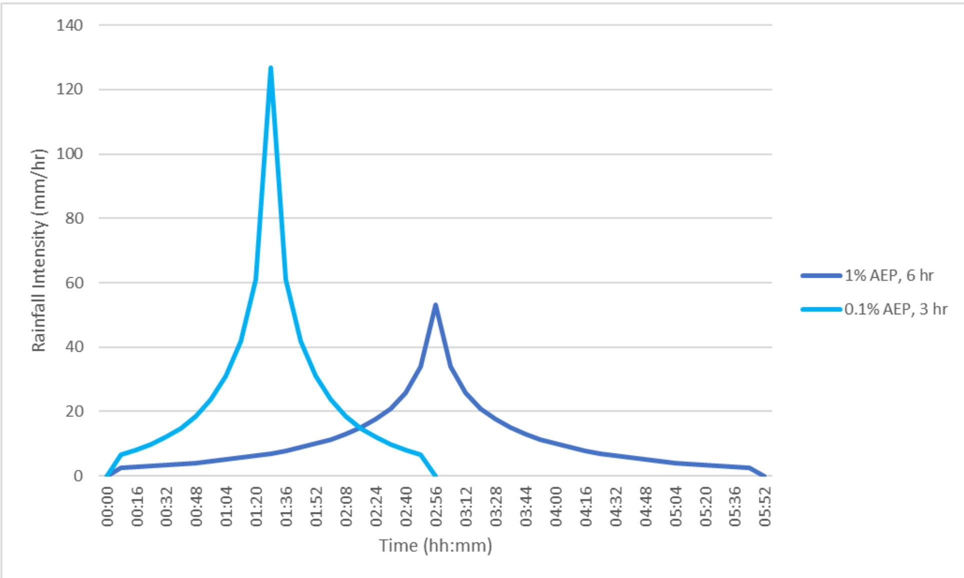
A summary of the findings is shown on the following table.

Table 6.1 Critical Duration Analysis

Rainfall Probability	Max Volume (m^3) for Storm Duration		
	1hr	3hr	6hr
1% AEP	1576	1737	1799
0.1% AEP	2482	2538	2496

Critical duration varies across return periods with the 6 hour event critical for the 1% AEP storm event and 3 hour for the 0.1% AEP event. The respective critical storm duration for each return period is used as a basis for all subsequent analysis and shown in the graph below.

Figure 6.2 Critical Storm Durations for 1% and 0.1% AEP Storm Events



6.3.2 Climate Change

The effect of climate change has been applied to the critical duration storms for the 1% and 0.1% AEP events for both the Mid Range (+20%) and High End (+30%) future scenarios as set out in the OPW's Climate Change Sectoral Adaptation Plan – Flood Risk Management (2015-2019). The resulting hyetographs are shown in and Figure 6.4.

Figure 6.3 Present Day and Climate Change Rainfall – 1% AEP, 6 hour

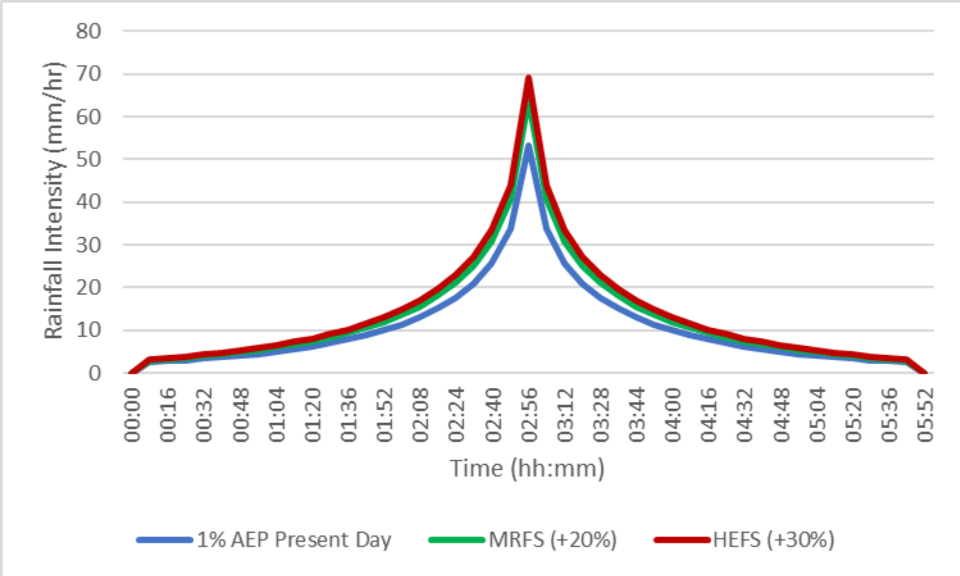
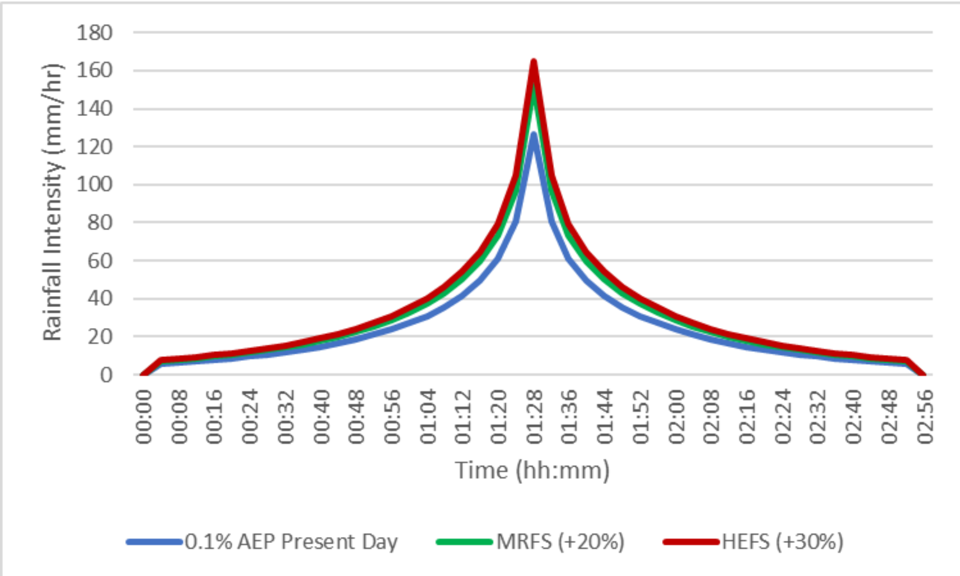


Figure 6.4 Present Day and Climate Change Rainfall – 0.1% AEP, 3 hour



6.4 Plan Area Specific Model Data

6.4.1 1-Dimensional Model Data

6.4.1.1 Open Drains

The Plan Area has the potential to be affected by flooding from an open drain that serves lands within the immediate vicinity and flows east to west along the southern boundary. A secondary drain flows from north to south into the southern drain. Due to the observed infill within the secondary drain impeding connectivity with the southern drain, definition within the LiDAR was deemed appropriate for its representation within the 2D surface rather than a 1D channel.

A topographical survey of the southern drain was undertaken by a specialist survey contractor. The survey included top and bottom bank lines, channel invert lines and additional spot levels within the channel at locations of change giving accurate depictions of the entire watercourses.

Cross section data at approximately 25 m spacing is derived from the detailed ground-based topographic and bathymetric survey. The cross-section data was incorporated into the model as a 1D river reach, with shown on Figure 6.5.

Figure 6.5 Modelled Open Drain within Plan Area

6.4.1.2 Culverts

Two culverts are located within the modelled extents along the southern drain as shown in Figure 6.6 and detailed in Table 6.2. Culvert details have been taken from the Plan Area specific survey.

The Ø300 mm outlet culvert of the southern drain was traced for downstream connectivity. The culvert was traced to a manhole east of the Plan Area within green space associated with the adjacent Heathfield development. No final outlet or discharge point could be determined within the scope of this assessment.

Analysis of the culvert alignment and lowest surveyed level on the culvert indicated that the culvert could feasibly discharge to the downstream / adjacent surface water sewer network, upstream of an attenuated flow control; and as such it was identified that a backwater effect as a result of that flow control could feasibly affect water levels in the culvert and on the Plan Area.

Sensitivity testing to this assumption, by allowing an alternative scenario where the culvert was allowed to drain out of the model with a free discharge, caused a reduction in predicted flood levels within the drain and on the Plan Area by 50 mm.

A conservative and precautionary approach has therefore been adopted that the drain outlet culvert connects to the downstream surface water sewerage network upstream of the flow control to ensure a conservative estimate of flood levels within the Plan Area.

Figure 6.6 Modelled Culverts

Table 6.2 Culvert Register

Culvert Ref:	Shape	Material	Size (mm)	Upstream Invert Level (mOD)	Downstream Invert Level (mOD)	Manning's 'n' roughness value
C1	CIRC	Concrete	1000	73.03	72.82	0.015
C2	CIRC	PVC	300	72.84	72.33	0.011

6.4.1.3 Urban Drainage Networks

Surface water sewerage asset information for the Heathfield development that has the potential to influence flood levels within the Plan Area has been obtained from Fingal CC and included in the model. Asset information was compiled from drainage design drawings for the development with cover levels and invert levels verified through topographic survey.

The extent of the surface water network applied to the model extends to the manhole downstream of the flow control device on lands connecting Heathfield Drive and Heathfield Grove. For all design simulations, the surface water sewer network is free from debris and siltation in line with best practice for urban drainage modelling.

Subcatchments were used within the Heathfield development to represent the collection of rainfall on urban areas and application to the local surface water sewer network through runoff surfaces representing roofs, roads and paths, and green space.

Subcatchments were digitised using close scale mapping provided by Fingal CC for the Heathfield development. New developed areas contributing to the surface water sewer network were included by digitising from more recent orthophotography mapping. The extent of subcatchments and surface water sewerage assets within the model is shown in Figure 6.7.

Figure 6.7 Modelled Surface Water Sewerage Network

6.4.2 Roughness

A Manning's N roughness value of 0.08 was applied to the 1-D southern drain representing the sluggish reaches and presence of weeds within the channel.

A Manning's N roughness value of 0.015 was applied to the urban drainage conduits representing surface water sewers with manholes and inlets.

6.4.3 2-Dimensional Model Data

6.4.3.1 Topography

Topographic survey of the Plan Area has been made available from a 3rd party surveyor in addition to Ordnance Survey Ireland (OSI) 2 m LiDAR provided by FCC. A terrain model was generated to represent the topography of the area using a combination of the two data sources. The LiDAR has been augmented by topographic survey where there has been observed land clearance, modification, infilling or new development.

6.4.3.2 Roads

Close scale mapping has been provided by Fingal CC and used to delineate roads for representation in the model. Further development of the Heathfield estate has taken place since the vector mapping. Additional roads in the east of the development were digitised from recent ortho mapping of the area.

The 2 m LiDAR was analysed and found to contain sufficient definition of roads and kerblines in the LiDAR terrain to ensure that preferential flow paths offered by roads are represented within the model. No further modification of road levels was therefore required within ICM.

6.4.3.3 Buildings

Vector mapping has been provided by Fingal CC and used to delineate existing buildings outside of the Plan Area for representation within the model.

While not intended to assess flood risk to buildings, it was pertinent to ensure that buildings are included in the model to ensure that the effect of obstructions to overland flooding and routing of surface water is assessed. In the absence of surveyed floor levels, building elevations are sited at the maximum ground level (from LiDAR) within the building footprint polygon.

Buildings have been assigned a porosity to allow water to flow through them.

6.4.3.4 Surface Roughness

Figure 6.8 summarises the Manning's N values applied to the model that includes both green areas and urban fabric.

Figure 6.8 Surface Roughness

6.4.3.5 Surface Infiltration

Infiltration was applied to the model instead of using effective rainfall which is the adopted methodology in the production of Environment Agency surface water mapping, due to the varying surface types within the Plan Area and wider catchment. No infiltration has been included in areas where runoff is managed through the surface water sewer network as indicated in Figure 6.9.

Permeable Areas

A geotechnical SI was conducted by Causeway Geotech for Fingal CC. Ground conditions determined as part of the investigation indicate that the Plan Area is underlain by made ground on top of stiff to very stiff glacial till. Infiltration testing indicated that the rate of infiltration was too low to calculate.

Losses have been applied to permeable areas based upon the 2D Horton Infiltration model included within the InfoWorks ICM software. This model converts the direct rainfall applied to the mesh into a runoff volume which is determined by the parameters set for the surface. The Horton infiltration model was selected as appropriate as it continues to simulate infiltration in the absence of rainfall, i.e. after the event.

Horton infiltration parameters reflective of the underlying soil conditions applied to the model across the wider catchment are detailed in Table 6.3.

Table 6.3 Horton Parameters

Soil Type	Horton Initial (mm/hr)	Horton Limiting (mm/hr)	Horton Decay (1/hour)	Description
Stiff to very stiff glacial till	25.4	0.1	2	Dry clay soils with little vegetation

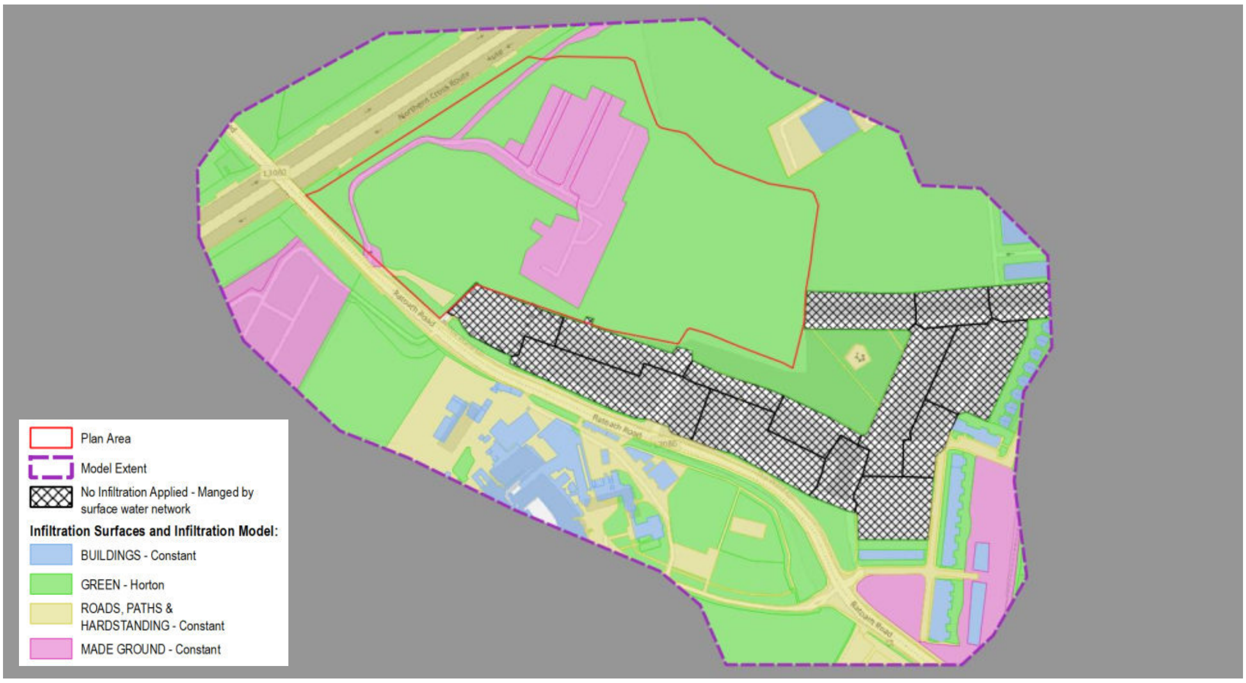
Impermeable Areas

A Constant Infiltration model where the maximum theoretical infiltration is given by the function of the infiltration loss coefficient was applied to roads, paths, other hardstanding areas and building surfaces where the surface water sewerage network is not represented, i.e. outside of 1D subcatchments. The effective infiltration is determined by the available water volume in the surface.

A runoff coefficient of 95% was adopted for all roads and paths, and 85% for buildings.

In areas where the surface water sewerage is not represented, a typical drainage removal rate of 12 mm/hr has been applied to roads and buildings in line with (England and Wales) Environment Agency Flood Maps for Surface Water updated guidance[6] adopted as best practice in the absence of particular guidance for Ireland, to account for losses to urban drainage systems.

Figure 6.9 Surface Infiltration



6.5 Model Stability

A number of parameters were checked to assess the model stability:

i. The mass balance is considered to give an indicator of model stability and relates to the flow entering and leaving the model. The mass balance values for the 1% and 0.1% AEP events are below 0.15%, which is well within acceptable tolerances.

[6] Environment Agency (2013) What is the updated Flood Map for Surface Water? Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/297432/LIT_8988_0bf634.pdf Accessed on 17/05/2019.

ii. The Froude number of the modelled reach representing the southern drain was reviewed with no reaches having a Froude number greater than 1.

iii. A review of stage hydrographs was undertaken across the model to locate any significant spikes in graphs that would suggest issues with model stability. A review of graphs indicated that the model exhibited no abnormal stage variations that would tend to indicate a model instability.

