Warehouse Development at College Lane, Greenogue, Rathcoole

Flood Risk Assessment

Final Report

March 2019

Jordanstown Properties Limited

Greenogue Business Park

Rathcoole

Co. Dublin

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Contract

This report describes work commissioned by Con McCarthy of Jordanstown Properties Limited. David Casey, Seodhna Foley and Tim Cooke of JBA Consulting carried out this work.

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Purpose

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Abbreviations

1D	One Dimensional (modelling)
2D	Two Dimensional (modelling)
AEP	Annual Exceedance Probability
CFRAM	Catchment Flood Risk Assessment and Management
DoEHLG	Department of the Environment, Heritage and Local Government
FARL	FEH index of flood attenuation due to reservoirs and lakes
FSR	Flood Studies Report
FSU	Flood Studies Update
IoH	Institute of Hydrology
mOD	Meters above Ordnance Datum
MRFS	Climate Change Medium Range Future Scenario
ODPM	Office of the Deputy Prime Minister
OPW	Office of Public Works
PFRA	Preliminary Flood Risk Assessment
SAAR	Standard Average Annual Rainfall (mm)
SFRA	Strategic Flood Risk Assessment
TUFLOW	Two-dimensional Unsteady FLOW (a hydraulic model)

1 Overview

Under The Planning System and Flood Risk Management Guidelines for Planning Authorities (DoEHIG & OPW, 2009) proposed development must undergo a Flood Risk Assessment to ensure sustainability and effective management of flood risk. This requires a review of all available flood information and assessment of Flood Zones for the development site.

Previous versions of this report have been submitted, most recently 2018s0431 - Jordanstown Properties Ltd - Warehouse Development FRA v3.0 which was submitted as a response to a Request for Further Information (RFI), dated the 13/09/2018. This report has been subsequently updated to further expand and update the proposed design following a Clarification of Further Information (CFI) dated the 22/01/2019. A letter has been issued to respond to each individual point regarding flood risk, which can be found in Appendix D of this report,

1.1 Aims and Objectives

This study is being completed to inform the planning application for the proposed site. It aims to identify, quantify and communicate to applicant, Planning Authority officials and other stakeholders the risk of flooding to land, property and people and the measures that would be recommended to manage the risk.

The objectives are to:

- Identify potential sources of flood risk,
- Confirm the level of flood risk and identify key hydraulic features,
- Assess the impact the proposed development has on flood risk in respect to the issue of attenuation and displacement of flooding,
- Develop appropriate flood risk mitigation and management measures which will allow for the long-term development of the site.

Recommendations for development have been provided in the context of the OPW / DoEHLG planning guidance, "The Planning System and Flood Risk Management ". A review of the likely effects of climate change, and the long-term impacts this may have on any development has also been undertaken.

1.2 Development Proposal

The proposed development is located on lands with an area of 9.637ha. It is located just off the Newcastle Road south of Greenogue Business Park. The land is currently zoned for Enterprise and Employment use and is an open greenfield site. The proposed development includes the construction of two large storage warehouse units. Similar units within Greenogue Business Park store building materials, consumable products, mechanical parts, and various other pallet products. Proposed development works include surface water drainage design and access roadways into the property. Carparking and HGV loading bays will be constructed around each building. The proposed site drainage masterplan is included in Appendix A. Figure 1-1 illustrates the proposed site layout.

