McCloy Consulting

Flood Risk Assessment

Proposed Development at
Dalguise House, Monkstown, Dublin 18

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1 INTRODUCTION

1.1 Terms of Reference

This Flood Risk Assessment report was commissioned by GEDV Monkstown Owner Limited to support a planning application for the development of lands at Dalguise House, Monkstown, Dublin 18. The proposed development is hereafter referred to as 'the site'.

It is noted that development at the site has previously been consented as part of an application to An Bord Pleanála (ref.: TA06D.306949) and the approach to modelling and flood risk mitigation was agreed in consultation with Dún Laoghaire-Rathdown County Council (DLR CC) as part of that process.

1.2 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:

- 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.
- Stephen Neill *BEng* – Senior Engineer and principal flood modeller, specialising in flood modelling and flood hydrology with experience in Ireland having had substantial involvement in a number of CFRAM projects and secondment to OPW.
- 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.

1.3 Purpose

This assessment is intended to produce a detailed site specific flood risk assessment (SSFRA) to ensure that all relevant issues related to flooding are addressed. This Stage 3 FRA will assess the adequacy of existing information and present analysis undertaken to supplement existing data.

The assessment will therefore determine potential sources of flooding at the site. This report will also determine flood zones relevant to planning policy guidelines specific to flood risk management planning and will provide a basis for appropriate design and mitigation measures to be considered as part of the proposed development.

1.4 Approach to the Assessment

Consideration has been given to the sources and extent of fluvial flooding at the site, as well as flooding to the site from pluvial sources, overland flow and ponding of localised rainfall within the site. A walk over survey of the site was conducted by McCloy Consulting Ltd to investigate all sources of potential flooding. During the visit a photograph survey of the site and adjacent lands was undertaken. A topographical survey of the site was also commissioned and undertaken by a third party.

The method of assessment complies with the Source-Pathway-Receptor model, allowing spatial assessment of flood risk to people, properties and the environment at the site.

This assessment is to be read in conjunction with a Justification Test provided in Appendix H.

1.4.1 Hydraulic Model Status

For the purposes of this assessment, the primary stakeholders are the Office of Public Works (OPW) and Dún Laoghaire-Rathdown (DLR) County Council (CC). OPW and DLR CC data is used to form the basis of this assessment and is presented in line with the relevant guidance and requirements.

The site and surrounding environs are included in the Preliminary Flood Risk Assessment (PFRA); the first stage of the CFRAM process that included national-scale flood mapping. The PFRA is a preliminary-only assessment based on available or readily-derivable information. The analysis was undertaken to identify areas prone to flooding, but the analysis is indicative and mapping is considered to be coarse and is designed to inform further stages in the CFRAM process.

The Greater Dublin Strategic Drainage Strategy (GDSDS) included modelling of surface water drainage in the vicinity of the site. This has been reviewed as part of the assessment and subject to interrogation as it was carried out in 2005 and as such may not reflect current conditions.

Therefore, to facilitate better understanding of flood risk at the site and to inform future development, detailed hydraulic modelling has been undertaken and is summarised in this report. It is noted that the hydraulic modelling undertaken as part of this SSFRA is designed to assess flood risk at the site and impact of development directly upstream and downstream and as such, is not suitable for informing / assessment of flood risk outwith the direct site environs.

1.4.2 Planning Guidelines

The requirements for FRAs are generally as set out in the OPW's *The Planning System and Flood Risk Management – Guidelines for Planning Authorities 2009* (hereafter referred to as 'the OPW Guidelines') and accompanying Technical Appendices. Clarifications of the advice contained in OPW Guidelines are provided in Departmental Circular PL 2/2014 issued by the DECLG in 2014. Further guidance is provided in the OPW's Flood Risk Management Climate Change Sectoral Adaptation Plan published in 2019 and CIRIA's Development and Flood Risk: Guidance for the Construction Industry (C624) published in October 2004.

Planning guidelines applicable to the area of interest is implemented in the DLR County Development Plan 2022-2028, and specifically through the Strategic Flood Risk Assessment (SFRA) [hereafter referred to as 'the SFRA'].

The DLR SFRA was prepared in accordance with the requirements of the OPW Guidelines and adopts an identical flood zone standard to the national planning guidelines. Flood Zones are the extent of a design flood event that determines the suitability of development from a flood risk viewpoint and are defined in both the SFRA and OPW Guidelines as follows:

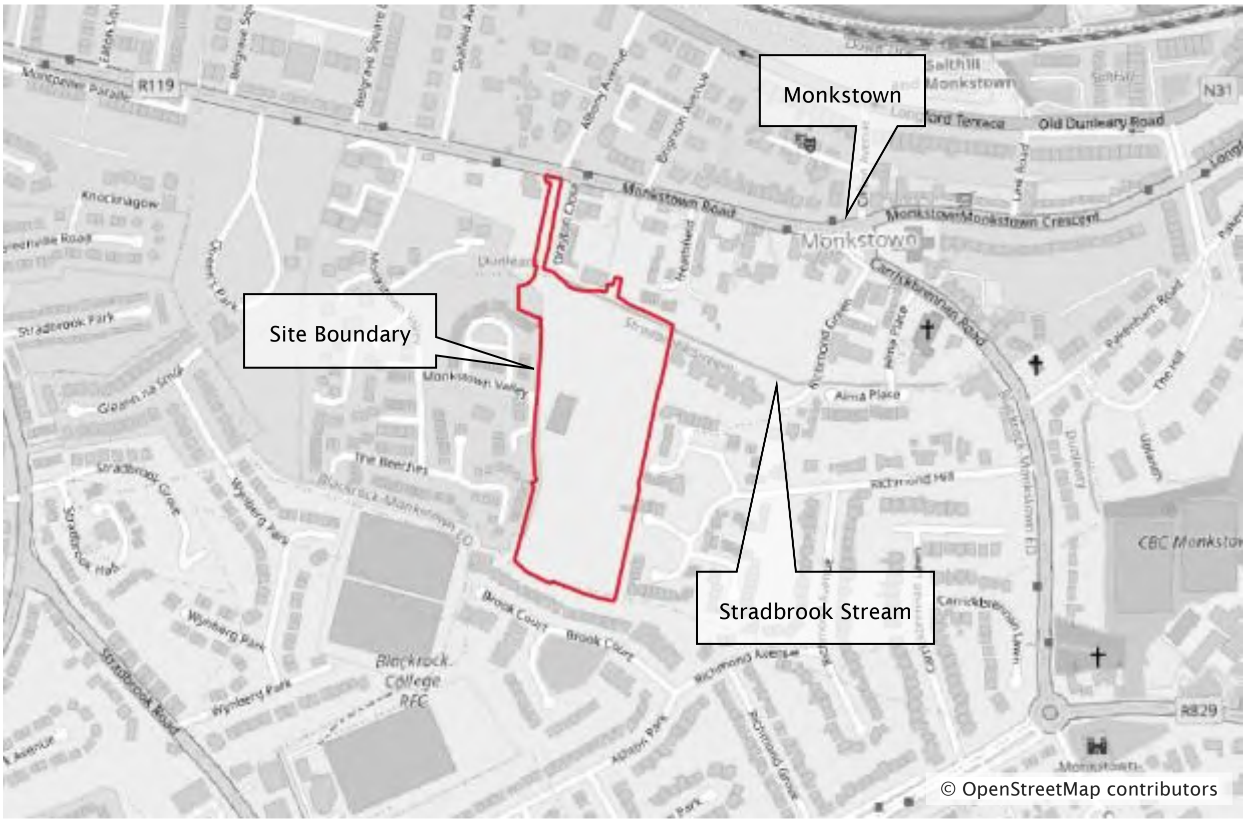
- **Flood Zone A** – where the probability of flooding from rivers and the sea is highest (greater than 1% or 1 in 100 for river flooding or 0.5% or 1 in 200 for coastal flooding).
- **Flood Zone B** – where the probability of flooding from rivers and the sea is moderate (between 0.1% or 1 in 1000 and 1% or 1 in 100 for river flooding and between 0.1% or 1 in 1000 and 0.5% or 1 in 200 for coastal flooding).
- **Flood Zone C** – where the probability of flooding from rivers and the sea is low (less than 0.1% or 1 in 1000 for both river and coastal flooding).

The OPW Guidelines clarify that Flood Zones are to be used to determine suitability of proposed development and are to be derived from 'present day' hydrological estimates ignoring any benefitting food defences. The OPW Guidelines also state that Flood Zones are generated without the inclusion of climate change and that in addition to flood zoning, development should be designed to be resilient to the effects of climate change.

2 DEVELOPMENT AND SITE DETAILS

2.1 Site Location

Figure 2.1: Site Location



2.2 Existing Site Description

The proposed development site is located at Monkstown, Dublin 18. Existing site characteristics are summarised below:

- Application site primarily comprises open green space to the rear of an existing residential property.
- Land within the site generally falls from south to north.
- Access is via the R119 Monkstown Road.

Existing site 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 site and its surroundings taken as part of a walkover survey are included in Appendix F.

2.3 Development Proposals

The Description of Development is as follows:

GEDV Monkstown Owner Limited intends to apply for a seven year permission for development on a site of c. 3.58 hectares at Dalguise House (Protected Structure RPS No. 870), Monkstown Road, Monkstown, County Dublin, A94 D7D1 (the lands include the following structures identified as Garage (A94 N3A1); Gate Lodge (aka Brick Lodge) (A94 R9T1); Dalguise Lodge (aka Entrance Lodge) (No. 71 Monkstown Rd, A94 TP46); White Lodge (A94 V6V9)); and on-street car parking in front of Nos. 6 and 7 Purbeck (A94 C586 and A94 HT99, respectively), with the provision of vehicular and pedestrian access and egress at two points on Monkstown Road: the existing entrance to Dalguise; and at Purbeck.

Alterations will be made at Purbeck including the relocation of 4 No. existing car parking spaces to facilitate the construction of a new vehicular and pedestrian bridge over the Stradbrook Stream.

The development, with a total gross floor area of approximately 47,382 sq m (including a basement of 5,396 sq m and undercroft parking of 1,403 sq m) (of which some 46,154 sq m is new build, and 1,228 sq m retained existing buildings), will consist of the construction of 493 No. residential units, consisting of 486 No. new build and 7 No. residential units (the latter within existing structures (repurposed from Dalguise House, Gate Lodge (Brick Lodge) and Coach House)).

The residential provision will comprise: 3 No. three storey 3-bed terraced houses (GFA 569 sq m), and 490 No. Build-to-Rent units (consisting of 2 No. studio units; 289 No. 1-beds; 20 No. 2-beds/3 persons; 166 No. 2-beds/4-persons; and 13 No. 3-beds) (with an option for the use of 4 No. of the BTR Units to cater for short-term stays of up to 14 days at any one time to cater inter alia for visitors and short-term visits to residents of the overall scheme) residential amenities and residential support facilities; a childcare facility; and restaurant/café.

The development will consist of: the demolition and partial demolition of existing structures (total demolition area 967 sq m, comprising: two residential properties (White Lodge (A94 V6V9), a 2 storey house (192 sq m); and a residential garage (A94 N3A1) and shed to the southwest of Dalguise House (285 sq m)); swimming pool extension to the southeast of Dalguise House (250 sq m); lean-to structures to the south of the walled garden (142 sq m); part-demolition of Lower Ground Floor at Dalguise House (9 sq m); single storey extension to the south of the Coach House (29 sq m) and three ancillary single-storey structures (8 sq m, 8 sq m, and 31 sq m) within the yard; potting shed (13 sq m); removal of 2 No. glasshouses; and alterations to, including the creation of 3 No. opes and the removal of a 12.4 m section of the walled garden wall to the east); the construction of: 11 No. residential blocks (identified as: Block A (total GFA 2,015 sq m) 7 storey, comprising 19 No. apartment units (15 No. 1-beds, 4 No. 2-beds/4-persons) and a childcare facility (540 sq m over Ground and First Floor Levels); Block B (total GFA 3,695 sq m) 7 storey over undercroft car parking, comprising 48 No. apartment units (33 No. 1-beds, 1 No. 2-beds/3 persons, 14 No. 2-beds/4-persons); Block C (total GFA 3,695 sq m) 7 storey over undercroft car parking, comprising 48 No. apartment units (33 No. 1-beds, 1 No. 2-beds/3 persons, 14 No. 2-beds/4-persons); Block D (total GFA 4,325 sq m) 7 storey over basement level car park, comprising 52 No. apartment units (25 No. 1-beds, 26 No. 2-beds/4-persons, 1 No. 3-bed); Block E (total GFA 5,946 sq m) 9 storey over basement level car park, comprising 66 No. apartment units (40 No. 1-beds, 26 No. 2-beds/4-persons), with residents' support facilities (75 sq m) and residents' amenities (gym, yoga studio, residents' lounge/co-working space; lobby 485 sq m) at Ground Floor Level, residents' amenities (bookable rooms 42 sq m) at First Floor, and residents' amenities (residents' lounge; games room; screen room; private lounge; kitchen 350 sq m) with roof terrace (106 sq m) at Eighth Floor Level; Block F (total GFA 5,469 sq m) 7 storey over basement level car park, comprising 76 No. apartment units (46 No. 1-beds, 5 No. 2-beds/3-persons, 23 No. 2-beds/4-persons, 2 No. 3-beds); Block G (total GFA 5,469 sq m) 7 storey over basement level car park, comprising 76 No. apartment units (46 No. 1-beds, 5 No. 2-beds/3-persons, 23 No. 2-beds/4-persons, 2 No. 3-beds); Block H (total GFA 4,252 sq m) 5 storey over Lower Ground Floor, comprising 54 No. apartment units (30 No. 1-beds, 1 No. 2-beds/3-persons, 21 No. 2-beds/4-persons, 2 No. 3-beds); Block I1 (total GFA 1,038 sq m) 3 storey, comprising 12 No. apartment units (3 No. 1-beds, 3 No. 2-beds/3-persons, 6 No. 2-beds/4-persons); Block I2 (total GFA 1,038 sq m) 3 storey, comprising 12 No. apartment units (3 No. 1-beds, 3 No. 2-beds/3-persons, 6 No. 2-beds/4-persons); and Block J (total GFA 1,844 sq m) 4 storey, comprising 20 No. apartment units (13 No. 1-beds; 1 No. 2-bed/4-persons, 6 No. 3-beds));the refurbishment, adaptation and reuse of: two storey Dalguise Lodge (Entrance Lodge) (GFA 55 sq m) comprising residential support facilities; a single storey Gate Lodge (GFA 55 sq m) comprising 1 No. 1-bed unit; and two storey Coach House and single storey Stableman's House (GFA 319 sq m) to provide 3 No. apartment units (1 No. 1-bed, 2 No. 2-bed/4 persons); the refurbishment, adaptation and change of use of Dalguise House (GFA 799 sq m) from a single residential dwelling to provide: 3 No. apartment units (2 No. studios and 1 No. 2-bed/3 person) at First Floor Level; a restaurant/cafe at Lower Ground Floor Level (GFA 273 sq m); and residents' amenities at Ground Floor Level (library, residents' lounge, events space, bar/bookable room, 157 sq m); works to the existing structures include: removal of existing internal partitions and doors, alterations to internal layout including provision of new partitions and doors to Dalguise Lodge (Entrance Lodge); the removal of existing internal partitions and doors, and alterations to internal layout including provision of new partitions and doors to Gate Lodge (Brick Lodge); replacement of existing roof, windows and doors, non-original mezzanine floor and stairs of Coach House, creation of new internal and external opes, reconstruction of chimney, construction of new stairs, provision of new internal partitions and doors, replacement of the demolished single storey structure to south of Coach House with a 42 sq m single storey extension, including construction of a link between Coach House and Stableman's House; replacement of existing roofs, windows, *doors, creation of new external opes and provision of new internal partitions and doors to Stableman's House; restoration of Coach House yard walls; removal of security bars from windows, internal partitions, doors, two secondary staircases, non-original fireplaces; and the reconfiguration of internal layout including introduction of new partitions, doors and fireplaces, in-fill of former secondary staircases; removal of an existing window at rear facade of Lower Ground Level, alterations to ope and replacement with a new external door; reinstatement of external wall fabric in place of demolished lean-to at the rear facade; and removal of external door to swimming pool on eastern facade and closure of ope; and creation of new external ope at Lower Ground Floor rear façade, provision of external plant (connected to the new ope by ducting), waste storage area, water tank at surface level adjoining the western façade, enclosed within a screen at Dalguise House).*

The development will also consist of: the construction of a garden pavilion; the provision of balconies and terraces, communal open space including roof gardens, public open spaces, hard and soft landscaping, landscaping works including the removal of trees, alterations to boundaries; the provision of: 228 No. car parking spaces (148 No. at basement level; 19 No. at undercroft; and 61 No. at surface level); motorbike spaces; level changes; ESB Substations (at Block D and Block H); plant areas; waste storage areas; provision of cycle parking (including cargo bike spaces) at basement and surface level; signage/wayfinding; and all ancillary site development works above and below ground.

Provision is made in the landscaping proposals for potential future pedestrian and cycle connections that would facilitate permeability through the site boundaries with the residential estates of Arundel and Richmond Park, respectively, and the former Cheshire Home site, subject to agreement with those parties and/or Dún Laoghaire-Rathdown County Council, as appropriate.

Proposal drawings can be found within the overall application documents.

2.4 Vulnerability Classification

The vulnerability of the proposed development, as per the OPW Guidelines, is summarised in Table 2.1

Table 2.1: Vulnerability Classification

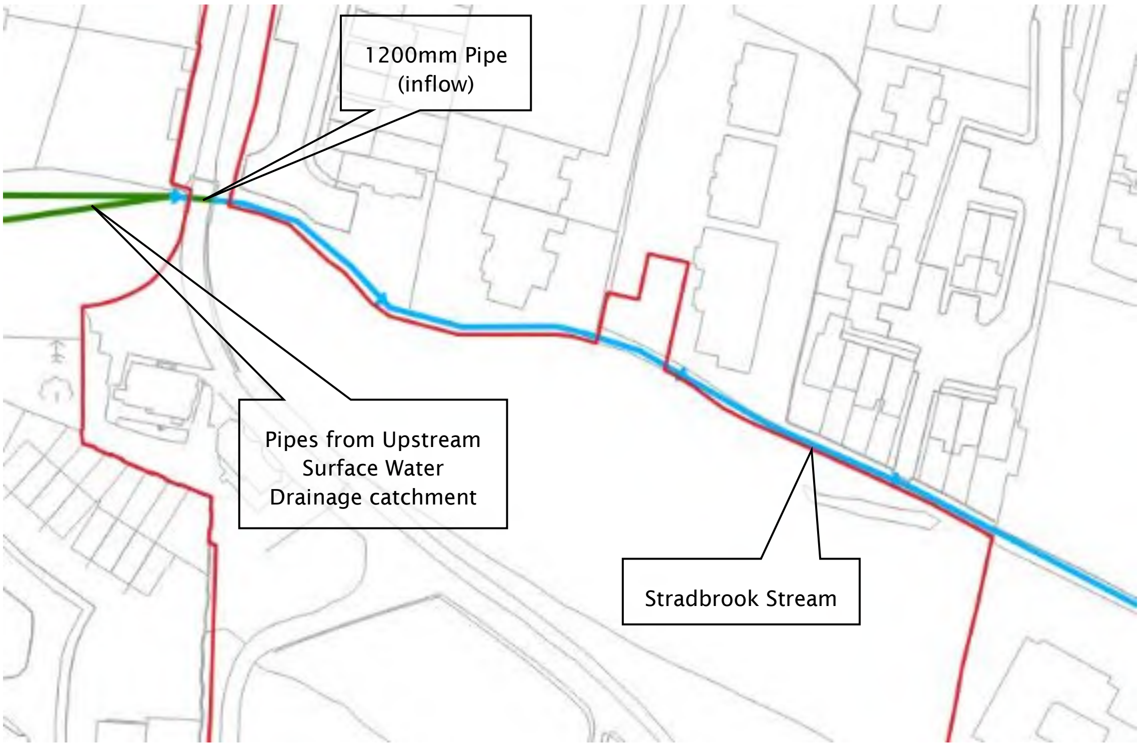
Part	Use	Classification
Built Development	Residential	Highly Vulnerable
Car Parking / Access Road	Local Transport Infrastructure	Less Vulnerable
Green Areas / Open Amenity Space	Open Amenity Space	Water-Compatible Development

2.5 Affecting Waterbodies

As shown on Figure 2.2, an open channel watercourse known as the Stradbrook Stream runs to the south of the proposed development area. The Stradbrook Stream flows from west to east and is approximately 2.5 m wide at the site.

The Stradbrook Stream is fed by a surface water drainage pipe at the western extent of the site. The upstream catchment (outside the site boundary) is substantially urbanised to the extent that the artificial surface water drainage network has replaced the natural hydrological catchment, and inflows consist of runoff from the upstream surface water drainage network. The open channel at the site is the first open section of the watercourse.

Figure 2.2: Affecting Watercourses



3 BACKGROUND INFORMATION REVIEW

As part of the data collection phase of this assessment, several available sources of information, generally as set out in the OPW Guidelines, were investigated to build an understanding of the potential risk of flooding to the site. The following review highlights the key findings of this background information.

3.1 Office of Public Works Data

3.1.1 Preliminary Flood Risk Assessment

The Office of Public Works (OPW) have developed draft 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 only a preliminary assessment based on available or readily-derivable information. The analysis was undertaken to identify areas prone to flooding but the analysis is indicative and mapping is considered to be coarse and is designed to inform further stages in the CFRAM process.

OPW PFRA mapping shows that areas to the north east of the site are predicted by surface water flooding. No fluvial flooding is shown in the vicinity of the site and is not considered to be at risk from groundwater flooding. It is noted that the PFRA is understood to be considered 'superseded' by the OPW but is included in this assessment in the absence of any other OPW flood data.

An extract from the PFRA flood map is shown in Figure 3.1. Copies of the original OPW map are included in Appendix B.

Figure 3.1: OPW PFRA Indicative Extents and Outcomes

3.1.2 Past Flood Events

OPW Past Flood Events mapping (also available through floodinfo.ie) has records of flooding in Monkstown to the east of the site. The closest recorded event to the site caused flooding of the Carrickbrennan Road area in October 2011. This event is considered unlikely to have flooded the site as the areas affected are at an elevation more than 2.5 m lower than existing ground levels at the site.

No reports of flooding at or upstream of the site were found.

3.2 Dún Laoghaire-Rathdown County Council

3.2.1 Development Plan

DLR County Development Plan 2022 – 2028 has been assessed as part of this assessment with the following objectives being the most relevant to this flood risk assessment:

- Policy Objective EI6: It is a Policy Objective to ensure that all development proposals incorporate Sustainable Drainage Systems (SuDS).
- Policy Objective EI22: It is a Policy Objective to support, in cooperation with the OPW, the implementation of the EU Flood Risk Directive (20010/60/EC) on the assessment and management of flood risks, the Flood Risk Regulations (SI No 122 of 2010) and the Department of the Environment, Heritage and Local Government and the Office of Public Works Guidelines on 'The Planning System and Flood Risk Management' (2009) and relevant outputs of the Eastern District Catchment and Flood Risk Assessment and Management Study (ECFRAMS Study).

3.2.2 Correspondence

In consultation undertaken as part of a previous application, DLR CC has stated that a SSFRA is to be undertaken for any development and must include hydraulic modelling of the Stradbrook Stream upstream and downstream of the site. Further correspondence with DLR CC staff in relation to the site is summarised as follows:

- Finished Floor Levels (FFLs) should be set at either the 0.1% AEP flood level plus 300 mm freeboard or the 1% AEP flood level including climate change plus 300 mm freeboard.
- The 'Drainage Planning' department consider that for the site, a hydraulic analysis of the surface water drainage network [upstream of the site] is the most appropriate approach in determining the flow input values for the SSFRA.
- The need for any proposed adjustments to levels or re-profiling of the stream or the construction of berms / walls has to be justified and can only be undertaken if it can be clearly demonstrated that the changes will not increase flood risk elsewhere, either upstream or downstream of the proposed development. Any such proposals will have to be supported by modelling outputs
- Where level for level compensatory storage cannot be provided, consideration may be given to alternative proposals. However, any such alternative proposal will have to be supported by hydraulic analysis over a range of AEP events that demonstrates the equivalent (or better) functionality of the proposed flood storage area to that of the existing flood storage area. It has to be clearly demonstrated that the changes will not increase flood risk elsewhere, either upstream or downstream, of the proposed development.
- The policy (and principle) that highly vulnerable development is not allowed within existing Flood Zones A & B will apply. If accommodation works, be it the form of cut or fill or a combination of both, are required to ensure that the footprint and access routes to the proposed highly vulnerable elements of the development are to remain outside of the existing flood Zones A & B extents, then the modelling exercises undertaken in the SSFRA will have to demonstrate that such accommodation works and the development as a whole will satisfy the requirements of Box 5.1 of the Justification Test for development management.

ByrneLooby and the drainage engineers for DLRCC consulted on March 1st 2022, for the site SuDS and drainage proposal, to ensure any requirements that had changed from the 2019 application were highlighted and captured in the new proposal.

3.2.3 Flood Maps

As part of the County Development Plan 2022-2028, Flood Zone Maps (dated March 2022) were published and consulted as part of this assessment. An extract from the maps, relative to the site, is included in Figure 3.2.

The DLR CC Flood Zone Maps do not show any flooding (Flood Zone A / Flood Zone B) affecting the site or surrounding areas. However, the northern extent of the site is shown to be an 'Area of Flood Risk Concern' for 'Fluvial – Surface Water; which is likely to coincide with the Stradbrook Stream.

Figure 3.2: DLR CC Flood Zone Map

3.3 Internet / Media / Background Search

Media reports of flooding in Monkstown in March 2018 were found. Flooding was caused by a tidal surge during storm weather conditions. It is noted that the site is located approx. 400 m from the sea and more than 14 m higher in elevation.

The media search found no further records of flooding in close proximity to the site.

3.4 Walkover Survey

A walkover survey of the site and adjacent lands was conducted by McCloy Consulting Ltd. on 2nd November 2018 and 11th December 2022 during which a photographic survey of the site and adjacent areas was undertaken; photos are included in Appendix F. Topographical survey of the site was undertaken by a third party and assessed as part of this SSFRA.

The site was noted to fall at a steep gradient towards the watercourse. The Stradbrook Stream was observed to be 2-3 m wide and flow in a shallow, clear channel that has been subject to bank improvement / reinforcement works as part of recent development to the north.

4 ASSESSMENT OF FLOOD MECHANISMS

4.1 Preamble

Development control procedures advise against inappropriate development in areas at risk of flooding and aim to avoid new development that increases flood risk elsewhere, in accordance with the OPW Guidelines.

The following assessment determines the flood hazards to life and property at the site to subsequently assess the site and proposed development based on the Flood Risk Framework outlined in the OPW Guidelines. Mitigation, where required, of flood hazards is detailed in Section 5.2.