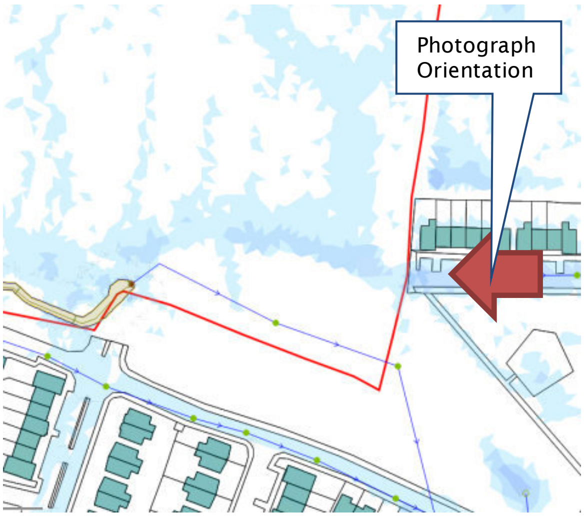
A review of the above parameters indicates that the model is stable, allowing substantial confidence in model outputs.

6.6 Model Verification

Limited historical flood data was available for detailed model verification; however, the model was verified against any historical records of flooding that were determined in the information gathering (Stage 1) phase.

The model predicts flooding in the south-eastern area of the Plan Area adjacent to Heathfield Terrace that coincides with the location of historical flooding in April 2009 as detailed in Section 4.3.4.

Figure 6.10 Validation within south-east of the Plan Area

1% AEP model prediction	Photographic Record
	

6.7 Model Sensitivity

Model sensitivity analysis was carried out to assess the sensitivity of the simulation to changes in base parameters. The sensitivity testing makes comparisons to the base model and was carried out for the 1% AEP flood event.

6.7.1 Sensitivity to Roughness

The sensitivity of the modelled water levels to channel and overland roughness was assessed by varying the standard values of Manning's n for the base model.

Increasing the roughness value of the river reaches by 20% causes a maximum increase in flood level of 0.02 m. Increasing the roughness value of the 2D Zone by 20% causes an increase in flood level of 0.01 m. Results for the sensitivity testing show no significant differences within the model output – flow paths and flood extents remain largely the same.

The increase in water levels within the 1D river reach and 2D zone are generally within acceptable limits. The model therefore does not exhibit a significant sensitivity to roughness variation, and would not cause the ultimate finding of the model to be unreliable. Careful consideration has been given to conservatively specifying Manning's n values and there is therefore reasonable confidence in model results.

6.7.2 Sensitivity to Infiltration

The infiltration / loss model to represent surface water sewer losses where no surface water drainage network is represented directly within the model is per normal industry practice by an approved EA methodology (in the absence of an Irish equivalent) and is not required to be tested further.

The sensitivity of the model to infiltration elsewhere has been assessed by varying the infiltration parameters on surfaces where parameters have been estimated based on GSI mapping and SI data. Horton initial and Horton limiting parameters were varied by +/-20%.

Water levels within the 2D zone were analysed for sensitivity to roughness. A 20% decrease in Horton infiltration parameters results in an increase of up to 0.04 m in water levels within the Plan Area. Subsequently, a 20% increase in Horton infiltration parameters results in a decrease of up to -0.03 m in water levels.

Horton values have been carefully specified to ensure representative values for the underlying ground conditions are adopted, and there is confidence that the model infiltration is suitably representative. Increases in flood levels due to changes in infiltration parameters are within acceptable limits.

6.7.3 Sensitivity to Rainfall

The design rainfall events were derived using best industry techniques and the most conservative storm durations were selected and there is therefore reasonable confidence in the results. In order to determine the effect of underestimation of rainfall on the model and what could be expected if an extreme event were to occur, the flows in the model have been increased by 30% in line with the OPWs Climate Change Sectoral Adaptation Plan – Flood Risk Management (2015-2019) High End Future Scenario. The hydrograph length / shape is unchanged and there is therefore an overall increase of mass within the model.

An increase of 30% in the design rainfall causes a maximum increase of 0.05 m within the 1D river reach representing the southern drain.

Increasing the design rainfall by 30% results in an increase in flood level within the 2D Zone of up to 0.21 m. The increase in the 2D zone is adjacent to the downstream culvert inlet of the southern drain. A lack of capacity within the culvert and open channel to convey additional flow as a result of increased rainfall results in greater surcharge of the culvert and channel to the 2D zone, in addition to increase in rainfall direct to the 2D surface.

The model indicates a moderate sensitivity within the 2D zone to increases in rainfall which would not be unexpected with increases to rainfall.

6.7.4 Sensitivity to Downstream Boundary Condition

The downstream boundary of the 2D component of the model is sufficiently located downstream that there is a 4.5 m height difference in favour of the Plan Area preventing any artificial influence on water levels at the Plan Area due to any uncertainty in the 2D downstream boundary condition.

The outlet of the 1D component of the model is sited at a surface water manhole downstream of the second flow control at Heathfield Way which has an invert level 3.4 m lower than the culvert inlet at the southern drain within the Plan Area. The 1D downstream boundary condition is sited at such a level that there would be no potential for backwatering of flows to affect water levels as the Plan Area.

Both the 1D and 2D downstream boundaries are therefore considered sufficiently robust against any uncertainty in downstream boundary condition.

6.7.5 Sensitivity Analysis Summary

The results of the sensitivity analysis are generally within acceptable limits and where the model has shown a sensitivity to downstream boundary condition, a conservative approach has been taken.

The sensitivity analysis has demonstrated that the model can be deemed reliable.

6.8 Assumptions and limitations of modelling

The representation of any complex system by a model requires a number of assumptions to be made. In the case of the hydraulic model developed for the purposes of the study it is assumed that:

- The terrain model (based on LiDAR and topographical survey information) accurately represents the surface topography and associated flow paths.
- The design rainfall is an accurate representation of rainfall of a given return period.
- Roughness does not vary with time.

The primary limitations of the study are noted as follows:

- The outfall of the culverted section of the southern drain has not been verified. A conservative approach has been taken in representation of its downstream boundary in connecting it to the surface water sewer network. Where the conservative approach is disproven then predicted water levels on the Plan Area would be unnecessarily conservative, but not to an extent that it materially changes the findings of this assessment.
- The model does not represent any topographic features smaller than the minimum resolution of the underlying terrain model derived for the area.

6.9 Discussion of Results

6.9.1 Results Processing

Flooding less than 20 mm in depth was removed from model outputs in line with best practice for pluvial flood mapping. The results were processed using a similar methodology to the (England and Wales) Environment Agency Flood Maps for Surface Water updated guidance[7], in the absence of a similar guidance document for such work in Ireland. The following filters were used on model outputs:

- Removed flood areas with a very low hazard rating below 0.55
- Removed areas of flooding with a total area of less than 100 m^2
- Filled in isolated dry areas (within a larger flooded area) of less than 50 m^2

6.9.2 Present Day Results

The modelling undertaken shows the Plan Area is affected by pluvial/overland flooding. The primary flood mechanism is direct rainfall falling onto the surface and routing towards / gathering in relative depressions.

The main surface water flow path is from lands within the north of the Plan Area that tend in a southerly direction towards the southern drain and a low point in the south-east corner, adjacent to Heathfield Terrace. In the west of the Plan Area water tends to gather in low points within the access road and within a localised depression.

A secondary flood mechanism is from the southern drain. The 300 mm downstream culvert is surcharged under both the 1% and 0.1% AEP events and there are several locations where channel capacity is exceeded and water overtops onto lands within the Plan Area, however the areas affected are locally contained around the channel itself and generally met by incoming overland flow to the drain.

Figure 6.11 provides an indication of the flood routing through the Plan Area to the southern drain and south-east corner. The most pertinent flow path for design considerations is surcharge of the southern drain onto lands within the south-east corner of the Plan Area.

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[7] Environment Agency (2013) What is the updated Flood Map for Surface Water? Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/297432/LIT_8988_0bf634.pdf Accessed on 17/05/2019.

McCloy Consulting

Figure 6.11 1% AEP Event Flood Routing

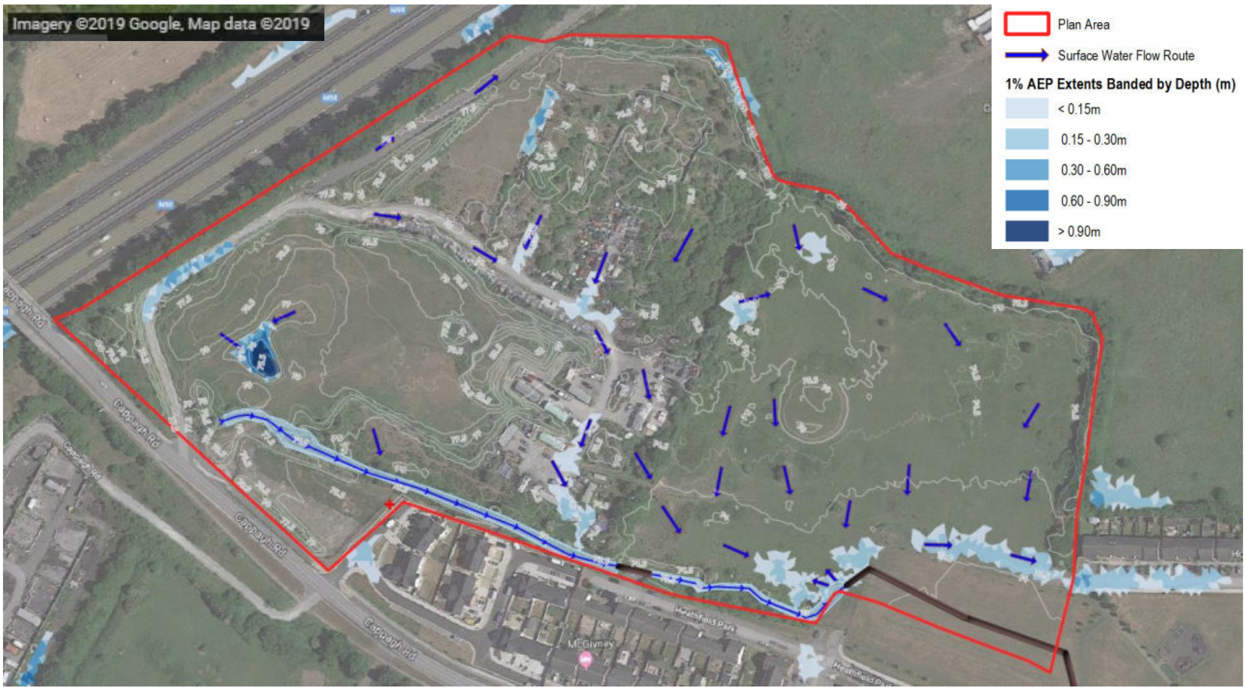


Table 6.4 summarises the 1% and 0.1% AEP present day surface water levels between upstream and downstream extents of the southern drain and south-east corner of the Plan Area.

Detailed flood mapping for the Plan Area in Appendix C provide both in channel and overland surface water flood levels for the 1% and 0.1% AEP events pertinent to design considerations within the Plan Area.

Table 6.4 Present Day Surface Water Flood Levels

Location	Water Level 1% AEP (m OD)	Water Level 0.1% AEP (m OD)
Plan Area	76.36 – 73.73	76.38 – 73.77

6.9.3 Climate Change

As outlined previously, the hydraulic model has been simulated with and uplift in rainfall of 20% and 30% in line with the OPW's Mid Range and High End future climate change scenarios, respectively, to ascertain existing climate change flood levels and extents.

The effect of climate change results in further intensification of the flow paths from the north of the Plan Area towards the southern drain. The climate change events result in further surcharge of the southern drain at the culvert inlet onto lands within the Plan Area. Table 6.5 shows the maximum change in water levels within the southern drain and Plan Area under the two future climate change scenarios assessed.

Table 6.5 Climate Change Surface Water Flood Levels

Climate Change Scenario	Water Level 1% AEP (m OD)	Water Level 0.1% AEP (m OD)
Mid Range Future Scenario (+20%)	76.36 – 73.75	76.39 – 73.79
High End Future Scenario (+30%)	76.37 – 73.75	76.39 – 73.79

Flood maps for each return period including allowance for climate change showing the full extent of flooding and flood levels within the Plan Area and surrounding lands are included in Appendix C.

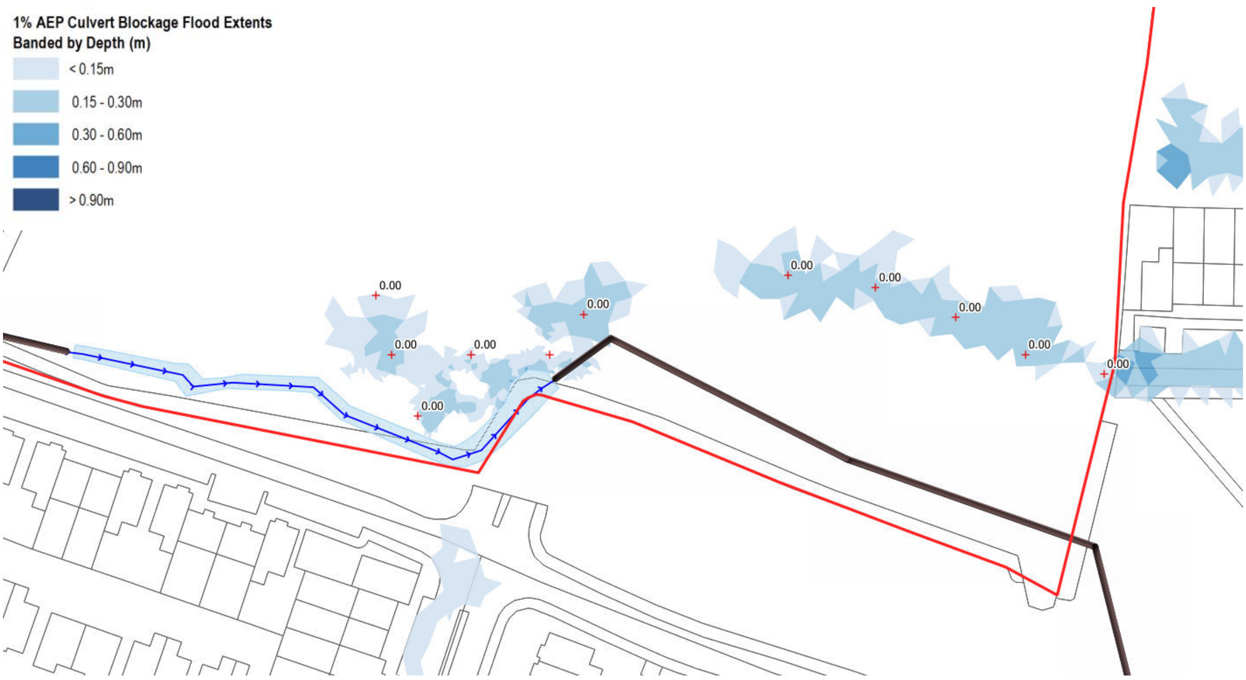
6.9.4 Culvert Blockage

The effect of blockage in the downstream culvert on flood levels in the Plan Area was assessed by blocking the Ø300 mm culvert by 50% of its capacity for the 1% AEP rainfall event.

Results indicated no significant increase in in-channel flood levels (<0.004 m) or on lands adjacent to the culvert inlet. The remainder of the Plan Area is unaffected by the effects of culvert blockage.

Figure 6.12 demonstrates no change in flood levels within the Plan Area as a result of culvert blockage.

Figure 6.12 Culvert Blockage Surface Water Flood Levels



7 SUMMARY OF FINDINGS AND RECOMMENDATIONS

7.1 Summary of Model Findings

The detailed flood risk assessment has determined that surface water (pluvial) flooding in combination with the effect of existing adjacent urban drainage infrastructure has potential to affect the Plan Area for floods of magnitude (probability) relevant to flood protection standards set out in the OPW Guidelines and Fingal SFRA.

The most significant source of flooding to the Plan Area is that of pluvial flooding from direct rainfall onto the ground surface and overtopping of the southern drain. The Plan Area is affected by surface water flooding during the 1% and 0.1% AEP rainfall events for the present day scenario. The effect of climate change would be anticipated to cause flood levels at and adjacent to the Plan Area to rise.

Predicted surface water flood levels are summarised as follows:

Table 7.1 Flood Level Summary

Event Probability	In Channel Flood Levels (m OD)	Out of channel Flood Levels (m OD)
1% AEP Present Day	76.36 – 73.74	73.75 – 73.73
1% AEP – MRFS (+20%)	76.36 – 73.76	73.77 – 73.75
1% AEP – HEFS (+30%)	76.37 – 73.76	73.78 – 73.75
0.1% AEP Present Day	76.38 – 73.79	73.80 – 73.77
0.1% AEP – MRFS (+20%)	76.39 – 73.81	73.82 – 73.79
0.1% AEP – HEFS (+30%)	76.39 – 73.83	73.83 – 73.79

No other significant flood mechanism exists at the Plan Area.

7.2 Development Land Use Zoning Compatibility

The land zoning objectives within the Fingal Development Plan for the plan area have been identified in Section 2.5 as RA – Residential Area.

As the flooding mechanism within the Plan Area is pluvial / urban drainage, then no Flood Zones as defined by the OPW Guidelines or Fingal SFRA applies. Therefore, no plan-making Justification Test is required to establish the principle of suitability of the lands for development.