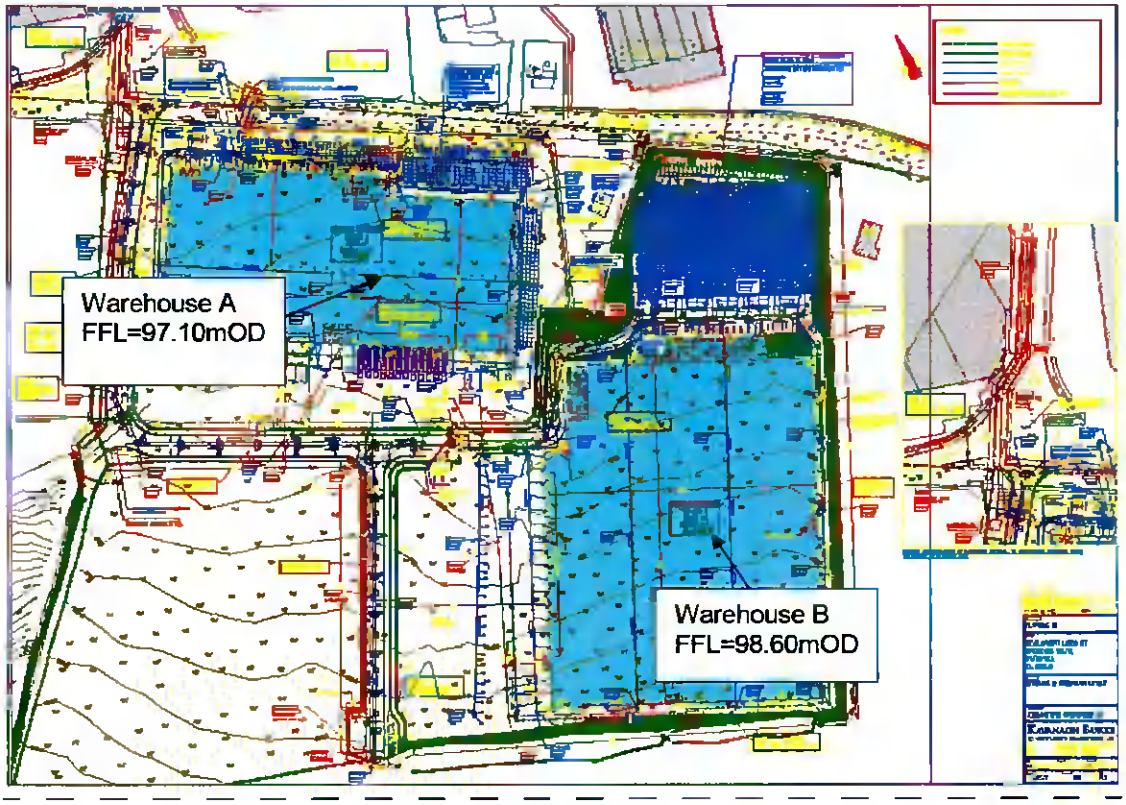


Figure 1-1: Proposed Development & Stormwater Layout

1.3 Report Structure

Section 2 of this report gives an overview of the study location and associated watercourses. Section 3 contains background information and initial assessment of flood risk. Section 4 provides an overview of the technical approaches carried out to assess the flood risk at the site using a 1D/2D hydraulic model. Section 5 explains proposed site specific mitigation measures for the development. Conclusions are highlighted in Section 6.

For general information on flooding, the definition of flood risk, flood zones and other terms, see 'Understanding Flood Risk' in Appendix B.

2 Site Background

2.1 Location

The proposed development site is situated at College Lane off the Newcastle Road (R120) in Rathcoole just south of the Greenogue Business Park. Rathcoole village is approximately 2km south east of the site and Newcastle Village is approximately 1.2km west of the site.

The development site is located in an area of land which is currently an open greenfield site, however the land is zoned for Enterprise and Employment uses. Figure 2-1 outlines the site location and mapping of local features within the surrounding area.

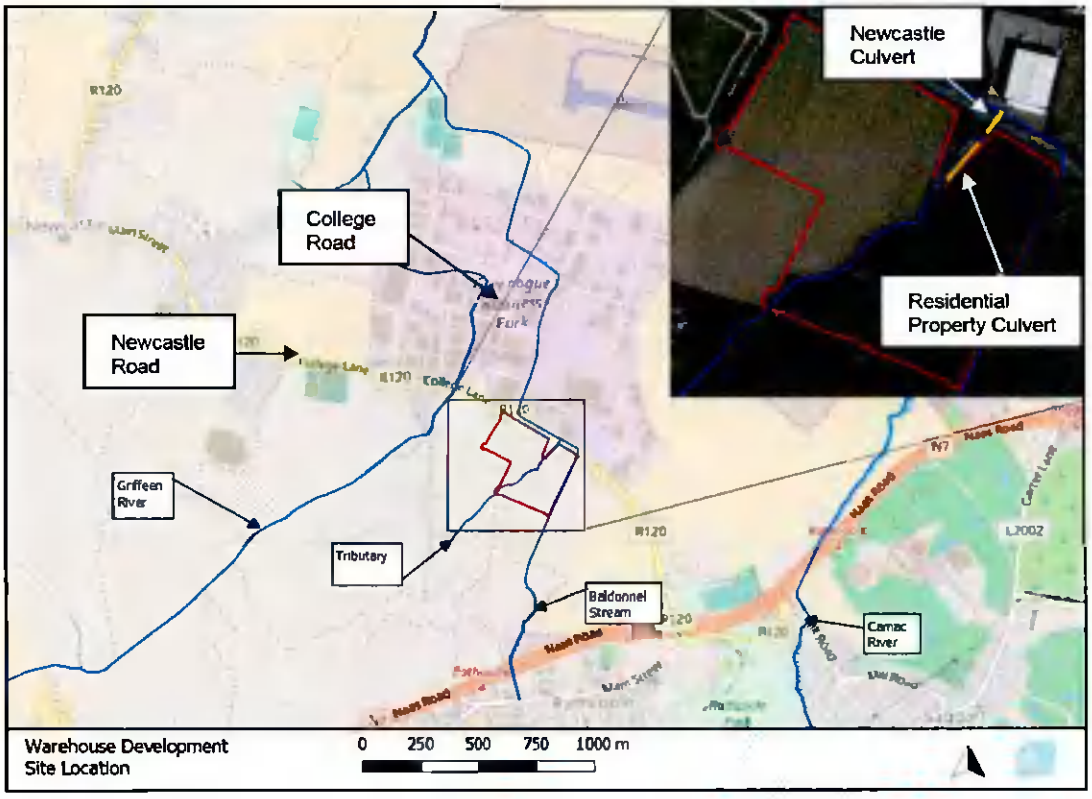


Figure 2-1: Site Location

2.2 Watercourses

Figure 2-1 shows the watercourses in the vicinity of the development site. The Griffeen River, The Baldonnel Stream and the Camac River are the three main local watercourses in the area. There is also a small, un-named stream which flows through the centre of the site and discharges into the Baldonnel Stream.

The Baldonnel Stream flows northwards in an open channel along the eastern boundary of the site. It then flows via culvert along the Newcastle Road before returning to open channel along College Road within the business park, where it flows in a northerly direction.

The Griffeen River flows roughly south-west to north-east and lies approximately 0.2km to the west of the site. It flows through the business park before joining with the Baldonnel Stream downstream of the Greenogue Business Park along Aylmer Road.

The development site is situated adjacent to the storage pond along the Griffeen Stream (see Figure 2-3). The purpose of the pond is to contain 100-year flow from the Griffeen Stream. It is predominantly excavated into the ground. Along the Newcastle Road, an earthen berm up to 4m is provided to retain flood waters within the pond, which extends around the western boundary of the site.

The Camac River is located approximately 1.25km to the east of the site boundary.