4.2 Initial Assessment

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

Table 4.1: Possible Flooding Mechanisms

Source/Pathway		Significant?	Reason
Fluvial Flooding	Floodplain	Yes	DLR CC has stated that the site may be at risk of flooding from the Stradbrook Stream and that hydraulic modelling of the watercourse is to be carried out to inform the SSFRA.
	Culvert Blockage	Possible	The proposed development constitutes a watercourse crossing. The Stradbrook Stream is culverted downstream of the site and development proposals include a new watercourse crossing.
Coastal Flooding		No	OPW / DLR CC flood mapping indicated no coastal flooding at or in the vicinity of the site. The site is situated at an elevation greater than 14 m the sea to the north.
Urban Drainage		No	No urban drainage flooding / sewer incapacity was identified in an initial evidence search.
Surface Water Flooding		Possible	OPW flood mapping indicates that the site is not anticipated to be affected by surface water flooding. The site does lie at a lower elevation than adjacent hardstanding areas.
Surface Water Discharge		Possible	Any development has the potential to increase the impermeable area at a site and thereby cause an increase in the rate and volume of surface water runoff from the site.
Groundwater		No	OPW flood mapping indicates that the site is not anticipated to be affected by groundwater flooding. Due to the site topography there are no areas which would cause impoundment of groundwater.
Reservoirs / Canals / Artificial Sources		No	A screening assessment based on OSI mapping indicates there to be no impoundments or reservoirs in close proximity or which drain toward the site.

Those flood mechanisms screened as being potentially significant have been assessed in further detail and are discussed in the following sections.

4.3 Existing (Pre-Development) Fluvial Flooding

4.3.1 Preamble

As outlined above, there is a potential risk of flooding from the Stradbrook Stream at the site. In the absence of CFRAM (or similar) model results or availability of other hydraulic model, a detailed site-specific river model based on a linked 1D-2D approach built in Innovyze InfoWorks ICM with hydrology estimates based on best available techniques has been prepared to inform this assessment.

4.3.2 Flood Zoning / Existing Flood Risk (Present Day)

An assessment of the hydrological characteristics of the watercourse, including review of local topography, surface water drainage records and a site visit, indicated that the Stradbrook Stream at the site is fed by a 1200 mm pipe (as shown in Figure 2.2) which constitutes the outfall from the upstream surface water drainage network. Natural hydrology in the upstream network is modified such that the former watercourse effectively no longer exists and its function has been replaced by the artificial surface water drainage network.

This was confirmed by DLR CC who stated that "*The 'Drainage Planning' department consider that for the site, a hydraulic analysis of the surface water drainage network [upstream of the site] is the most appropriate approach in determining the flow input values for the SSFRA*"; i.e. the flow from the 1200 mm pipe is the primary, and only, source of flow at the upstream extent of the watercourse.

In addition to the 'pipe full' flow, lateral inflows were considered to account for any overland flows downstream of the 1200 mm pipe along the extent of the watercourse that have the potential to affect the site. Lateral inflows are based on the topographical catchment at a number of locations along the watercourse and are calculated at the range of return periods and scenarios modelled.

Therefore, a two-stage approach for hydrology calculation was adopted. Upstream flows from surface water drainage catchment through the 1200 mm pipe were assumed as 'pipe full' for all return periods and scenarios (i.e. 1% AEP / 0.1% AEP present day and climate change) and added to the return period / scenario specific lateral inflow to provide the total design flow.

The river model methodology used is consistent with and exceeds detailed CFRAM model standards; further specific details relating to the hydraulic and hydrological assessment are included in Appendix C.

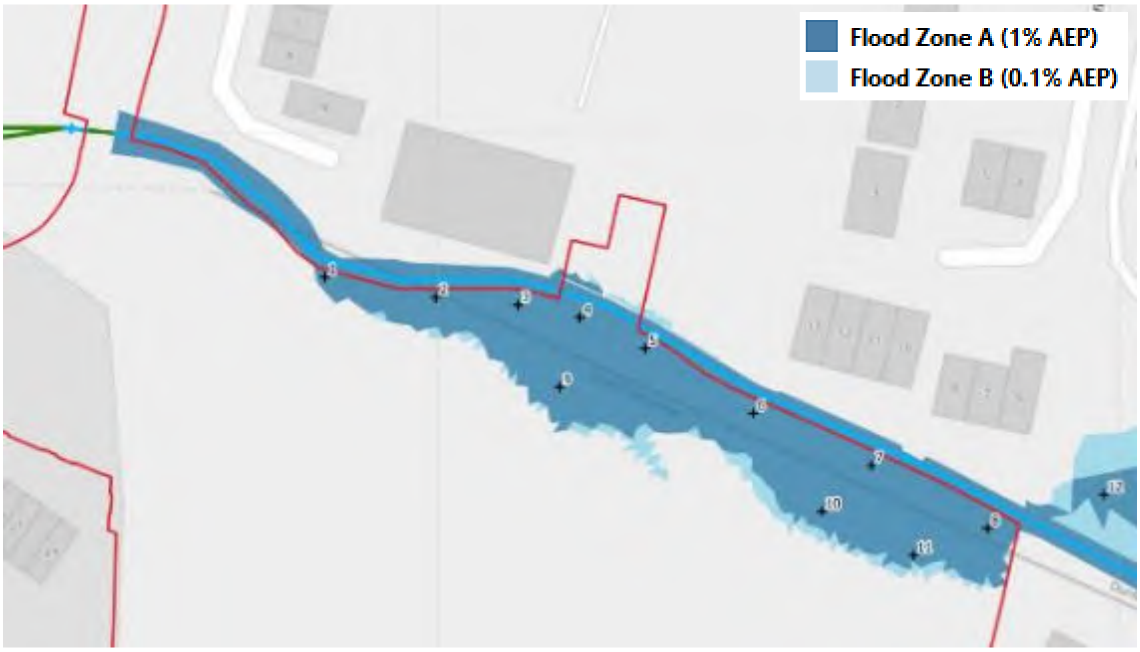
Table 4.2 indicates the flood levels determined at the site following site specific linked 1D-2D hydraulic modelling of the Stradbrook Stream which includes the open channel as well as overland flow routes. The 1% AEP and 0.1% AEP events cause out-of-bank flooding along the southern bank of the watercourse. It is noted that due to the steep nature of the site on the southern side and wall along the bank on the northern side, the increased 0.1% AEP level does not cause a significant increase in flood extent from Flood Zone A to Flood Zone B.

Table 4.2: Modelled Flood Levels – Existing Scenario Present Day

Location	1% AEP Water Level (m OD)	0.1% AEP Water Level (m OD)
Upstream extent of Site (location point 1)	15.84	15.85
Middle of Site at (location point 3)	15.57	15.61
Downstream extent of Site (location point 8)	15.38	15.46

An extract from existing scenario, present day flood mapping is shown in Figure 4.1. The Flood Zone Map is provided in Appendix E. As stated previously, the hydraulic modelling undertaken as part of this SSFRA is designed to assess flood risk at the site and impact of development directly upstream and downstream and as such, is not suitable for informing / assessment of flood risk outwith the direct site environs. Therefore, flood mapping provided as part of this FRA covers areas relevant to the subject application only.

Figure 4.1: Flood Zone Map



Mitigation of flood risk to any future development by siting development outside of the 1% AEP / 0.1% AEP fluvial extent where possible and ensuring proposed finished levels are to have a sufficient freeboard adjacent flood levels are described in Section 5.2.

4.4 Proposed (Post-Development) Fluvial Flooding

4.4.1 Preamble

The following report sections assess flood risk to the development as proposed and determine the effect of the development proposal on flood risk elsewhere.

4.4.2 Proposed Flood Risk – Present Day (Effect of the Development)

Figure 4.2 presents the proposed layout overlain with the 'existing scenario' Flood Zones (i.e. not the floodplain extents with the impact of the proposals included). While designed to minimise impact of the existing floodplain, the watercourse crossing and associated site access is inevitably sited over and within Flood Zone A and Flood Zone B. However, all proposed residential development is located in Flood Zone C.

The impact of the proposed development on 1% AEP and 0.1% AEP flooding at and outside the site is discussed in detail in subsequent sections of this report. It is noted that raising of levels / restricting the floodplain either side of the bridge is essential to achieve design level and freeboard requirements and that the proposed top / deck level of the bridge will be sited above the 1% AEP and 0.1% AEP flood levels.

To facilitate an analysis of the proposed development, a proposed scenario model has been created that incorporates the proposals by modifying the model geometry to represent ground levels and structure(s) as shown in Figure 4.3.

Full versions of the site-specific flood maps are presented in Appendix E as well as flood maps showing comparisons of the pre- and post-development design flood events.

Figure 4.2: Proposed Development overlain with Flood Zones

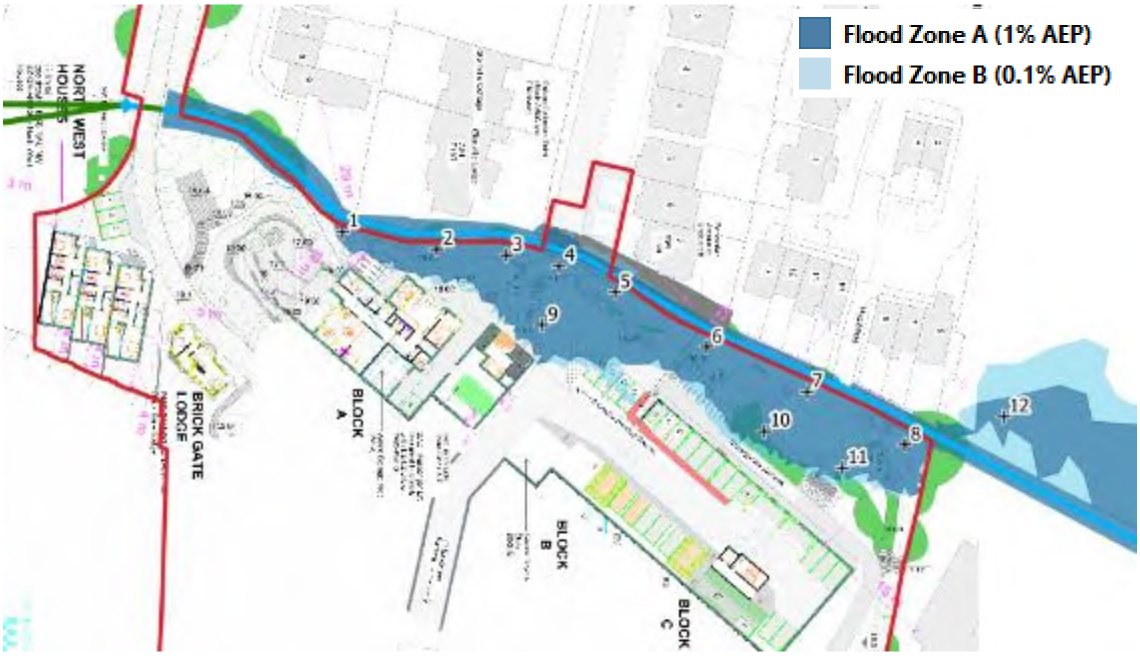


Figure 4.3: Proposed Scenario (Present Day) Flood Map

4.4.2.1 Flood Zone A / 1% AEP Flood Event

As stated previously, the proposed development is partly sited within the existing scenario Flood Zone A / 1% AEP floodplain, necessarily due to the requirement to achieve site access via the new bridge and associated approach embankments. The proposals would therefore result in displacement of flooding within the site.

As a result, development proposals for the site have the potential to influence flood risk elsewhere (through displacement or rerouting of floodwater) and so further consideration of the impact of the development on existing floodplains is required.

Table 4.3 summarises post-development flood levels at various locations relative to the site, highlighting the effect of the proposal.

Table 4.3: Modelled Flood Levels – 1% AEP Proposed Scenario Present Day comparison

Location / Description	Pre-Development 1% AEP Level (m OD)	Post-Development 1% AEP Level (m OD)	Effect of the Development (m)
Upstream extent of Site (location point 1)	15.84	15.84	-
Middle of Site (location point 3)	15.57	15.71	+ 0.14
Downstream extent of Site (location point 8)	15.38	15.38	-
Downstream of Site (location point 12)	14.95	14.95	-

Analysis of the model results confirms:

- The proposals cause no off-site effect; showing no increase upstream, adjacent or downstream of the site.
- The proposals cause an increased flood level upstream of the proposed bridge that causes no off-site effect. The effect is contained within the application boundary due to the steep-sided northern watercourse bank, which causes there to be no area increase in flood extents to third parties, and no new or increased out of bank flooding to lands to the north.
- Floodplain extents are reduced at the site and flood levels are raised by a maximum of 0.14 m, wholly within the site, upstream and immediately proximal to the proposed bridge as a result of the proposed development.
- The reduction in floodplain extents leads to a corresponding reduction in floodplain volume. However, this is fully contained within the site as demonstrated by the pre- and post-development flood levels upstream / downstream.

Hydraulic modelling for the 1% AEP proposed scenario pertinent to planning policy tests therefore confirms that the proposal causes no measurable effect on flood risk elsewhere.

In relation to mitigation of the effect of the development:

- Increased flood levels within the site can be mitigated through setting design levels for the proposed scenario (refer to Section 5.2.2).
- The increase is contained within lands under control of the applicant and affects no third party by causing new or increased out of bank flooding. While OPW Guidelines would normally require that, in principle, mitigation (nominally compensatory storage) should be provided for floodplain lost in Flood Zone A (1% AEP event), in this instance where the detailed assessment has demonstrated that the adverse effect is contained within the application site, then it is reasonable that the need for mitigation of the effect of the development can be set aside as not required.

4.4.2.2 Flood Zone B / 0.1% AEP Flood Event

While not explicitly required by the OPW Guidelines, the effect of the development on lands elsewhere during a flood exceeding the required compensatory storage design standard has been considered by simulating an iteration of the proposed scenario hydraulic model with the 0.1% AEP flow. Table 4.4 summarises post-development flood levels at various locations relative to the site, highlighting the effect of the proposal.

Flood levels within the site boundary are raised by a maximum of 0.15 m. Similarly to the 1% AEP results, the proposed 0.1% AEP scenario indicates that there is no increased flood risk off-site. Flood levels are increased within the site at and immediately upstream of the proposed bridge location but are not raised to a level that poses a risk to lands to the north, with flooding contained in-channel by the steep-sided northern watercourse bank.

Proposed scenario flood extents mapping is provided in Appendix E.

Table 4.4: Modelled Flood Levels – 0.1% AEP Proposed Scenario Present Day comparison

Location / Description	Pre-Development 0.1% AEP Level (m OD)	Post-Development 0.1% AEP Level (m OD)	Effect of the Development (m)
Upstream extent of Site (location point 1)	15.85	15.86	+ 0.01
Middle of Site (location point 3)	15.61	15.76	+ 0.15
Downstream extent of Site (location point 8)	15.46	15.46	-
Downstream of Site (location point 12)	15.14	15.14	-

4.4.2.3 Summary (Effect of the Development)

Notwithstanding the findings of the preceding sections, in order to address a request raised by DLR CC in consultation, the effect of the development on flood levels adjacent to the site for 1% AEP and 0.1% AEP horizons is summarised in Table 4.5 and confirm no off-site impact of the proposed development.

Table 4.5: Effect of the Development summary – 1% AEP & 0.1% AEP Present Day

Location / Description	1% AEP Flood Level (m OD)		0.1% AEP Flood Level (m OD)	
	Pre-Development	Post-Development	Pre-Development	Post-Development
Upstream extent of Site (location point 1)	15.84	15.84 *(0)*	15.85	15.86 *(+0.01)*
Middle of Site (location point 3)	15.57	15.71 *(+0.14)*	15.61	15.76 *(+0.15)*
Downstream extent of Site (location point 8)	15.38	15.38 *(0)*	15.46	15.46 *(0)*
Downstream of Site (location point 12)	14.95	14.95 *(0)*	15.14	15.14 *(0)*

4.4.3 Effect of Climate Change

The OPW Guidelines and the SFRA require SSFRAs to consider increased flood risk to the proposed development due to climate change. OPW guidance suggests using a Mid-Range Future Scenario (MRFS), which represents a 20% increase in flood flows and / or 0.5 m increase in mean sea level.

An estimation of the effect of climate change on the proposed development has been derived through modelling an increase of current design flows by 20%. As discussed previously, the design flow for each scenario consists of the 'pipe full' flow from the 1200 mm pipe, and as such there is no uplift applied to this point inflow.

Table 4.6 displays the anticipated climate change flood levels at the site, representing a maximum increase of up to 0.03 m compared to the present day proposed scenario. The climate change flood level causes a very slight increase in flood levels and extent across the site as shown in Figure 4.4. Full versions of the site-specific flood maps are presented in Appendix E.

Mitigation of the predicted effect of climate change (through selection of an appropriate freeboard) is discussed in Section 5.2.

Table 4.6: Modelled Flood Levels – Climate Change Scenario

Location	1% AEP + CC Water Level (m OD)	0.1% AEP + CC Water Level (m OD)
Upstream extent of Site (location point 1)	15.85	15.87
Middle of Site (location point 3)	15.72	15.79
Downstream extent of Site (location point 8)	15.40	15.48

Figure 4.4: Proposed Scenario (Climate Change) Flood Map

4.4.4 Effect of Culvert Blockage

OPW Guidelines states that FRAs should consider increased flood risk to the development arising from potential culvert blockage.

The upstream culvert / pipe has not been further assessed as blockage at that location would cause overland flooding upstream of the site that would tend toward the open channel when entering the site.

Blockage of the proposed clear span bridge has not been further assessed due to it being of considerably larger dimensions than existing culverts affecting the river reach, and as such is of significantly lower likelihood of blockage. The proposed bridge shall also lie within the riparian ownership of the applicant and as such can be actively managed; refer to maintenance requirements stated in Section 5.3.

The Stradbrook Stream navigates through two culvert / bridge openings downstream of the site that were represented within the hydraulic model for the baseline and subsequent scenarios. The model was deliberately designed to extend sufficiently downstream to permit assessment of those culverts and their potential backwater effect onto the site, and to ensure a robust model boundary condition.

Additional hydraulic modelling of blockage has therefore been undertaken on existing culverts / bridges downstream of the site, i.e. those with the potential to increase flood risk if blocked, to test the effect of reduced capacity at those openings. Watercourse crossings downstream would have the potential effect of causing a backing up effect that may affect water levels on the site. Locations of culvert subject to blockage testing are shown in Figure 4.5.

Figure 4.5: Downstream Watercourse Crossing Locations

4.4.4.1 Richmond Green Bridge

The bridge is a masonry box culvert; the arrangement is shown in Figure 4.6. Background information gathering has established a history of previous overtopping, however it was not apparent whether this was as a result of blockage or otherwise.

Likelihood of blockage is generally dictated by a combination of capacity relative to frequent floods; upstream land use; presence and nature of any screening; prevalence of fly tipping; and frequency or maintenance, and visibility. Blockage likelihood of the bridge has been conservatively assessed as "high" given the prevalence of debris observed at the openings during the river survey, issues with blockage at that location have been provided anecdotally, and the noted surcharge of the structure for baseline "free flowing" model simulations.

An initial horizon of 50% blockage has been adopted as an industry norm consistent with typical Local Authority requirements for such assessments; given the high likelihood of blockage an additional scenario of 90% blockage has also been simulated to ensure that the analysis is precautionary.

Figure 4.6: Richmond Green Culvert – Upstream Face

The downstream bridge parapet was noted on site to have been modified with a grille as shown in Figure 4.7 to permit surface water on Richmond Green to flow into the river channel.

Figure 4.7: Richmond Green Culvert – Grille

Modelling excluded the effect of this grille and as such is conservative and precautionary in its assessment of water levels at the site, as the grille may feasibly have the effect of lowering overtopping water levels that would otherwise be impounded by the bridge parapet. Model results are presented in Table 4.7.

Flood routing at in the event of blockage scenarios at the bridge are characterised by floodwater backing up on the upstream face, spilling onto Richmond Green, and flowing north away from the watercourse. The overtopping level onto Richmond Green is therefore the critical factor dictating hydraulic performance in the event of blockage.

Table 4.7: Modelled Flood Levels – Richmond Green Bridge Culvert Blockage Scenario

Location / Description	Post-Development 1% AEP Level (m OD)	Richmond Green Bridge 50% blockage Level (mOD) / *Effect (m)*		Richmond Green Bridge 90% blockage Level (mOD) / *Effect (m)*	
Upstream extent of Site (location point 1)	15.84	15.84	-	15.84	-
Middle of Site (location point 3)	15.71	15.72	*0.01*	15.72	*0.01*
Downstream extent of Site (location point 8)	15.38	15.39	*0.01*	15.42	*0.04*

Model results confirm that the effect of blockage, including in the extreme 90%-blockage scenario, would cause no significant effect on predicted flood levels at the site, and can satisfactorily be mitigated through selection of an appropriate freeboard, discussed further in Section 5.2. Flood mapping showing culvert blockage scenario flood extents are presented in Appendix E and as shown, there is a negligible difference in extent between the Richmond Green blockage and proposed scenario present day flood event.

It is noted that the bridge lies outside the land under control of the applicant, and it is not therefore feasible to improve maintenance to reduce likelihood of blockage as part of the present application.

4.4.4.2 Alma Place Bridge

The bridge is a pre-cast box culvert with decorative parapets / cladding. Anecdotal evidence obtained from adjacent residents indicated that the culvert had been replaced with an increased opening size following previous flooding at the site; a timescale was not indicated for this previous work. The present arrangement is shown in Figure 4.8.

Figure 4.8: Alma Place Culvert

Likelihood of blockage is generally dictated by a combination of capacity relative to frequent floods; upstream land use; presence and nature of any screening; prevalence of fly tipping; and frequency or maintenance, and visibility. Blockage likelihood of the bridge has been assessed as "low" given the clear, free flowing channel and culvert observed on site, lack of any noted blockage issues, and the predicted free flowing (no surcharge) conditions for the baseline model simulation.

A horizon of 50% blockage has been adopted as an industry norm consistent with typical Local Authority requirements for such assessments, with that blockage implemented as a depth of siltation reducing the effective height of the culvert. It is noted that a higher blockage percentage is not required due to the relatively low risk of blockage and risk to the site.

Table 4.8 displays the anticipated culvert blockage flood levels at the site. The analysis confirms that the modelled blockage would have no effect on predicted water levels at the site. There is no significant additional backwater effect, primarily because the lower stages within the culvert are ineffective for flow conveyance as they are depressed relative to downstream in-channel levels; and so blockage of that ineffective area has a limited effect on upstream water levels. The residual backwater effect from such a blockage is contained at an elevation lower than predicted water levels at the site; and as such, the significance of blockage at Alma Place can be discounted from further consideration. Flood mapping showing culvert blockage scenario flood extents are presented in Appendix E and as shown, there is a no difference in extent between the Alma Green blockage and proposed scenario present day flood event.

Further interrogation of model results indicates that the effect of blockage at Alma Way would be contained within the river channel, with no out of bank flooding predicted.

Table 4.8: Modelled Flood Levels – Alma Place Bridge Culvert Blockage Scenario

Location / Description	Post-Development 1% AEP Level (m OD)	Alma Place Bridge 50% blockage Level (mOD) / *Effect (m)*	
Upstream extent of Site (location point 1)	15.84	15.84	-
Middle of Site (location point 3)	15.71	15.71	-
Downstream extent of Site (location point 8)	15.38	15.38	-

4.5 Surface Water

4.5.1 Pluvial Runoff onto Site

The proposed is situated at a higher level than lands to the north and east. Surface water runoff from these areas will not affect the site.

Lands to the west of the site lie at a higher elevation and are widely developed. These areas are drained by a surface water drainage network that discharges to the Stradbrook Stream through the 1200 mm diameter pipe at the upstream extent of the site.

As part of this assessment, a review of GDSDS modelling for the site and surrounding area has been undertaken. Appendix N 'Peak River Flood Flows and Levels' to 'Phase 2 (Storm) of Dun Laoghaire West Pier West Drainage Area – S2014' of the GDSDS gives a flow of 1.9 m^3/s for the Monkstown Stream (watercourse also referred to as the Stradbrook Stream) downstream of the site. This flow is similar to, but lower than, the design flow for the Stradbrook Stream estimated as part of this assessment. Therefore, it is considered that the effect of upstream surface water drainage has been comprehensively assessed as part of the hydraulic modelling for the site.

Furthermore, DLR CC have stated in consultation that due to nature of catchment of the Stradbrook Stream, watercourse hydrology will be based on a hydraulic analysis of the upstream surface water network as it is the primary source of flow at the site. Therefore, hydraulic modelling / assessment of fluvial flooding will include analysis of pluvial flooding.

Lands to the south of the site are situated at a higher elevation but comprise generally open space / low density development so rate and volume of runoff towards is likely to be relatively low. In addition, the design flows for the hydraulic modelling include lateral inflows that account for runoff from adjacent lands, including lands to the south, so the potential effect of runoff from this area is fully considered.

Exceedance of existing or proposed surface water drainage in the vicinity of the site at a higher elevation would tend to flow toward the open channel when entering the site.

Therefore, the site is not considered to be at significant risk of flooding from pluvial runoff onto the site. Mitigation of residual impact of surface water to the development, by means of an effective surface water drainage network and surface water management, is detailed in Section 5.2.

4.5.2 Pluvial Flooding from the Site

All runoff from the site would tend to drain towards the adjacent Stradbrook Stream. There is no potential for runoff from the site to flow towards neighbouring lands / properties in the vicinity.

Development of new residential units and associated infrastructure will increase the impermeable area of the site and as such, could result in an increase in the rate and volume of runoff from the site when compared to the existing scenario.

Mitigation of residual impact of surface water to the development, by means of an effective surface water drainage network and surface water management, is discussed in Section 5.2.

5 SUMMARY OF FINDINGS AND RECOMMENDATIONS

5.1 Summary of Findings

It has been demonstrated through site-specific hydraulic modelling that proposed development will be resilient to flooding; lying outside the present day and climate change 1% AEP and 0.1% AEP fluvial floodplain of the Stradbrook Stream. Furthermore, hydraulic modelling has shown that the proposals will not increase flood risk elsewhere.

No other significant flood mechanism exists at the site.

5.2 Design Requirements

The following section details measures incorporated within the proposal submitted in support of the planning application, and to be further developed in any detailed design post-determination of the planning application.

5.2.1 Land Use

The site has been shown to be partly affected by flooding. Therefore, the 'sequential approach' has been applied to the existing flood scenario at the site as follows:

- Highly vulnerable development (residential) has been wholly located in Flood Zone C / outside the 0.1% AEP floodplain.
- Less vulnerable development (access roads, car parking) has been located in Flood Zone C / outside the 0.1% AEP floodplain with the exception of the watercourse crossing and associated access roads in the vicinity which are necessary to provide site access. Finished levels in those areas are subsequently raised relative to adjacent flood levels and have a post-development probability of flooding equivalent to Flood Zone C. It is noted that proposed levels of the watercourse crossing and connecting roads will ensure they lie outside / above the 0.1% AEP flood level.
- Open green space (non-amenity) areas are sited within Flood Zone A but are considered appropriate as such under the OPW Guidelines.

Following the OPW Guidelines, due to parts of the access roads and car parking being proposed within 'inappropriate' Flood Zones, the development would be required to meet the requirements of a Justification Test provided in Appendix H.