7.3 Recommendations

While no restriction to land use is directed by the OPW Guidelines or Fingal SFRA, there remains an onus on any planned development to:

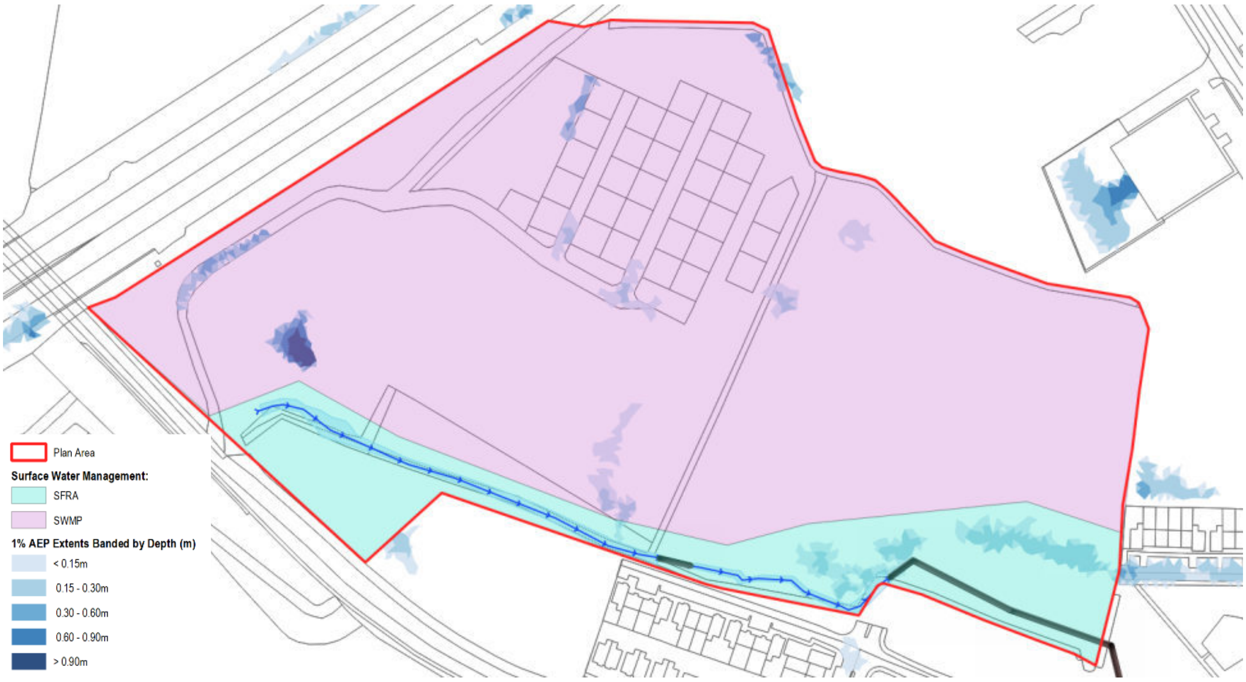
- Ensure that the proposal is flood resilient.
- Ensure that the proposal causes no increased flood risk that would cause an adverse effect elsewhere.

Management of internal surface water runoff within the Plan Area (i.e. surface water from development) shall be managed in accordance with the Sustainable Drainage Strategy (SDS) component of the Surface Water Management Plan (SWMP), the outcomes of which are informed by this SFRA.

Measures designed to manage flood risk connected to existing pluvial flooding are set out within the following sections. Recommendations are intended to inform plan-making for the lands, and / or any subsequent Site Specific Flood Risk Assessment (SSFRA) for a planning application.

Figure 7.1 indicates the areas of surface water runoff that are to be managed by the Sustainable Drainage Strategy of the SWMP and the areas of surface water flood risk that are to be managed by recommendations set out in this SFRA.

Figure 7.1 Surface Water Management



7.3.1 Design Levels

Guidance from the Fingal SFRA relevant to specifying of design levels is designed as follows:

- The minimum finished floor level (FFL) for highly vulnerable development should be above the 0.1% AEP event level plus suitable freeboard, whereby the recommended level of freeboard is 500 mm over and above the adjacent 0.1% AEP [*fluvial*] flood level.
- The minimum FFL for less vulnerable development should be above the 1% AEP event level plus suitable freeboard whereby the recommended level of freeboard is 500 mm over and above the adjacent 1% AEP [*fluvial*] flood level.

While the guidance states that it is to be applied to fluvial flood levels, it is considered appropriate and prudent to apply the freeboard requirements to the relevant return periods for pluvial flood levels.

Lands within the Plan Area are subject to a R1 (residential) zoning objective under the Fingal Development Plan which is classified as 'highly vulnerable'. Therefore, all residential dwellings and associated essential infrastructure shall be sited with a 500 mm freeboard relative to the adjacent 0.1% AEP surface water flood level as shown on flood mapping (Ref.: M02127-01_FL02) or as may be changed where development proposals include works to the drains that affects predicted flood levels.

Any 'less vulnerable' development, such as commercial development or local transport infrastructure, shall be sited with a 500 mm freeboard relative to the adjacent 1% AEP surface water flood level as shown on flood mapping (Ref.: M02127-01_FL01) or as may be changed where development proposals include works to the drains that affects predicted flood levels.

While no flood zoning applies to the Plan Area, it is recommended that water compatible development such as open, amenity space is considered for areas affected by surface water flooding from the southern drain.

The Fingal SFRA also states the following:

- A precautionary approach to climate change includes recommendations to ensure that levels of structures designed to protect against flooding (such as flood defences or raised floor levels) are sufficient to cope with the effects of climate change over the lifetime of the development.

Therefore, proposals for the Plan Area should be tested against future climate change as well as culvert blockage scenarios at the Development Management stage to ensure that finished floor levels of structures are able to withstand their effects over the design life of the proposed development.

As well as the above, any SSFRA should consider the potential impact of development on lands elsewhere, particularly where any development within the existing pluvial flood extents is proposed.

It is recommended that additional scenarios and impact of the development are based on detailed hydraulic modelling as part of a SSFRA.

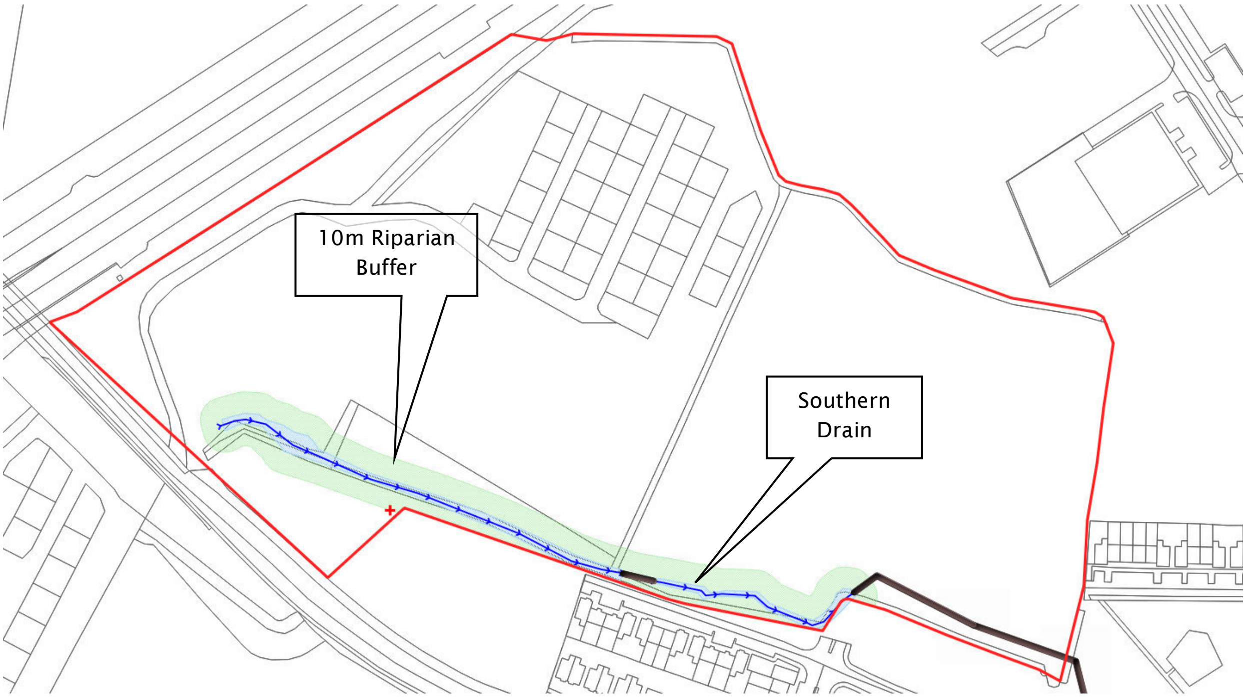
7.3.2 Protection and Maintenance of Drain

It is recommended that the southern drain (as mapped on Figure 7.2) within the Plan Area should be maintained and protected as an open channel on its present alignment as it serves as a drainage function to a wider area extending beyond the Plan Area. It is recommended that:

- The southern drain should be incorporated into public open space and consideration given to de-culverting where feasible.
- A minimum 10 m wide riparian buffer strip each side of the channel should be provided to allow access for maintenance, and encourage biodiversity.
- Ownership and maintenance obligations are established, and provision should be made by the relevant party for preventative inspection and maintenance of the channel and culverted sections.
- The full alignment and downstream connectivity of the downstream culvert is established. Any significant deviation from the assumptions on which this assessment is based should be subject to a detailed flood risk assessment.
- Consideration should be given to improvement of the culvert inlet to aide access for safe inspection and maintenance. Provision of a screen is not recommended on the basis that the culvert opening is not of a size that would permit access (e.g. by children) and land use is not of a type that would cause industrial rubbish or vegetation (leaves, branches etc.) are likely to block the culvert and cause significant flooding.

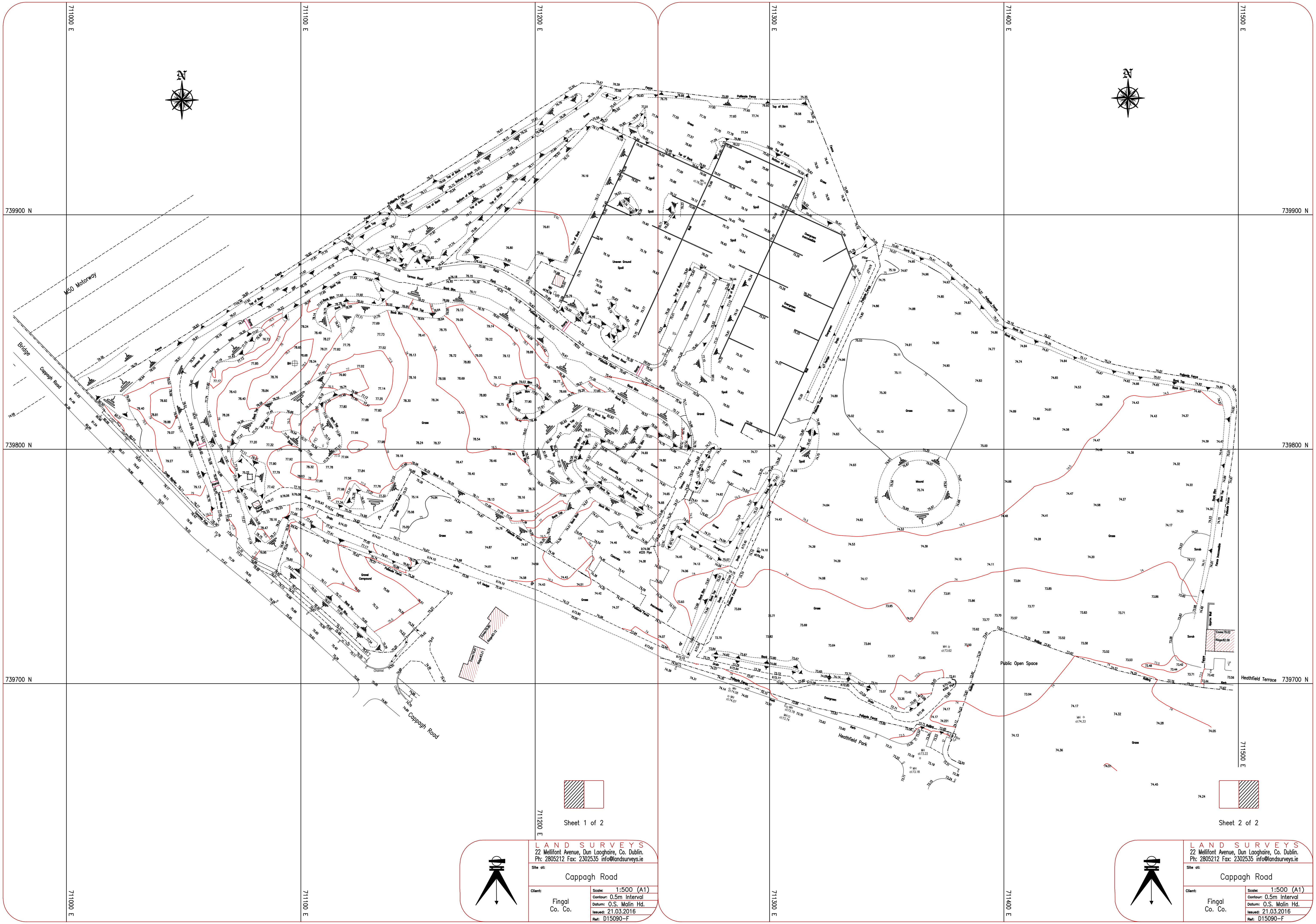
Any proposal to realign, divert, increase the dimension of, or otherwise alter the drain or culvert should be subject to robust hydraulic modelling and a flood risk assessment to assess the effect of such a proposal on flood risk at the Plan Area and elsewhere.

Figure 7.2 Southern Drain



Appendix A

Topographical Survey



711000 E
711100 E
711200 E
711300 E
711400 E
711500 E
739900 N
739800 N
739700 N
N
M50 Motorway
Bridge
Cappagh Road
Public Open Space
Heathfield Terrace
Heathfield Park
Mound
Sheet 1 of 2
Sheet 2 of 2
LAND SURVEYS
22 Mellifont Avenue, Dun Laoghaire, Co. Dublin.
Ph: 2805212 Fax: 2302535 info@landsurveys.ie
Site at:
Cappagh Road
Client:
Fingal Co. Co.
Scale: 1:500 (A1)
Contour: 0.5m Interval
Datum: O.S. Malin Hd.
Issued: 21.03.2016
Ref: D15090-F

Appendix B

Plan Area Photographs

Photo Location 1: View of Plan Area from north along boundary between western and eastern extents	Photo Location 2: View of eastern Plan Area from the east
	
Photo Location 3: **Upstream reach of secondary drain**	**Photo Location 4:** **Downstream reach of secondary drain**

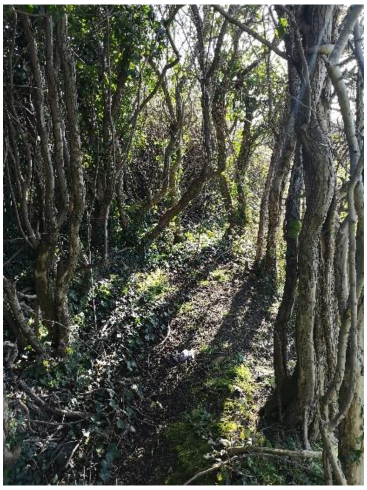
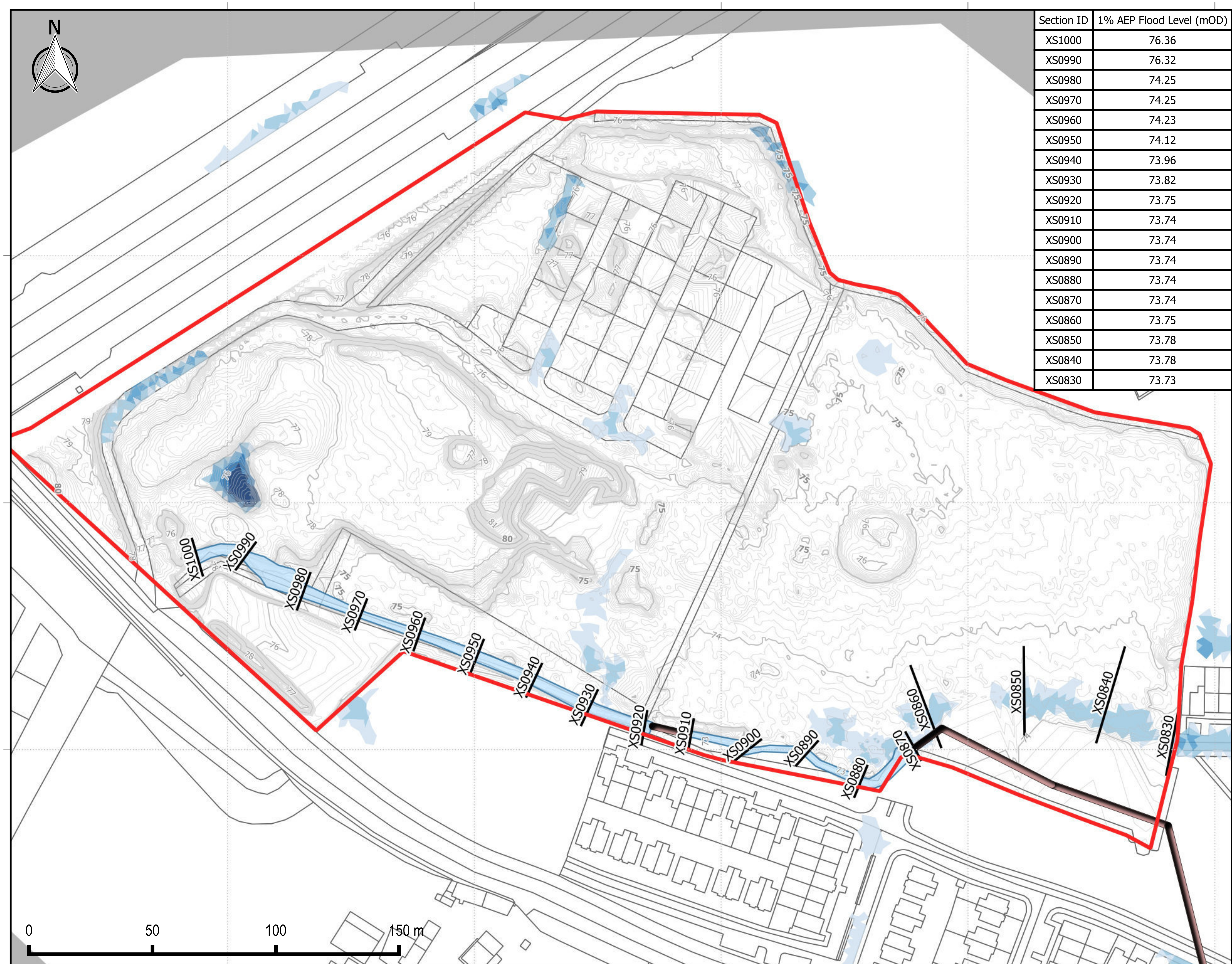