A small un-named stream flows in a north-easterly direction through the centre of the site before joining the culverted Baldonnel Stream to the north of the site. The un-named stream is culverted adjacent to the existing residential property at the northern boundary of the site. The culvert locations are shown in Figure 2-2.

A site visit was carried out in April 2018 to appraise the flood risk to the site. Figure 2-2 shows these culverted sections through the site.

Figure 2-2: Site Visit photos - Culverted sections

2.3 Local site and topography

There is existing site access along the northern boundary at Newcastle Road which will be utilised for the proposed access roadway into the site. The topography across the site slopes from the southern boundary to the northern boundary with elevations ranging from approximately 102mOD to 95.5mOD. Figure 2-3 shows the topography at the site.

Greenfield/agricultural lands border the site to the east and south. Greenogue Business Park is located to the north of the site. An attenuation storage pond on the Griffeen Rivers lies to the west of the site.

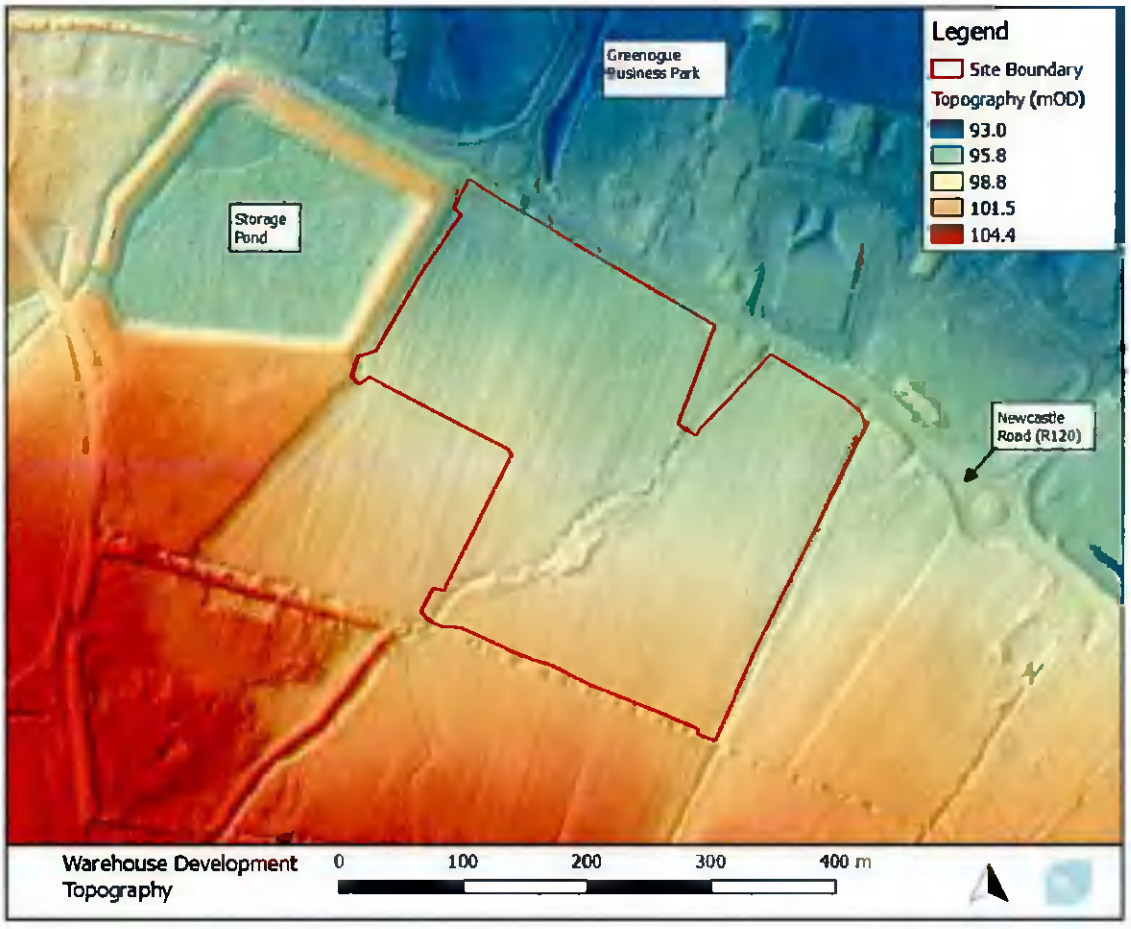


Figure 2-3: Site Topography

2.4 Site Geology

The Geological Survey of Ireland (GSI) groundwater and geological maps were reviewed. The subsoil within the site is made of Limestone Till and Sandstone/Shale Till. The underlying bedrock is classified as Lucan Formation (LU). There are no karst features noted within the site boundary or surrounding area. The associated groundwater vulnerability which indicated the risk of underlying waterbody for the sites is classified as extreme at this location.

3 Flood Risk Identification

An assessment of the potential and scale of flood risk at the site is conducted using historical and predictive information. This identifies any sources of potential flood risk to the site and reviews historic flood information. The findings from the flood risk identification stage of the assessment are provided in the following sections. Further detail on the Planning Guidelines and technical concepts are provided in Appendix A.

3.1 Flood History

A number of sources of flooding information were reviewed to establish any recorded flood history at or near the site. This includes the OPW's website, www.floodmaps.ie and general internet searches.

3.1.1 Floodmaps.ie

The OPW host a National Flood hazard mapping website, www.floodmaps.ie, which highlights areas at risk of flooding through the collection of recorded data and observed flood events. Figure 3-2 shows historical events for the area.

Review of this mapping shows no instances of historical flooding at the specific site location. There are however several recorded flood events in the wider regional area.