The Justification Test outlines the planning / zoning status of the site, how the development has applied the 'sequential approach' as well as how the site incorporates the required flood risk mitigation (described subsequently in this report) and does not pose a risk of flooding to lands elsewhere as discussed in Section 4.4.2

5.2.2 Design Levels

The OPW Guidelines and SFRA require freeboard to be applied to relevant design flood levels when setting finished floor levels (FFLs) and finished ground levels (FGLs). The DLR County Development Plan 2022-2028 SFRA and DLR CC correspondence outlined in Section 3.2.2 states that 300 mm freeboard is to be applied to either the 1% AEP + CC or 0.1% AEP flood level.

The 1% AEP + CC flood level at the upstream extent of the site is 15.84 mOD and the 0.1% AEP flood level is 15.85 mOD. Applying a conservative, precautionary approach, the 0.1% AEP is taken as the design flood level for the site resulting in a min. design FFL / FGL of **16.15 mOD**. It is noted that development proposals comply with these requirements.

5.2.3 Proposed Watercourse Crossing

In order to facilitate the crossing of the existing watercourse at the site by the proposed access road, a bridge crossing will be required. In line with OPW stated requirements and in compliance with Section 50 design criteria, the soffit of the proposed watercourse crossing has been set at **16.18 mOD**; higher than the minimum 300 mm freeboard to the 1% AEP + CC flood level (15.72 mOD), as shown in Table 5.1. OPW Section 50 consent is required and has been applied for as per details outlined in Table 5.1.

It is noted that, while not a stated requirement, the proposed watercourse crossing will have a minimum top / deck level of 16.80 mOD. It is therefore set above both the 0.1% AEP and 0.1% AEP flood levels including allowance for climate change and culvert blockage and, as such, will be resilient to all design events and facilitate access / egress to and from the site during a flood event.

Riparian maintenance requirements for culverts and watercourses is outlined in Section 5.3.

Table 5.1: Proposed Watercourse Crossing Details

Location	Type	1% AEP + CC Flood Level (mOD)	Min. Soffit Level (mOD)	Freeboard (mm)
Unnamed Watercourse	Clear Span Pedestrian Bridge	15.72	16.18	460

5.2.4 Drainage Design

Surface water drainage design is as per the requirements of Dún Laoghaire-Rathdown County Development Plan 2022 – 2028 and DLR CC Drainage Department. It is noted that, as stated in Section 3.2.1, that all development proposals are to incorporate Sustainable Drainage Systems (SuDS).

Surface water drainage design uses SuDS techniques and will ensure that there is no increased flood risk elsewhere to increase flow rate and volume from the site. It is noted that the proposed development will lead to an increase in impermeable area at the site; therefore attenuation storage is required.

In relation to water quality, Section 8.8.2.3 of Chapter 8 of the EIAR states the following:

- *During the operational phase, rainwater from the roofs and roads will be conveyed directly to a surface water drainage system (designed following SUDS principles), which will include a petrol interceptor, a pond, swales and rain gardens, and attenuation tanks.*
- *Measures will be employed to improve the physical characteristic of the Stradbrook Stream. The location of these measures will be limited to the south bank of the river which is within the ownership of the Applicant. The measures will include the removal of block walls which were constructed to form the bank, the setting back of mesh fencing. The riverbank will be regraded to provide a more natural channel. The regrading of the bank will need to be cognisant of, and may be restricted by, the root protection zones of trees. The use of coir or similar may be required to prevent erosion while natural vegetation becomes established.*

Drainage design is to be carried out by others and submitted separately.

5.3 Maintenance Requirements

5.3.1 Watercourse Maintenance

The ultimate owner / occupier(s) of the site shall be required to include general watercourse / culvert maintenance which will reduce the risk of blockage at downstream crossings and screens and maintain the capacity of the channels. The following measures are intended to inform any future maintenance programme for watercourses and culverts / bridges:

- Maintenance should consist of removal of any items within the channel that can impede its flow including (small) trees, excess vegetation etc.
- River banks should be due adequate attention which would normally consist of removal of brambles, bushes and stiff vegetation; these reduce flow capacity and can encourage collection of debris increasing the risk of blockages. Grass and nettles do not always need removing as they will lay flat during high flows.
- Weed growth should to be removed from the centre of the channel as this will impede the flow and increase water levels up stream. Hand picking is best but cutting off under the water level is acceptable if it is done on an annual basis.
- Build-up of silt in watercourse channels and at culvert inlets should be removed and disposed of appropriately.

- Cyclical (min. annual) visual inspection of watercourse crossing inlets and screens and removal of debris as required, ensuring debris removed is not deposited in an area likely to fall back into the channel.

The need or otherwise for any new screen under the proposed bridge shall be determined in consultation with OPW in developing a detailed design and obtaining the necessary authorisation under Section 50 of the Arterial Drainage Act. It is initially deemed that an inlet screen would be unnecessary in that the proposed structure is of a significantly larger opening size than upstream and downstream structures; lies shortly downstream of a smaller culvert opening that would limit larger debris that would cause a blockage risk and would be inconsistent given the lack of screens at other culverts on the Stradbrook Stream.

If OPW require that a new screen is incorporated, then it shall be in compliance with the requirements of the Culvert Design & Operation Guide (CIRIA 2010). Detailed design of any screen would be required to incorporate a foul manhole located adjacent to the culvert opening.

5.3.2 Drainage System Maintenance

The owner / occupier(s) shall be responsible for maintenance of drainage networks at the site and will ensure that maintenance of the drainage system is provided for. Detailed drainage layout for the site is to ensure that key SuDS features requiring maintenance are located in accessible public locations.

Maintenance plans for drainage assets should include (where applicable):

- Cyclical (min. annual) check of all surface water drainage features – in particular clearing of debris;
- Cyclical (min. annual) visual inspection of any surface or underground features – blockages and obstructions to be removed by jetting as required.

5.4 Summary of Flood Risk and Mitigation

Table 5.2 summarises the mechanisms of flooding identified in the course of this study, their associated hazards / consequence (as per the guidance set out in the OPW Guidelines and proposed measures to mitigate the predicted risk.

Table 5.2: Summary of Risks and Mitigation

Identified Flood Mechanism	Consequence	Summary & Mitigating Measures
Fluvial flooding	Risk to life and property	The proposed development will not be at risk of flooding and does not lead to an increase in flood risk elsewhere.
Effect of Climate Change	Risk to life and property	Finished development levels ensure a standard of protection exceeding 0.1% AEP + climate change flood levels.
Effect of Culvert Blockage	Risk to life and property	Finished development levels ensure a standard of protection exceeding 0.1% AEP + culvert blockage flood levels.
Effect of the Development	Increased risk to adjacent lands and developments	Detailed hydraulic flood modelling analysis indicates that the effect of the proposed development is contained within channel and within the application boundary.
Pluvial / Surface Water flooding	Risk to property on site, risk to adjacent lands and property.	On-site surface water flooding shall be mitigated by a site drainage system to comply with local authority drainage standards. Off-site surface water effects shall be mitigated by provision of SuDS components and by ensuring that runoff from site is attenuated and treated prior to discharge.

5.5 Residual Risk

Consideration has been given regarding flooding caused by events or greater than the design standard.

Table 5.3: Residual Impacts

Description of Risk	Hazard	Residual Impact
Underestimation of 1% AEP / 0.1% AEP flood level	Inundation of the site for a design event	Extreme flood events well in excess of the design event would cause increased flooding to the site, the extent of which would be dependent on the flood magnitude. Critical design levels provide in excess of 300 mm freeboard to the 1% AEP + CC design flood level, and it is considered highly improbable that the degree of freeboard would be exceeded by a flood event.

Appendix A

Site Drawings

NOTE : THE FOOTPRINTS OF ADJOINING PROPERTIES ARE TAKEN FROM THE MOST CURRENT OS MAP PROVIDED TO THE ARCHITECT

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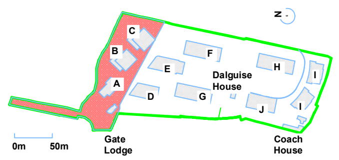

Undercroft
1 : 500

Notes:

- Do not scale from this drawing. Use figured dimensions in all cases.
- Verify dimensions on site and report any discrepancies to the Architect immediately.
- This drawing to be read in conjunction with the Architect 's Specification.
- © This drawing is copyright and may only be reproduced with the Architect 's permission.

Drawing Notes:

COPYRIGHT:
OSi Licence No.: CYAL50273835

= Indicates Extent of Application
Site Area within Application : 35767.1 m²
= Indicates Adjacent Site in Ownership of Applicar
= Wayleave
= Part V allocation
WSA = Waste Storage Area
= Access / Connection to surrounding Neighbourhoods.
Site Access

Issues & Revisions

Revision Number	Date	Drwn	Details of Issue / Revision
P01	12.10.22		Issued for Planning
P02	19.05.23		Response to RFI

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Project Details:
Dalguise Monkstown

Drawing Title:
GA-Site-Proposed Purbeck Level

Job No.	Sheet Size:	Scale @A1:	Status	Purpose of Issue
P21-066D	A1	1:500		PLANNING PERMISSION

Issue Date:	Drawn By:	Reviewed By:	Drawing No.	Revision
12/10/22	MG	EOB	MKS-RAU-ZZ--2-DR-AR-050	P02

Appendix B

OPW / DLR CC Flood Mapping

Mapping Notes

1. The lines of the Road Proposals shown are diagrammatic only and may be subject to change.
2. Wave Overtopping layer is relevant to the following maps only: Map No's. 2, 3, 4, 7, 10 & 14 unless noted otherwise.
3. These flood maps contain Land Use Zonings & Flooding information only. Please refer to the Land Use Zoning maps for more detailed land use objectives.

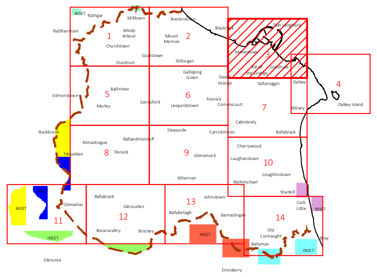
Flood Zone Map

COMHAIRLE CHONTAE DHÚN LAOGHAIRE-RÁTH AN DÚIN

DÚN LAOGHAIRE-RATHDOWN COUNTY COUNCIL

COUNTY DEVELOPMENT PLAN 2022-2028

Adopted March 2022



INDEX

Land Use Zonings

Objective A	To provide residential development and improve residential amenity while protecting the existing residential amenities.	
Objective A1	To provide for new residential communities and Sustainable Neighbourhood Infrastructure in accordance with approved local area plans.	
Objective A2	To provide for the creation of sustainable residential neighbourhoods and preserve and protect residential amenity.	
Objective B	To protect and improve rural amenity and to provide for the development of agriculture.	
Objective DC	To protect, provide for and-or improve mixed-use district centre facilities.	
Objective E	To provide for ecomonic development and employment.	
Objective F	To preserve and provide for open space with ancillary active recreational amenities.	
Objective G	To protect and improve high amenity areas.	
Objective GB	To protect and enhance the open nature of lands between urban areas.	
Objective LIW	To improve and provide for low density warehousing/light industrial warehousing uses	
Objective MIC	To consolidate and complete the development of the mixed use inner core to enhance and reinforce sustainable development.	
Objective MOC	To provide for a mix of uses which complements the inner core, but with less retail and residential and more emphasis on employment and services.	
Objective MTC	To protect, provide for and-or improve major town centre facilities.	
Objective NC	To protect, provide for and-or improve mixed-use neighbourhood centre facilities.	
Objective OE	To provide for office and enterprise development.	
Objective TLI	To facilitate, support and enhance the development of third level education institutions.	
Objective W	To provide for waterfront development and harbour related uses.	
Objective SNI	To protect, improve and encourage the provision of sustainable neighbourhood infrastructure	

Areas of Flood Risk Concern

Fluvial - Surface Water .... F

Pluvial - Surface Water .... P

Pluvial - Foul .... P

Flood Zone A ....

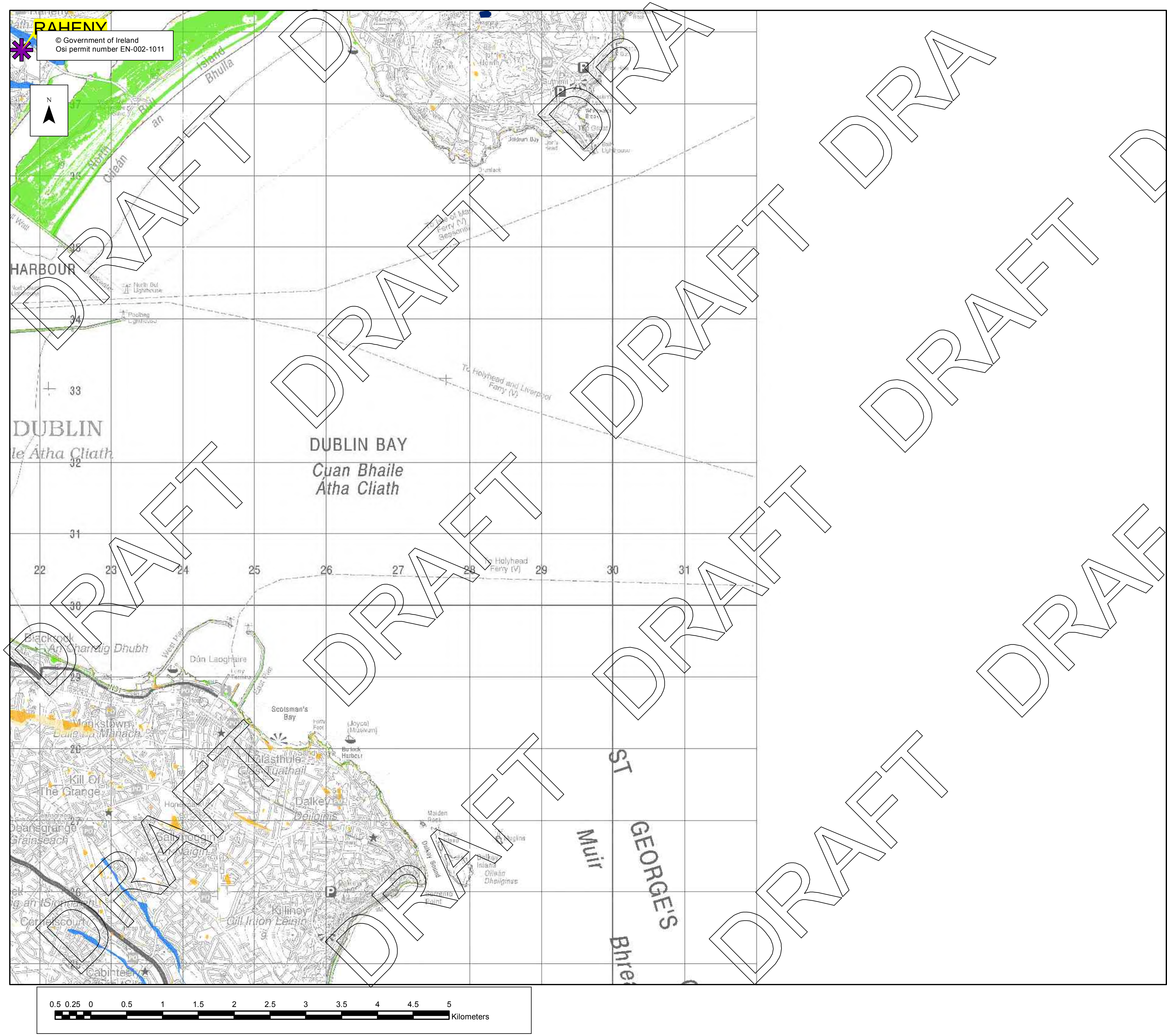
Flood Zone B ....

Wave Overtopping ....

County Boundary ....

Metres
0 50 100 200 300 400 500

Director of Planning: M Henchy
Senior Planner: L McGauran



Location Plan :

Legend:

Flood Extents

- Fluvial - Indicative 1% AEP (100-yr) Event
- Fluvial - Extreme Event
- Coastal - Indicative 0.5% AEP (200-yr) Event
- Coastal - Extreme Event
- Pluvial - Indicative 1% AEP (100-yr) Event
- Pluvial - Extreme Event
- Groundwater Flood Extents
- Lakes / Turloughs

PFRA Outcomes

- Probable Area for Further Assesment
- Possible Area for Further Assesment

Important User Note:

The flood extents shown on these maps are based on broad-scale simple analysis and may not be accurate for a specific location. Information on the purpose, development and limitations of these maps is available in the relevant reports (see www.cfram.ie). Users should seek professional advice if they intend to rely on the maps in any way.

If you believe that the maps are inaccurate in some way please forward full details by contacting the OPW (refer to PFRA Information leaflets or 'Have Your Say' on www.cfram.ie).

Office of Public Works
Jonathon Swift Street
Trim
Co Meath
Ireland

Project :
PRELIMINARY FLOOD RISK ASSESSMENT (PFRA)

Map :
PFRA Indicative extents and outcomes
- Draft for Consultation

Figure By : PJW — Date : July2011

Checked By : MA — Date : July 2011

Figure No. : 2019 / MAP / 239 / A — Revision 0

Drawing Scale : 1:50,000 — Plot Scale : 1:1 @ A3

Appendix C

Hydraulic Modelling

PREAMBLE

There is no detailed CFRAM mapping or flood model available for the Stradbrook Stream. In order to quantify the peak flow levels and possible flooding from the Stradbrook Stream, a detailed river model of the watercourse is required. An Infoworks ICM 1D / 2D model has been developed allowing accurate determination of flood level and extent at the site. The following sections detail the works conducted.

HYDROLOGICAL ASSESSMENT

The estimation of peak flow for the required design annual probability has been necessary to determine the peak inflow for input to an unsteady state hydraulic model.

Inspection of the Stradbrook stream at time of site visit informed that upstream limit of the open watercourse was fed via a 1200 mm circular concrete conduit which limits any flows to the upstream extent of the modelled stream adjacent to the site from the upper catchment.

With this information in hand, and to ensure channel flows were conservatively appraised, a two-stage approach for hydrology calculation was adopted to estimate inflows to the head of the channel, and lateral inflows along the length of the modelled watercourse.

Upstream Catchment

Natural hydrology in the upstream network is modified such that the former watercourse effectively no longer exists and its function has been replaced by the artificial surface water drainage network. This was confirmed by DLR CC who stated that "*The 'Drainage Planning' department consider that for the site, a hydraulic analysis of the surface water drainage network [upstream of the site] is the most appropriate approach in determining the flow input values for the SSFRA*"; i.e. the flow from the 1200 mm pipe is the primary, and only, source of flow at the upstream extent of the watercourse.

FSU Analysis

The Flood Studies Update (FSU) is the preferred method for flood estimation in Ireland; however, its applicability in this instance is limited by the small, urbanised nature of the drained catchment, and the lack of similar small and/or urbanised catchment within the gauged network on which the FSU method is based. The Stradbrook Stream is not included within the available FSU Hydrological Estimation Points (HEP) dataset and as such any FSU analysis would rely on scaling pro-rata from a larger downstream catchment, with significant loss of confidence.

Consultation with OPW confirmed that the FSU method was not suitable for use at the site (correspondence included in Appendix G). As detailed in the correspondence, FSU analysis was undertaken on an adjacent similar urbanised catchment in order to estimate an appropriate **hydrograph shape only**, but without any particular analysis to the peak flood magnitude. The FSU analysis for hydrograph shape is included in Appendix D for information.

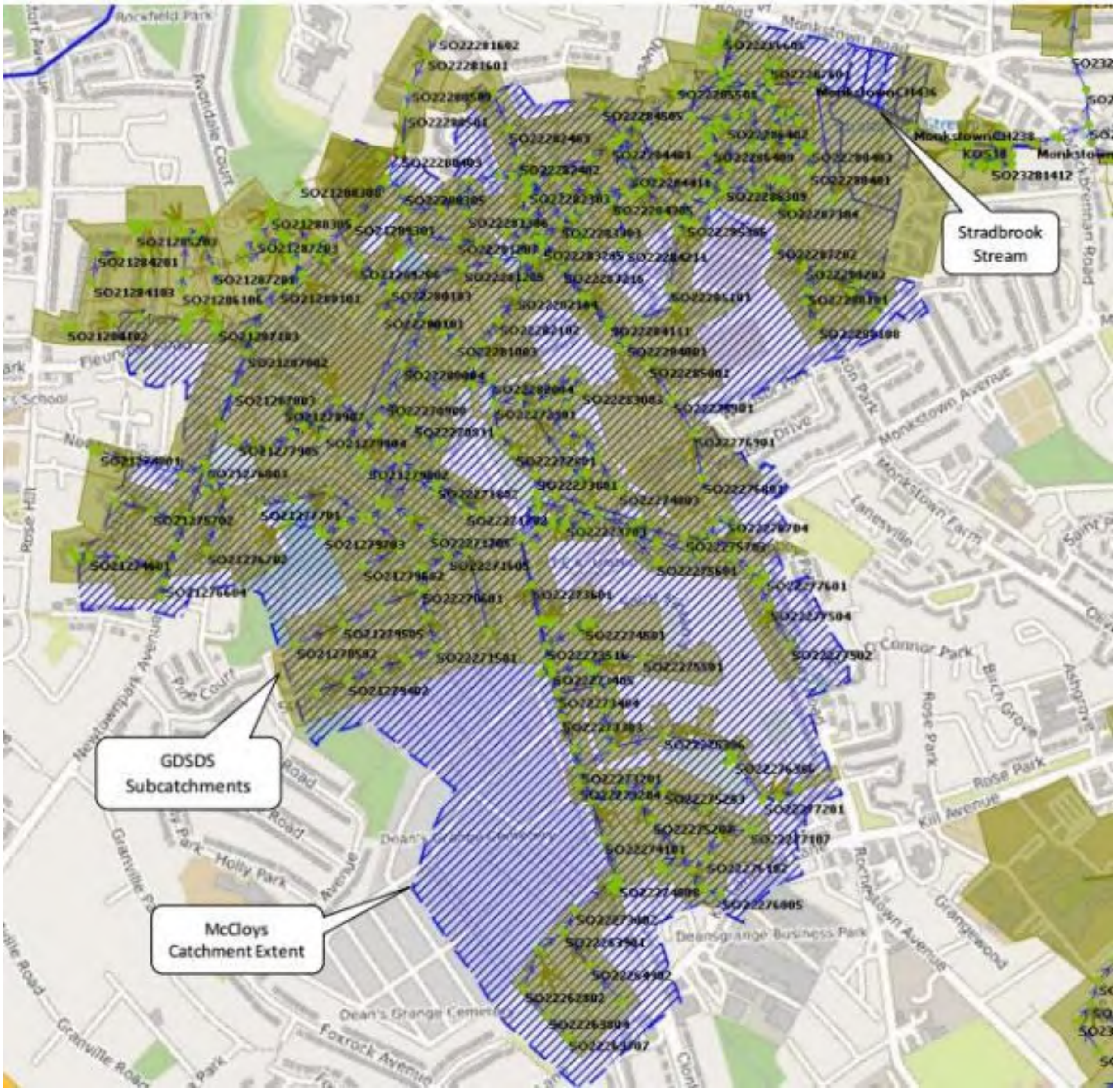
GDSDS

Practice guidance would tend to indicate that for catchments such as the Stradbrook, inflow hydrology is best appraised by alternative urban drainage estimation methodologies. Production of a new urban drainage model would be disproportionate to the scale and nature of the proposal and would require access to asset information that is unavailable to private developers.

The upstream urban catchment, surface water sewer network and Stradbrook stream was included within a previous wider urban drainage flood modelling project within the Greater Dublin Strategic Drainage Study (GDSDS), with flows derived from a 1D Infoworks CS model that would utilise Wallingford / Rational methods. DLR CC has provided excerpts from that modelling study.

The model was verified in terms of its catchment extent by comparison with the drained sewer-catchments upstream of the Stradbrook with an independent analysis of catchment hydrology (based on OSI LiDAR) and urban drainage hydrology based on a review of Irish Water drainage asset records, as shown on the following figure.

Figure C.1: GDSDS vs McCloy Catchment



GDSDS results[1] report a predicted 1% AEP flow of 1.9 m^3/s for the Monkstown Stream (watercourse also referred to as the Stradbrook Stream) 0.5 km downstream of the site. This value has not been verified as to do so is beyond the scope of this study.

For comparison, and per the initial guidance directed from DLR CC Water Services, an estimated full bore discharge for the upstream 1200 mm pipe was estimated using the Colebrook White equation (refer to Appendix D), resulting in a peak discharge of **1.54 m^3/s** from that outlet. The full bore discharge would be identical for all flood probabilities.

[1] Appendix N 'Peak River Flood Flows and Levels' to 'Phase 2 (Storm) of Dun Laoghaire West Pier West Drainage Area – S2014'

Lateral Catchment

Lateral inflows were applied to the watercourse accounting for any overland flows downstream of the 1200 mm pipe along the extent of the watercourse that has the potential to affect the site.

Lateral inflows were assessed using various calculation techniques. Due to the small size of the laterals in comparison to the whole catchment (a total size of 1.67 km²), the larger catchment was used to assess contribution and lateral-specific flows estimated by linearly scaling by catchment area. Refer to Table C-1 for results and Appendix D for detailed calculation summaries.

Table C.1: Peak Flow Summary (Total Catchment)

Calculation Method	Peak Flow (wider catchment) 1%AEP (m³/s)	Peak Flow per Area 1%AEP (m³/s/km2)
FSR	1.53	0.92
FSSR (3 var equation)	2.71	1.62
IoH124	2.76	1.65
Modified Rational	*19.12*	*11.45*

The Modified Rational method was adopted as the most onerous with a value far in excess of any other calculated values, and as such is consistent with the precautionary principle and is consistent with OPW advice to use a rational or Wallingford method approach to hydrology in the area.

Catchments were delineated for application to the model, refer to Figure C.2, with catchment size used with to calculate peak flows relative to total catchment size, refer to Table C.2 & C.3. Hydrograph shape was adopted from a hydrologically similar catchment to the north of the proposal site using FSU methodology. Full details of this catchment and hydrograph shape have been provided in Appendix D.