Photo Location 5: **Southern drain at culvert inlet**	**Photo Location 6:** **Culvert in southern drain beneath Heathfield Park**
	

Photo Location 7: View of south-east corner of Plan Area (ponding surface water visible)	Photo Location 8: Ponding of surface water adjacent to southern drain and secondary drain
	
Photo Location 9: **Localised depression in western Plan Area**	**Photo Location 10:** **Open drainage basin in Heathfield estate**
	

Appendix C

Flood Maps



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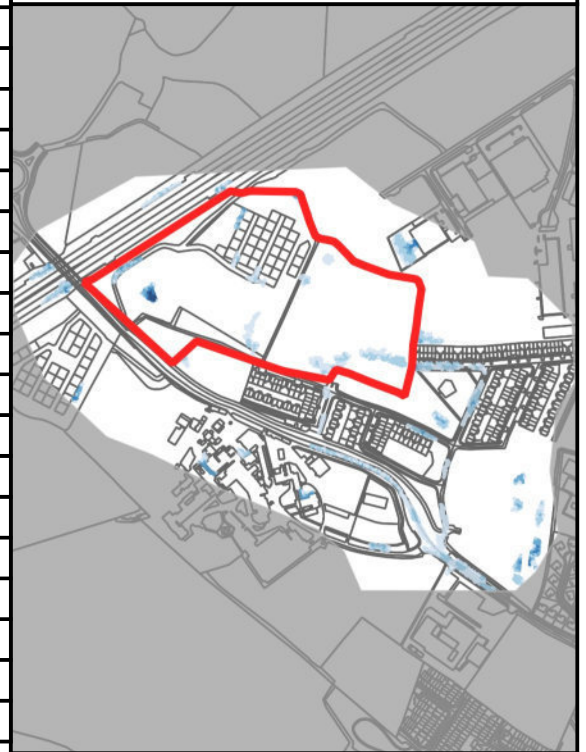
XS0990	76.32
XS0980	74.25
XS0970	74.25
XS0960	74.23
XS0950	74.12
XS0940	73.96
XS0930	73.82
XS0920	73.75
XS0910	73.74
XS0900	73.74
XS0890	73.74
XS0880	73.74
XS0870	73.74
XS0860	73.75
XS0850	73.78
XS0840	73.78
XS0830	73.73

MODEL OVERVIEW



LEGEND

- SFRA Site
- Drainage Ditch
- Culverts
- Result Cross Sections

Flood Extents Banded by Depth (m)

- < 0.15m
- 0.15 - 0.30m
- 0.30 - 0.60m
- 0.60 - 0.90m
- > 0.90m

NOTES
1. ALL LEVELS INDICATED ARE TO ORDNANCE DATUM MALIN
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McCloy Consulting
Unit 12,
The Beat Centre,
Stephenstown Industrial Estate,
Balbriggan, Co. Dublin
T: +353 (0)1 5138963
E: info@mccloyconsulting.ie
W: www.mccloyconsulting.ie

PROJECT	HYDROLOGY SCENARIO	SCALE	ORIGINAL SIZE
M02127-01	PRESENT DAY	1:1500	A3
MAP TYPE	**GEOMETRY SCENARIO**	**DRAWN BY**	**APPROVED BY**
FLOOD EXTENTS AND LEVELS	EXISTING	VR	DKS

SOURCE	FLOOD PROBABILITY	FIGURE NUMBER	REVISION	DATE
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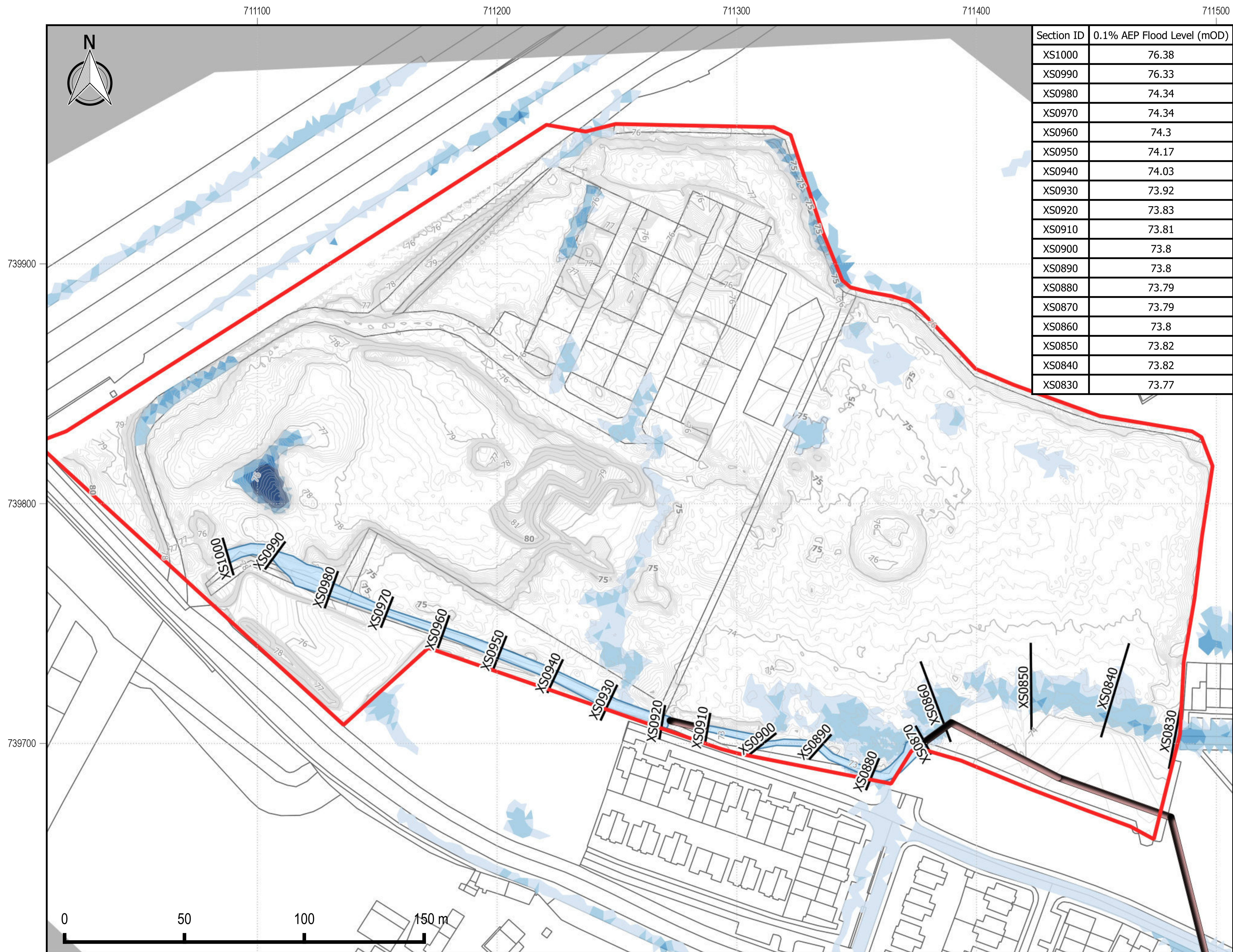

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XS0900	73.8
XS0890	73.8
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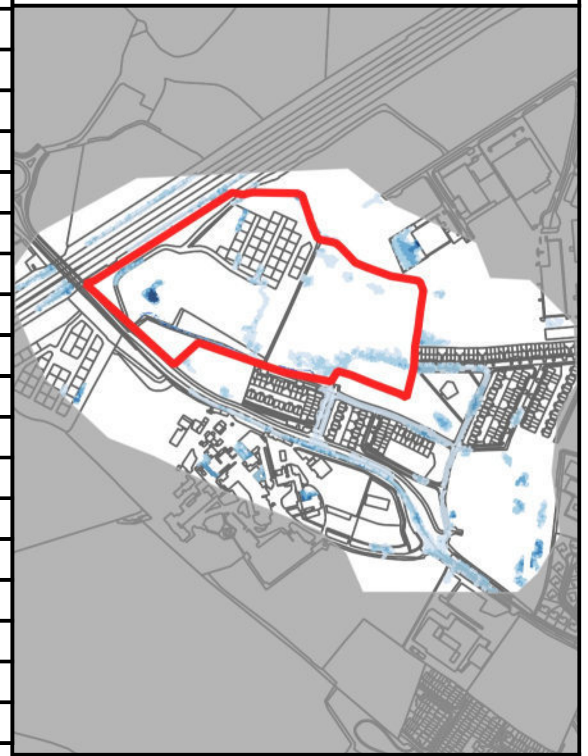
XS0840	73.82
XS0830	73.77

MODEL OVERVIEW



LEGEND

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McCloy Consulting
Unit 12,
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Stephenstown Industrial Estate,
Balbriggan, Co. Dublin
T: +353 (0)1 5138963
E: info@mccloyconsulting.ie
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PROJECT	HYDROLOGY SCENARIO	SCALE	ORIGINAL SIZE
M02127-01	PRESENT DAY	1:1500	A3
MAP TYPE	**GEOMETRY SCENARIO**	**DRAWN BY**	**APPROVED BY**
FLOOD EXTENTS AND LEVELS	EXISTING	VR	DKS
SOURCE: PLUVIAL / **FLOOD PROBABILITY:** 0.1% AEP	**FIGURE NUMBER**	**REVISION**	**DATE**
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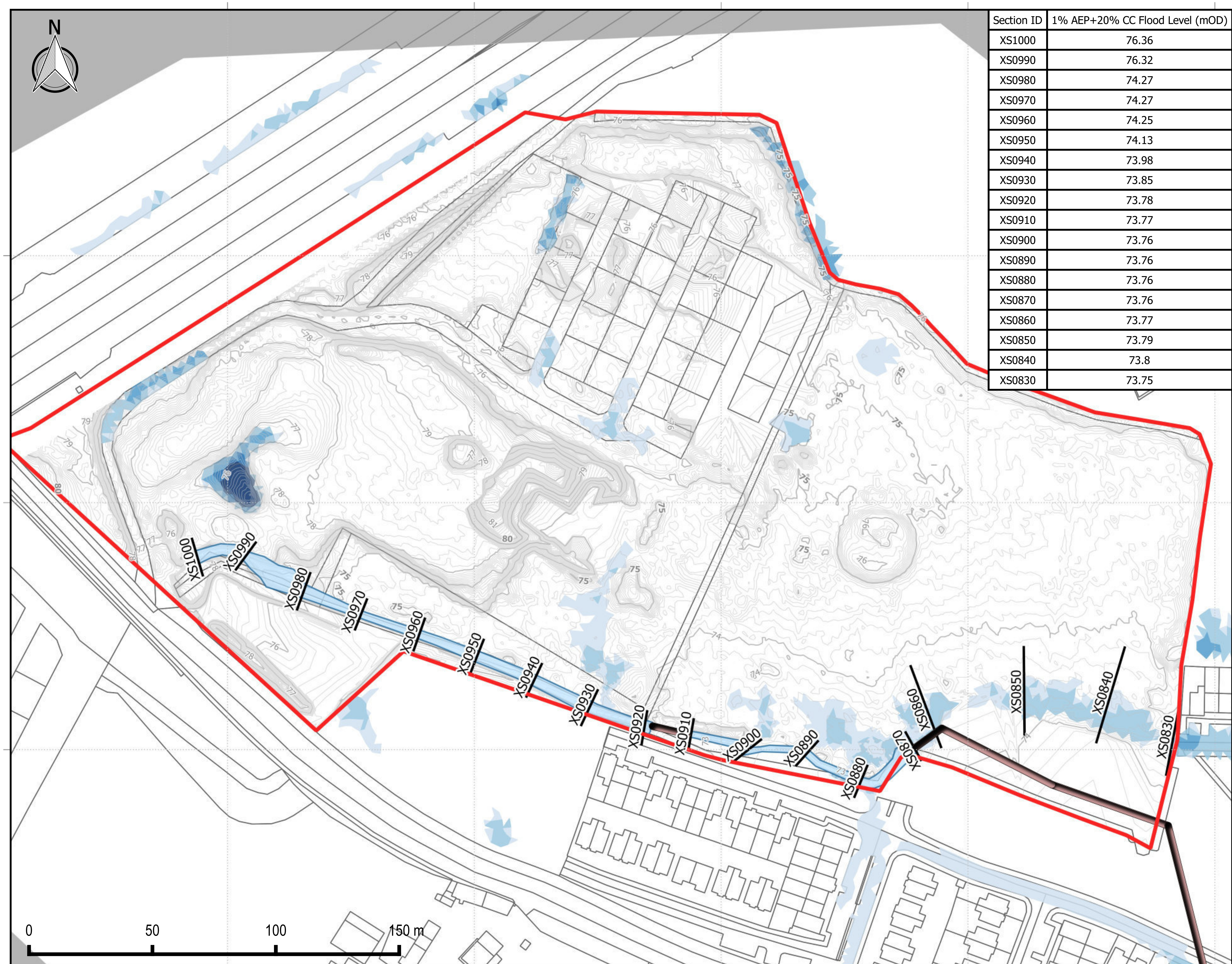

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XS0970	74.27
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XS0930	73.85
XS0920	73.78
XS0910	73.77
XS0900	73.76
XS0890	73.76
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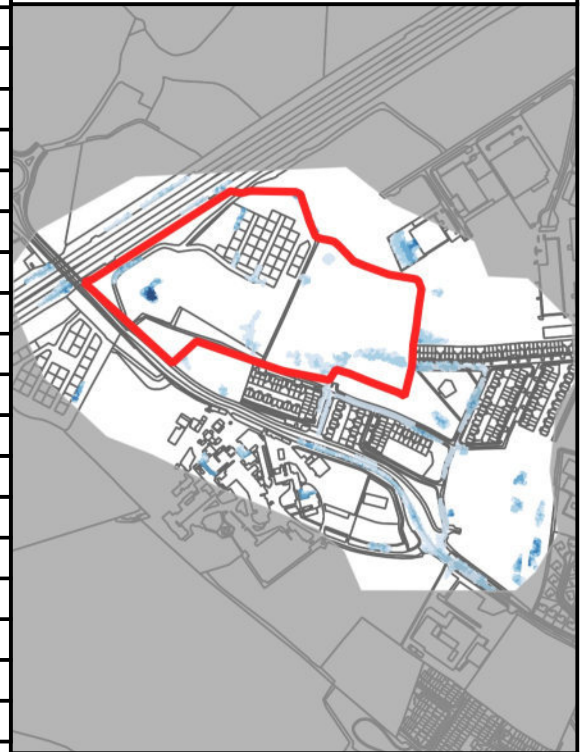
XS0840	73.8
XS0830	73.75

MODEL OVERVIEW



LEGEND

- SFRA Site
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Flood Extents Banded by Depth (m)

- < 0.15m
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- 0.30 - 0.60m
- 0.60 - 0.90m
- > 0.90m

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Unit 12,
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Stephenstown Industrial Estate,
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T: +353 (0)1 5138963
E: info@mccloyconsulting.ie
W: www.mccloyconsulting.ie