- 24th October 2011 - Flooding occurred in Greenogue Business Park to commercial unit 525. Heavy rainfall resulted in pluvial flooding at the site, this event also caused significant inundation to adjacent road networks. This site is located approximately 1.1km north of the proposed development.
- November 2000 - Overtopping of the Griffeen River following heavy rainfall causing flooding along Aylmer Road (70-year return event). Flooding was located approximately 2km southwest of the development site.
- Aylmer Road - Re-occurring flooding occurring from the Griffeen River.
- Newcastle Co Dublin - Re-occurring flooding near Newcastle Village approximately 1km from the proposed development site.
- Rathcoole Bridge - Re-occurring flooding along Rathcoole bridge affecting the Dublin bound slip road traffic to Rathcoole off the N7. This did not impact the site which is north of Rathcoole Village.

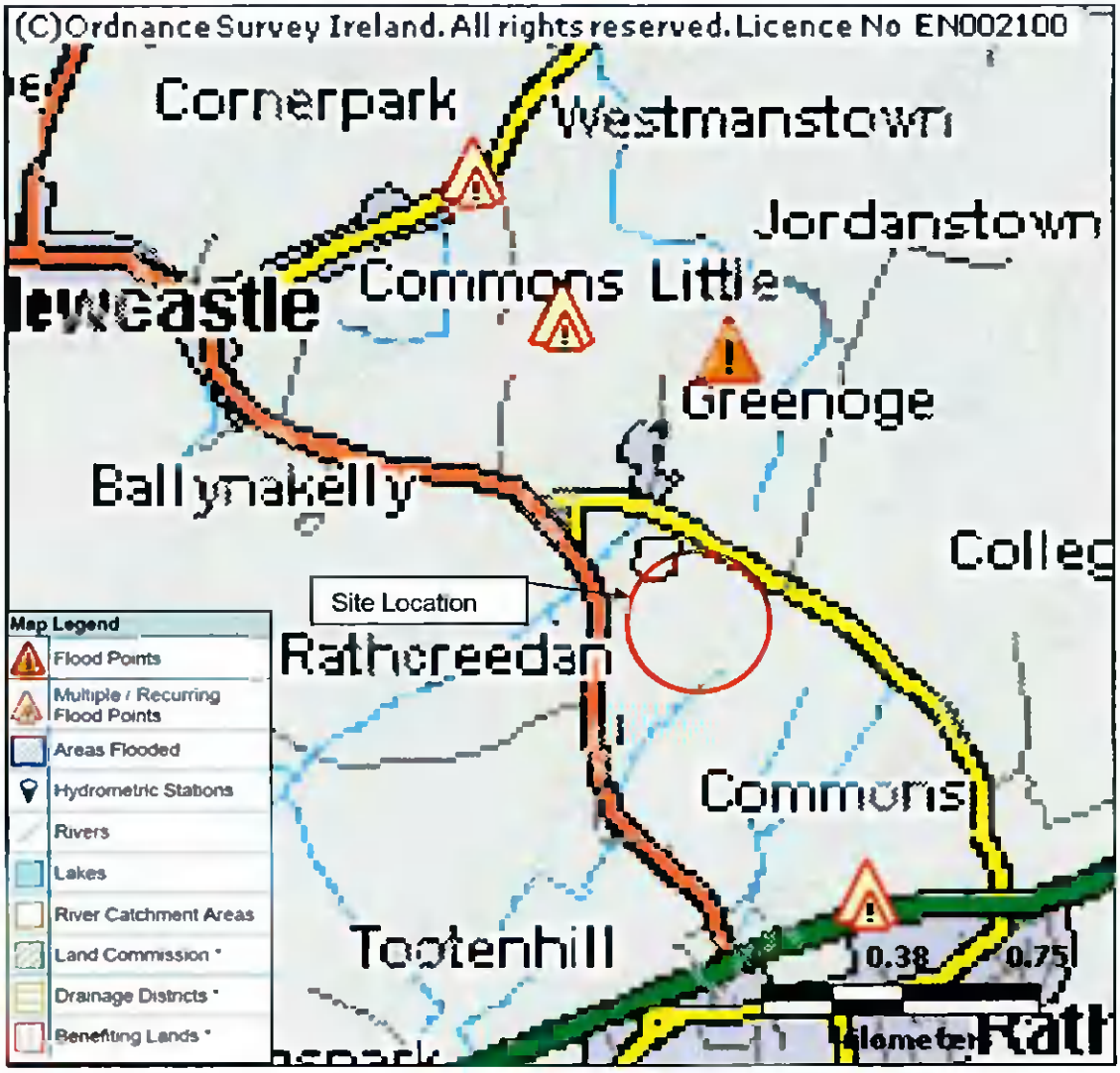


Figure 3-1: Historical Flooding (source: floodmaps.ie)

3.1.2 Internet search

An internet search was conducted to gather information about whether or not the site was affected by flooding previously. While there were no results of flooding affecting the site itself there were reports of flooding in the surrounding area which have been mentioned above.

3.2 Predictive Flooding

The Greenogue area has been subject to three predictive flood mapping and modelling studies

- OPW Preliminary Flood Risk Assessment (PFRA)
- Eastern Catchment Flood Risk Assessment and Management Study (Eastern CFRAM)
- SDCC Strategic Flood Risk Assessment (SFRA)

The level of detail presented by each method varies according to the quality of the information used and the approaches involved. The Eastern CFRAM is the most detailed assessment of flood extent and supersedes the fluvial flood outlines that were presented in the OPW PFRA mapping.