Figure C.2: Lateral Catchments

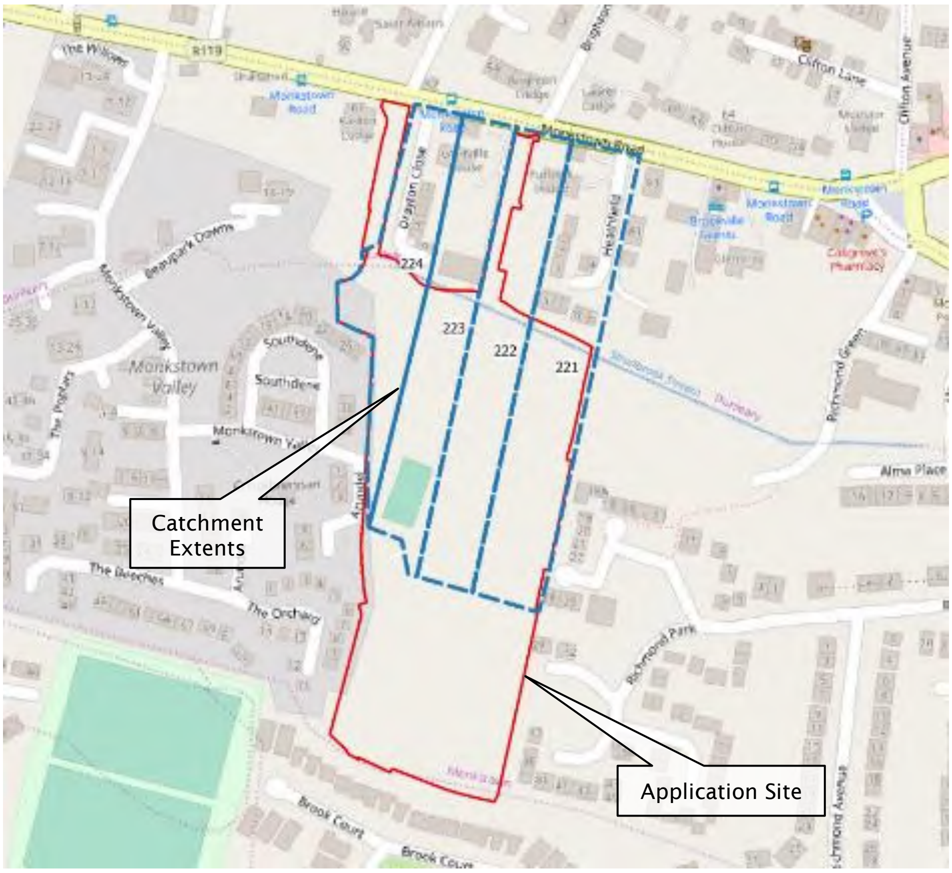


Table C.2: Lateral Inflow Summary

Catchment	221	222	223 & 224
Modelled Element name	Site_DS.1	Site_US.S	STRAD_BR3_DS.1
Inflow Type	Lateral	Lateral	Lateral
10% AEP (m^3/s)	0.07	0.06	0.09
1% AEP (m^3/s)	0.14	0.11	0.18
1%+CC AEP (m^3/s)	0.17	0.13	0.22
0.1% AEP (m^3/s)	0.27	0.22	0.34
0.1%+CC AEP (m^3/s)	0.32	0.26	0.41

Summary

The finalised inflow hydrology adopted is the maximum full bore inflow capacity of the upstream culvert, and lateral inflows derived from the Modified Rational method. Cumulative flows are shown in the following table.

Table C.3: Hydrology Summary

Return Period	Laterals (m^3/s)	Pipe Full (m^3/s)	Total Flow (m^3/s)
10% AEP (m^3/s)	0.22	1.54	1.76
1% AEP (m^3/s)	0.43	1.54	1.97
1%+CC AEP (m^3/s)	0.52	1.54	2.06
0.1% AEP (m^3/s)	0.83	1.54	2.37
0.1%+CC AEP (m^3/s)	1.00	1.54	2.54

The cumulative flow when compared with like-for-like estimates for the 1% AEP flow derived from the GDSDS model results (i.e. 1.9 m^3/s for the 1% AEP event) confirm that the analysis tends to result in a larger magnitude flood and as such is likely to be sufficiently conservative for purposes of the site specific FRA.

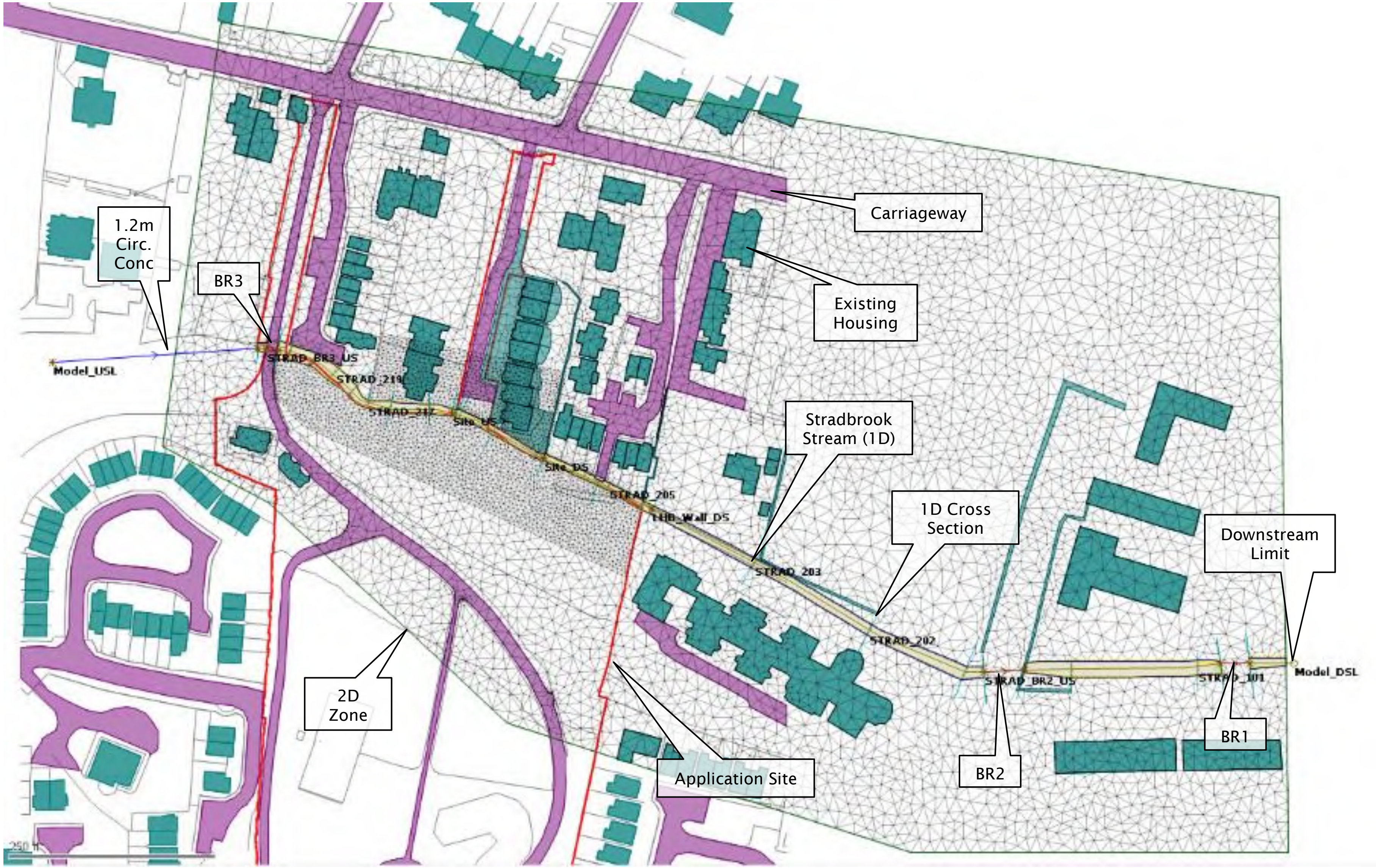
HYDRAULIC MODEL SIMULATION

The hydraulic model for the site has the purpose of providing peak water levels from the derived design flow estimates for the Stradbrook Stream flowing along the northern boundary of the site. The modelling has established the capacity of the watercourse adjacent to the proposed development site.

The river reach has been modelled using unsteady state techniques using ICM v9.0.1 software, with the most conservative flood levels predicted at the site used for purposes of the flood risk assessment in accordance with the precautionary principle.

The extent of the model is provided on Figure C.2. This figure also details model elements included and discussed in subsequent chapters.

Figure C.3: Model Extent



1-Dimensional River Reaches

River Sections

The geometry of natural channel is irregular and cannot be characterised using simple mathematical relationships. Therefore, representation in mathematical models requires that the stream geometry, in the form of discrete cross sections, be taken transversely at key locations in the watercourse.

Invert levels and bank levels of the Stradbrook Stream were provided in a topographic survey of the site completed by a third-party surveyor. Due to the nature and scale of development and associated risk, it was determined that a linked 1D-2D model would be of sufficient detail to generate conservative estimates of flood levels at the site.

The roughness of the river reach is represented by applying Manning's n roughness values to the river sections for floodplains and river channel. A conservative roughness value of 0.04 was used based on characteristics of the channel, which is generally clean with some stones and weeds.

Structures

The Stradbrook Stream navigates through several culvert / bridge openings in the vicinity of the site that were represented within the hydraulic model. Bridge openings are represented as closed conduits utilising in-built routines. No blockages are represented by default; sensitivity to culvert blockage is discussed subsequently. All opening sizes and shapes were modelled as surveyed with a combination of sprung arch sprung and rectangular box conduits, and the minimum width and height adopted from upstream and downstream elevation surveys to ensure a conservative analysis. A link schedule is provided in Table C.4 with reference locations provided on Figure C.2.

Table C.4: Link Schedule

Reference	Length (m)	Shape	Width (mm)	Height (mm)	US invert level (m AD)	DS invert level (m AD)	Conduit material
STRAD_BR1_DS	10.8	RECT	2971	1359	11.81	11.49	Conc.
STRAD_BR2_DS	14.9	RECT	1151	731	12.84	12.87	Conc.
STRAD_BR3_DS	4.2	ARCHSPRUNG	3511	1583	15.73	15.66	Stone
Conduit_DSL	75.2	CIRC	1200		15.65	15.57	Conc.

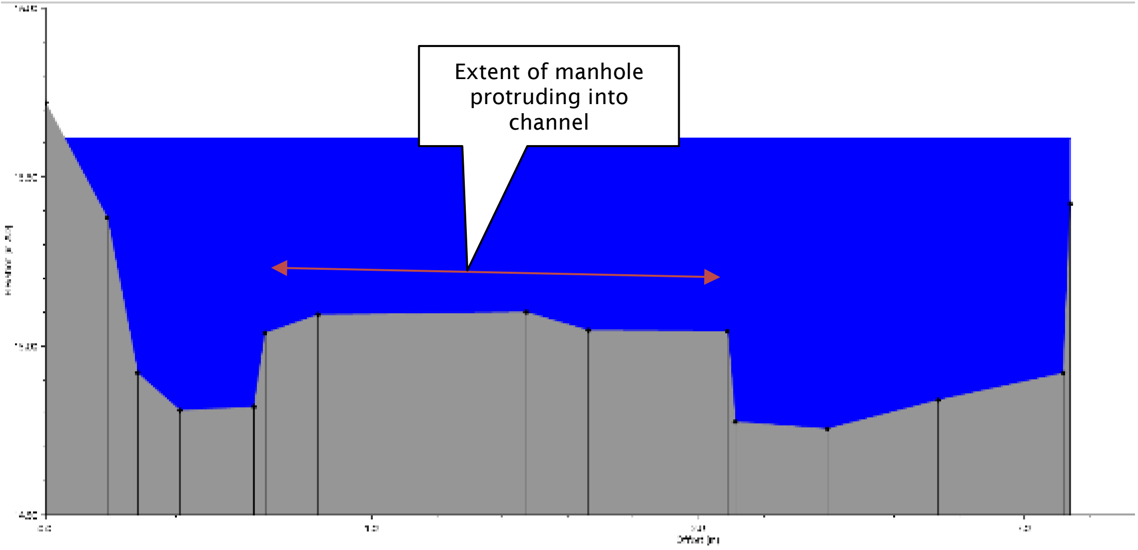
Manning's n was applied to represent roughness within the model. Bed roughness values were applied as per bed of watercourse as was considered most appropriate, whilst top roughness values were applied to the culverts depending on the conduit material.

Other Obstructions

The model includes within the 1D geometry the effect of a raised foul manhole built within the river channel adjacent to the site. The Manhole is included within a 1-Dimensional cross section and as such permits the model to include the effect of the structure on in-channel conveyance capacity, and contraction / expansion losses as the channel is obstructed.

All subsequent scenarios include the presence of the manhole in unchanged form. The application that this assessment and flood model were prepared to inform and supports include no work that would affect the manhole.

Figure C.4: Manhole Obstruction



Upstream and Downstream Limits

The upstream limit of the model was defined using a break node at the location of the first manhole upstream of the 1200 mm circular concrete outlet. The pipe full flow is applied at this break node and lateral inflows applied to the open reaches upstream and adjacent to the site, refer to the Hydrological Assessment section for more detail.

The downstream limit of the model, located approx. 480 m downstream, is defined using an outfall node set to the invert of the last cross section, allowing water to leave the system.

The downstream model extent was designed to ensure that underestimation of a normal depth boundary condition would have no effect predicted water levels in the area of interest; and similarly to ensure that potential backwater effects arising out of two downstream culverts were taken into account in water levels at the site, and to permit appraisal of culvert blockages and associated increased backwater effects to the site.

Sensitivity testing was conducted in order to ensure that the boundary location was sited sufficiently downstream in order that significant variation in downstream water levels would not impact the area of interest, discussed separately.

2-Dimensional Surface Model Areas

Topography

Out of bank topography was based on detailed site topographic survey for the site area, with outlying areas derived from 2 m DTM. The datasets were combined in a single TIN mesh and exported as a single terrain model with 0.5 m resolution.

2D Zone

The terrain model was loaded into InfoWorks ICM as a ground model, and subsequently converted into 2D mesh elements (the surface used to simulate flows across the topography within the model). The 2D zone has a maximum triangle size of 25 m^2.

Additional mesh zones were applied within the vicinity of proposed development and along features represented within the 2D domain for enhanced representation. Mesh zones have a maximum triangle size of 2 m^2 with terrain sensitive meshing applied.

Mesh level zones were employed to represent walls in the 2D mesh that would have the potential to influence flow paths. Walls are located both within, and in the wider vicinity of the site, and have been built in line with topographic survey and site visit information.

Boundary Conditions

A normal depth boundary condition was applied to all boundaries in the 2D zone. This boundary has been sited sufficiently downstream of the study area to limit the possibility of levels being artificially influenced by the boundary condition. The normal condition assumes that slope balances friction forces with flow depth and velocity remaining constant when water reaches the boundary, so water can flow out without energy losses.

Surface Roughness

A Manning's n Roughness value of 0.035 has been applied to the whole 2D zone to represent the area over which water would flow which comprises of grass / light brush due to the urban location. It is noted that roughness takes affecting vegetation (including trees) into account and that there will be no significant difference in vegetation between the existing and proposed scenario within the floodplain. Roughness zones have been applied in road locations with a roughness of 0.013 to replicate smooth asphalt in those areas.

Surface Infiltration

No infiltration has been included in the model in keeping with the approach used in similar OPW CFRAM detailed models. The absence of infiltration in the model is likely to ensure conservative results permitting a precautionary approach to flood risk analysis.

Proposed Development

A variant of the model was generated to test the effect of proposals on flooding at and within the wider vicinity of the site. Adjustments to the base model are detailed below to reflect proposals for the site.

2D Modelled Areas

Proposed development at the site was incorporated into the model using a series of mesh level zones to adjust the ground model to proposed finished ground levels.

1D River Reach

The proposed clear span bridge was incorporated into the model as a concrete box 3.2 m wide x 1.15 m high, with 2D mesh along the bridge deck, allowing flows to be represented on top of the bridge should this require reflection. A manning's roughness value of 0.04 was applied to the bed to reflect the proposed construction technique with 0.015 was applied to the top to represent the construction material.

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 topographic survey accurately represents the surface topography and associated flow paths and provides a representative channel geometry.
- The design flows are an accurate representation of flows of a given return period.
- Roughness does not vary with time.

The primary limitations of the study are noted as follows:

- Site drainage has not been modelled.
- No allowance for infiltration has been made within the model.
- The model does not represent any topographic features smaller than the minimum resolution of the underlying terrain model derived for the site.

MODEL SENSITIVITY

A model sensitivity analysis was carried out on the base model to assess the sensitivity of the simulation to changes in flow, roughness and downstream boundary within the model.

Roughness

The sensitivity of the model to roughness was assessed by varying the roughness values in the model. The results of the sensitivity analysis indicate that an increase of 20% in the Manning's n roughness value would cause an increase of <0.065 m in flood levels adjacent to the site.

Such an increase is not indicative of a particular sensitivity in the model to roughness. Roughness values have been carefully specified to ensure that a suitably conservative value was adopted, and there is confidence that the model roughness is suitably conservative.

McCloy Consulting

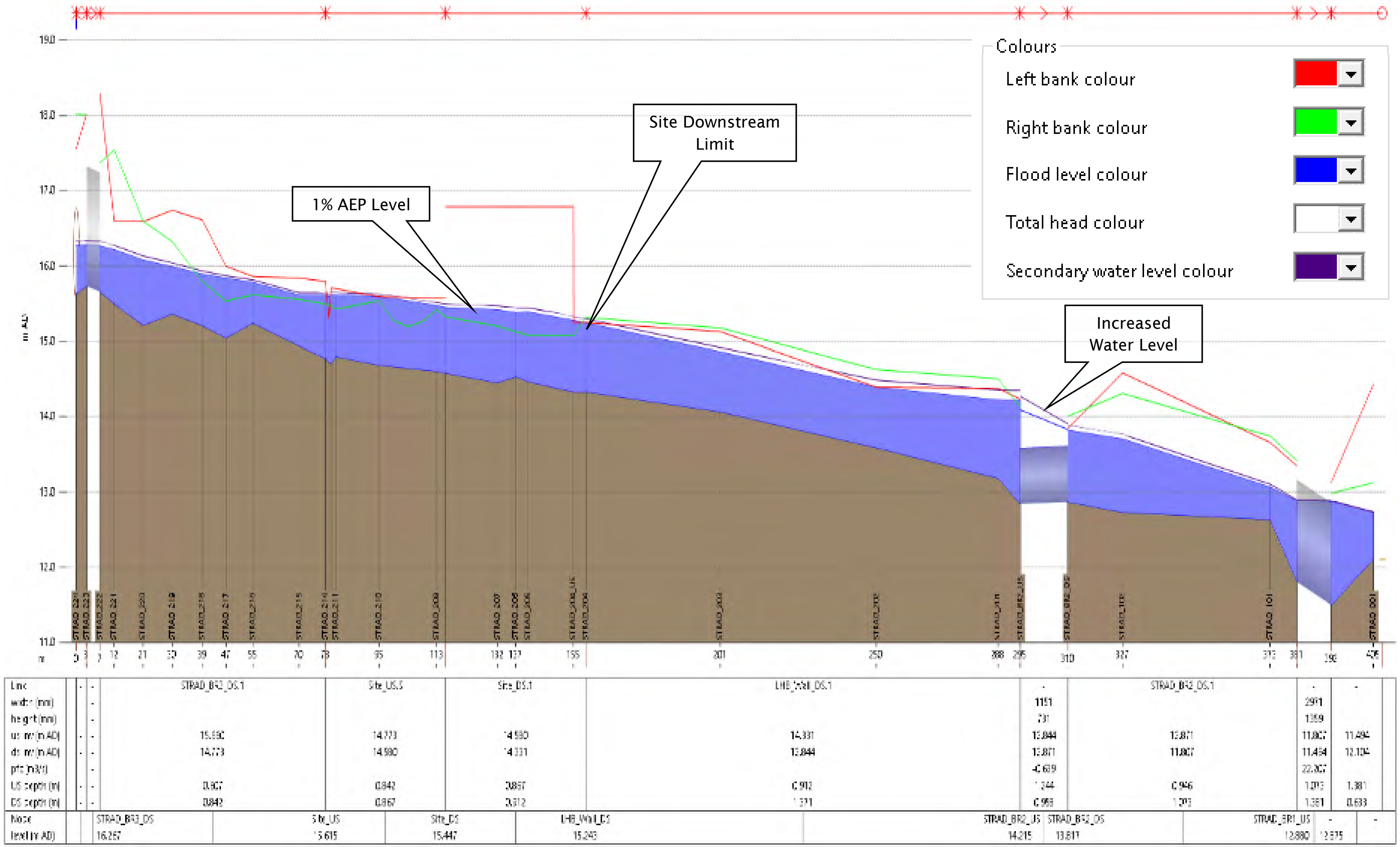


Figure C-5 Sensitivity Testing - Roughness

Flow

The 1% AEP flows for the model were derived using best industry techniques and the most conservative flows were selected and there is therefore reasonable confidence in the results.

Sensitivity to flow is assessed within the main report by evaluation of the effect of climate change; which confirms that the effect of climate change would cause a maximum of +0.20 m in the vicinity of the site. Flow sensitivity is therefore deemed insignificant in relation to the findings of the assessment.

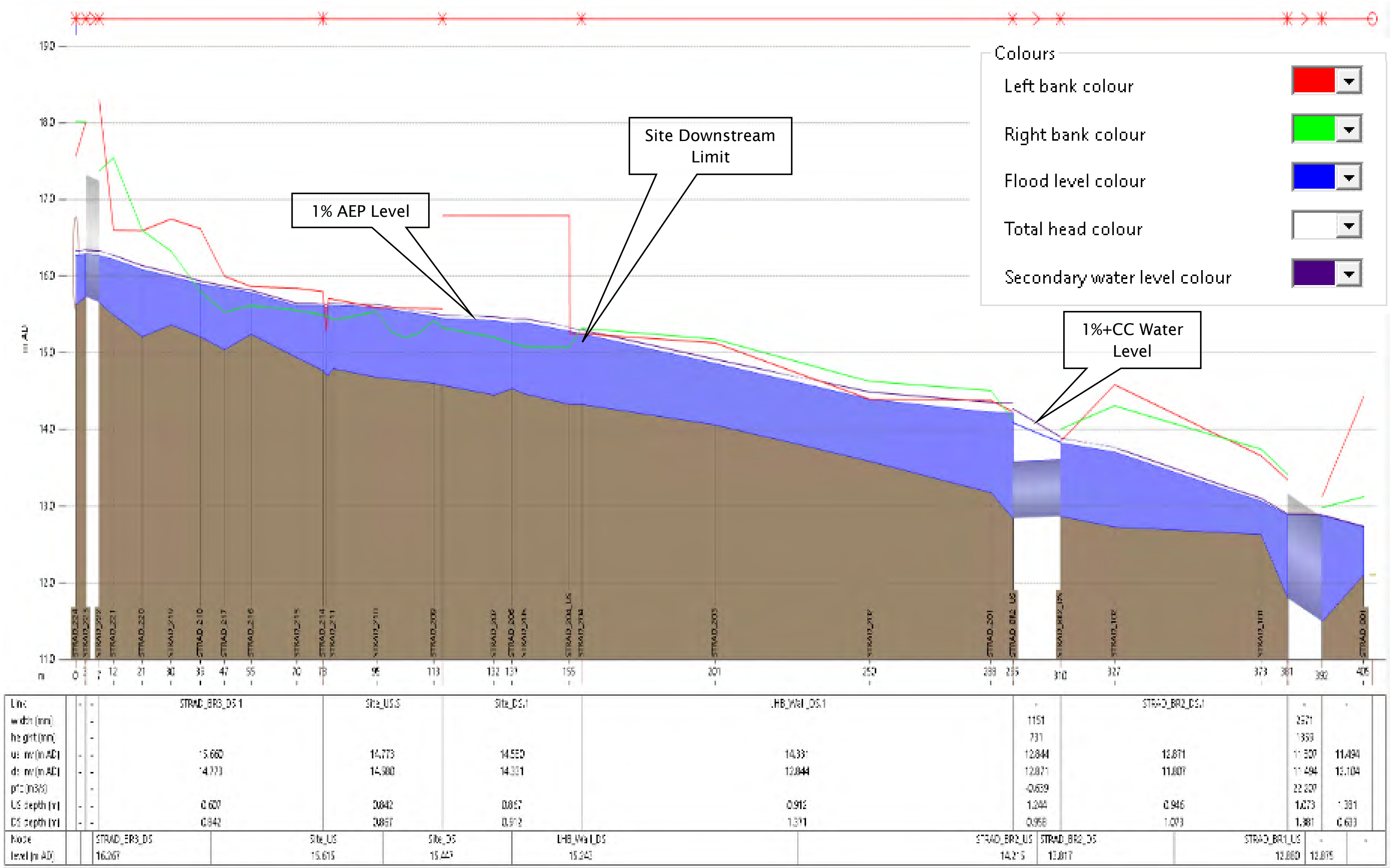


Figure C-6 Sensitivity Testing - Flow

Boundary

The downstream extent of the model was carefully sited to ensure that there was sufficient difference in elevation between the model boundary and site such that a reasonable variation in normal water level at the boundary would have no influence on water levels predicted at the site.

The boundary condition was initially set as the normal water depth as a function of bed slope.

The downstream boundary of the model was edited to assess the effects of flood levels at the site in the event of a change to the downstream conditions. A relative time level boundary was extracted from the last section for the 1% AEP and edited to apply an increase in level by 1 m for the duration of the simulation. This was then applied as a downstream level boundary to assess effect.

Results show the effect is localised around the downstream extent of the model, with no elevation difference noted at the proposal site, indicating the model is not sensitive to the downstream conditions.

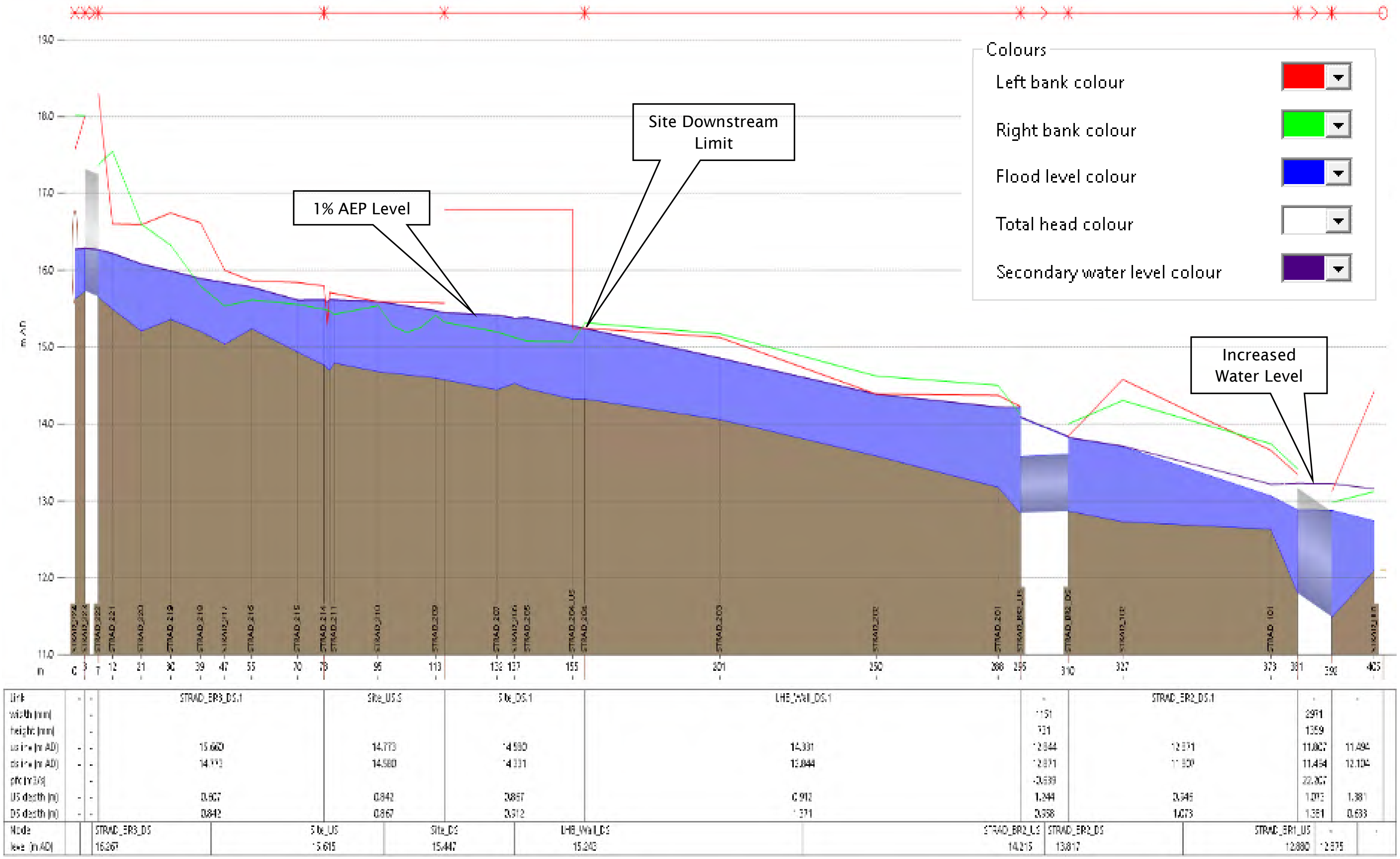


Figure C-7 Sensitivity Testing - Boundary

Blockage

Blockage was assessed at two locations, BR1, Alma Place, and BR2, Richmond Green, where siltation was applied to the conduit reducing capacity by 50%. Results analysis informs that the blockade at BR1 has minimal effect on flow levels due to the capacity the conduit provides, no increase in water levels found on site.