PROJECT: M02127-01	HYDROLOGY SCENARIO: MID RANGE FUTURE SCENARIO (+20%)	SCALE: 1:1500	ORIGINAL SIZE: A3
MAP TYPE: FLOOD EXTENTS AND LEVELS	GEOMETRY SCENARIO: EXISTING	DRAWN BY: VR	APPROVED BY: DKS
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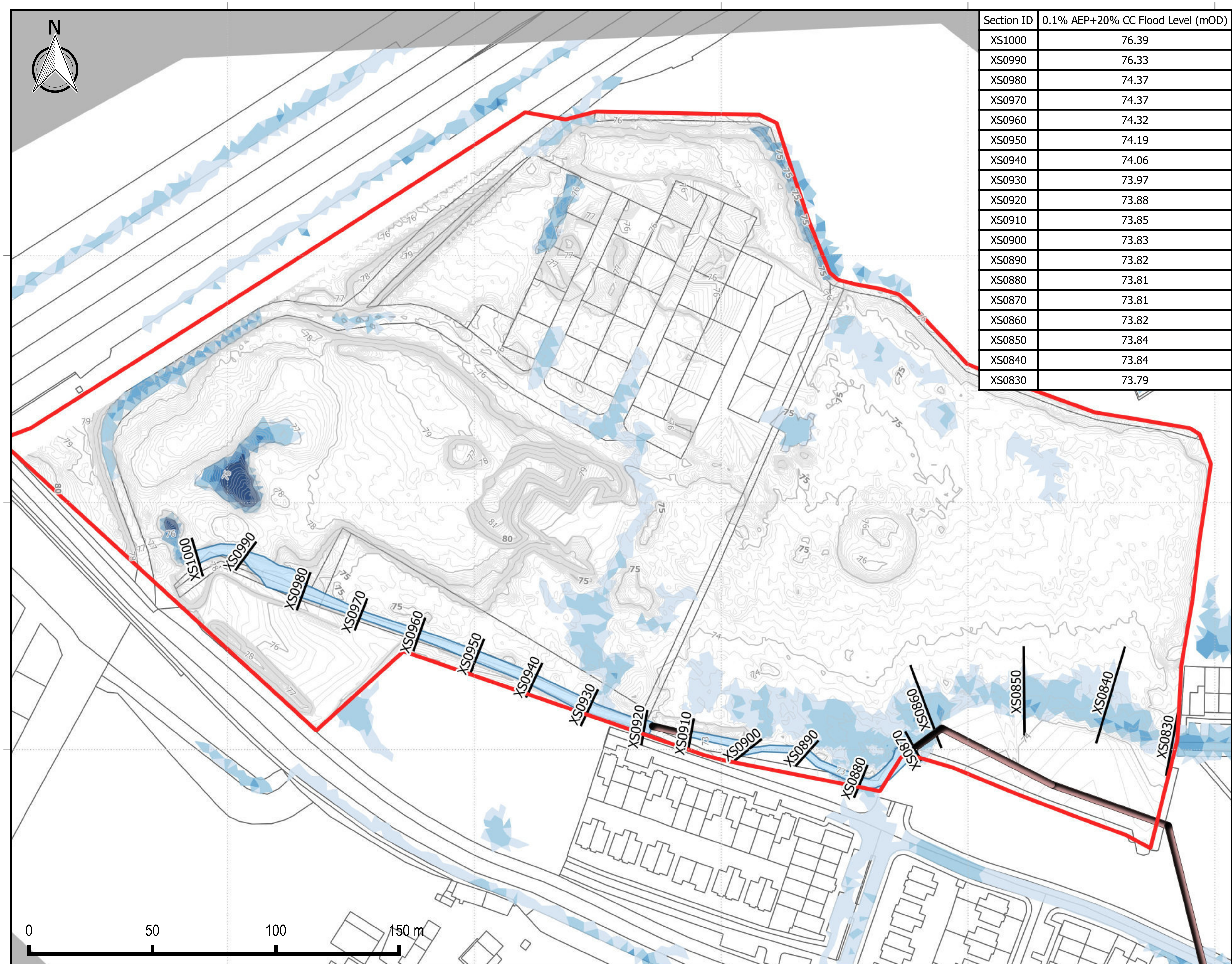

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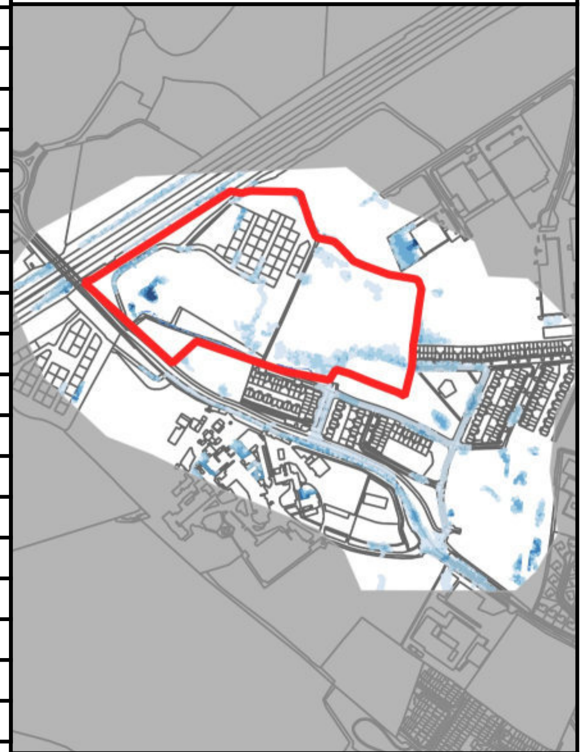
MODEL OVERVIEW



LEGEND

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- Drainage Ditch
- Culverts
- Result Cross Sections

Flood Extents Banded by Depth (m)

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- 0.60 - 0.90m
- > 0.90m

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McCloy Consulting
Unit 12,
The Beat Centre,
Stephenstown Industrial Estate,
Balbriggan, Co. Dublin
T: +353 (0)1 5138963
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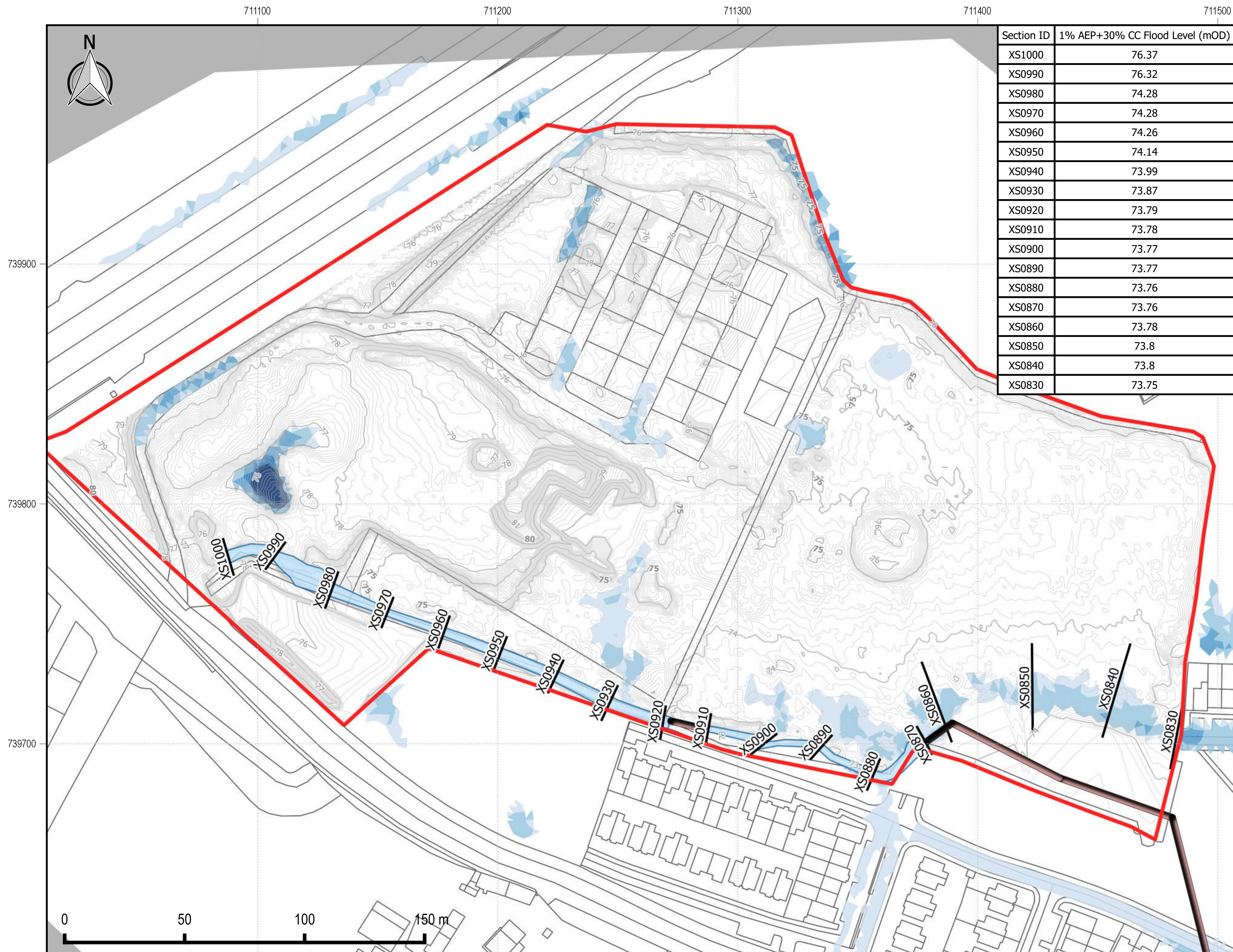
PROJECT: M02127-01	HYDROLOGY SCENARIO: MID RANGE FUTURE SCENARIO (+20%)	SCALE: 1:1500	ORIGINAL SIZE: A3
MAP TYPE: FLOOD EXTENTS AND LEVELS	GEOMETRY SCENARIO: EXISTING	DRAWN BY: VR	APPROVED BY: DKS
SOURCE: PLUVIAL / FLOOD PROBABILITY: 0.1% AEP + 20%CC	FIGURE NUMBER: M02127-01_FL04	REVISION: 5	DATE: 24/07/2019



Section ID	1% AEP+30% CC Flood Level (mOD)
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XS0910	73.78
XS0900	73.77
XS0890	73.77
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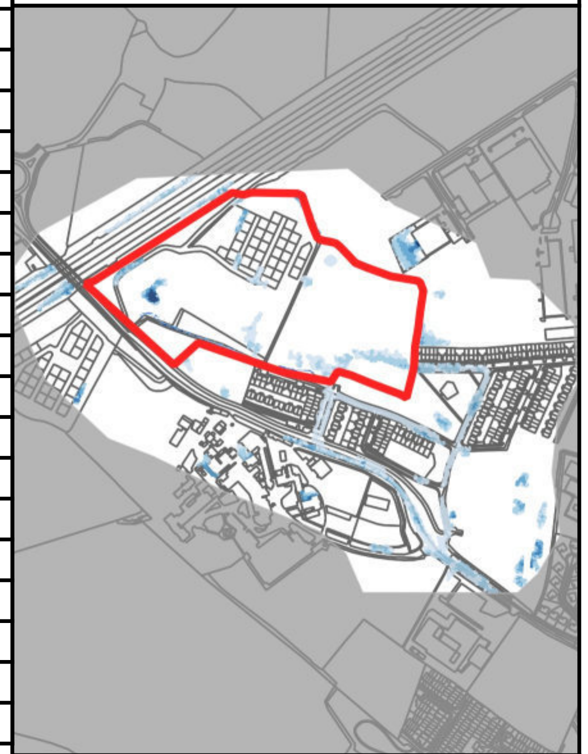
XS0830	73.75

MODEL OVERVIEW



LEGEND

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McCloy Consulting
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The Beat Centre,
Stephenstown Industrial Estate,
Balbriggan, Co. Dublin
T: +353 (0)1 5138963
E: info@mccloyconsulting.ie
W: www.mccloyconsulting.ie

PROJECT M02127-01		**HYDROLOGY SCENARIO** HIGH END FUTURE SCENARIO (+30%)	**SCALE** 1:1500	**ORIGINAL SIZE** A3
MAP TYPE FLOOD EXTENTS AND LEVELS		**GEOMETRY SCENARIO** EXISTING	**DRAWN BY** VR	**APPROVED BY** DKS
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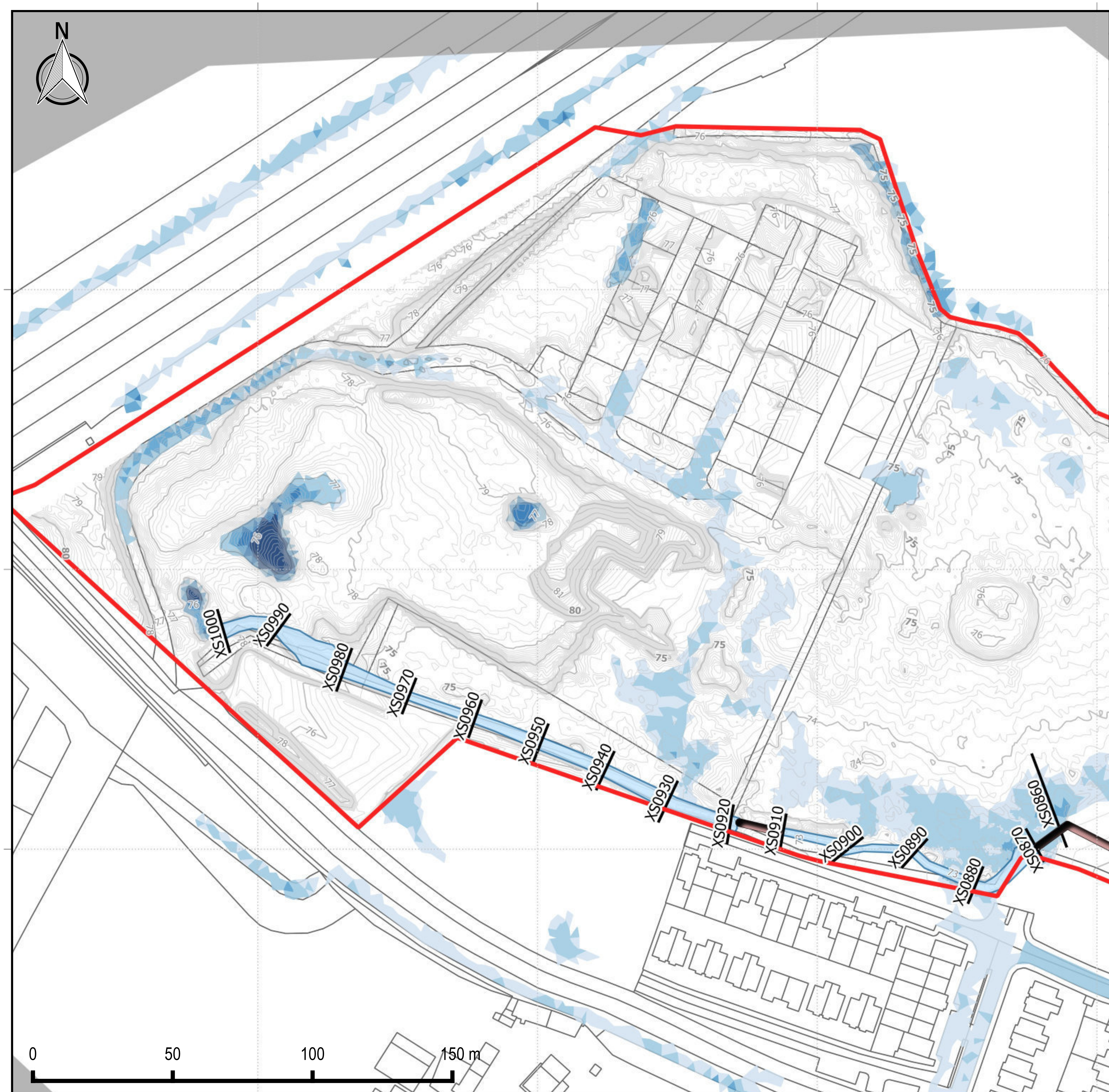

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XS0910	73.86
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XS0880	73.82
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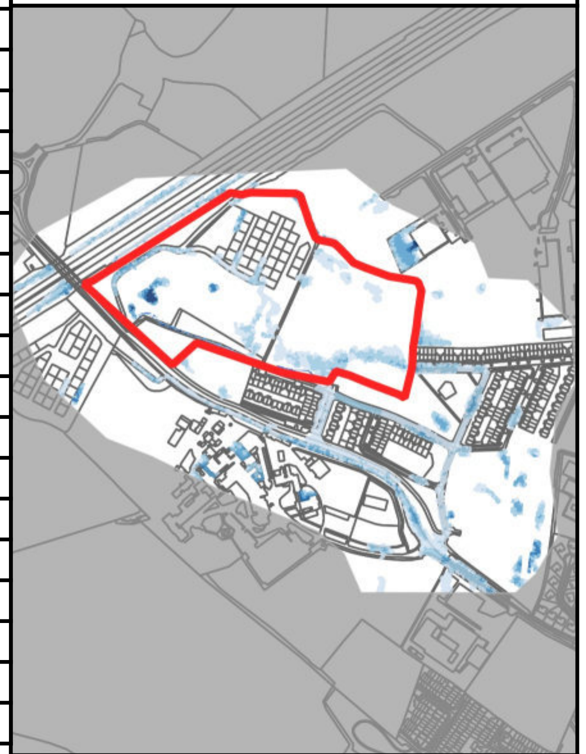
XS0830	73.79

MODEL OVERVIEW



LEGEND

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The Beat Centre,
Stephenstown Industrial Estate,
Balbriggan, Co. Dublin
T: +353 (0)1 5138963
E: info@mccloyconsulting.ie
W: www.mccloyconsulting.ie

PROJECT	HYDROLOGY SCENARIO	SCALE	ORIGINAL SIZE
M02127-01	HIGH END FUTURE SCENARIO (+30%)	1:1500	A3
MAP TYPE	**GEOMETRY SCENARIO**	**DRAWN BY**	**APPROVED BY**
FLOOD EXTENTS AND LEVELS	EXISTING	VR	DKS
SOURCE / **FLOOD PROBABILITY**	**FIGURE NUMBER**	**REVISION**	**DATE**
PLUVIAL / 0.1% AEP + 30%CC	M02127-01_FL06	5	24/07/2019

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Sustainable Drainage Strategy

Cappaghfinn, Finglas, Dublin 11

M02127-01_DG03 | July 2019

WATER & ENVIRONMENTAL CONSULTANTS

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CLIENT CONTACT	Daragh Sheedy
PROJECT MANAGER	Anthony McCloy
AUTHOR(S)	Charlotte Riddell, Paul Singleton
BRANCH	DUBLIN Unit 12, The BEaT Centre, Stephenstown Industrial Estate, Balbriggan T: +353 (0)1 5138963 | W: www.mccloyconsulting.ie

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2	24/07/2019	CR	PS	AMC	Minor Amendments	Issued for Information

DISTRIBUTION

Recipient	Revision					
	1	2	3	4	5	6
FILE	✓	✓				
Fingal County Council	✓	✓				

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APPENDICES

1 INTRODUCTION

1.1 Terms of Reference

This Sustainable Drainage Strategy (SDS) was commissioned by Fingal County Council (hereafter *Fingal CC*) to form a Surface Water Management Plan (SWMP) in conjunction with a Strategic Flood Risk Assessment (SFRA) for lands at Cappaghfinn, Finglas, Dublin 11 (hereafter the *Plan Area*).