3.2.1 OPW Preliminary Flood Risk Assessment (PFRA)

The preliminary Flood Risk Assessment (PFRA) is a requirement of the EU Flood Directive (2007/60/EC). One of the PFRA deliverables is flood probability mapping for various sources: pluvial (surface water), groundwater, fluvial and tidal. The PFRA is a preliminary or 'indicative' assessment and analysis has been undertaken to identify areas potentially prone to flooding. The OPW PFRA study has largely been superseded by the CFRAM programme however, it does provide valuable information regarding pluvial and groundwater flooding. The PFRA flood maps are also the main source of flood risk in areas not covered by the CFRAM programme.

Review of Figure 3-2 indicates that pluvial flooding is noted along the northern boundary of the site. The most significant area of flooding is located to the northwest where the access roadway will be located. It should be noted that the flood cell is located within the site boundary in a localised depression. It does not extend onto the Newcastle Road.

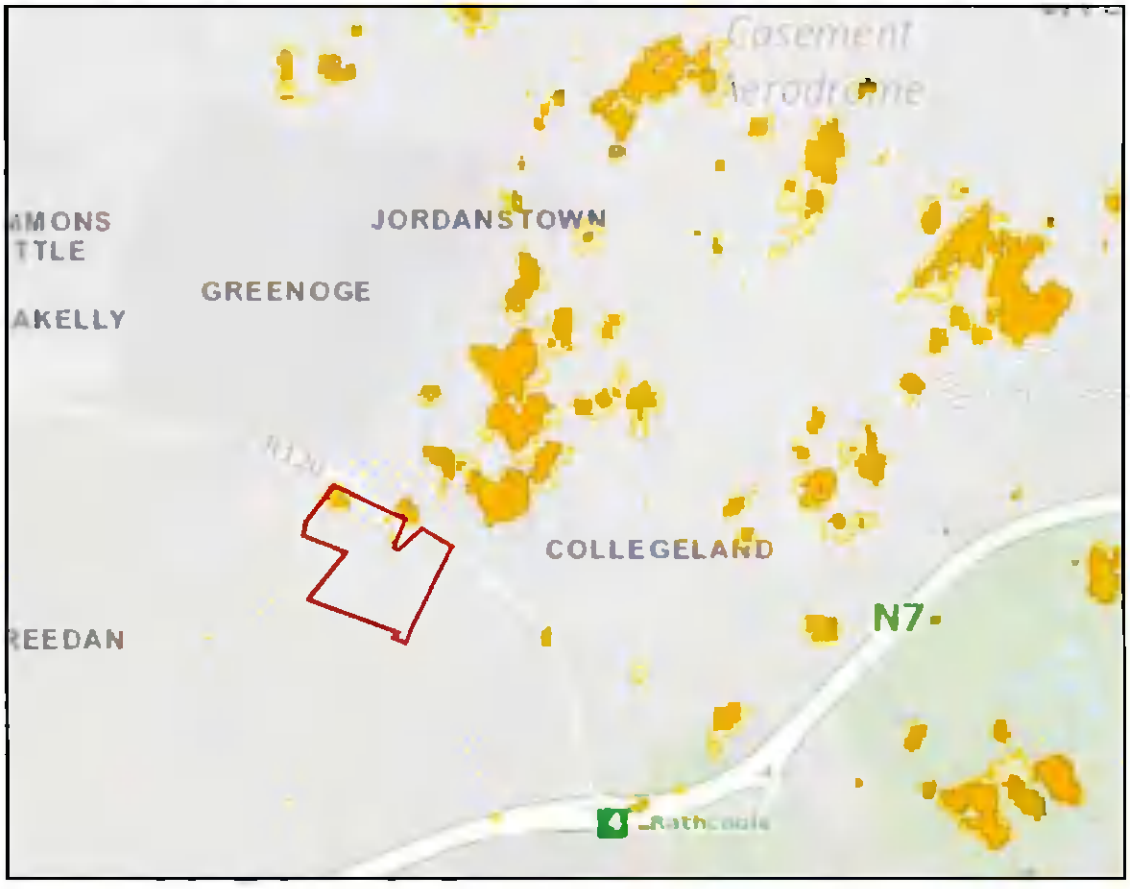


Figure 3-2: OPW PFRA Mapping

3.2.2 Eastern Catchment Flood Risk Assessment and Management Study

The Eastern CFRAM study is the most detailed mapping undertaken in the Dublin region. It commenced in June 2011 with final flood maps issued during 2016. The study involves detailed hydraulic modelling of rivers and their tributaries. The main watercourses in the study area were modelled in the CFRAM study which resulted in flood mapping for the 10%, 1% and 0.1% AEP fluvial events. The Baldonnel Stream and Griffeen River watercourse were included in the study.

The Baldonnel Stream runs along the eastern boundary of the site. During the 1 in 1000 year (0.1% AEP) event overtopping does occur however, most out of bank flows occur along the right bank and does not flow onto the site.

The Griffeen River to the west of site location was also modelled. Out of bank flows occurring during extreme events are captured by the storage pond to the west of the site.

The most significant flood risk to the site is out of bank flows occurring through the centre of the site from the un-named stream. The un-named stream was not incorporated directly as part of the CFRAM study, with CFRAM flood mapping only representing generalised overland flows conveyed from upstream of the site location.

Reported CFRAM water levels and flows at relevant model nodes within the vicinity of the site have been included in Figure 3-3.