The application of 50% blockage at BR2 provides a notable increase in out of bank flooding originating from the upstream side of the conduit. Resultant in channel and flood plain levels are found to increase by <0.02 m at the proposal location.

A further blockage scenario was tested where a 90% blockage was applied at BR2 as constriction on flows provided by this conduit, teamed with the lack of inlet grill to collect debris, would lend itself to blockage. This simulation provided extensive flooding around the location of the bridge with overland flows affecting Richmond Green, Alma Park and place. Analysis of impact on flows at the proposal site for this scenario found an increased level <0.05 m.

Figures depicting the impact on flood levels in comparison to the 1% AEP are contained within the body of the report. Please refer to section

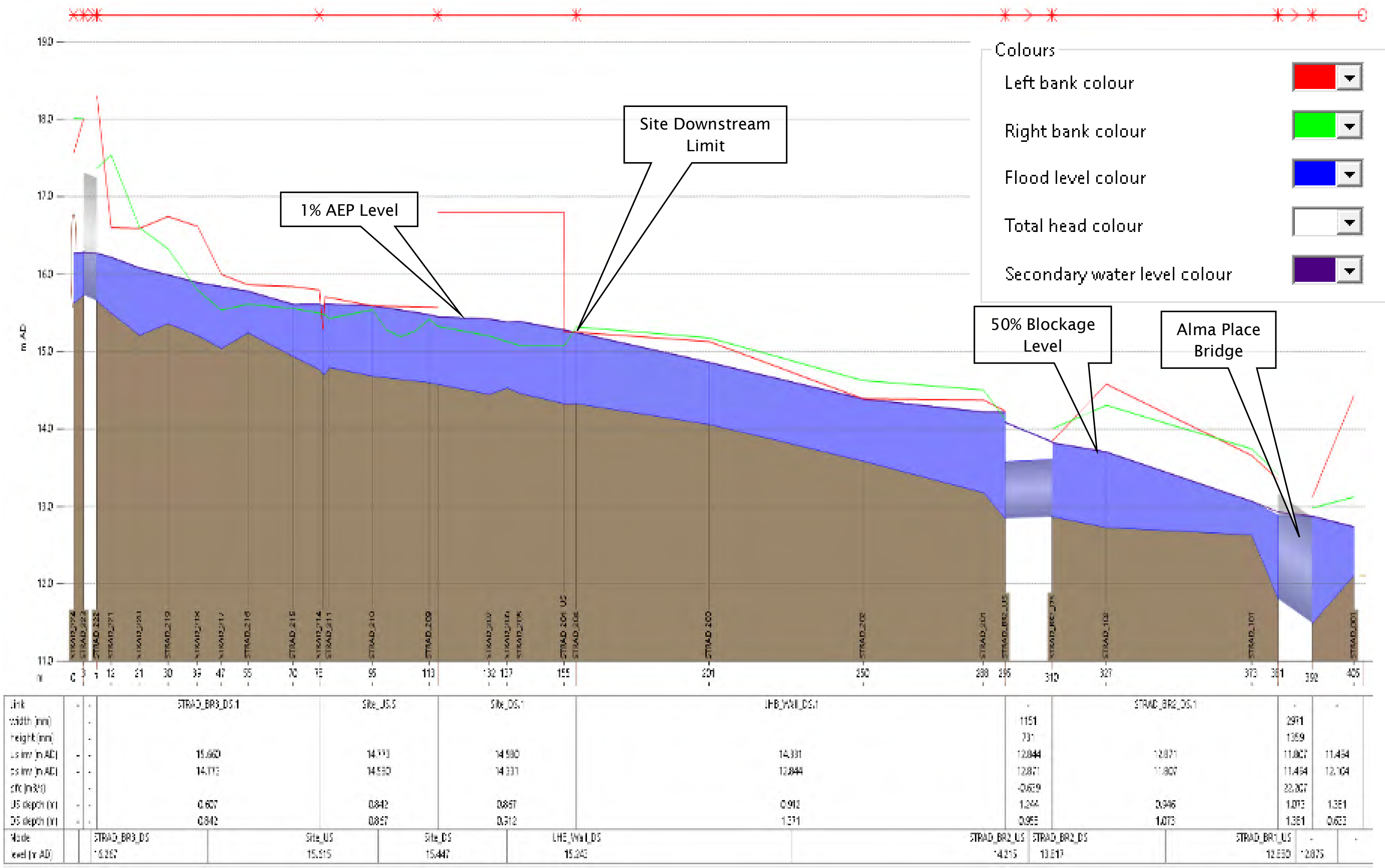


Figure C-8 Long Section Depicting 1% AEP & 50% Blockage Level at Alma Place (BR1)

McCloy Consulting

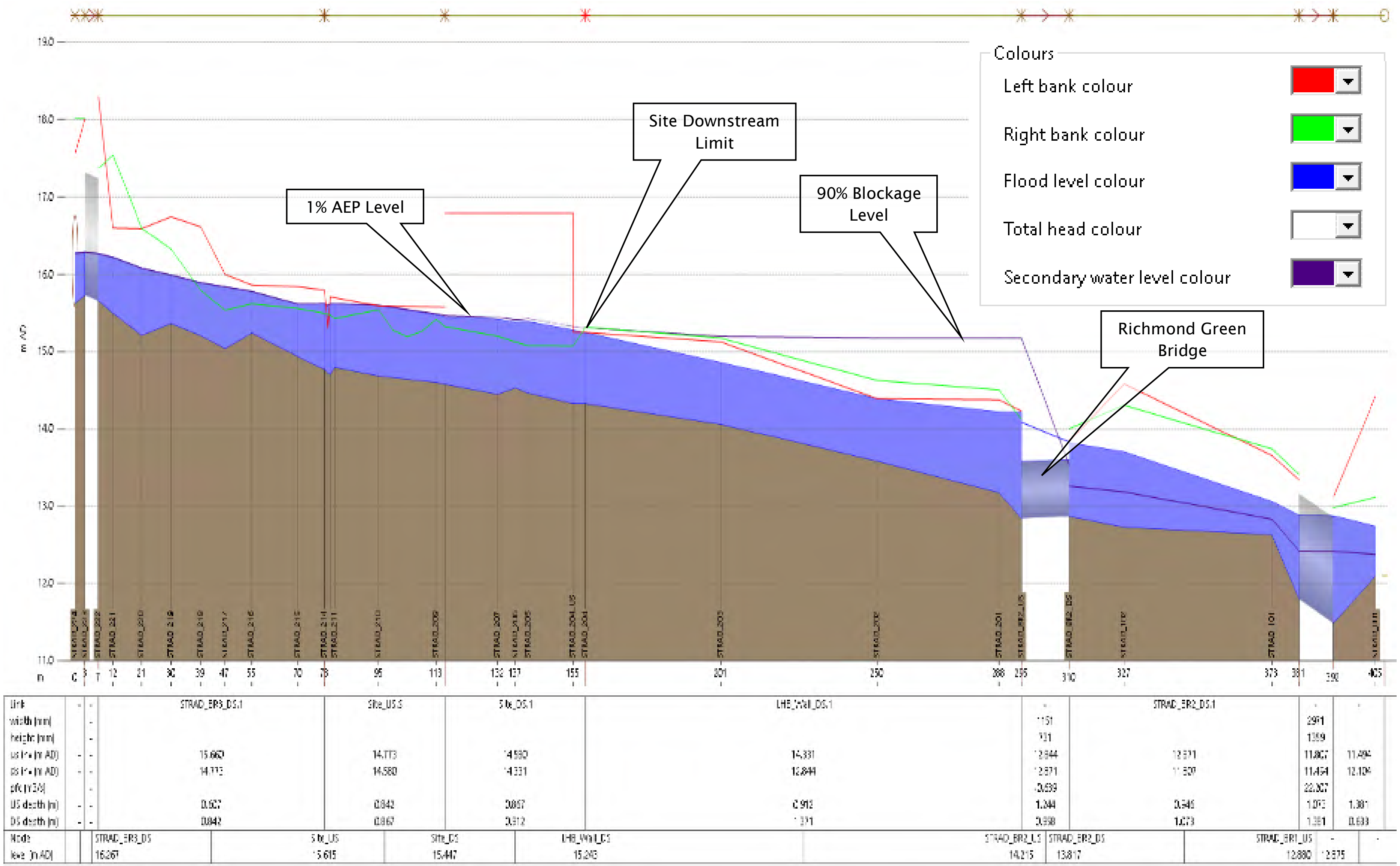


Figure C-9 Long Section Depicting 1% AEP & 90% Blockage Level at Richmond Green (BR2)

Summary

The sensitivity analysis demonstrates that the model is not particularly sensitive to variations in roughness and that the freeboard to development levels exceeds the effects of the model sensitivity to increased flows, downstream boundary conditions and blockage.

As a form of further scrutiny, the model was subject to an audit. The audit report is included subsequently.

Appendix D

Hydrological Calculation Summaries

Project	Dalguise, Monkstown, Co. Dublin
Ref	M02136-04
Watercourse	Stradbrook Stream
Date	06/04/2022

Purpose

To estimate the Q100 design flow by the general method outlined in the Flood Studies Report

$$Qbar = C \times AREA^{0.94} \times STMFRQ^{0.27} \times SOIL^{1.23} \times RSMD^{1.03} \times S1085^{0.16} \times (1+LAKE)^{-0.85}$$

C	0.0172	-	FSR regression coefficient for Ireland
AREA	1.672	km2	from FSU Portal
Stream Junctions	1	no.	from OS 1:25000 Mapping
STMFREQ	0.60	jct/km^2	calculated
Drained via lakes	0	km2	from OS 1:25000 Mapping
LAKE	0.000	-	calculated
24-h M5	50.6	mm	from FSU Portal
SMD	3	mm	from Met Eireann SMD Map
RSMD	42.1	mm	calculated
S1085	3.2	m/km	from FSU portal

$$SOIL = \frac{(0.15S1 + 0.30S2 + 0.40S3 + 0.45S4 + 0.5S5)}{S1 + S2 + S3 + S4 + S5}$$

	SOIL Area		%
S1	0	km2	0
S2	0	km2	
S3	0	km2	
S4	0	km2	
S5	1.672	km2	100
SOIL	0.50	-	

Notes

WRAP maps informed the lower part of the catchment as soil Type U denoting urban, and upper catchment as soil Type 1. Inspection of the area indicated it was now fully urbanised therfore percentages were applied to soil type to appropiately represent the catchment.

Qbar *0.59* *m3/sec*

Frequency factors for Ireland used in Flood Studies Report

	Growth Curve	Flow
QBAR	1.00	0.59 m3/sec
Q5	1.05	0.62 m3/sec
Q10	1.48	0.87 m3/sec
Q30	1.96	1.15 m3/sec
Q50	1.85	1.09 m3/sec
Q100	2.61	**1.53 m3/sec**
Q1000	2.87	**1.69 m3/sec**

By	Checked	Revision	Reason for Change	Date
SN	DKS	Original		06/04/2022

Project Dalguise, Monkstown, Co. Dublin
Ref M02136-04
Watercourse Stradbrook Stream
Date 06/04/2022

Purpose: To estimate a Q100 design flow for the catchment by the FSSR No. 6 3-Variable Eqn method

This spreadsheet is suitable for estimating design flows on small rural catchments (less than 25 km ^{2}) using the IH Report 124 equation for QBAR plus the FSR regional growth curves. Rural can be taken as meaning URBAN less than 0.05, or equivalently URBEX

AREA	From FSU	1.672	km2
SAAR4170	From UKSUDS	881	mm
WRAP class:	From FSR WRAP maps	5	
SOIL		0.5	

QBAR	1.04	m3/s

Map Region	East

Return period (years)	Design flow (m^3/s)	Specific runoff (l/s/ha)
2	0.92	5.53
2.33	0.98	5.87
5	1.26	7.56
10	1.54	9.19
20	1.84	11.00
25	1.94	11.63
30	2.03	12.16
50	2.30	13.76
75	2.53	15.14
100	**2.71**	**16.19**
1000	**2.97**	**17.78**

Project	Dalguise, Monkstown, Co. Dublin
Ref	M02136-04
Watercourse	Stradbrook Stream
Date	06/04/2022

Purpose: To estimate a Q100 design flow for the catchment by the Institute of Hydrology Report 124 (IoH 124) "Flood Estimation on Small Catchments" method

This spreadsheet is suitable for estimating design flows on small rural catchments (less than 25 km ^{2}) using the IH Report 124 equation for QBAR plus the FSR regional growth curves. Rural can be taken as meaning URBAN less than 0.05, or equivalently URBEX

AREA	From FSU	1.672	km2
SAAR4170	From FSU	881	mm
WRAP class:	From FSR WRAP maps	5	
SOIL		0.5	

QBAR	1.06	m3/s

Map Region	East

Return period (years)	Design flow (m^3/s)	Specific runoff (l/s/ha)
2	0.94	5.64
2.33	1.00	5.99
5	1.29	7.72
10	1.57	9.38
20	1.88	11.22
25	1.98	11.87
30	2.08	12.41
50	2.35	14.04
75	2.58	15.45
100	**2.76**	**16.52**
1000	**3.03**	**18.14**

Project	Dalguise, Monkstown, Co. Dublin
Ref	M02136-04
Date	06/04/2022

Purpose

To estimate the indicative (1-hr) runoff rate from the catchment. Note that proposed / indicative runoff rates are outline only and rely on the routing equation within the Modified Rational and Wallingford methods; actual runoff rates may differ significantly dependant on the nature of the surface water drainage network.

Catchment	A1	A2	A3	A4	TOTAL	
Drained Impermeable Areas	1672363.27				1672363.3	m^2
					1672363.3	m^2

Catchment Details

Total Catchment Area	167.24	Ha	
SAAR	881	mm	From uksuds.com
SAAR4170	881	mm	From uksuds.com
UCWI	107	mm	
IOH124 region	East		from map ->
SOIL	5		From WRAP maps
SOIL	0.50		
DEEPSTOR	0.59		

Modified Rational Method (MRM):

Length (m)	1287	m	From Maps
Impermeable Area (ha)	167.236	Ha	
Max Height	38.710	mAOD	From 2m DTM
Min Height	20.104	mAOD	From 2m DTM
DeltaH	18.606		
Slope (%)	1.45		
Te (mins)	17.43		
ARF	0.925		

	Catchment	
PIMP	100.000	%
Percentage Runoff PR	83.03	%
Cv	0.83	
Cr	1.3	

Institute of Hydrology Report 124 (IoH 124) "Flood Estimation on Small Catchments" method

	Catchment	
Remaining Greenfield Area	0.00	Ha
% Greenfield	0.00	%

Catchment assumed to be 100% impermeable to provide conservative flow

Catchment - Peak (1-hr) Runoff Rates

Return Period	Permeable Runoff (IOH124) (lps)	Impermeable Runoff (MRM) (lps)	Total Runoff (lps)
1 in 10 year (1hr)	0.00	10287.66	10287.66
1 in 100 year (1hr)	0.00	19119.99	19119.99
1 in 1000 year (1hr)	0.00	37085.75	37085.75

Catchment - Peak (1-hr) Runoff Rates

Return Period	Permeable Runoff (IOH124) (m3/s)	Impermeable Runoff (MRM) (m3/s)	Total Runoff (m3/s)
1 in 10 year (1hr)	0.00	10.29	10.29
1 in 100 year (1hr)	0.00	19.12	19.12
1 in 1000 year (1hr)	0.00	37.09	37.09

By	Checked	Revision	Reason for Change	Date
SN	DKS	Original		06/04/2022

Flood Estimation Report #8368

Subject site

Attributes

Name	Unit	Value
Coordinate [X]		319626.998861228
Coordinate [Y]		230765.004357601
Distance	km	0.687775053280015
Station Number		09_488_2
Location		
Water Body		
Catchment		
Hydrometric Area		
Organisation		
FSU Rating Classification		
Drainage works	year	
Contributing Catchment Area	km^2	1.632
Center Northing	m	229630
Center Easting	m	318570
Northing	m	230765
Easting	m	319627
A-Max series gap in years	year	
A-Max series number of years	year	
A-Max series number of usable years	year	
A-Max series end year	year	
A-Max series start year	year	
FARL		1
ALLUV		0
PEAT		0
FOREST		0
PASTURE		0
S1085	m/km	9.44142
MSL	km	1.009
DRAIND	km/km^2	0.617
ALTBAR		30.9
NETLEN	km	1.007
T4		
T3		

SAAPE	mm	558.85
T2		
ARTDRAIN2		0
ARTDRAIN		0
TAYSLO		0.626498
STMFRQ		1
BFISOIL		0.468151853
SAAR	mm	690.52
RWSEG_CD		09_488
TOP_RWSEG		
Bankfull		
HGF	m^3/s	
MAF	m^3/s	
FAI		0.04
FLATWET		0.54
URBEXT		0.8028
HGF/QMED		
centroidx3857		-692358.767561257
centroidy3857		7039611.3430416
x3857		-690831.442101928
y3857		7041271.41170908

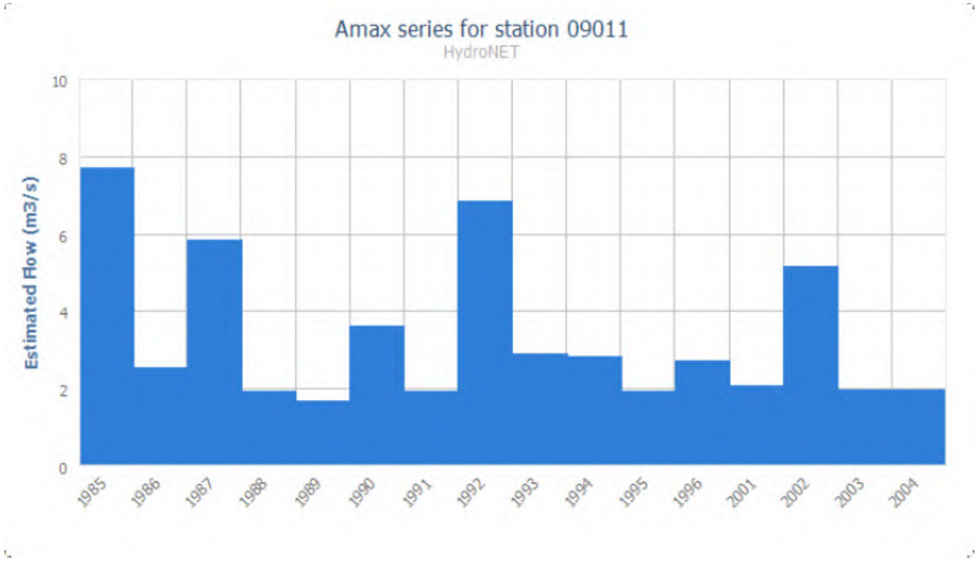
Pivotal site

Attributes

Name	Unit	Value
Coordinate [X]		316906.000185814
Coordinate [Y]		228859.999862863
Station Number		09011
Location		FRANKFORT (Post 21/08/19
Water Body		SLANG
Catchment		Liffey
Hydrometric Area		9
Organisation		EPA
FSU Rating Classification		B
Drainage works	year	0
Contributing Catchment Area	km^2	5.46
Center Northing	m	226240
Center Easting	m	317260
Northing	m	228860
Easting	m	316906
A-Max series gap in years	year	0
A-Max series number of years	year	20
A-Max series number of usable years	year	19
A-Max series end year	year	2004
A-Max series start year	year	1985
FARL		1
ALLUV		0
PEAT		0
FOREST		0.0491
PASTURE		0
S1085	m/km	31.15616
MSL	km	5.582
DRAIND	km/km^2	1.396
ALTBAR		0
NETLEN	km	7.625
T4		0.100080471959 02
T3		0.429417521465 06
SAAPE	mm	546.58
T2		0.295993367460 82
ARTDRAIN2		0
ARTDRAIN		0
TAYSLO		1.533224
STMFRQ		3
BFISOIL		0.563
SAAR	mm	772.95
RWSEG_CD		09_1381
TOP_RWSEG		09_1382
Bankfull		N/A
HGF	m^3/s	1.95
MAF	m^3/s	3.9
FAI		0.19
FLATWET		0.54
URBEXT		0.6833
HGF/QMED		0.758754863813 23
x3857		-695451.865189105
y3857		7038197.26374737
centroidx3857		-694975.568253712
centroidy3857		7034469.71473468
Distance	km	5.769227635528 35

Map

Amax Series Chart



QMED Estimates

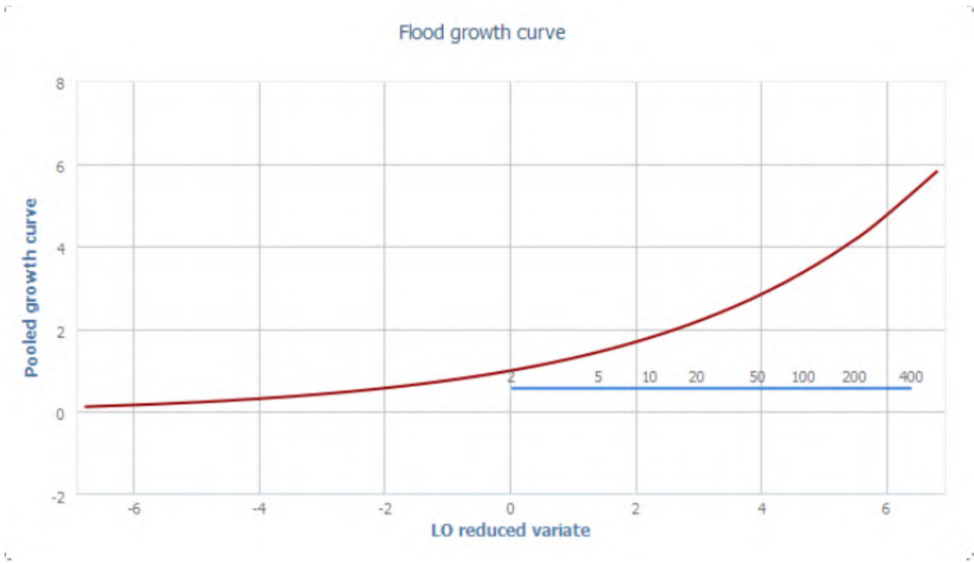
Subject rural QMED	0.26
Subject urban QMED	0.62
Pivotal gauged QMED	2.65
Pivotal adjustment factor QMED	0.95
Subject adjusted QMED	**0.59**

Pooling Group

Station	**Amax years**
09011 FRANKFORT (Post 21/08/19	16
08005 KINSALEY HALL	18
10022 CARRICKMINES	17
08012 BALLYBOGHIL	19
08002 NAUL	21
08007 ASHBOURNE	15
10021 COMMONS ROAD	24
09002 LUCAN	25
08009 BALHEARY	15
06033 CONEYBURROW BR.	25

09035 KILLEEN ROAD	9
24022 HOSPITAL	20
06031 CURRALHIR	18
08003 FIELDSTOWN	18
16051 CLOBANNA	13
25034 ROCHFORT	26
36031 LISDARN	30
06030 BALLYGOLY	27
25040 ROSCREA	19
26022 KILMORE	33
08008 BROADMEADOW	25
14009 CUSHINA	25
14007 DERRYBROCK	24
09010 WALDRONS BRIDGE	19

Selected Flood Growth Curve



Pooled growth curve	LO reduced variate
0.12	-6.8
0.18	-5.77
0.21	-5.27
0.24	-4.94
0.26	-4.69
0.28	-4.49
0.29	-4.32
0.3	-4.18
0.32	-4.05
0.33	-3.94
0.34	-3.84
0.35	-3.75
0.36	-3.66
0.37	-3.58
0.37	-3.51
0.38	-3.44
0.39	-3.38
0.4	-3.32
0.4	-3.26
0.41	-3.2
0.41	-3.15
0.42	-3.1
0.43	-3.05
0.43	-3.01
0.44	-2.97
0.44	-2.92
0.45	-2.88
0.45	-2.84
0.46	-2.81

0.46	-2.77
0.47	-2.73
0.47	-2.7
0.48	-2.67
0.48	-2.63
0.49	-2.6
0.49	-2.57
0.49	-2.54
0.5	-2.51
0.5	-2.48
0.51	-2.46
0.51	-2.43
0.52	-2.4
0.52	-2.38
0.52	-2.35
0.53	-2.33
0.53	-2.3
0.53	-2.28
0.54	-2.26
0.54	-2.23
0.54	-2.21
0.55	-2.19
0.55	-2.17
0.55	-2.14
0.56	-2.12
0.56	-2.1
0.56	-2.08
0.57	-2.06
0.57	-2.04
0.57	-2.02
0.58	-2
0.58	-1.98
0.58	-1.97
0.59	-1.95
0.59	-1.93
0.59	-1.91
0.59	-1.89
0.6	-1.88
0.6	-1.86
0.6	-1.84
0.61	-1.83
0.61	-1.81
0.61	-1.79
0.61	-1.78
0.62	-1.76
0.62	-1.74
0.62	-1.73
0.63	-1.71
0.63	-1.7
0.63	-1.68
0.63	-1.67
0.64	-1.65
0.64	-1.64
0.64	-1.62
0.64	-1.61
0.65	-1.59
0.65	-1.58