1.2 Introduction

Sustainable Drainage Systems or SuDS is a way of managing rainfall that minimises the negative impacts on the quantity and quality of runoff whilst maximising the benefits of amenity and biodiversity for people and the environment as defined in The SuDS Manual C753 (2015)[1] published by CIRIA.

SuDS, if designed correctly, has the ability to deliver multiple benefits. The layout of SuDS should consider the inter-relationships with the following aspects of the Plan Area (all of which have delivery objectives which are compatible with delivery of wider planning objectives including:

- Biodiversity
- Parks, Open Space and Recreation
- Sustainable Water Management
- Archaeological and Architectural Heritage
- Landscape

The SDS outlines the preferred approach for the management of rainfall runoff within the development to ensure no increase in flood risk to any development at the Plan Area or elsewhere with delivery of wider water quality, amenity and biodiversity benefits.

1.3 Sustainable Drainage Strategy Objectives

The purpose of the SDS is to set out a framework for the delivery of a drainage system which will integrate multi-functional SuDS components within the Plan Area to manage water at or near the surface, providing high quality blue / green infrastructure which enhances and improves biodiversity and brings significant community benefits within developed areas.

The layouts and components as depicted within the SDS are not fixed and there is flexibility as to how the final layout will be defined. The proposed development should carefully consider the findings and recommendations of the SDS when developing outline and detailed layouts.

The SDS seeks to demonstrate that the objectives set out in Fingal Development Plan (2017 – 2023) and requirements set out in GDSDS (Volume 3) SuDS Requirements can be satisfied.

The Fingal Development Plan 2017-2013 sets out the following objectives which relate directly to the delivery of SuDS or where delivery of the objective can be (in part) facilitated through the provision of suitably designed and constructed SuDS.

- SW01, SW04, SW06, SW10
- CC01
- NH32, NH34, NH36,
- GI11, GI02, GI03, GI04, GI07, GI08

The SDS is in line with the requirements and criteria set out in the Greater Dublin Strategic Drainage Study (GDSDS) (2005) and the Greater Dublin Regional Code of Practice for Drainage Works (2012) and ensures that drainage from the Plan Area is managed sustainably.

[1] CIRIA (2015). The SuDS Manual C753. [online] Available at: https://www.ciria.org/Resources/Free_publications/SuDS_manual_C753.aspx [Accessed 20 May 2019]

As well as establishing water quantity and quality criteria, discussed later in this report, the GDSDS provides the following definitions:

- *SuDS involve a change in our way of managing urban run-off from solely looking at volume control to an integrated multi-disciplinary approach which addresses water quality, water quantity, amenity and habitat (Vol 3 p.132)*
- *SuDS minimise the impacts of urban runoff by capturing runoff as close to source as possible and then releasing it slowly (Vol 3 p.133)*

In addition, the SDS is prepared generally in accordance with industry guidance - The SuDS Manual C753 (published by CIRIA) and the SuDS Design and Evaluation Guide (produced by McCloy Consulting and Robert Bray Associates 2017).

Requirements for climate change allowances are as per OPW 'General Map User Guidance Notes' found through floodinfo.ie[2].

[2] OPW (2019) General Map User Guidance Notes (2019) Available at: https://www.floodinfo.ie/map/general_map_user_guidance_notes/ [Accessed 18 June 2019]

2 BASELINE CHARACTERISTICS

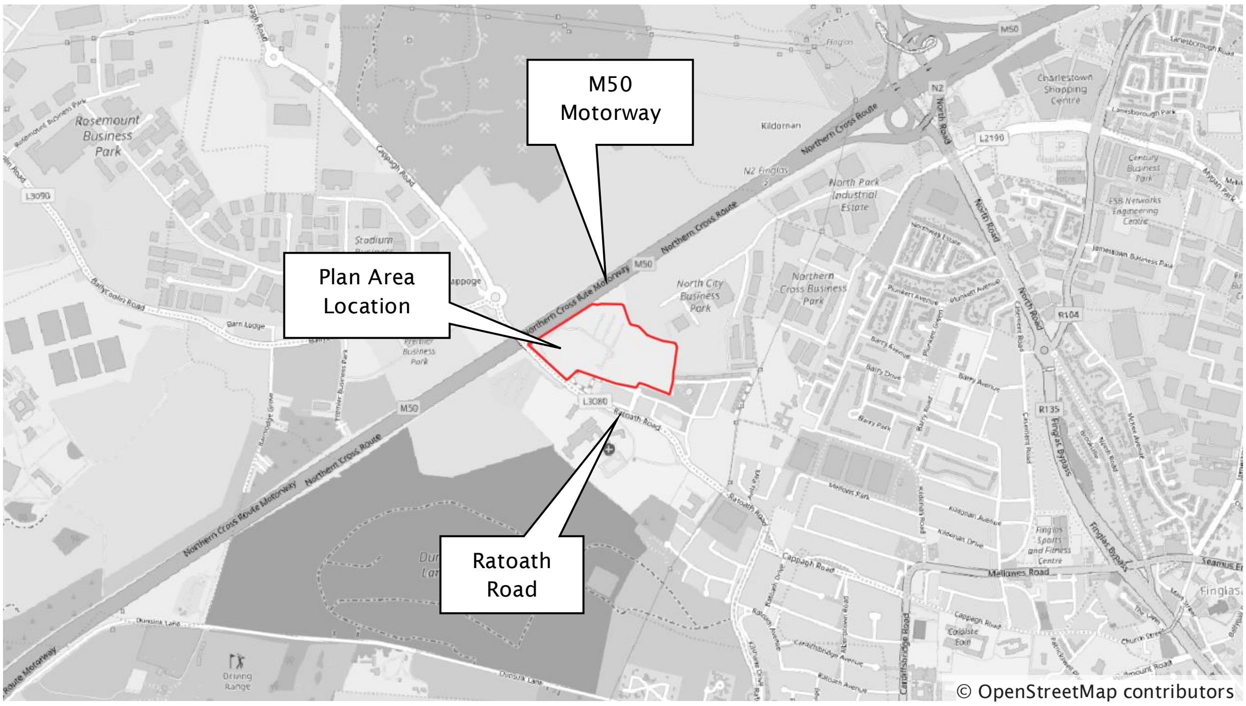
2.1 Plan Area Description

The Plan Area is located in Cappagh, Dublin 11, west of Finglas, and lies north of the Ratoath Road and east of the M50 motorway between Junctions 5 and 6. The Heathfield development lies to the east of the Plan Area, Cappagh Hospital to the south and Dublin City Business Park to the north.

The Plan Area has an extent of 8.4 ha. Heathfield Terrace is contiguous with the Plan Area and provides access from the east. Access into the west is via the Ratoath Road.

The Plan Area contains a Recorded Monument which is considered as part of the development of surface water drainage proposals.

Figure 2-1 Plan Area Location



2.2 Existing Land Use

Site observations and review of readily available mapping and orthophotography indicate that the lands currently comprise traveller accommodation (i.e. brownfield development) in the west and undeveloped green space in the east., as shown on Figure 2-2.

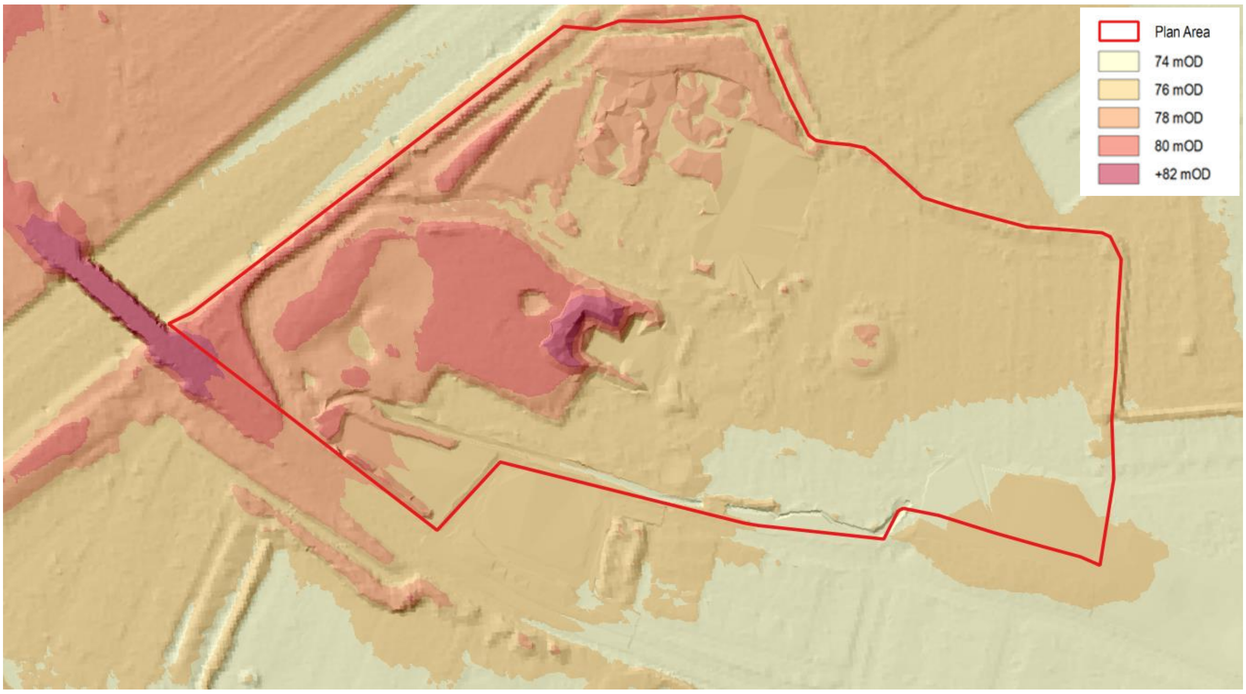
Figure 2-2 Existing Land Use

2.3 Topography

Land within the Plan Area generally falls from west to east with ground levels varying between 73.44 metres Ordnance Datum (m OD) to 78.84 m OD. Topography is shown in Figure 2-3.

A topographical survey and photographs of the existing Plan Area are included in the SFRA.

Figure 2-3 Plan Area Topography



2.4 Geology

Geological mapping indicates that the Plan Area is underlain by a bedrock of calcareous shale and limestone conglomerate with superficial deposits of till derived from limestone.

Geological Survey of Ireland mapping and Site Investigation (SI) undertaken by Causeway Geotech were assessed to determine ground conditions at the Plan Area. During the SI, made ground comprising of sandy gravelly clay with general fill of construction and demolition waste interspersed throughout, extended to between 3-4 m below existing ground level. Glacial till comprising sandy gravelly silty clay becoming very stiff with increasing depth was found to extend to the maximum borehole depth of 6.5 m.

Soil and groundwater samples were collected and tested for a range of contaminants and the SI found there was no evidence of contamination within the site.

Soakaway testing was undertaken during the SI in accordance with BRE Digest 365[3]. The investigation found the rate of infiltration was too low to calculate due to the low permeability fine-grained soils which are considered poor infiltration media. The findings specified that the Plan Area is unsuitable for the use of infiltration drainage systems.

2.5 Water Environment

2.5.1 Existing Drainage Features

The closest watercourses are Bachelors Stream located 1.26 km to the east and Scribblestown Stream located 1.22 km south of the Plan Area.

Drainage records within the wider catchment were gathered to identify inflows to the Plan Area from outside the surface water catchment. Drainage asset data was provided for the Heathfield development east of the Plan Area and the Ratoath Road south of the Plan Area as well as the M50 to the west. No drainage assets were identified to flow into the Plan Area outside of the surface water catchment.

A drainage ditch, hereafter referred to as the 'southern drain', is located adjacent to the southern boundary and is culverted beneath Heathfield Park by a by a Ø1000 mm concrete circular pipe and sinks beneath the south-east of the Plan Area via a Ø300 mm PVC pipe. Another ditch, hereafter referred to as the 'secondary drain', flows from north to south and discharges to the southern drain as shown in Figure 2-4.

The drainage asset data provided no indication of the flow route of the Ø300 mm pipe from the southern drain once it leaves the Plan Area so no discharge location / route from the site has been established.

Drainage asset information for Heathfield development to the south east indicates that it is served by a separate drainage system that flows south-east to the Cappagh Road. Prior to this discharge point the surface water sewer network is controlled by two flow control devices beneath Heathfield Park, and beneath lands linking Heathfield Drive and Heathfield Way. The flow control device in Heathfield Park is immediately downstream of an attenuation basin within green space north and west of Heathfield Park and Heathfield Green, respectively.

Figure 2-5 indicates the surface water sewer network within the Heathfield development that may have hydraulic connectivity with the Plan Area.

It is noted that flood risk to the Plan Area is considered within the SFRA which should be read in conjunction with this SDS as part of the overall SWMP.