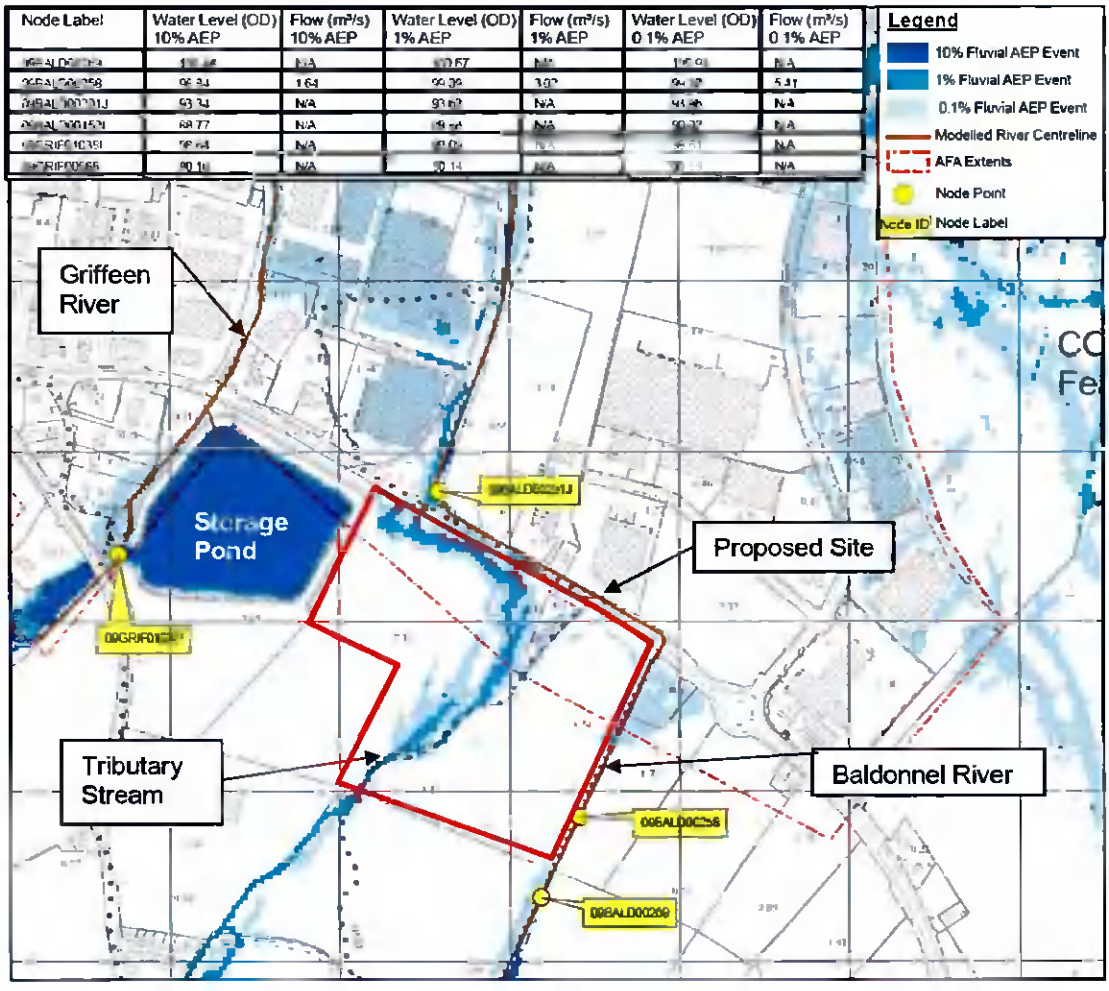


Figure 3-3: CFRAM Flood Extents

3.2.3 South Dublin County Council Strategic Flood Risk Assessment (SFRA) 2016-2022

The SFRA for the South Dublin County Development Plan (2016-2021) assists SDCC in making strategic land-use planning decisions by providing information about flood risk within the County. The assessment is based on the Eastern CFRAM Study flood mapping discussed above and therefore, presents the same flood outlines. CFRAM flood maps were replicated as part of the SFRA, which includes the Greenogue Business Park.

The SFRA recommends consideration of the likelihood and impact of failure of the storage pond. The integrity and risk of failure has been reviewed in SFRA. In the context of the subject site, the following points are highlighted.

- The storage area operates from a fixed concrete spillway and manual offtake to control flows into the basin.
- Blockage is more likely to occur in the channel, rather than of the spillway. This will result in an increase in flow in the retention basin, rather than an increase in flow down the channel.

3.3 Summary of Flood Sources

The initial stage of Flood Risk Assessment requires the identification and consideration of probable sources of flooding. These sources are described below:

3.3.1 Fluvial

Fluvial flooding is the dominant source of potential flood risk to the site. The Griffeen River out of bank flows are captured by the storage pond and is not considered a risk to the site. During the 1% and 0.1% AEP event, the Eastern CFRAM study predicted an overland flow path through the site although the un-named stream was not directly modelled as part of the study. The source of the overland flows appears to originate from the overtopping of the Griffeen River approximately 1.2km upstream of the site.

Minor flooding is noted along the Baldonnel Stream along the site boundary during the 1000-year flood event but does not appear to inundate the site.

Further investigation of these flood mechanisms is required and is discussed in detail in Section 4.

3.3.2 Pluvial

Pluvial or surface water flooding is the result of rainfall- generated flows that arise before run-off can enter a watercourse or sewer. The OPW PFRA mapping indicates that there is a potential for pluvial flooding on the site along the north boundary of the site at the Newcastle road, in particular to the northwest corner at the site. The potential for pluvial flooding and surface water runoff can be managed as part of the surface water design for the proposed development. A poor design of a stormwater system or inappropriate design of roadways, ground levels and finished flood levels can influence the specific surface water flood risk to the site.

To manage the generation of surface water runoff by the proposed development careful consideration should be given to the overall site design. The general principles of surface water mitigation are discussed in Section 5 of the report.