0.65	-1.57
0.65	-1.55
0.66	-1.54
0.66	-1.53
0.66	-1.51
0.66	-1.5
0.67	-1.48
0.67	-1.47
0.67	-1.46
0.67	-1.45
0.68	-1.43
0.68	-1.42
0.68	-1.41
0.68	-1.39
0.69	-1.38
0.69	-1.37
0.69	-1.36
0.69	-1.35
0.7	-1.33
0.7	-1.32
0.7	-1.31
0.7	-1.3
0.7	-1.29
0.71	-1.27
0.71	-1.26
0.71	-1.25
0.71	-1.24
0.72	-1.23
0.72	-1.22
0.72	-1.2
0.72	-1.19
0.73	-1.18
0.73	-1.17
0.73	-1.16
0.73	-1.15
0.73	-1.14
0.74	-1.13
0.74	-1.12
0.74	-1.11
0.74	-1.1
0.74	-1.09
0.75	-1.07
0.75	-1.06
0.75	-1.05
0.75	-1.04
0.76	-1.03
0.76	-1.02
0.76	-1.01
0.76	-1
0.76	-0.99
0.77	-0.98
0.77	-0.97
0.77	-0.96
0.77	-0.95
0.77	-0.94
0.78	-0.93
0.78	-0.92

0.78	-0.91
0.78	-0.9
0.78	-0.89
0.79	-0.88
0.79	-0.87
0.79	-0.86
0.79	-0.85
0.8	-0.85
0.8	-0.84
0.8	-0.83
0.8	-0.82
0.8	-0.81
0.81	-0.8
0.81	-0.79
0.81	-0.78
0.81	-0.77
0.81	-0.76
0.82	-0.75
0.82	-0.74
0.82	-0.73
0.82	-0.72
0.82	-0.72
0.83	-0.71
0.83	-0.7
0.83	-0.69
0.83	-0.68
0.83	-0.67
0.84	-0.66
0.84	-0.65
0.84	-0.64
0.84	-0.64
0.84	-0.63
0.85	-0.62
0.85	-0.61
0.85	-0.6
0.85	-0.59
0.85	-0.58
0.86	-0.57
0.86	-0.57
0.86	-0.56
0.86	-0.55
0.86	-0.54
0.87	-0.53
0.87	-0.52
0.87	-0.51
0.87	-0.51
0.87	-0.5
0.88	-0.49
0.88	-0.48
0.88	-0.47
0.88	-0.46
0.88	-0.45
0.89	-0.45
0.89	-0.44
0.89	-0.43
0.89	-0.42
0.89	-0.41

0.9	-0.4
0.9	-0.4
0.9	-0.39
0.9	-0.38
0.9	-0.37
0.91	-0.36
0.91	-0.35
0.91	-0.35
0.91	-0.34
0.91	-0.33
0.92	-0.32
0.92	-0.31
0.92	-0.31
0.92	-0.3
0.92	-0.29
0.93	-0.28
0.93	-0.27
0.93	-0.26
0.93	-0.26
0.94	-0.25
0.94	-0.24
0.94	-0.23
0.94	-0.22
0.94	-0.22
0.95	-0.21
0.95	-0.2
0.95	-0.19
0.95	-0.18
0.95	-0.18
0.96	-0.17
0.96	-0.16
0.96	-0.15
0.96	-0.14
0.96	-0.14
0.97	-0.13
0.97	-0.12
0.97	-0.11
0.97	-0.1
0.97	-0.1
0.98	-0.09
0.98	-0.08
0.98	-0.07
0.98	-0.06
0.99	-0.06
0.99	-0.05
0.99	-0.04
0.99	-0.03
0.99	-0.02
1	-0.02
1	-0.01
1	0
1	0.01
1	0.02
1.01	0.02
1.01	0.03
1.01	0.04
1.01	0.05

1.02	0.06
1.02	0.06
1.02	0.07
1.02	0.08
1.02	0.09
1.03	0.1
1.03	0.1
1.03	0.11
1.03	0.12
1.03	0.13
1.04	0.14
1.04	0.14
1.04	0.15
1.04	0.16
1.05	0.17
1.05	0.18
1.05	0.18
1.05	0.19
1.06	0.2
1.06	0.21
1.06	0.22
1.06	0.22
1.06	0.23
1.07	0.24
1.07	0.25
1.07	0.26
1.07	0.26
1.08	0.27
1.08	0.28
1.08	0.29
1.08	0.3
1.09	0.31
1.09	0.31
1.09	0.32
1.09	0.33
1.09	0.34
1.1	0.35
1.1	0.35
1.1	0.36
1.1	0.37
1.11	0.38
1.11	0.39
1.11	0.4
1.11	0.4
1.12	0.41
1.12	0.42
1.12	0.43
1.12	0.44
1.13	0.45
1.13	0.45
1.13	0.46
1.13	0.47
1.14	0.48
1.14	0.49
1.14	0.5
1.14	0.51
1.15	0.51

1.15	0.52
1.15	0.53
1.16	0.54
1.16	0.55
1.16	0.56
1.16	0.57
1.17	0.57
1.17	0.58
1.17	0.59
1.17	0.6
1.18	0.61
1.18	0.62
1.18	0.63
1.19	0.64
1.19	0.64
1.19	0.65
1.19	0.66
1.2	0.67
1.2	0.68
1.2	0.69
1.2	0.7
1.21	0.71
1.21	0.72
1.21	0.72
1.22	0.73
1.22	0.74
1.22	0.75
1.23	0.76
1.23	0.77
1.23	0.78
1.23	0.79
1.24	0.8
1.24	0.81
1.24	0.82
1.25	0.83
1.25	0.84
1.25	0.85
1.26	0.85
1.26	0.86
1.26	0.87
1.27	0.88
1.27	0.89
1.27	0.9
1.28	0.91
1.28	0.92
1.28	0.93
1.29	0.94
1.29	0.95
1.29	0.96
1.3	0.97
1.3	0.98
1.3	0.99
1.31	1
1.31	1.01
1.31	1.02
1.32	1.03
1.32	1.04

1.32	1.05
1.33	1.06
1.33	1.07
1.34	1.09
1.34	1.1
1.34	1.11
1.35	1.12
1.35	1.13
1.35	1.14
1.36	1.15
1.36	1.16
1.37	1.17
1.37	1.18
1.37	1.19
1.38	1.2
1.38	1.22
1.39	1.23
1.39	1.24
1.39	1.25
1.4	1.26
1.4	1.27
1.41	1.29
1.41	1.3
1.42	1.31
1.42	1.32
1.43	1.33
1.43	1.35
1.43	1.36
1.44	1.37
1.44	1.38
1.45	1.39
1.45	1.41
1.46	1.42
1.46	1.43
1.47	1.45
1.47	1.46
1.48	1.47
1.48	1.48
1.49	1.5
1.49	1.51
1.5	1.53
1.5	1.54
1.51	1.55
1.52	1.57
1.52	1.58
1.53	1.59
1.53	1.61
1.54	1.62
1.54	1.64
1.55	1.65
1.56	1.67
1.56	1.68
1.57	1.7
1.58	1.71
1.58	1.73
1.59	1.74
1.59	1.76

1.6	1.78
1.61	1.79
1.62	1.81
1.62	1.83
1.63	1.84
1.64	1.86
1.64	1.88
1.65	1.89
1.66	1.91
1.67	1.93
1.68	1.95
1.68	1.97
1.69	1.98
1.7	2
1.71	2.02
1.72	2.04
1.73	2.06
1.74	2.08
1.74	2.1
1.75	2.12
1.76	2.14
1.77	2.17
1.78	2.19
1.79	2.21
1.8	2.23
1.82	2.26
1.83	2.28
1.84	2.3
1.85	2.33
1.86	2.35
1.87	2.38
1.89	2.4
1.9	2.43
1.91	2.46
1.93	2.48
1.94	2.51
1.96	2.54
1.97	2.57
1.99	2.6
2	2.63
2.02	2.67
2.04	2.7
2.06	2.73
2.08	2.77
2.1	2.81
2.12	2.84
2.14	2.88
2.16	2.92
2.18	2.97
2.21	3.01
2.23	3.05
2.26	3.1
2.29	3.15
2.32	3.2
2.36	3.26
2.39	3.32
2.43	3.38

2.47	3.44
2.51	3.51
2.56	3.58
2.61	3.66
2.67	3.75
2.74	3.84
2.81	3.94
2.89	4.05
2.99	4.18
3.1	4.32
3.23	4.49
3.41	4.69
3.63	4.94
3.95	5.27
4.49	5.77
5.83	6.8

Adopted Growth Factors

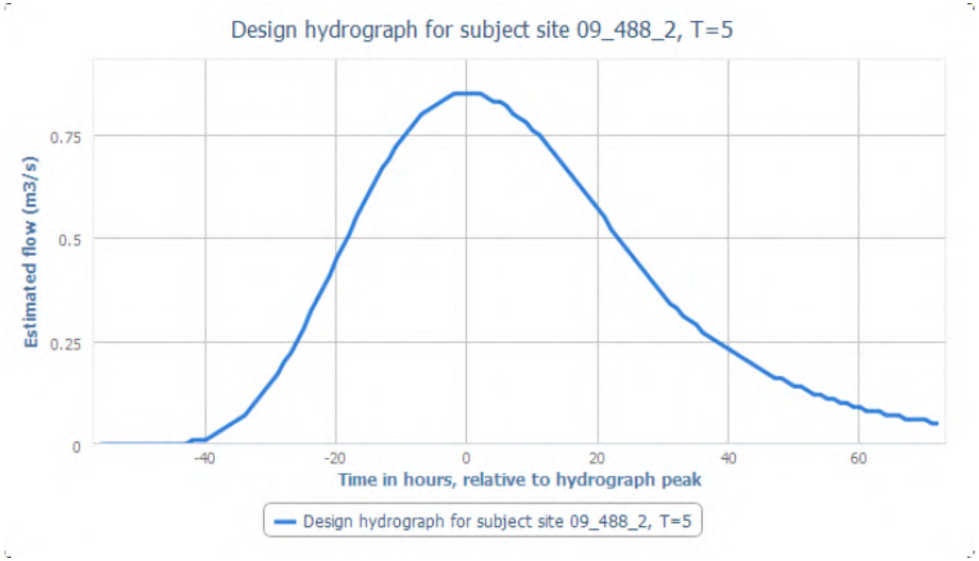
Return Period	Growth Factor	Design Peak Flow (m^3/s)
1.3	0.72	0.42
2	1	0.59
5	1.45	0.85
10	1.79	1.05
20	2.17	1.27
30	2.42	1.42
50	2.77	1.63
100	3.32	1.95
200	3.97	2.33
500	5.02	2.95
1000	5.99	3.52

Hydrograph Width Estimation Summary

Name	Value
Pivotal site	23012 "BALLYMULLEN"
Adjustment type	The user adopted the original PCD hydrograph
Transfer type	The user adjusted the subject site estimate with the pivotal site deformation factor
Deformation factor	1
Custom deformation factor	1
Accepted n	8.57244264603951
Accepted Tr	56.0213493610462
Accepted C	21.3735135813026

Hydrograph Plots

Return Period: 5

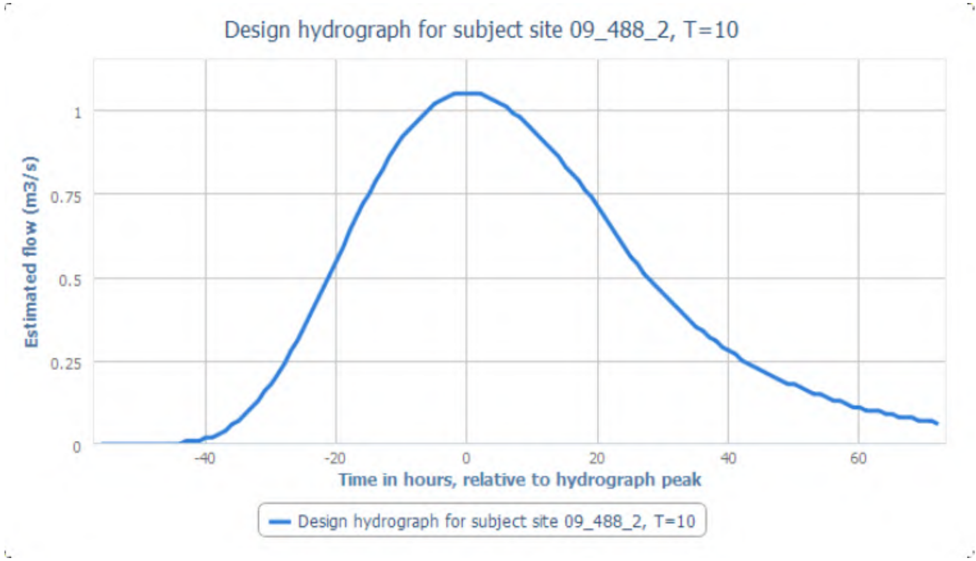


Hours relative to hydrograph peak	Estimated flow (m3/s)
-56.02	0
-56	0
-55	0
-54	0
-53	0
-52	0
-51	0
-50	0
-49	0
-48	0
-47	0
-46	0
-45	0
-44	0
-43	0
-42	0.01
-41	0.01
-40	0.01
-39	0.02
-38	0.03
-37	0.04
-36	0.05
-35	0.06
-34	0.07
-33	0.09
-32	0.11
-31	0.13
-30	0.15
-29	0.17

-28	0.2
-27	0.22
-26	0.25
-25	0.28
-24	0.32
-23	0.35
-22	0.38
-21	0.41
-20	0.45
-19	0.48
-18	0.51
-17	0.55
-16	0.58
-15	0.61
-14	0.64
-13	0.67
-12	0.69
-11	0.72
-10	0.74
-9	0.76
-8	0.78
-7	0.8
-6	0.81
-5	0.82
-4	0.83
-3	0.84
-2	0.85
-1	0.85
0	0.85
1	0.85
2	0.85
3	0.84
4	0.83
5	0.83
6	0.82
7	0.8
8	0.79
9	0.78
10	0.76
11	0.75
12	0.73
13	0.71
14	0.69
15	0.67
16	0.65
17	0.63
18	0.61
19	0.59
20	0.57
21	0.55
22	0.52
23	0.5
24	0.48
25	0.46
26	0.44
27	0.42
28	0.4

29	0.38
30	0.36
31	0.34
32	0.33
33	0.31
34	0.3
35	0.29
36	0.27
37	0.26
38	0.25
39	0.24
40	0.23
41	0.22
42	0.21
43	0.2
44	0.19
45	0.18
46	0.17
47	0.16
48	0.16
49	0.15
50	0.14
51	0.14
52	0.13
53	0.12
54	0.12
55	0.11
56	0.11
57	0.1
58	0.1
59	0.09
60	0.09
61	0.08
62	0.08
63	0.08
64	0.07
65	0.07
66	0.07
67	0.06
68	0.06
69	0.06
70	0.06
71	0.05
72	0.05

Return Period: 10

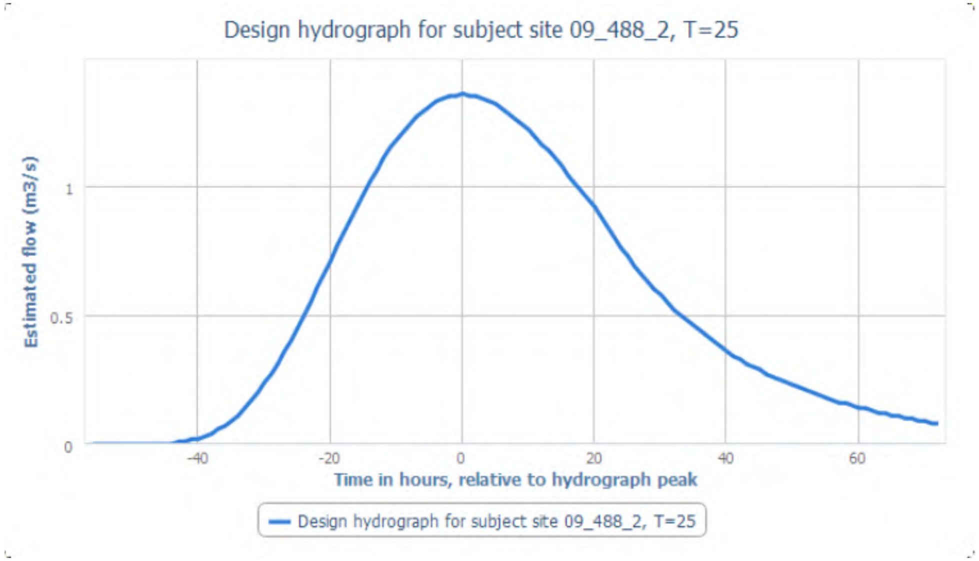


Hours relative to hydrograph peak	Estimated flow (m3/s)
-56.02	0
-56	0
-55	0
-54	0
-53	0
-52	0
-51	0
-50	0
-49	0
-48	0
-47	0
-46	0
-45	0
-44	0
-43	0.01
-42	0.01
-41	0.01
-40	0.02
-39	0.02
-38	0.03
-37	0.04
-36	0.06
-35	0.07
-34	0.09
-33	0.11
-32	0.13
-31	0.16
-30	0.18
-29	0.21
-28	0.24
-27	0.28

-26	0.31
-25	0.35
-24	0.39
-23	0.43
-22	0.47
-21	0.51
-20	0.55
-19	0.59
-18	0.64
-17	0.68
-16	0.72
-15	0.75
-14	0.79
-13	0.82
-12	0.86
-11	0.89
-10	0.92
-9	0.94
-8	0.96
-7	0.98
-6	1
-5	1.02
-4	1.03
-3	1.04
-2	1.05
-1	1.05
0	1.05
1	1.05
2	1.05
3	1.04
4	1.03
5	1.02
6	1.01
7	0.99
8	0.98
9	0.96
10	0.94
11	0.92
12	0.9
13	0.88
14	0.86
15	0.83
16	0.81
17	0.79
18	0.76
19	0.74
20	0.71
21	0.68
22	0.65
23	0.62
24	0.59
25	0.56
26	0.54
27	0.51
28	0.49
29	0.47
30	0.45

31	0.43
32	0.41
33	0.39
34	0.37
35	0.35
36	0.34
37	0.32
38	0.31
39	0.29
40	0.28
41	0.27
42	0.25
43	0.24
44	0.23
45	0.22
46	0.21
47	0.2
48	0.19
49	0.18
50	0.18
51	0.17
52	0.16
53	0.15
54	0.15
55	0.14
56	0.13
57	0.13
58	0.12
59	0.11
60	0.11
61	0.1
62	0.1
63	0.1
64	0.09
65	0.09
66	0.08
67	0.08
68	0.08
69	0.07
70	0.07
71	0.07
72	0.06

Return Period: 25

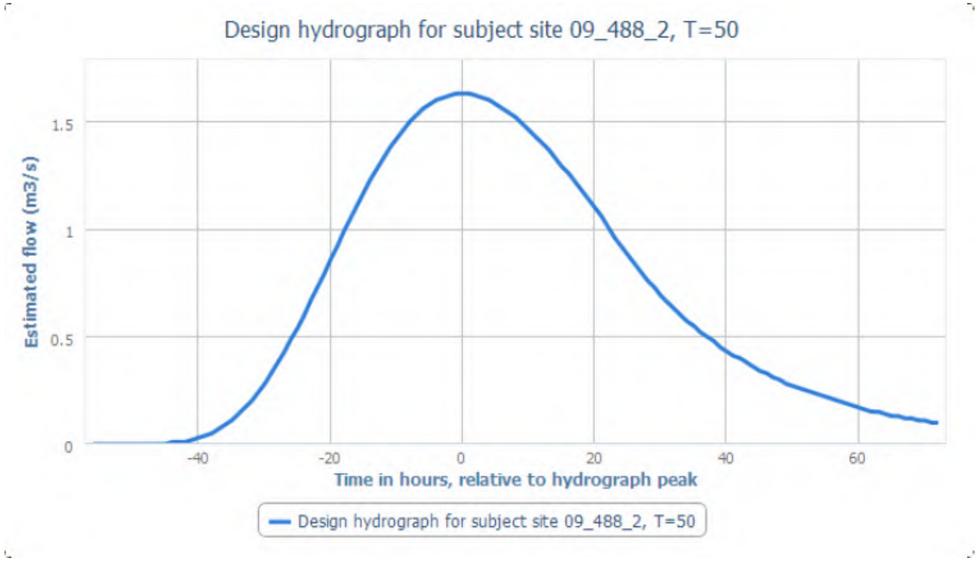


Hours relative to hydrograph peak	Estimated flow (m3/s)
-56.02	0
-56	0
-55	0
-54	0
-53	0
-52	0
-51	0
-50	0
-49	0
-48	0
-47	0
-46	0
-45	0
-44	0
-43	0.01
-42	0.01
-41	0.02
-40	0.02
-39	0.03
-38	0.04
-37	0.06
-36	0.07
-35	0.09
-34	0.11
-33	0.14
-32	0.17
-31	0.2
-30	0.24
-29	0.27
-28	0.31
-27	0.36

-26	0.4
-25	0.45
-24	0.5
-23	0.55
-22	0.61
-21	0.66
-20	0.71
-19	0.77
-18	0.82
-17	0.87
-16	0.92
-15	0.97
-14	1.02
-13	1.06
-12	1.11
-11	1.15
-10	1.18
-9	1.21
-8	1.24
-7	1.27
-6	1.29
-5	1.31
-4	1.33
-3	1.34
-2	1.35
-1	1.35
0	1.36
1	1.35
2	1.35
3	1.34
4	1.33
5	1.32
6	1.3
7	1.28
8	1.26
9	1.24
10	1.22
11	1.19
12	1.16
13	1.14
14	1.11
15	1.08
16	1.04
17	1.01
18	0.98
19	0.95
20	0.92
21	0.88
22	0.84
23	0.8
24	0.76
25	0.73
26	0.69
27	0.66
28	0.63
29	0.6
30	0.58

31	0.55
32	0.52
33	0.5
34	0.48
35	0.46
36	0.44
37	0.42
38	0.4
39	0.38
40	0.36
41	0.34
42	0.33
43	0.31
44	0.3
45	0.29
46	0.27
47	0.26
48	0.25
49	0.24
50	0.23
51	0.22
52	0.21
53	0.2
54	0.19
55	0.18
56	0.17
57	0.16
58	0.16
59	0.15
60	0.14
61	0.14
62	0.13
63	0.12
64	0.12
65	0.11
66	0.11
67	0.1
68	0.1
69	0.09
70	0.09
71	0.08
72	0.08

Return Period: 50

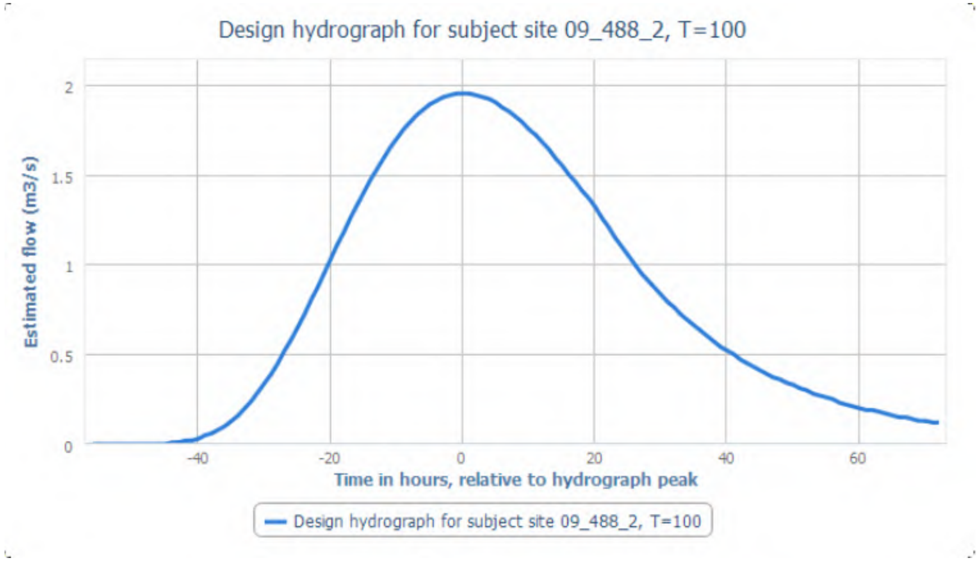


Hours relative to hydrograph peak	Estimated flow (m3/s)
-56.02	0
-56	0
-55	0
-54	0
-53	0
-52	0
-51	0
-50	0
-49	0
-48	0
-47	0
-46	0
-45	0
-44	0.01
-43	0.01
-42	0.01
-41	0.02
-40	0.03
-39	0.04
-38	0.05
-37	0.07
-36	0.09
-35	0.11
-34	0.14
-33	0.17
-32	0.2
-31	0.24
-30	0.28
-29	0.33
-28	0.38
-27	0.43

-26	0.49
-25	0.54
-24	0.6
-23	0.67
-22	0.73
-21	0.79
-20	0.86
-19	0.92
-18	0.99
-17	1.05
-16	1.11
-15	1.17
-14	1.23
-13	1.28
-12	1.33
-11	1.38
-10	1.42
-9	1.46
-8	1.5
-7	1.53
-6	1.56
-5	1.58
-4	1.6
-3	1.61
-2	1.62
-1	1.63
0	1.63
1	1.63
2	1.62
3	1.61
4	1.6
5	1.58
6	1.56
7	1.54
8	1.52
9	1.49
10	1.46
11	1.43
12	1.4
13	1.37
14	1.33
15	1.29
16	1.26
17	1.22
18	1.18
19	1.14
20	1.1
21	1.06
22	1.01
23	0.96
24	0.92
25	0.88
26	0.84
27	0.8
28	0.76
29	0.73
30	0.69

31	0.66
32	0.63
33	0.6
34	0.57
35	0.55
36	0.52
37	0.5
38	0.48
39	0.45
40	0.43
41	0.41
42	0.4
43	0.38
44	0.36
45	0.34
46	0.33
47	0.31
48	0.3
49	0.28
50	0.27
51	0.26
52	0.25
53	0.24
54	0.23
55	0.22
56	0.21
57	0.2
58	0.19
59	0.18
60	0.17
61	0.16
62	0.15
63	0.15
64	0.14
65	0.13
66	0.13
67	0.12
68	0.12
69	0.11
70	0.11
71	0.1
72	0.1