3 Building Research Establishment (2007), BRE Digest 365: Soakaways.

McCloy Consulting

Figure 2-4 Plan Area Water Features

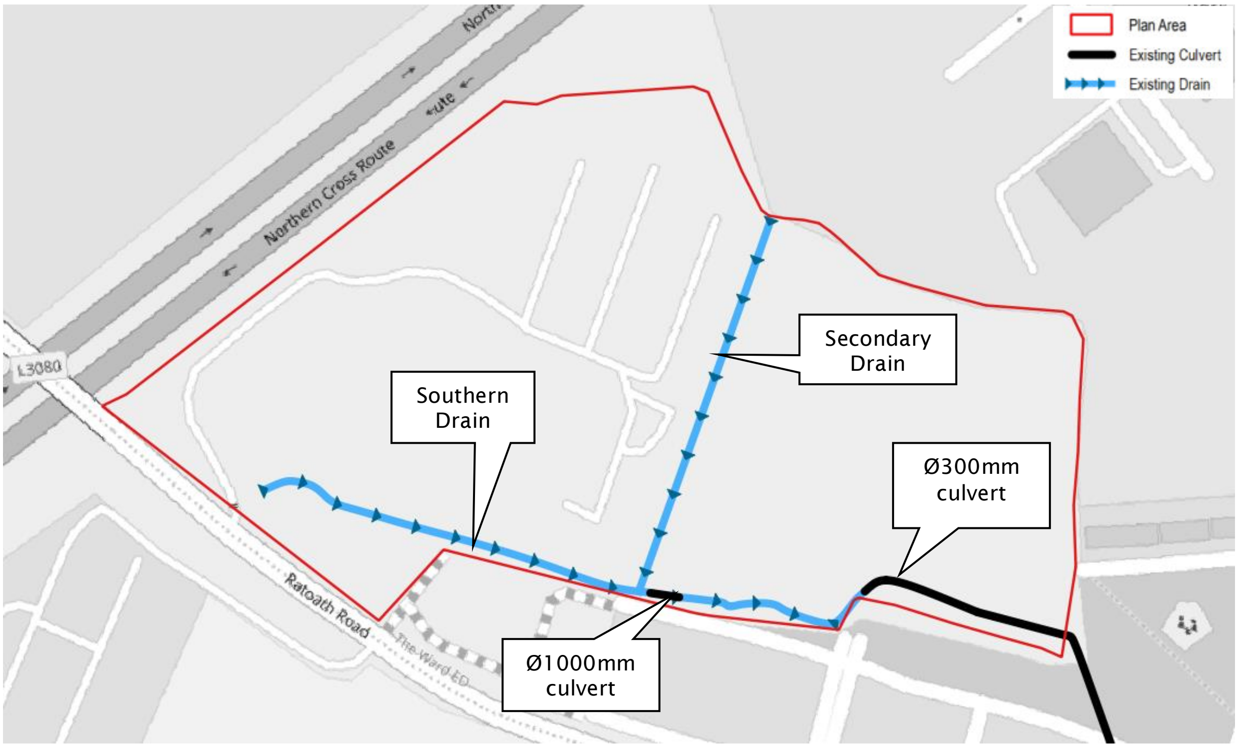
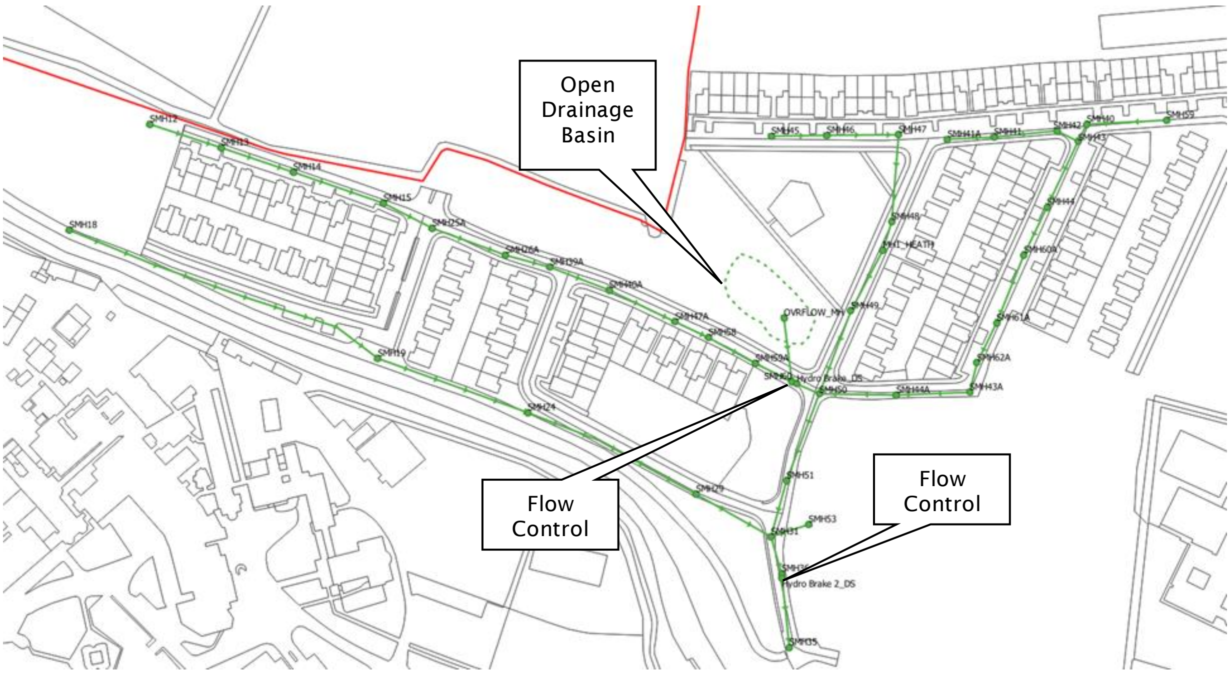


Figure 2-5 Heathfield Drainage Asset Information



2.5.2 Groundwater

There has been no Plan Area specific groundwater level monitoring undertaken. Causeway Geotech reported the following observations from the boreholes and trial pits during the Site Investigation:

- BH03, BH04 and BH09 groundwater was encountered at 1.20-3.20 m
- BH05, BH06 and BH07 groundwater was encountered at 4.40-5.40 m
- BH02 and BH08 were dry
- Groundwater was not encountered in any of the trial pits

Geological Survey of Ireland mapping has been reviewed and the following noted:

- There is a well approximately 200 m to the south of the Plan Area at Cappagh Hospital.
- The hydrogeological setting is described as low permeability subsoil.
- The average groundwater recharge is 92 mm per year.
- The Plan Area is noted as having a high vulnerability for groundwater to be contaminated by human activities.
- The eastern extent of the Plan Area is situated within a locally important aquifer area where bedrock is moderately productive only in local zones. The western extent is situated within a poor aquifer area where bedrock is generally unproductive except for local zones.
- The Plan Area is situated within the Liffey and Dublin Bay WFD catchment.

2.6 Existing Utilities

No utility records have been provided for the purposes of undertaking the SDS. Utilities are likely to be present which service the 'brownfield' / occupied parts of the Plan Area as well as the wider catchment. Plan Area observations indicated the potential presence of a pumping station.

For the purposes of the SDS, no account will be taken for existing utilities. It is recommended that the non-presence of utilities be confirmed prior to progressing outline / detailed design for the Plan Area.

2.7 Proposed Development

Notwithstanding particular objectives of the Plan Area that this assessment is intended to inform, Zoning objectives contained within the Fingal Development Plan 2017 – 2023 are shown in Figure 2-6 and summarised in Table 2-1.

In line with zoning objectives, development proposals for the Plan Area will include the construction of residential development and associated infrastructure. Given the nature of existing land use, it is reasonable to anticipate that the proposed development will lead to an increase to the extent of impermeable areas within the Plan Area, resulting in an increased rate and volume of runoff when compared to the existing scenario.

Figure 2-6 Fingal CC Zoning Objectives

Table 2-1 Fingal CC Zoning Objectives

Objective	Description
RA – Residential Area (R1)	Provide for new residential communities subject to the necessary social and physical infrastructure.

2.8 Plan Area Constraints

Table 2-2 summarises the constraints / parameters which will inform the development of the SDS.

Table 2-2 Plan Area Constraints / Parameters

Attribute	Description	Dataset Confidence Rating (L/M/H)	Comment / Influence on SuDS design
Flooding	Flood risk at the site is assessed in the SFRA for the site.	H	Hydraulic model results, presented in the SFRA, have determined existing flow routes, informed modified flow routes and pluvial flow routes and extents should be considered at all stage of design.
Existing Drainage Infrastructure	Existing drainage infrastructure is established by the SFRA. Data gaps are identified in relation to the outfall of the main drain leaving the site, and a contributing piped drain / culvert identified by surveys within the site whose drainage function is unknown.	M	A detailed drainage strategy will be required to ensure that the route and downstream connectivity of the main downstream drainage culvert is established where this conduit is intended to convey flows from the Plan Area. A detailed drainage strategy will be required to ensure that any off-site drainage function served by existing assets within the Plan Area is preserved.
Utilities	Utilities may be present – location unknown.	L	CAT scan / trial pits required – extent dependent on options taken to detailed design.
Topography	Overall levels vary between 73.44 metres Ordnance Datum (m OD) to 78.84 m OD generally falling from west to east.	M / H	The topography will influence the existing and modified flow routes / management train.
Land use existing and proposed	Used as traveller accommodation in the west of the Plan Area and grassland in the east. Proposals include residential development.	H	SuDS components / design should be compatible with residential development design and landscape character.

Attribute	Description	Dataset Confidence Rating (L/M/H)	Comment / Influence on SuDS design
Size of Plan Area	Plan Area is approximately 84,000 m^2.	H	
Ground Contamination	No evidence of contamination was recorded within the SI Report.	M / H	
Depth of Water Table	Isolated cases of high ground water table	M	Consideration to be given to likely seasonal high ground water table levels.
Infiltration potential	Soakaway testing found the rate of infiltration was too low to calculate due to the low permeability fine-grained soils which are considered poor infiltration media.	M / H	Infiltration is unsuitable.
Archaeological and Architectural Heritage	A Ringfort[4] (circular mound) is located within the Plan Area which is designated as a recorded monument and protected structure.	H	Will impact on implementation of SuDS features within 20 m of the protected structure/recorded monument.
Local Authority requirements	Fingal CC has identified that it does not currently take in charge permeable pavement. Fingal CC Parks Department has indicated that SuDS should not take up greater than 10% of amenity space (to ensure that the space is useable for other purposes)	H	Where SuDS infrastructure is not taken in charge, these assets (if provided) would have to be managed by a maintenance company. Where SuDS space exceeds 10% amenity space allowance, design is to consider multi-functional space that is only used for drainage during extreme events.

[4] Fingal County Council. (2016). Appendix 2: Record of protected structures | Fingal County Council Online Consultation Portal. [online] Available at: https://consult.fingal.ie/en/consultation/draft-fingal-development-plan-2017-%E2%80%93-2023-stage-2/chapter/appendix-2-record-protected [Accessed 22 May 2019].

3 SUSTAINABLE DRAINAGE STRATEGY

The SDS outlines the preferred approach for the management of rainfall runoff within the development to ensure no increase in flood risk to any development within the Plan Area or elsewhere with delivery of wider water quality, amenity and biodiversity benefits.

The approach to the SDS is as per the guidance from the CIRIA SuDS Manual which is summarised as follows:

- Identify existing and modified flow routes.
- Identify suitable mechanism of discharge for Plan Area drainage.
- Allocate a management train and appropriate number of subcatchments to provide the collection, treatment, storage, conveyance of runoff across the Plan Area.
- Identify a range of SuDS components which are in keeping with the proposed landscape character and other objectives for the Plan Area. At this stage of the strategy, any definition of SuDS features for specific areas of the Plan Area should not be treated as 'fixed' aspects of the design.

3.1 Flow Route Analysis

3.1.1 Existing Flow Route Analysis

The natural hydrology and existing characteristics have been assessed through flow route analysis to determine how the Plan Area behaves naturally before development and are illustrated in Figure 3-1.

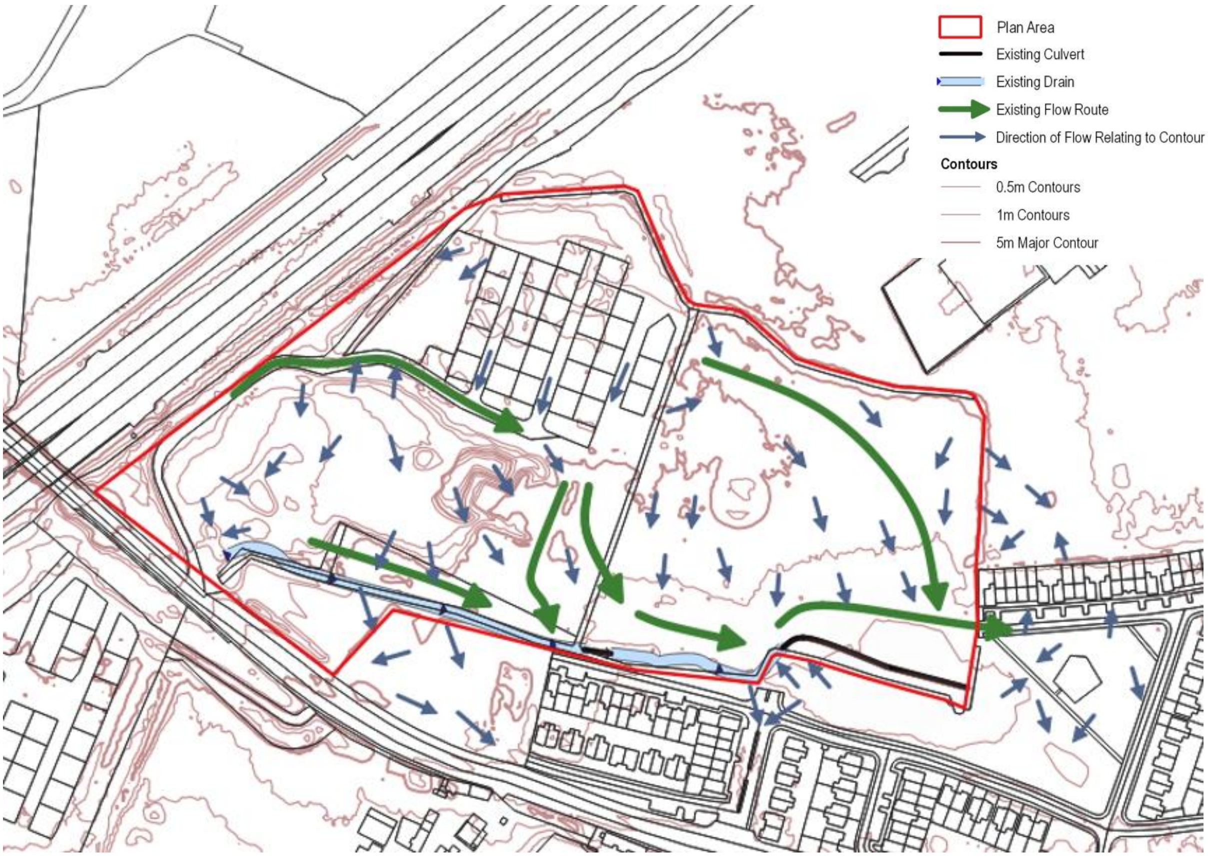


Figure 3-1 Existing Flow Route Analysis

3.1.2 Modified Flow Route Analysis

The modified flow route analysis is the basis for low flow conveyance, overflow arrangements and exceedance routes when design criteria are exceeded. The modified flow routes have been assessed and informs the overall design by predicting the flow of runoff through the Plan Area as shown in Figure 3-2

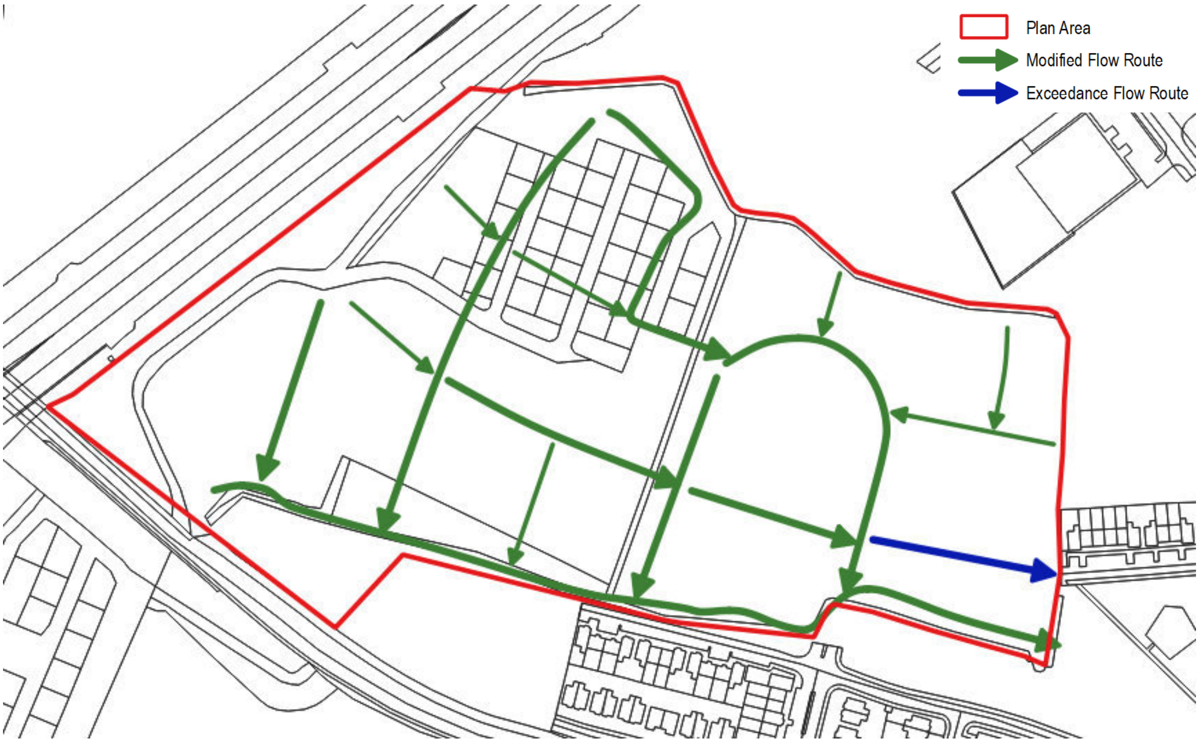


Figure 3-2 Modified Flow Route Analysis

3.2 Subcatchments

Figure 3-3 demonstrates how runoff from the Plan Area will be managed in subcatchments using natural overland conveyance. Flows will be conveyed from one subcatchment to the next along one or more management trains, following the modified flow routes.