3.3.3 Groundwater

The OPW PFRA mapping does not indicate any groundwater flooding at the site or surrounding area. The Geological Survey of Ireland (GSI) groundwater vulnerability for the site is classified as Extreme. There are no karst features in the area which would indicate areas oat risk of groundwater flooding. Groundwater should not be considered as a likely source of flood risk to the site.

3.3.4 Coastal

Greenogue Business Park is inland approximately 18.5km from the coastline. Coastal flooding is not considered a source of risk to the site.

4 Flood Risk Assessment

The initial flood risk assessment found the site to be at risk of fluvial flooding. Based on the identified flood risk to the development, it is necessary to further assess the likelihood of flooding to the site in more detail by using a 1D/2D hydraulic model. This will provide clarification of the anticipated flood zone extents, updating the information provided by the Eastern CFRAM by using site specific information.

The hydraulic model will then be used to confirm the design layout and propose mitigation measures that ensure flood risk is effectively managed. These mitigation measures and development scenarios will be assessed in the hydraulic model. The modelling scenarios are outlined as follows:

1. Pre-development i.e. The flood risk occurring to the existing site
2. Post-development i.e. The flood risk after the construction of the proposed development based on proposed mitigation measures.

The following sections will detail the process of flow estimation, hydraulic modelling and present the results.

4.1 Hydrology

This section provides a brief description of the flood hydrology undertaken for the FRA. The hydrological inflows in terms of annual exceedance probability were derived for the development site. This allows the calculation of flow rates that were used within the hydraulic model.

4.1.1 Baldonnel flow estimation

The FSR Rainfall-Runoff and the IH124 methods were chosen as the appropriate methods for the catchment area. These methods are more representative of a small catchment such as the Baldonnel watercourse. The IH 124 is based on a relatively limited sample of small catchments with flood peak data that is more than 20 years out of date. The factorial standard error associated with the estimate is also significant and would result in flows approximately equal to the FSR rainfall runoff if applied at the 95% confidence interval. For the above reasons it was decided that the FSR Rainfall Run-off is deemed to be the most appropriate method for this FRA.

The results calculated for the inflows into Greenogue Park differ from the Eastern CFRAM hydrology estimates. The ECFRAM calculated flows using pooling groups and derived median flood growth curves for the catchments by dividing the locations into categories based on the catchment area. There are a number of limitations for this method when looking at catchments under 10km^2. These limitations are:

- Firstly, the pooling group does not represent small catchments well with only 2 FSU stations with catchment area less than 10km^2 included in the pooling group and four in total.
- Many of the physical catchment descriptors on the FSU are based on the 2km^2 grid (SAAR and BFIsoils included) so errors may exist when using FSU's recommendations for the selection of pooling group (i.e. using AREA, SAAR and BFIsoils for similarity).

4.1.2 Un-named Stream Flow Estimation

As the un-named stream through the site was not modelled as part of the Eastern CFRAM study, It is therefore necessary to account for this overland flow in the hydrology determination of the un-named stream.

The base hydrology of the un-named stream was calculated using a catchment area based off the available Lidar data. Due to the small area of the catchment (0.51km^2) the IH124 method was used to determine base flows through the site. The 1% AEP flows were calculated as 0.21m^3/s. Total flows for the channel were estimated as 0.31m^3/s for the 1% AEP flood event. This includes the calculated flows of the localised un-named stream catchment and the contribution of overland flows originating upstream of the site. A 2d only model was developed to assist in the determination of hydrology estimates for the un-named stream and to compare overland spill extents with the ECFRAM mapping is shown in Figure 4-1.

To achieve this, it was necessary to replicate the flood extents as depicted in the CFRAM flood map as shown in Figure 4-1. A series of flows were tested, ranging from 0.01 to 0.5m^3/s to determine

the overland flow rate through the site. Similar flood extents to the 0.1% AEP event were encountered during the 0.01m³/s scenario, refer to Figure 4-1. However, as a conservative approach was undertaken flows were taken as 0.1m³/s within the hydraulic model to appraise flood risk at the site.

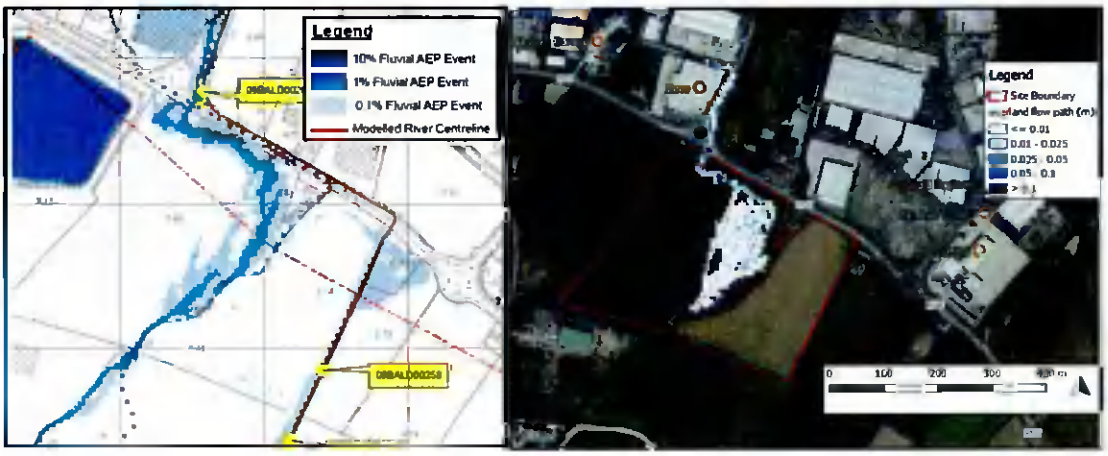


Figure 4-1: Estimation of Overland Flow

4.1.3 Hydrology Summary

A summary of the calculated peak flows is provided in Table 4-1 for the Baldonnel Stream and Tributary stream.