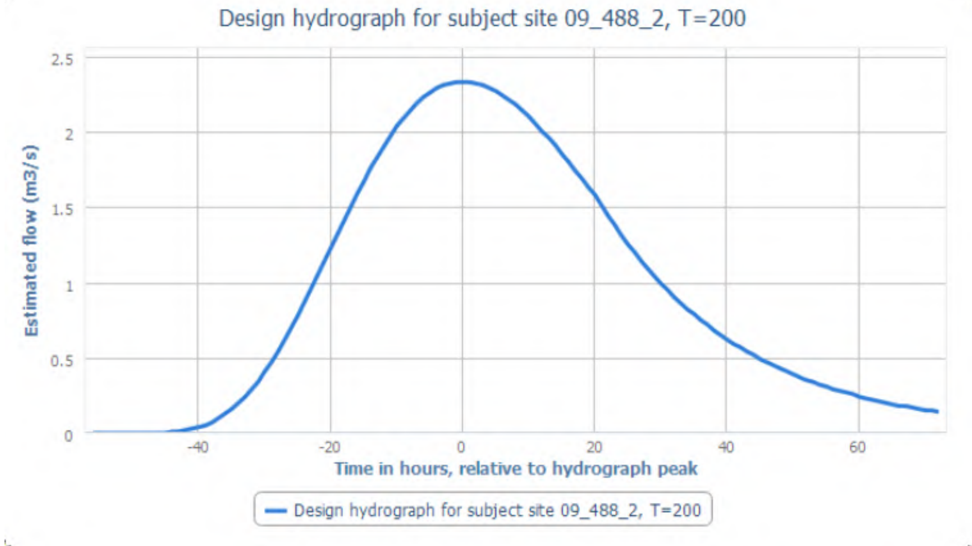
Return Period: 100



Hours relative to hydrograph peak	Estimated flow (m3/s)
-56.02	0
-56	0
-55	0
-54	0
-53	0
-52	0
-51	0
-50	0
-49	0
-48	0
-47	0
-46	0
-45	0
-44	0.01
-43	0.01
-42	0.02
-41	0.02
-40	0.03
-39	0.05
-38	0.06
-37	0.08
-36	0.1
-35	0.13
-34	0.16
-33	0.2
-32	0.24
-31	0.29
-30	0.34
-29	0.39
-28	0.45
-27	0.52
-26	0.58
-25	0.65
-24	0.72
-23	0.8
-22	0.87
-21	0.95
-20	1.03
-19	1.11
-18	1.18
-17	1.26
-16	1.33
-15	1.4
-14	1.47
-13	1.53
-12	1.59
-11	1.65
-10	1.7
-9	1.75
-8	1.79
-7	1.83
-6	1.86
-5	1.89
-4	1.91
-3	1.93
-2	1.94
-1	1.95
0	1.95
1	1.95
2	1.94
3	1.93
4	1.92
5	1.9
6	1.87
7	1.85
8	1.82
9	1.79
10	1.75
11	1.72
12	1.68
13	1.64
14	1.59
15	1.55
16	1.5
17	1.46
18	1.41
19	1.37
20	1.32
21	1.26
22	1.21
23	1.15
24	1.1
25	1.05
26	1
27	0.95
28	0.91
29	0.87
30	0.83

31	0.79
32	0.76
33	0.72
34	0.69
35	0.66
36	0.63
37	0.6
38	0.57
39	0.54
40	0.52
41	0.5
42	0.47
43	0.45
44	0.43
45	0.41
46	0.39
47	0.37
48	0.36
49	0.34
50	0.33
51	0.31
52	0.3
53	0.28
54	0.27
55	0.26
56	0.25
57	0.23
58	0.22
59	0.21
60	0.2
61	0.19
62	0.19
63	0.18
64	0.17
65	0.16
66	0.15
67	0.15
68	0.14
69	0.13
70	0.13
71	0.12
72	0.12

Return Period: 200



Hours relative to hydrograph peak	Estimated flow (m3/s)
-56.02	0
-56	0
-55	0
-54	0
-53	0
-52	0
-51	0
-50	0
-49	0
-48	0
-47	0
-46	0
-45	0
-44	0.01
-43	0.01
-42	0.02
-41	0.03
-40	0.04
-39	0.05
-38	0.07
-37	0.1
-36	0.13
-35	0.16
-34	0.2
-33	0.24
-32	0.29
-31	0.34
-30	0.41
-29	0.47
-28	0.54
-27	0.62

-26	0.7
-25	0.78
-24	0.87
-23	0.96
-22	1.05
-21	1.14
-20	1.23
-19	1.32
-18	1.41
-17	1.5
-16	1.59
-15	1.67
-14	1.76
-13	1.83
-12	1.9
-11	1.97
-10	2.04
-9	2.09
-8	2.14
-7	2.19
-6	2.23
-5	2.26
-4	2.29
-3	2.31
-2	2.32
-1	2.33
0	2.33
1	2.33
2	2.32
3	2.31
4	2.29
5	2.27
6	2.24
7	2.21
8	2.18
9	2.14
10	2.1
11	2.05
12	2
13	1.96
14	1.91
15	1.85
16	1.8
17	1.74
18	1.69
19	1.63
20	1.58
21	1.51
22	1.44
23	1.38
24	1.31
25	1.25
26	1.2
27	1.14
28	1.09
29	1.04
30	0.99

31	0.95
32	0.9
33	0.86
34	0.82
35	0.79
36	0.75
37	0.72
38	0.68
39	0.65
40	0.62
41	0.59
42	0.57
43	0.54
44	0.52
45	0.49
46	0.47
47	0.45
48	0.43
49	0.41
50	0.39
51	0.37
52	0.35
53	0.34
54	0.32
55	0.31
56	0.29
57	0.28
58	0.27
59	0.26
60	0.24
61	0.23
62	0.22
63	0.21
64	0.2
65	0.19
66	0.18
67	0.18
68	0.17
69	0.16
70	0.15
71	0.15
72	0.14

Project:	Dalguise, Monkstown, Co. Dublin
Ref:	M02136-04
Culvert Ref:	Stradbrook Stream
Date:	06/04/2022

Purpose: *To assess hydraulic capacity of culvert at Stradbrook Stream using the Colebrooke White Equation*

Inputs:

Ks	0.15	*mm*		
Diameter	1200	*mm*		
Gradient	0.001064	*1 in 940*		*(From survey data)*
Peak Inflow	1.2	*m^3/s*	*(0.6 l/s)*	*(From flow assessment)*

Results:

Pipe Capacity	1.543	*m^3/s*
Velocity	1.365	*m/s*

Checks:

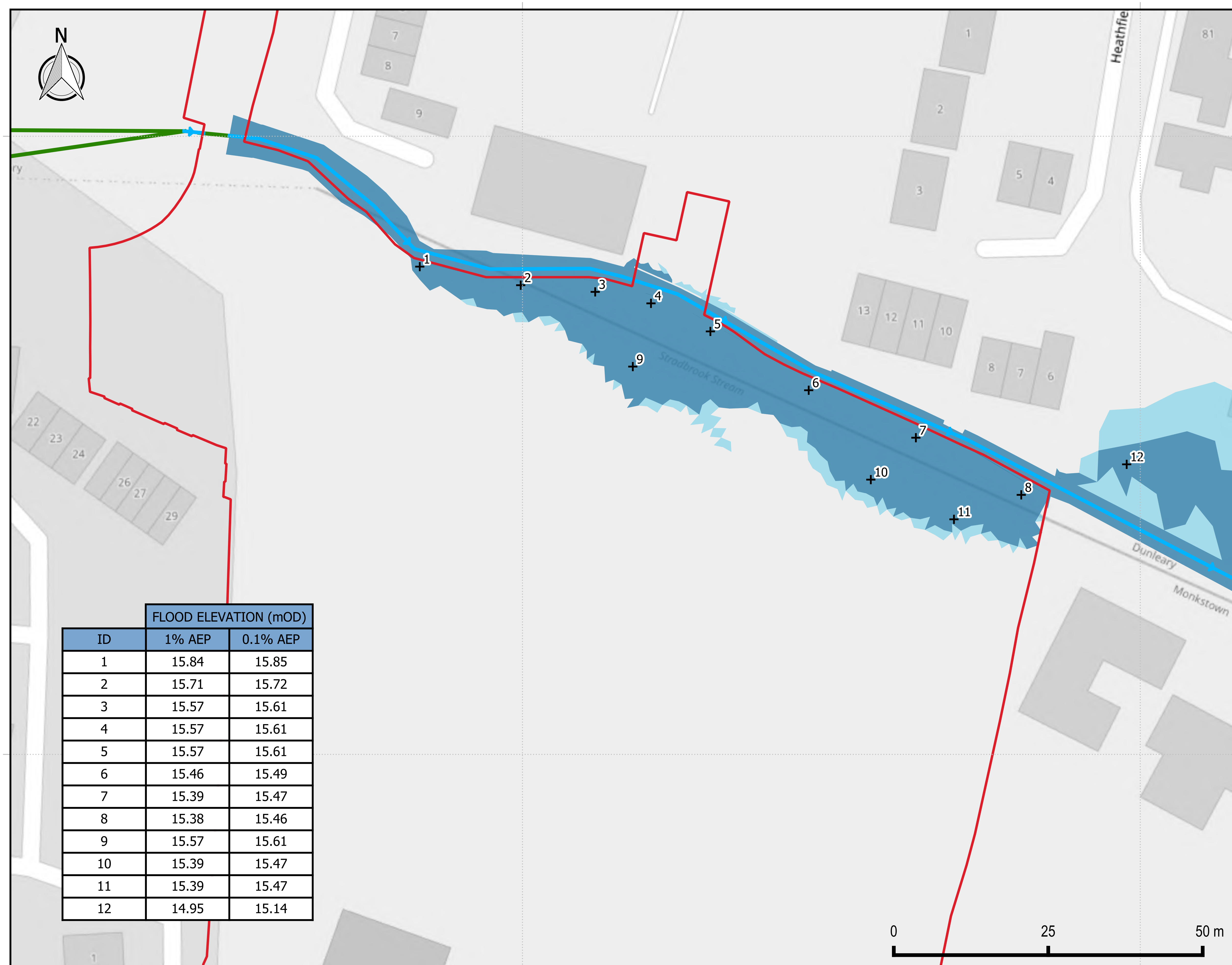
Inflow as % of capacity 77.76%

Capacity > Inflow? *Ok*

By	Checked	Revision	Reason for Change	Date
SN	DKS	Original		06/04/2022

Appendix E

Site-Specific Flood Maps



	FLOOD ELEVATION (mOD)	
ID	1% AEP	0.1% AEP
1	15.84	15.85
2	15.71	15.72
3	15.57	15.61
4	15.57	15.61
5	15.57	15.61
6	15.46	15.49
7	15.39	15.47
8	15.38	15.46
9	15.57	15.61
10	15.39	15.47
11	15.39	15.47
12	14.95	15.14

MODEL OVERVIEW

LEGEND

- Site Boundary
- Modelled River Centreline
- Conduits
- Flood Extent Sample Points
- 1% AEP (Flood Zone A)
- 0.1% AEP (Flood Zone B)

NOTES

1. ALL LEVELS INDICATED ARE TO ORDNANCE DATUM
2. FLOOD EXTENTS WITHIN THE RED LINE BOUNDARY ARE PLOTTED ON GROUND BASED TOPOGRAPHIC SURVEY.
3. FLOOD EXTENTS SHOWN OUTWITH THE PLANNING BOUNDARY ARE PLOTTED ON A COMBINATION OF GROUND BASED TOPOGRAPHIC SURVEY AND LIDAR AND AS SUCH ARE NOT SUITABLE FOR PROPERTY LEVEL ASSESSMENT.
4. ALL GRID COORDINATE INFORMATION IS TO IRISH TRANSVERSE MERCATOR.

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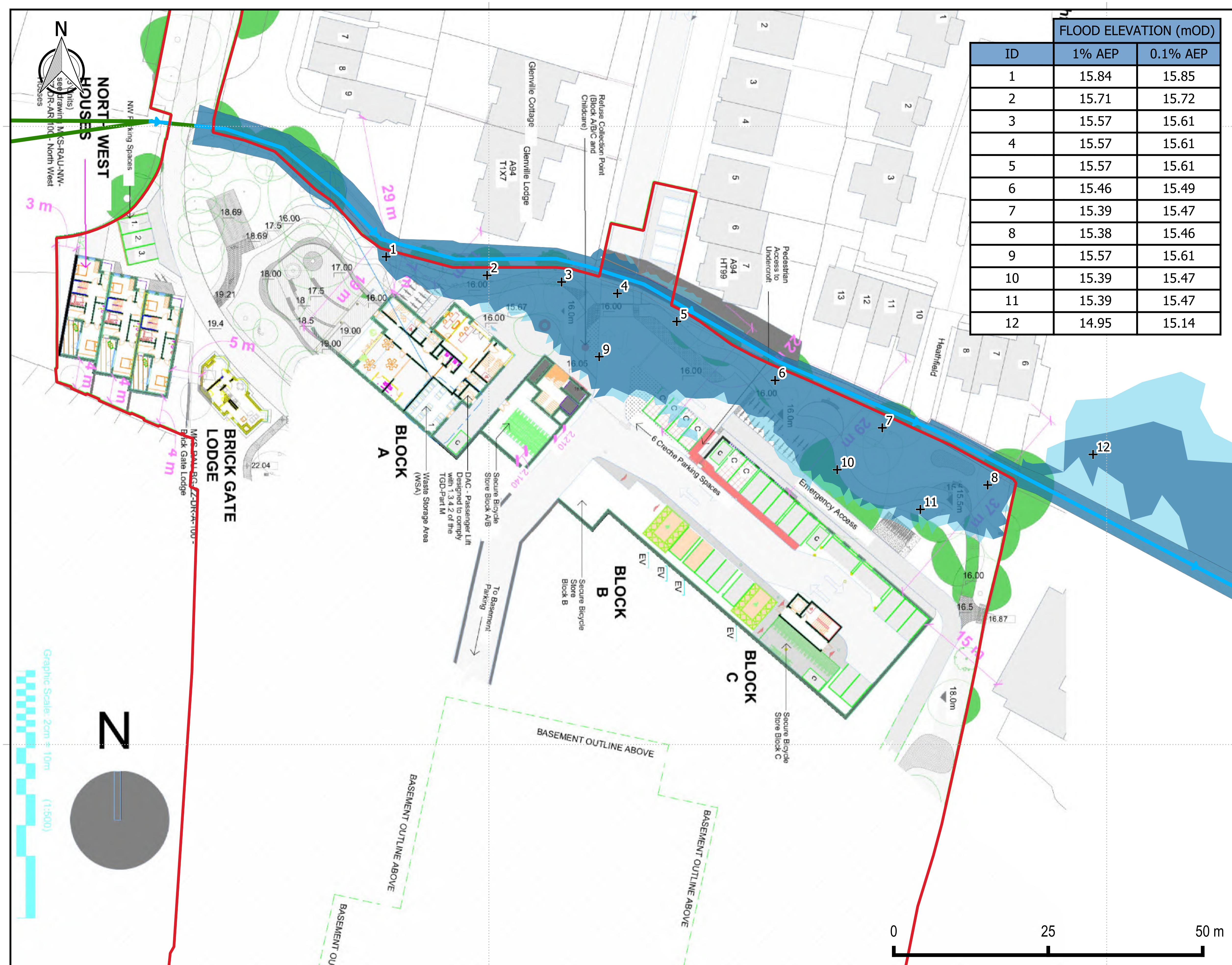
PROJECT: DALGUISE HOUSE, MONKSTOWN	HYDROLOGY SCENARIO: PRESENT DAY	SCALE: AS SHOWN	ORIGINAL SIZE: A1
MAP TYPE: FLOOD ZONE / EXTENT	GEOMETRY SCENARIO: EXISTING	DRAWN BY: DL	APPROVED BY: DKS
SOURCE: FLUVIAL / FLOOD EVENT: 1% AEP / 0.1% AEP	FIGURE NUMBER: M02136-04_FL50	REVISION: 2	DATE: 29/04/2022



	FLOOD ELEVATION (mOD)	
ID	1% AEP	0.1% AEP
1	15.84	15.85
2	15.71	15.72
3	15.57	15.61
4	15.57	15.61
5	15.57	15.61
6	15.46	15.49
7	15.39	15.47
8	15.38	15.46
9	15.57	15.61
10	15.39	15.47
11	15.39	15.47
12	14.95	15.14

MODEL OVERVIEW

LEGEND

- Site Boundary
- Modelled River Centreline
- Conduits
- Flood Extent Sample Points
- 1% AEP (Flood Zone A)
- 0.1% AEP (Flood Zone B)

NOTES

1. ALL LEVELS INDICATED ARE TO ORDNANCE DATUM

2.FLOOD EXTENTS WITHIN THE RED LINE BOUNDARY ARE PLOTTED ON GROUND BASED TOPOGRAPHIC SURVEY.

3.FLOOD EXTENTS SHOWN OUTWITH THE PLANNING BOUNDARY ARE PLOTTED ON A COMBINATION OF GROUND BASED TOPOGRAPHIC SURVEY AND LIDAR AND AS SUCH ARE NOT SUITABLE FOR PROPERTY LEVEL ASSESSMENT.

4.ALL GRID COORDINATE INFORMATION IS TO IRISH TRANSVERSE MERCATOR.

5.NOTE THAT THIS FLOOD MAP IS DESIGNED TO FACILITATE A COMPARISON OF FLOOD ZONES WITH PROPOSED DEVELOPMENT AND DOES NOT REPRESENT THE EXISTING OR PROPOSED SCENARIOS FLOOD EXTENTS

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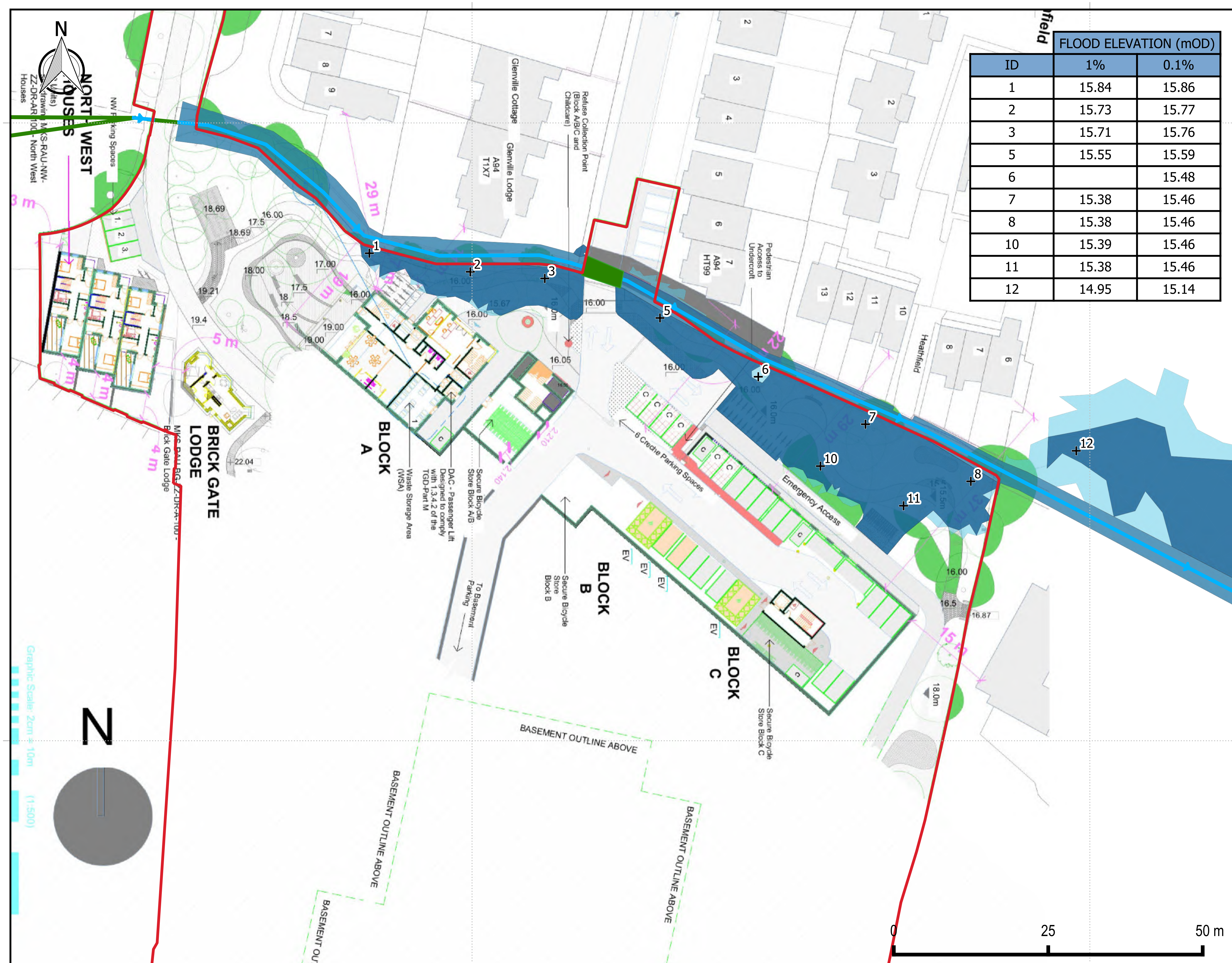
PROJECT		HYDROLOGY SCENARIO	SCALE	ORIGINAL SIZE
DALGUISE HOUSE, MONKSTOWN		PRESENT DAY	1:600	A3
MAP TYPE		GEOMETRY SCENARIO	DRAWN BY	APPROVED BY
FLOOD ZONES OVERLAID ON PROPOSED LAYOUT		EXISTING	DL	DKS
SOURCE	FLOOD EVENT	FIGURE NUMBER	REVISION	DATE
FLUVIAL	1% AEP / 0.1% AEP	M02136-04_FL51	3	10/07/2023



ID	FLOOD ELEVATION (mOD) 1%	0.1%
1	15.84	15.86
2	15.73	15.77
3	15.71	15.76
5	15.55	15.59
6		15.48
7	15.38	15.46
8	15.38	15.46
10	15.39	15.46
11	15.38	15.46
12	14.95	15.14

MODEL OVERVIEW

LEGEND

- Site Boundary
- Modelled River Centreline
- Watercourse Crossings / Conduits
- Flood Extent Sample Points
- 1% AEP
- 0.1% AEP

NOTES

1. ALL LEVELS INDICATED ARE TO ORDNANCE DATUM

2. FLOOD EXTENTS WITHIN THE RED LINE BOUNDARY ARE PLOTTED ON GROUND BASED TOPOGRAPHIC SURVEY.

3. FLOOD EXTENTS SHOWN OUTWITH THE PLANNING BOUNDARY ARE PLOTTED ON A COMBINATION OF GROUND BASED TOPOGRAPHIC SURVEY AND LIDAR AND AS SUCH ARE NOT SUITABLE FOR PROPERTY LEVEL ASSESSMENT.

4. ALL GRID COORDINATE INFORMATION IS TO IRISH TRANSVERSE MERCATOR.

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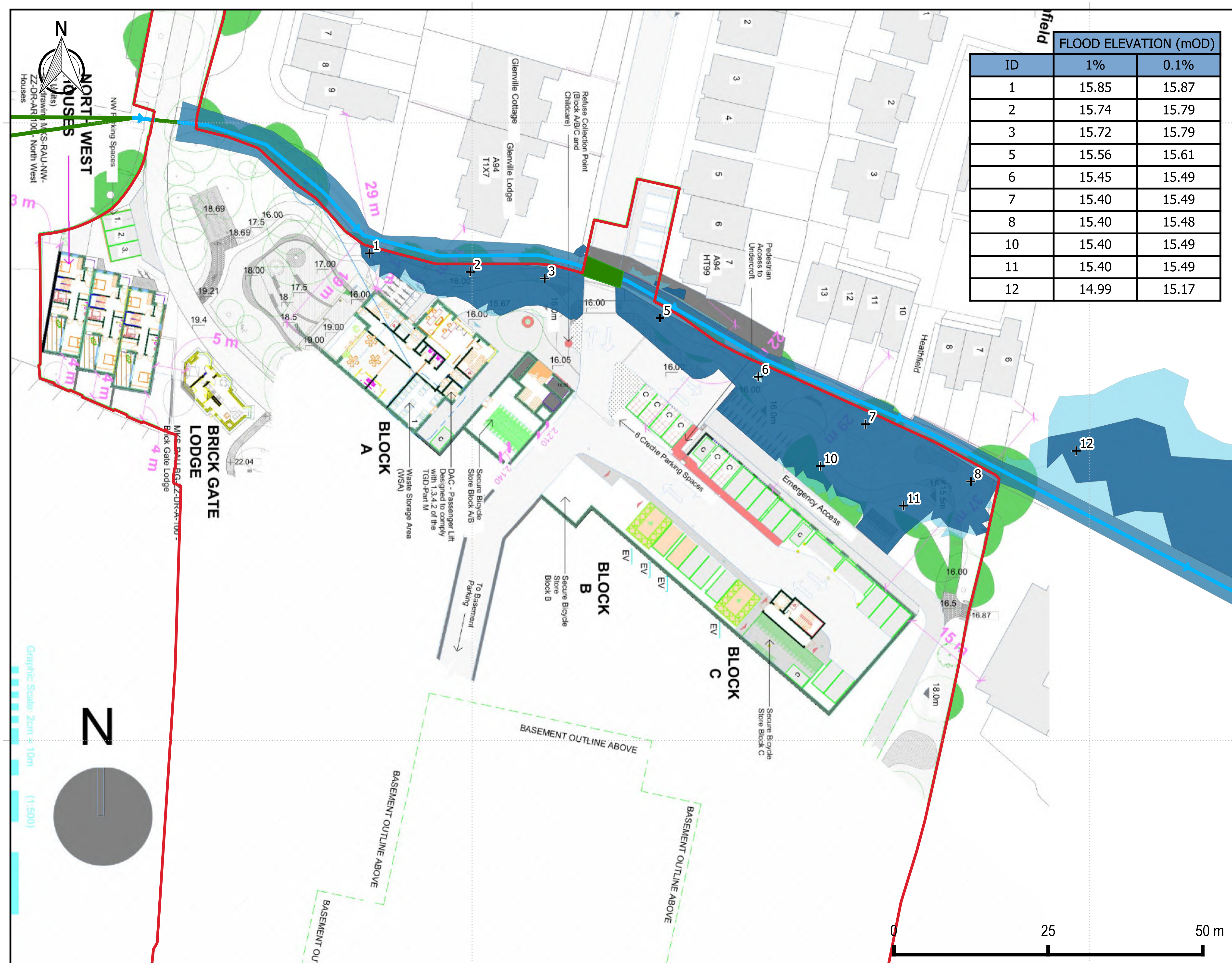
E: info@mccloyconsulting.ie
W: www.mccloyconsulting.ie

PROJECT: DALGUISE HOUSE, MONKSTOWN	HYDROLOGY SCENARIO: PRESENT DAY	SCALE: 1:600	ORIGINAL SIZE: A3
MAP TYPE: FLOOD EXTENT MAP	GEOMETRY SCENARIO: PROPOSED	DRAWN BY: DL	APPROVED BY: DKS
SOURCE: FLUVIAL / FLOOD EVENT: 1% AEP / 0.1% AEP	FIGURE NUMBER: M02136-04_FL60	REVISION: 6	DATE: 10/07/2023



FLOOD ELEVATION (mOD)

ID	1%	0.1%
1	15.85	15.87
2	15.74	15.79
3	15.72	15.79
5	15.56	15.61
6	15.45	15.49
7	15.40	15.49
8	15.40	15.48
10	15.40	15.49
11	15.40	15.49
12	14.99	15.17

MODEL OVERVIEW

LEGEND

- Site Boundary
- Modelled River Centreline
- Watercourse Crossings / Conduits
- Flood Extent Sample Points
- 1% AEP +CC
- 0.1% AEP +CC

NOTES

1. ALL LEVELS INDICATED ARE TO ORDNANCE DATUM

2. FLOOD EXTENTS WITHIN THE RED LINE BOUNDARY ARE PLOTTED ON GROUND BASED TOPOGRAPHIC SURVEY.

3. FLOOD EXTENTS SHOWN OUTWITH THE PLANNING BOUNDARY ARE PLOTTED ON A COMBINATION OF GROUND BASED TOPOGRAPHIC SURVEY AND LIDAR AND AS SUCH ARE NOT SUITABLE FOR PROPERTY LEVEL ASSESSMENT.