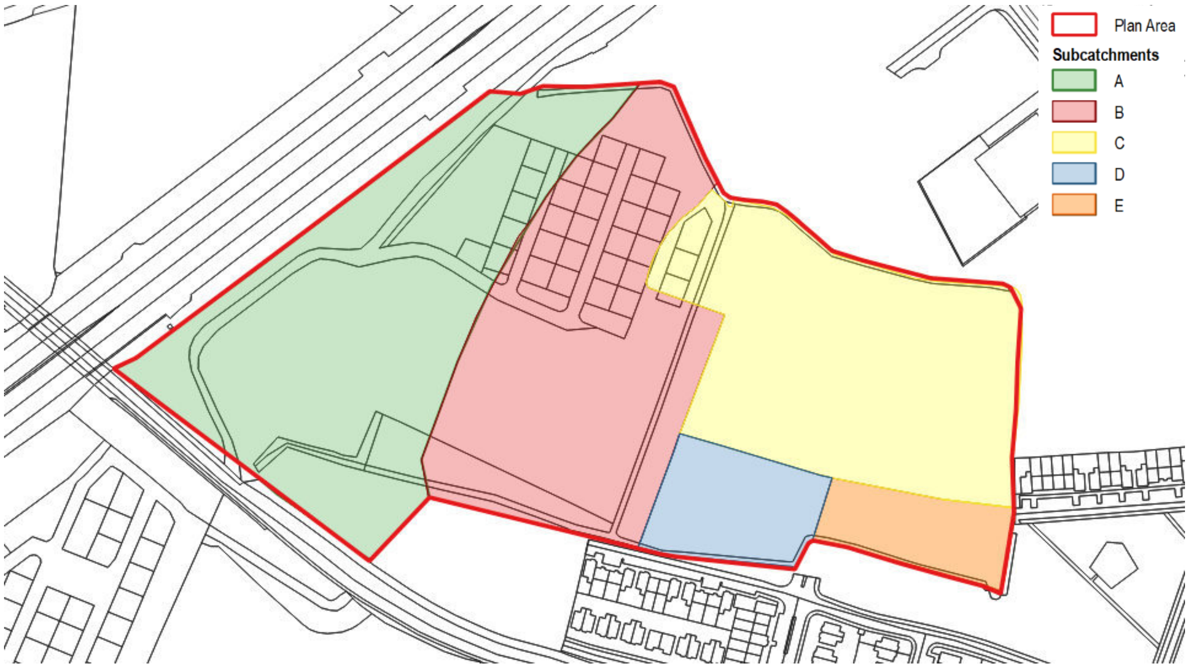


Figure 3-3 Subcatchments

3.3 Drainage Hierarchy

The way that runoff is disposed from the Plan Area should adhere to the following hierarchy of discharge:

i. Re-Use – Where opportunities arise for rainfall harvesting within proposed development plans, these should be maximised

ii. Infiltration – Infiltration has been discounted within the assessment as it was deemed unsuitable within the Phase 2 SI Report as discussed in Section 2.4.

iii. Watercourse – There are no natural watercourses in the vicinity of the Plan Area. Existing open drains collect and convey flows but are not considered suitable for receiving runoff discharge.

iv. Surface Water Sewer – Surface water sewer exists immediately downstream from the Plan Area and will serve as the primary mode of discharge of surface runoff from proposed development.

v. Combined Sewer – Not applicable

3.4 Water Quantity

Sufficient attenuation is to be provided to ensure that there is no unpredictable flooding within the Plan Area, future buildings are protected and no increase in flood risk elsewhere.

3.4.1 Climate Change

The future impacts of climate change on rainfall should be accounted for within the design of the drainage scheme.

Requirements for climate change allowances are as per OPW 'General Map User Guidance Notes' found through floodinfo.ie[5] which recommended a 20% uplift in extreme rainfall depths for the Mid-Range Future Scenario (MRFS) and 30% for the High-End Future Scenario (HEFS).

In line with the standard adopted in practice at the time of writing, the MRFS is applied for purposes of evaluation of the effect climate change to inform this SDS.

3.4.2 Runoff Rates

The flow rates in the following table are based on the requirements of GDSDS and FCC for restriction of post-development runoff to greenfield rates. They provide guidance on the extent to which flows will be controlled from any proposed development within the Plan Area. The flow rates are calculated using IoH 124 methodologies based on catchment specific characteristics; Soil WRAP Class 4 and SAAR of 740 mm.

Table 3-1 Attenuation Flow Rates

Return period	Attenuation Rate (l/s/ha) Greenfield Rate*	Attenuation Rate (l/s/ha) Qbar or 2 l/s/ha**
100% AEP (1 in 1 year)	3.98	4.66 (Qbar)
3.33% AEP (1 in 30 year)	7.71	4.66 (Qbar)
1% AEP (1 in 100 year) + CC	9.17	4.66 (Qbar)

*Where volume is controlled to Greenfield volumes – flows attenuated to respective GF rate

**Volume not controlled – all return periods attenuated to Qbar or 2 l/s/ha whichever is the greater.

[5] OPW (2019) General Map User Guidance Notes (2019) Available at: https://www.floodinfo.ie/map/general_map_user_guidance_notes/ [Accessed 18 June 2019]

3.4.3 Storage of Runoff & Discharge Location

Runoff will be attenuated throughout the Plan Area within respective subcatchments. SuDS components for collection, storage and conveyance of flow will be selected on the basis of suitability for the development design and in consideration of relevant constraints.

Attenuation storage will be sized for the 1% AEP (with allowance for climate change) critical rainfall event. Specimen storage volumes, based on an outflow rate of Qbar or 2 l/s/ha, are provided in Table 3-2.

Table 3-2 Indicative Attenuation Storage Volumes

Return period	Indicative Attenuation Volume* (m^3)
100% AEP (1 in 1 year)	306 m^3
3.33% AEP (1 in 30 year)	1001 m^3
1% AEP (1 in 100 year) + CC	1864 m^3

* Attenuated to Qbar or 2 l/s/ha whichever is the greater

Final discharge from the proposed development will likely be to surface water drainage network to the south east of the Plan Area. The route of discharge is to be proven and agreed as part of outline / detailed design process.

The existing southern drain within the Plan Area may be incorporated into a future detailed SuDS strategy and utilised to convey and attenuate flows to the surface water drainage network to the south east of the Plan Area. This drain should be retained as open channel in its present alignment and consideration should be given to de-culverting / daylighting as recommended in Section 7.3.2 in the SFRA.

3.4.4 Designing for Exceedance

Plan Area levels and landscaping should be designed to route exceedance flows away from buildings. Overland flow routes should be managed in a safe manner by utilising the drainage systems, roads and public spaces to convey and control floodwater during extreme events.

3.5 Water Quality

3.5.1 Water Quality Requirements

Proposals for the Plan Area are likely to comprise residential development and therefore considered to be low risk. Treatment requirements are summarised as follows:

- Roof only runoff – removal of solids
- Roads used for vehicular movement – 1-2 stages of treatment dependant on SuDS component selected

Design of individual SuDS features for water quality treatment should comply with criteria set out in the CIRIA SuDS Manual. The ‘simple index approach’ is to be used to validate design for water quality treatment (as outlined in Chapter 26).

First stage of treatment is to be provided prior to flows being attenuated in any areas being promoted for biodiversity / amenity function.

3.5.2 Construction Management

A Management Plan will be required to outline how surface water runoff will be managed during construction and ensure appropriate mitigation is in place to minimise risk of flooding and pollution during construction.

3.6 Amenity

Amenity focuses on the usefulness and aesthetic elements of SuDS design associated with features 'at or near the surface' and considers both multi-functionality and visual quality.

The following are highlighted for consideration as part of the development of the SuDS design:

- SuDS should be 'legible', i.e. understandable to people using the area as well as maintenance personnel.
- The visual character of the SuDS will enhance the development.
- Spaces and connecting routes are multi-functional and can be used when not providing a SuDS function for surface water management.
- The design shall ensure the proposed development is generally accessible to meet FCC objective GI03 and be safe 'by design'.

3.7 Biodiversity

Biodiversity must be considered in the design at catchment scale to create sympathetic blue / green infrastructure and at local scale to provide habitat and connectivity linkages within and around the proposed development.

The following are highlighted for consideration as part of the development of the SuDS design:

- Ensure water quality within the water environment by following the steps of the simple index approach as per CIRIA SuDS Manual guidance (Chapter 26, Box 26.2).
- Demonstrate ecological design and the creation of habitats within the SuDS corridor to meet objectives NH02, GI03 and GI25.
- Keep water at or near the surface as it flows through the SuDS management train towards to wider landscape to ensure habitat connectivity.
- Confirm management practices to enhance habitat development during maintenance.

3.8 SuDS Components

Table 3-3 summarises a comprehensive review of potential SuDS components relative to Plan Area characteristics. It is noted that at initial / concept stage, this is not an exhaustive list and further information relating to the area is likely to lead to refinement of the audit.

Table 3-3 SuDS Component Audit

SuDS Component	Description	Suitable?	Rationale
Green roofs	Green roofs are areas of living vegetation, installed on the top of buildings.	Possible	Proposed roof have potential for green / blue roof solutions. There is potential to integrate into roof structures as part of design to promote biodiversity as well as reducing runoff and attenuating peak flows. This would meet Objective SW06 and GI33 in the Fingal Development Plan 2017-2023 which encourages the use of Green Roofs on apartments and provides benefits for biodiversity. Use of green roofs may be influenced by required landscape character for the Plan Area, e.g. if apartments are proposed.
Infiltration systems	Infiltration systems allow surface water runoff to infiltrate and filter through to the sublayer layer before returning to the water table.	No	Discharge via an infiltration system is not suitable for the Plan Area due to the low permeability fine-grained soils and the low infiltration rates found during the SI as discussed in Section 2.5. Some losses may be achieved through the installation of 'leaky' unlined systems. Infiltration has been discounted and will not form part of the primary drainage strategy.
Filter strips	The hard edge from a pavement to a filter strip is generally defined by a kerb.	Yes	There is potential to incorporate filter strips into the development to collect and provide treatment surface water runoff.
Filter drains	Filter drains, also known as a French drain, is an open stone filled trench.	No	Final appearance is considered not in keeping with the proposed landscape character of the Plan Area.
Swales	Swales are shallow, flat bottomed vegetated channels which can collect, treat, convey and store runoff.	Yes	Swales could be suitable to convey flows between other SuDS features and connect green-space areas. This would meet Objective GI03, GI11, GI21, GI25 and NH02 in the Fingal Development Plan 2017-2023.
Bioretention systems / rain planters	Bioretention systems are shallow landscaped depressions used to reduce runoff rates, volumes and treat pollution through the use of engineered soils and vegetation.	No	There is potential to incorporate bioretention systems into the development to collect existing roof runoff with the use of 'raised planters'. There is unlikely to be significant levels of pollution generated in development runoff to warrant the use of bioretention for treatment purposes solely.

SuDS Component	Description	Suitable?	Rationale
Tree pits	Trees pits attenuate surface water runoff underneath by utilising the void within each tree's rooting zone.	Yes	Trees will be planted across the Plan Area therefore there is potential to incorporate tree pits within the SuDS design.
Permeable pavements	Permeable pavements allow rainwater to infiltrate through the surface and into the underlying structural layers where it is temporarily stored before infiltrating or discharged downstream.	Yes	New Roads and hardstanding areas will be provided as part of the development therefore there is scope to include permeable paving within the development which would support Objective SW04 in the Fingal Development Plan 2017-2013. Given that infiltration is not suitable as discussed in Section 2.4, positive drainage outlets will be required. Fingal County Council do not currently take in charge permeable paving. This requires consideration in terms of future ongoing maintenance consideration.
Rain harvesting	Rainwater harvesting (RWH) involves the collection of rainwater runoff for reuse.	Possible	Rainwater reuse could be utilised to reduce surface water runoff and reduce demand on potable water supply. It is unlikely to yield sufficient decreases in flow rates to satisfy the requirements of the drainage strategy but may be considered at the discretion of the client/developer but will not form part of the primary drainage strategy.
Attenuation storage tanks	Attenuation tanks are used to create below ground storage before infiltrating or controlled release or use.	Possible	Elevated discharge level will limit the potential for storage tanks (generally they require sufficient cover to facilitate structural loading). Removal of silt ingress to tanks is likely to pose a significant maintenance risk due to lack of direct accessibility. Objective DMS74 of the Fingal Development Plan 2017-2023 states that "underground tanks and storage systems will not be accepted under public open space, as part of a SuDS solution". In addition, preference should be given to above ground attenuation features to maximise benefits for water quality, amenity and biodiversity to support the Objectives outlined within the Development Plan. Below ground storage / tanks should only be used as a last resort where it has been demonstrated that other Green Infrastructure measures are not feasible. This assessment has found no reason why above ground surface water features would not be feasible.

SuDS Component	Description	Suitable?	Rationale
Detention basins	Detention basins are landscaped depressions that are normally dry except during and immediately after storms.	Yes	Detention basins could be utilised to attenuate flows, improve water quality, and reduce runoff rates prior to discharge. They can be used for recreation and public open space which would support Objectives GI03, GI11, GI21, GI25 and NH02 in the Fingal Development Plan 2017-2023 which encourages the provision of accessible parks, open spaces and recreational facilities alongside the sustainably managing water within the Plan Area. There is potential to utilise the existing main drain within the Plan Area to incorporate linear detention features which are easily accessible and maintainable, whilst maintaining their use as amenity spaces for significant majority of the time (with exception of periods post significant rainfall where they would fill with water to design depths).
Ponds & wetlands	Ponds and wetlands are features with a permanent pool of water that provide attenuation and treatment of surface water runoff.	Possible	There is potential to utilise ponds and wetlands within the development which would specifically support Objectives SW01, NH02, GI21, GI25, GI31 and GI32 in the Fingal Development Plan 2017-2023. Careful consideration needs to be given to the proposed landscape character of the Plan Area as the Architects Department has indicated that ponds and wetlands may not be suitable and / or appropriate.

4 SUMMARY AND RECOMMENDATIONS

4.1 Summary

This Sustainable Drainage Strategy outlines the approach and criteria that should be followed when developing a SuDS design as part of any future proposals for the Plan Area. The report includes design considerations for managing quantity, quality, amenity and biodiversity as well as demonstrating flow routes and sub-catchments.

A SuDS Concept Masterplan based on the sub-catchments, modified flow routes and SuDS component audit has been developed and is included in Appendix A. The conceptual layout will be developed through outline and detailed design in parallel with development and finalisation of the proposed development layouts.

In addition to general design criteria outlined in the SDS, the following Plan Area specific recommendations are made to guide and improve sustainable surface water drainage management.

4.2 Recommendations

The following recommendations are made for the development of the SuDS / Sustainable Drainage Strategy for the Plan Area.

i. Proposed development layout design to consider the existing flow route analysis and be undertaken in conjunction with the SuDS design to facilitate consideration of modified flow routes.

ii. The SuDS / Sustainable Drainage Strategy will provide a management train through definition of subcatchments to maximise treatment and storage capacity.

iii. Consideration should be given to the use of the 'southern drain' as part of the SuDS strategy for the Plan Area as well as daylighting of the existing culvert to restore the natural drainage channel.

iv. A minimum 10 m wide riparian buffer strip each side of the 'southern drain' should be provided to allow access for maintenance and encourage biodiversity.

v. No SuDS features are to be located within 20 m of the protected structure / recorded monument.

vi. Application of greenfield runoff rate, dependent on adequate provision of 'long term storage / losses' to be agreed with Fingal CC.

vii. The outfall route of discharge from the Plan Area is to be identified and agreed with Fingal CC as a material consideration in any design process, including outline design.

viii. Ownership and maintenance obligations for existing surface water drainage features should be established, and provision should be made by the relevant party for preventative inspection and maintenance of the channel and culverted sections.

ix. The downstream connectivity and drainage function of the main drainage culvert leaving the site should be established; its ownership and maintenance obligations established, and measures put in place to ensure that the function of the asset is preserved put in place.

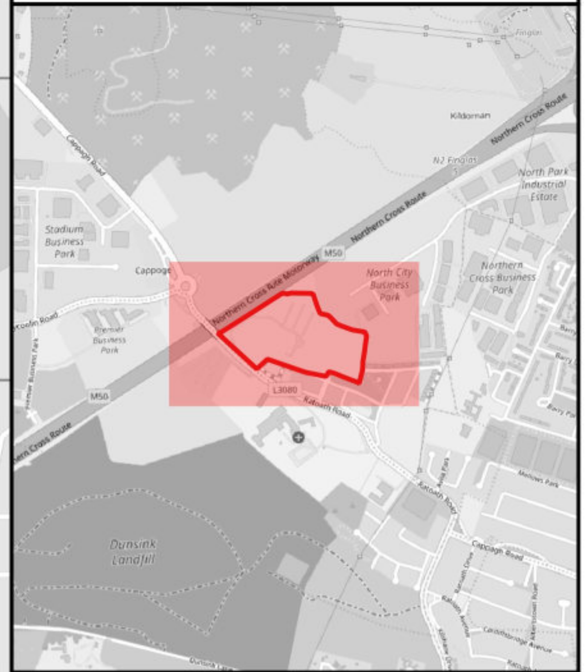
x. The drainage function of drainage assets within the site (and in particular a partly mapped drain identified by surveys to inform the SFRA) are to be identified and any offsite drainage function maintained by the proposed drainage strategy.

xi. A construction management plan will be required to ensure appropriate mitigation is in place to minimise risk of flooding and pollution during construction.

Appendix A

SuDS Concept Masterplan

OVERVIEW



LEGEND

- Plan Area
- SuDS Components
- Control
- Modified Flow Route
- Exceedance Flow Route

Subcatchments

- A
- B
- C
- D
- E

Images show sample SuDS schemes using permeable surfaces, swales, tree pits, filter strips and basins to demonstrate potential landscape design and character of the Plan Area. SuDS components appropriate for proposed development to be decided at outline / detailed design stage.

McCloy Consulting
Mossley Mill,
Lower Ground (West),
Carnmoney Road North,
Newtownabbey BT36 5QA
T: 028 9084 8694
E: info@mccloyconsulting.com
w: www.mccloyconsulting.com

DESCRIPTION			
Cappaghfinn SuDS Concept Masterplan			
PROJECT / FIGURE NO.			
M02127-01_SK03			
DRAWN BY	SCALE	REVISION	DATE
CR	1:2500 @ A3	3	18/06/2019

Comhairle Contae Fhine Gall
Fingal County Council