4. ALL GRID COORDINATE INFORMATION IS TO IRISH TRANSVERSE MERCATOR.

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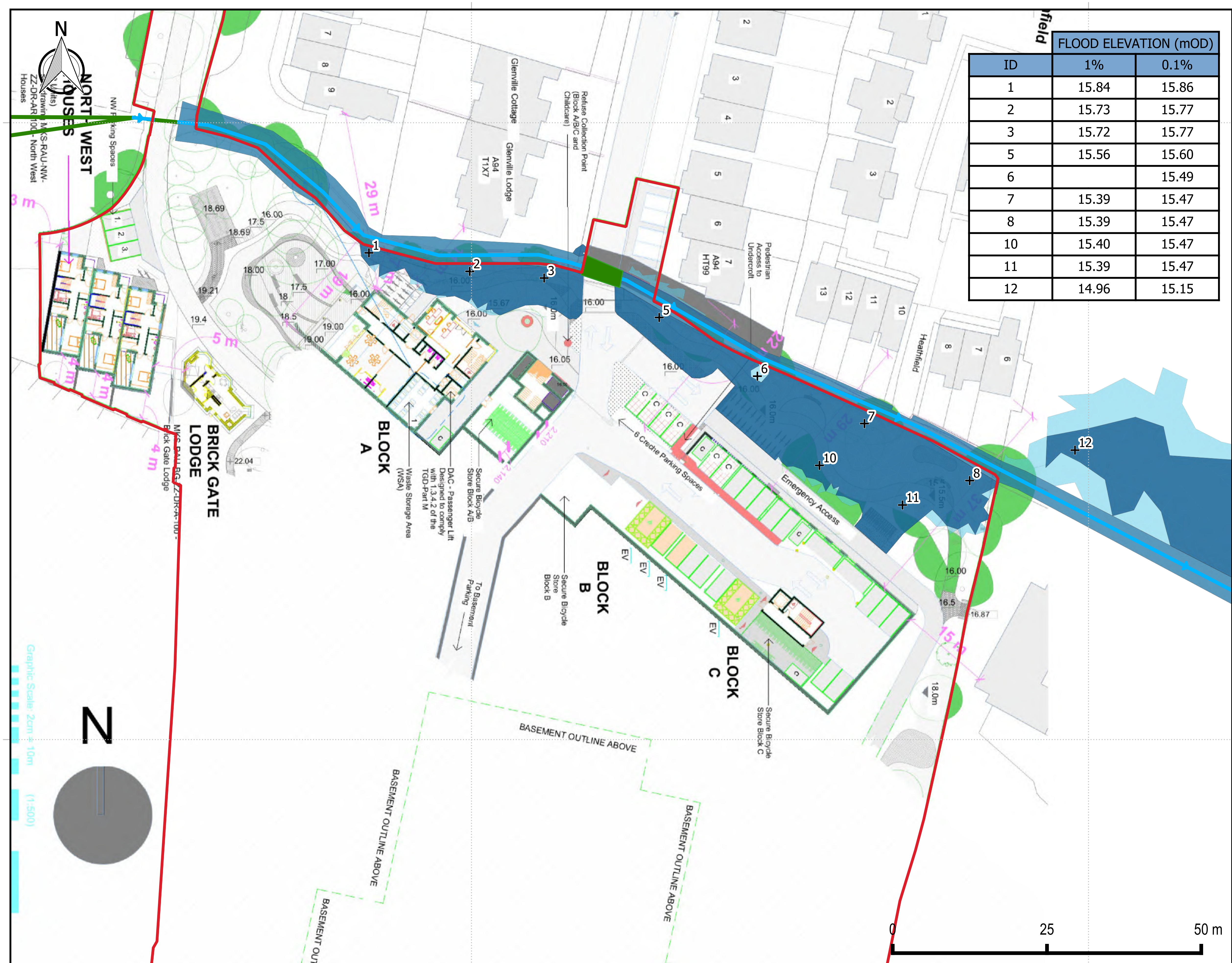
PROJECT		HYDROLOGY SCENARIO	SCALE	ORIGINAL SIZE
DALGUISE HOUSE, MONKSTOWN		CLIMATE CHANGE	1:600	A3
MAP TYPE		GEOMETRY SCENARIO	DRAWN BY	APPROVED BY
FLOOD EXTENT MAP		PROPOSED	DL	DKS
SOURCE	FLOOD EVENT	FIGURE NUMBER	REVISION	DATE
FLUVIAL	1% AEP / 0.1% AEP	M02136-04_FL61	1	13/07/2023



ID	FLOOD ELEVATION (mOD) 1%	0.1%
1	15.84	15.86
2	15.73	15.77
3	15.72	15.77
5	15.56	15.60
6		15.49
7	15.39	15.47
8	15.39	15.47
10	15.40	15.47
11	15.39	15.47
12	14.96	15.15

MODEL OVERVIEW

LEGEND

- Site Boundary
- Modelled River Centreline
- Watercourse Crossings / Conduits
- Flood Extent Sample Points
- 1% AEP
- 0.1% AEP

NOTES

1. ALL LEVELS INDICATED ARE TO ORDNANCE DATUM
2. FLOOD EXTENTS WITHIN THE RED LINE BOUNDARY ARE PLOTTED ON GROUND BASED TOPOGRAPHIC SURVEY.
3. FLOOD EXTENTS SHOWN OUTWITH THE PLANNING BOUNDARY ARE PLOTTED ON A COMBINATION OF GROUND BASED TOPOGRAPHIC SURVEY AND LIDAR AND AS SUCH ARE NOT SUITABLE FOR PROPERTY LEVEL ASSESSMENT.
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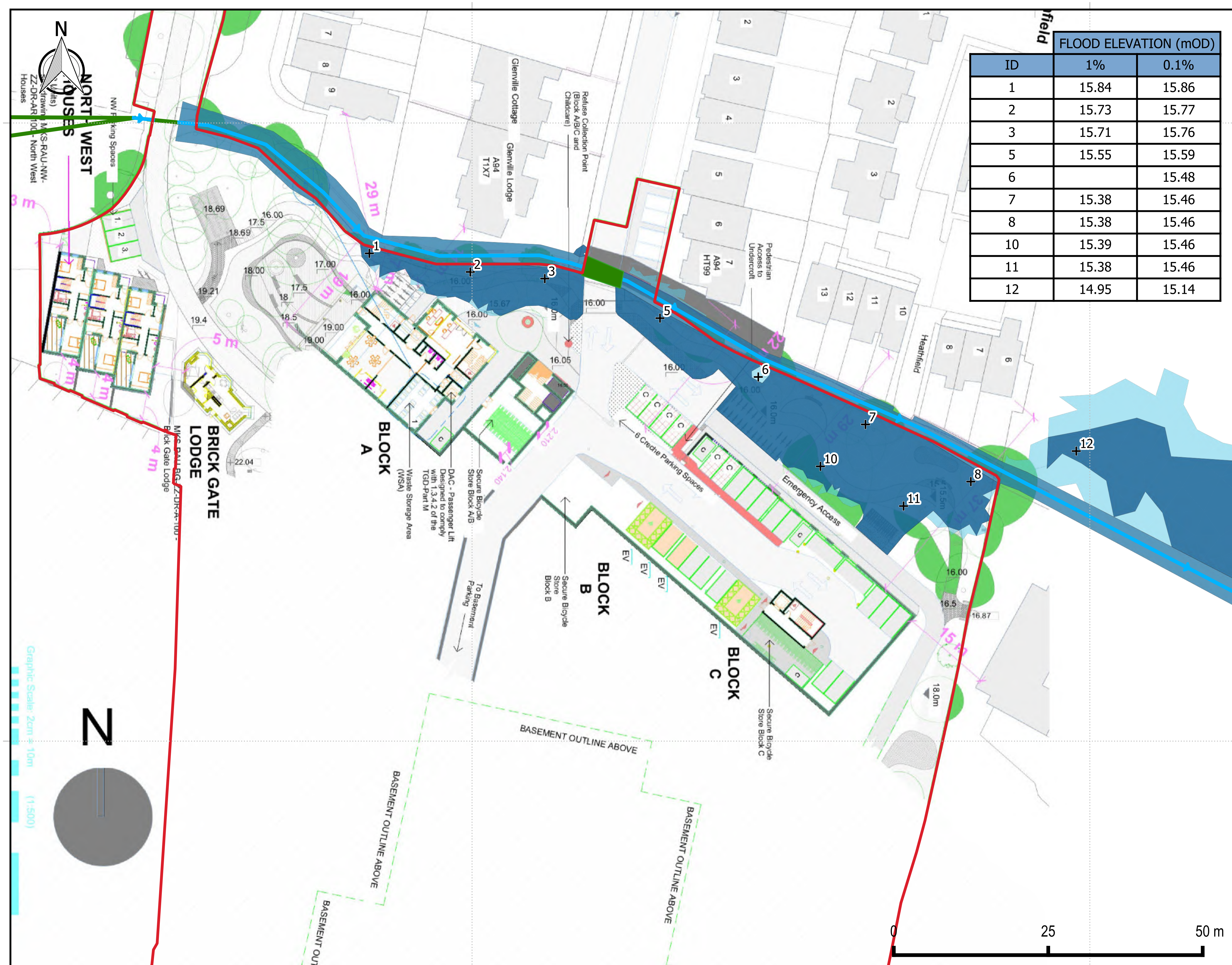
PROJECT: DALGUISE HOUSE, MONKSTOWN		HYDROLOGY SCENARIO: PRESENT DAY	SCALE: 1:600	ORIGINAL SIZE: A3
MAP TYPE: FLOOD EXTENT MAP		GEOMETRY SCENARIO: RICHMOND GREEN CULVERT BLOCKAGE	DRAWN BY: DL	APPROVED BY: DKS
SOURCE: FLUVIAL	FLOOD EVENT: 1% AEP / 0.1% AEP	FIGURE NUMBER: M02136-04_FL62	REVISION: 1	DATE: 14/07/2023



	FLOOD ELEVATION (mOD)	
ID	1%	0.1%
1	15.84	15.86
2	15.73	15.77
3	15.71	15.76
5	15.55	15.59
6		15.48
7	15.38	15.46
8	15.38	15.46
10	15.39	15.46
11	15.38	15.46
12	14.95	15.14

MODEL OVERVIEW

LEGEND

- Site Boundary
- Modelled River Centreline
- Watercourse Crossings / Conduits
- Flood Extent Sample Points
- 1% AEP
- 0.1% AEP

NOTES

1. ALL LEVELS INDICATED ARE TO ORDNANCE DATUM

2. FLOOD EXTENTS WITHIN THE RED LINE BOUNDARY ARE PLOTTED ON GROUND BASED TOPOGRAPHIC SURVEY.

3. FLOOD EXTENTS SHOWN OUTWITH THE PLANNING BOUNDARY ARE PLOTTED ON A COMBINATION OF GROUND BASED TOPOGRAPHIC SURVEY AND LIDAR AND AS SUCH ARE NOT SUITABLE FOR PROPERTY LEVEL ASSESSMENT.

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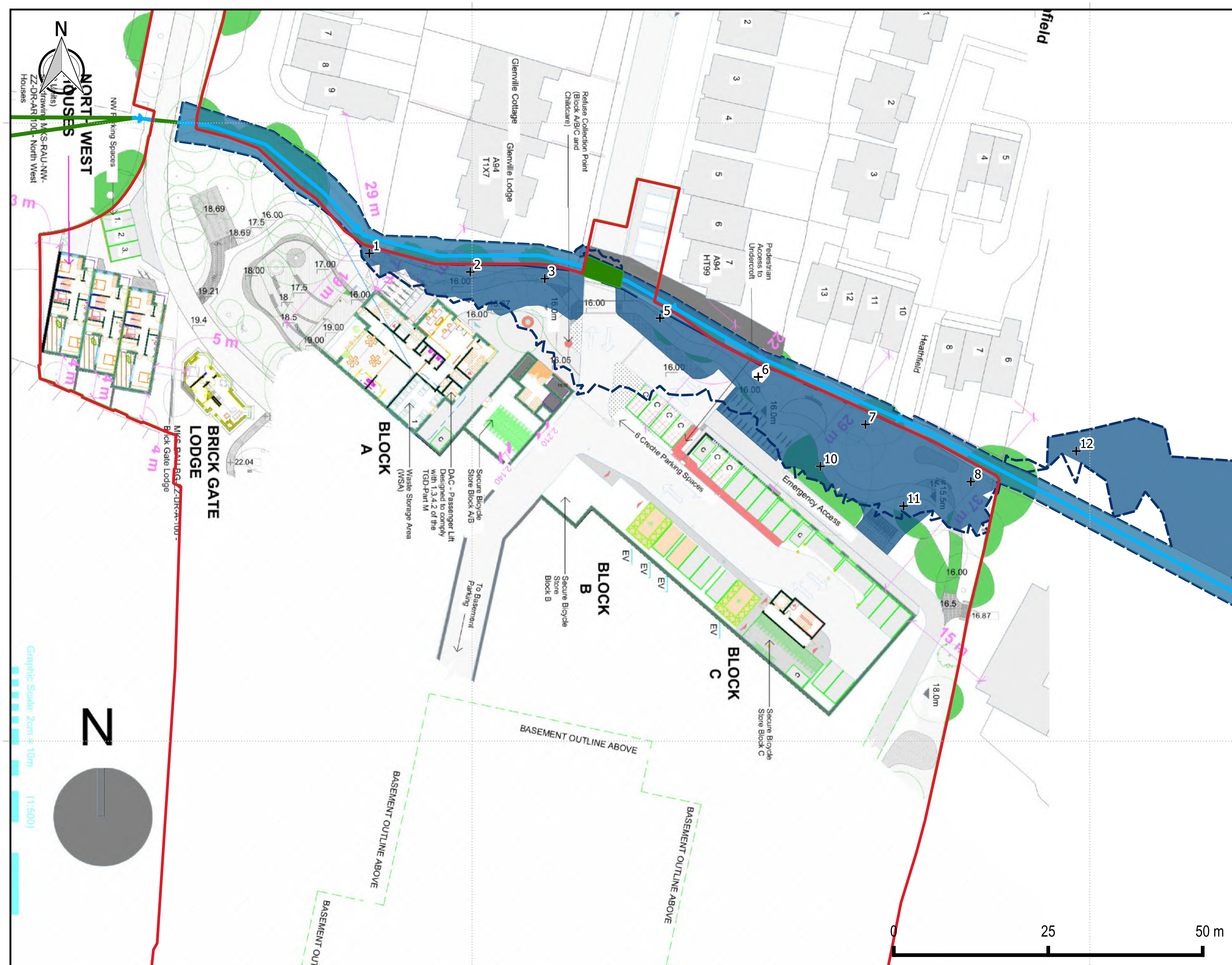
PROJECT	HYDROLOGY SCENARIO	SCALE	ORIGINAL SIZE
DALGUISE HOUSE, MONKSTOWN	PRESENT DAY	1:600	A3
MAP TYPE	GEOMETRY SCENARIO	DRAWN BY	APPROVED BY
FLOOD EXTENT MAP	ALMA PLACE CULVERT BLOCKAGE	DL	DKS
SOURCE: FLUVIAL / FLOOD EVENT: 1% AEP / 0.1% AEP	FIGURE NUMBER	REVISION	DATE
	M02136-04_FL63	1	14/07/2023



MODEL OVERVIEW

LEGEND

- Site Boundary
- Modelled River Centreline
- Watercourse Crossings / Conduits
- Pre-Development Flood Zone A Extent
- Proposed 1% AEP Flood Extent

NOTES

1. ALL LEVELS INDICATED ARE TO ORDNANCE DATUM

2.FLOOD EXTENTS WITHIN THE RED LINE BOUNDARY ARE PLOTTED ON GROUND BASED TOPOGRAPHIC SURVEY.

3.FLOOD EXTENTS SHOWN OUTWITH THE PLANNING BOUNDARY ARE PLOTTED ON A COMBINATION OF GROUND BASED TOPOGRAPHIC SURVEY AND LIDAR AND AS SUCH ARE NOT SUITABLE FOR PROPERTY LEVEL ASSESSMENT.

4.ALL GRID COORDINATE INFORMATION IS TO IRISH TRANSVERSE MERCATOR.

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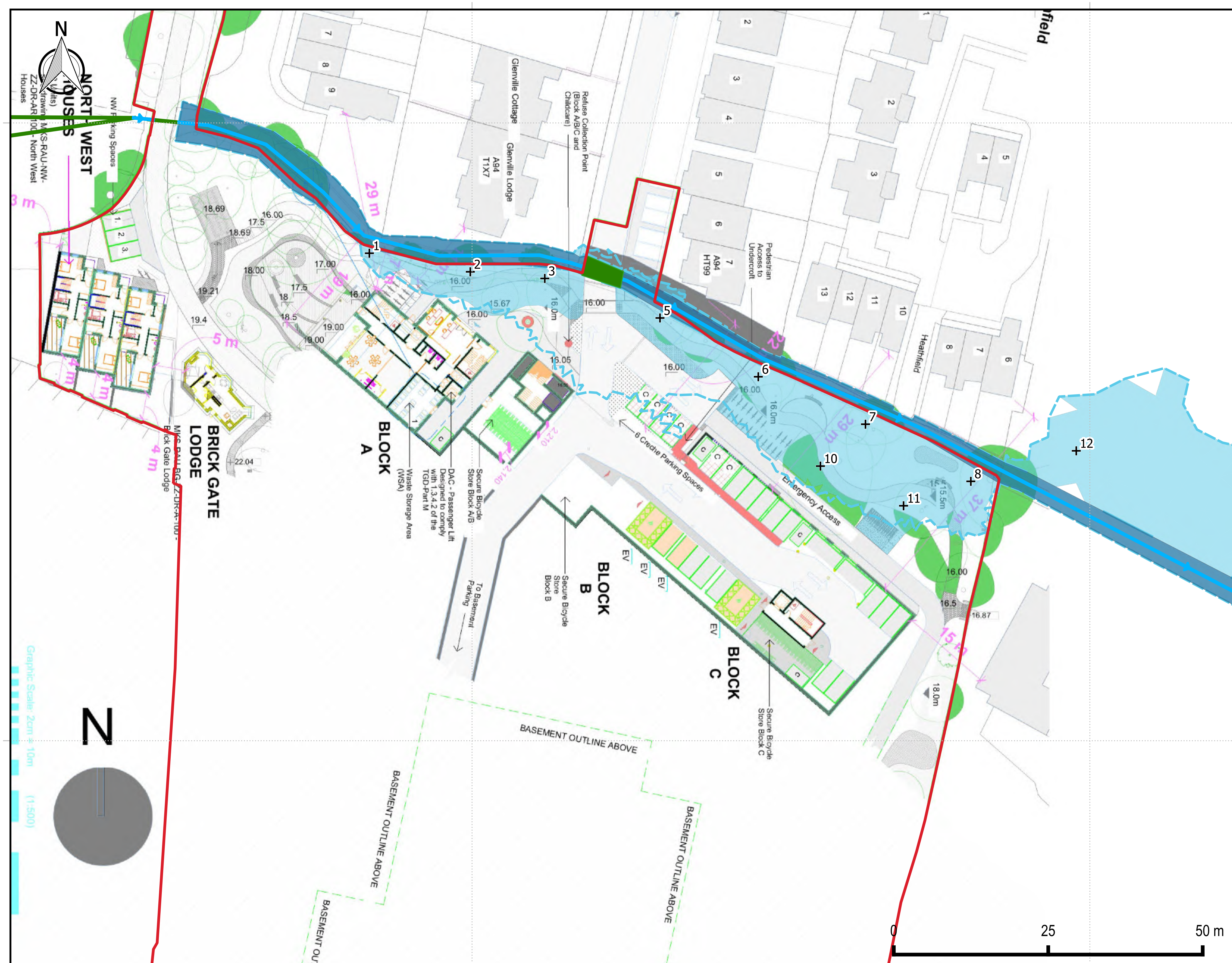
PROJECT		HYDROLOGY SCENARIO	SCALE	ORIGINAL SIZE
DALGUISE HOUSE, MONKSTOWN		PRESENT DAY	1:600	A3
MAP TYPE		GEOMETRY SCENARIO	DRAWN BY	APPROVED BY
PRE AND POST COMPARISON MAP		EXISTING AND PROPOSED	DL	DKS
SOURCE	FLOOD EVENT	FIGURE NUMBER	REVISION	DATE
FLUVIAL	1% AEP	M02136-04_FL71	1	14/07/2023



MODEL OVERVIEW

LEGEND

- Site Boundary
- Modelled River Centreline
- Watercourse Crossings / Conduits
- Pre-Development Flood Zone B Extent
- Proposed 0.1% AEP Flood Extent

NOTES

1. ALL LEVELS INDICATED ARE TO ORDNANCE DATUM

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3.FLOOD EXTENTS SHOWN OUTWITH THE PLANNING BOUNDARY ARE PLOTTED ON A COMBINATION OF GROUND BASED TOPOGRAPHIC SURVEY AND LIDAR AND AS SUCH ARE NOT SUITABLE FOR PROPERTY LEVEL ASSESSMENT.

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PROJECT	HYDROLOGY SCENARIO	SCALE	ORIGINAL SIZE
DALGUISE HOUSE, MONKSTOWN	PRESENT DAY	1:600	A3
MAP TYPE	**GEOMETRY SCENARIO**	**DRAWN BY**	**APPROVED BY**
PRE AND POST COMPARISON MAP	EXISTING AND PROPOSED	DL	DKS
SOURCE: FLUVIAL / **FLOOD EVENT:** 0.1% AEP	**FIGURE NUMBER**	**REVISION**	**DATE**
FLUVIAL / 0.1% AEP	M02136-04_FL72	1	14/07/2023

Appendix F

Site Visit Photographs

Photo Location 1: View Upstream of Stradbrook Stream from centre of Site	Photo Location 2: View Downstream of Stradbrook Stream from centre of Site
	
Photo Location 3: **View of Stradbrook Stream at Upstream extent**	**Photo Location 4:** **View of Stradbrook Stream downstream of the Site**
	
Photo Location 5: **Existing Site Entrance on Monkstown Road**	**Photo Location 6:** **View of Existing Local Access Road to south of the Site**
	

Appendix G

OPW Correspondence

Stephen Neill

From: Oliver Nicholson <oliver.nicholson@opw.ie>
Sent: 15 January 2019 13:49
To: Stephen Neill
Subject: RE: M02121-01_Hydrology Calc advice

Hello Stephen,

All fine here, I hope all of your family are keeping well too.

The FSU is simply not applicable for catchments less than 25km^2, and most definitely not for catchments less than 5km^2.

From research that Fasil carried out a few years ago, the rational method or the Wallingford modified rational method is probably your best bet (http://opw.hydronet.com/data/files/FSU%20Work%20Package%204_2.pdf). This is driven by a design rainfall intensity applied as part of the equation.

Regarding the hydrograph shape,
There is no hydrograph procedure for very small catchments, and so, I agree with what you are proposing, i.e. to scale down a nearby hydrograph shape.
I would challenge anybody to come up with a better alternative.

Regards,

Oliver Nicholson
Civil Engineer MLitt, BE, Dip, CEng, MIEI

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(t) 046 942 6000 (reception)
(e) oliver.nicholson@opw.ie

To send files larger than 9MB go to https://filetransfer.opw.ie/filedrop/oliver.nicholson@opw.ie

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From: Stephen Neill <Stephen.Neill@mccloyconsulting.com>
Sent: 14 January 2019 16:42
To: Oliver Nicholson <oliver.nicholson@opw.ie>
Subject: M02121-01_Hydrology Calc advice

Hey Olly,

How are you? How was your Christmas? Happy new year to you.

I have a couple of hydrology related questions I was hoping you could provide some advice/help with. I'm looking at the calculation of upstream hydrology for a location in Monkstown, Dublin, but there is not available FSU data for it, it appears to be in an FSU black hole. Background is that the site, located at 322887, 228518 (in ITM 722818, 728543), has a small watercourse running adjacent to it. The upstream topographical catchment, calculated using 2m DTM, is 0.06km² but inspection of the local storm network informs of a total upstream catchment of 1.6km².

Question is, with no FSU methodology available what is the preferred OPW calculation method for:

- Calculating peak flow

- Apply hydrograph shape

I carried out a couple of calcs and worked out the 1% AEP using Ioh124 & FSSR 3 variable equation and found the 3 variable to be more conservative. I applied the eastern region growth curve of 2.61 to this and got $0.24m^3/s$ for the 1% AEP. Can you inform if this process is detailed enough to be accepted by OPW? Should I be carrying out further comparative calcs using any other method? And if so which would you recommend?

Can you also provide some advice on application of hydrograph shape? My initial thoughts are to go through the FSU process for an HEP located to the north of the site on another watercourse (09_488_1) and use that shape. The catchment for it is of same size and with similar URBEXT. On completion of this I could scale the hydrograph to my peak flow. Would this method be acceptable to OPW or can you provide alternative method for calculation?

Any help would be gratefully appreciated.

Many thanks

Stephen Neill

Senior Engineer | Belfast

McCloy Consulting

ice award 2016 winner
ICE London Civil Engineering Awards

2016 sustainable Ireland awards WINNER

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Appendix H

Justification Test

JUSTIFICATION TEST FOR DEVELOPMENT MANAGEMENT

This assessment shows that part of the development is located in Flood Zone A and Flood Zone B. Therefore, in line with the requirements of the OPW Guidelines, a Justification Test has been prepared and is presented below.

Part	Item	Response
1	The subject lands have been zoned or otherwise designated for the particular use or form of development in an operative plan, which has been adopted or varied taking account of these Guidelines.	Yes – the site is zoned for residential use in the Dun Laoghaire County Development Plan 2022-2028.
2	*The proposal has been subject to an FRA that demonstrates:*	*Yes – the site has been subject to a site-specific Flood Risk Assessment (SSFRA).*
2 (i)	The development proposed will not increase flood risk elsewhere, and, if practicable will reduce overall flood risk	Yes – the SSFRA demonstrates that the proposed development will not increase flood risk elsewhere by not increasing flood extent / levels outside the site boundary and controlling runoff from the site to greenfield rate.
2 (ii)	The development proposal includes measures to minimise flood risk to people, property, the economy, and the environment as far as reasonably possible.	Yes – no development is located in the proposed scenario floodplain and design levels of development are set higher than adjacent flood levels including appropriate freeboard.
2 (iii)	The development proposed includes measures to ensure that residual risks to the area and / or development can be managed to an acceptable level as regards the adequacy of existing flood protection measures or the design, implementation and funding of any future flood risk management measures and provisions for emergency services access.	Yes – no development is located in the proposed scenario floodplain. Freeboard has been applied to design flood levels to allow for residual risk, climate change, culvert blockage and inherent modelling uncertainties. The proposed watercourse crossing, designed as per OPW Section 50 guidelines, will facilitate safe access and egress to / from the site at a level higher than the maximum design flood.
2 (iv)	The development proposed addresses the above in a manner that is also compatible with the achievement of wider planning objectives in relation to development of good urban design and vibrant active streetscapes.	Yes – the proposed development provides much needed residential development on zoned and serviced lands, proximate to public transport corridors and close to Monkstown village. The proposed development is within the Dublin Metropolitan Area; the densification and compactness is a National Planning Objective.