Table 4-1: Summary of Peak Flows

Watercourse	Return Period	Peak Flow (m³/s)
Baldonnel Stream	1% (100Year)	4.1
Baldonnel Stream	1% + CC (100year + Climate Change)	4.92
Tributary stream	1% (100Year)	0.31
Tributary Stream	1% + CC (100 year + 20% climate change)	0.37

4.2 Hydraulic Modelling

The Hydraulic modelling for the study was completed using a combination of two software packages: ISIS/Flood Modeller by Halcrow and TUFLOW by BMT-WBM. When both software packages are used in conjunction with each other, they form what is termed a 'linked-model'. A linked-model allows flow in the river channel and structures to be represented using 1D modelling equations (ISIS) and allows any out-of-bank volumes to be represented in the 2D routing equations (TUFLOW). The Baldonnel Stream and the un-named stream were combined as one ISIS-TUFLOW model.

The hydraulic modelling was carried out in the following stages:

- An ISIS Model was used for the Baldonnel Stream. The tributary stream through the site was added into the existing model using river data surveyed in June 2018, supplemented with on-site observations.
- A 2D model grid enclosing the study area was created.
- 1D and 2D components were linked along the bank crest lines with deactivation of the flood plain in the 1D domain and deactivation of the channel in the 2D domain.
- Simulations were run for a pre-development scenario for the existing flood risk at the site. The results than compared to those of the CFRAM study.
- The model was then altered to account for the new proposed development. This involved stamping the 2D domain with proposed finished floor levels, surrounding site levels and allowance for mitigation measures at the site.

- Simulations were run for the post-development scenario impacts and residual risks to the site.

4.2.1 Pre-Development

Figure 4-2 outlines existing flooding across the site for the 1% AEP event. The channel capacity is large enough to contain the flows shown as running overland in the CFRAM. Out of bank flows occur along the left and right bank where the open channel meets the existing 400mm diameter culvert at the site. Shallow overland flows continue to towards the north boundary and are conveyed west by existing topography along the north boundary. Figure 4-2 indicates the direction of overland flow across the site pre-construction, i.e. the existing site conditions.

Figure 4-2: Pre-Construction 1% AEP flood event

4.2.2 Post-Development

To manage the flood risk to the site post-development, a number of mitigation measures have been proposed. These mitigation measures and resulting flood map are present in Section 5.

5 Flood Mitigation measures

5.1 Flood Risk

The Griffeen River flows to the west of the development site. Any out of bank flows occurring from the 1% and 0.1% AEP events are contained within the storage pond. Catastrophic failure of this pond is an unlikely event and if it were to occur would likely convey overland flow back into the Griffeen channel further downstream and away from the site. For this reason, the Griffeen River is not considered a risk to the development site. The Baldonnel stream flows along the east boundary of the site. Flows remain in channel before being conveyed under the Newcastle Road. The River does not impact on the development site. The main flood risk to the site is the tributary stream which runs through the centre of the site before joining the Baldonnel stream. Mitigation measures have been developed in response to this risk.

5.2 Mitigation Measures

The following mitigation measures have been proposed and are outlined in

Figure 5-1:

- The existing open watercourse across the site will be maintained as an open watercourse to replicate the existing flow conditions across the site. The course will be slightly modified however, which will result in the lengthening of the watercourse through the site by approximately 40m. A single 900mm culvert (c. 25m) will be installed to enable site access.
- As depicted in Figure 4-2, out of bank flows occur in the existing scenario where the open channel section meets the two existing 400mm culvert pipe which feed into the larger drainage network of Greenogue Business Park. A proposed concrete box chamber will be designed at the downstream section of the channel which will enable exceedance flows from the culverted system to be conveyed by a landscaped channel around Warehouse A to the west along the north boundary, replicating existing flood behaviour. The stormwater design layout ensures all surface run-off is attenuated completed independently of any flood water mitigation measures or flows across the site (see section 5.4).

The proposed landscaped channel will convey flood waters around the perimeter of the building to a discharge point located at the existing flow pathway as depicted in Figure 4-2. The channel will be planted with dense vegetation to reduce the flow velocity through the site and retain flow travel times across the site to existing conditions. The purpose of the channel is to ensure that flood waters will not inundate the proposed car park areas or interact with on-site drainage. A simplified cross-section detail is also provided in

- Figure 5-1. It is designed such that the channel will only contain water during flood conditions
- The proposed finished floor levels for the warehouse buildings are 97.1mOD for Warehouse Block A and 98.6.0mOD for Warehouse Block B. The peak water level at the downstream end of the open channel watercourse 96.60moD in the 1% MRFS AEP flood event. The FFL of Warehouse A ensures that a freeboard of 500mm is provided above the peak modelled water level. Water level in the overland conveyance channel rapidly drops to 95.95mOD, ensuring that sufficient freeboard is maintained along the full length of the flow route adjacent to Warehouse Block A. The proposed FFL for Warehouse B provides a freeboard greater than 500mm for the 1% and 1% AEP plus MRFS allowance flood events.
- A 2m high wall and screen planting are proposed to be constructed around the neighbouring property to mitigate visual impacts.. This wall will also act as a mitigation measure to ensure no risk of inundation to the neighbouring property. Whilst a 2m wall is proposed, a wall height greater than 1m would provide sufficient freeboard for flood mitigation purposes. A 200mm nib wall will also be constructed along the perimeter of the site, parallel with the landscaped channel.

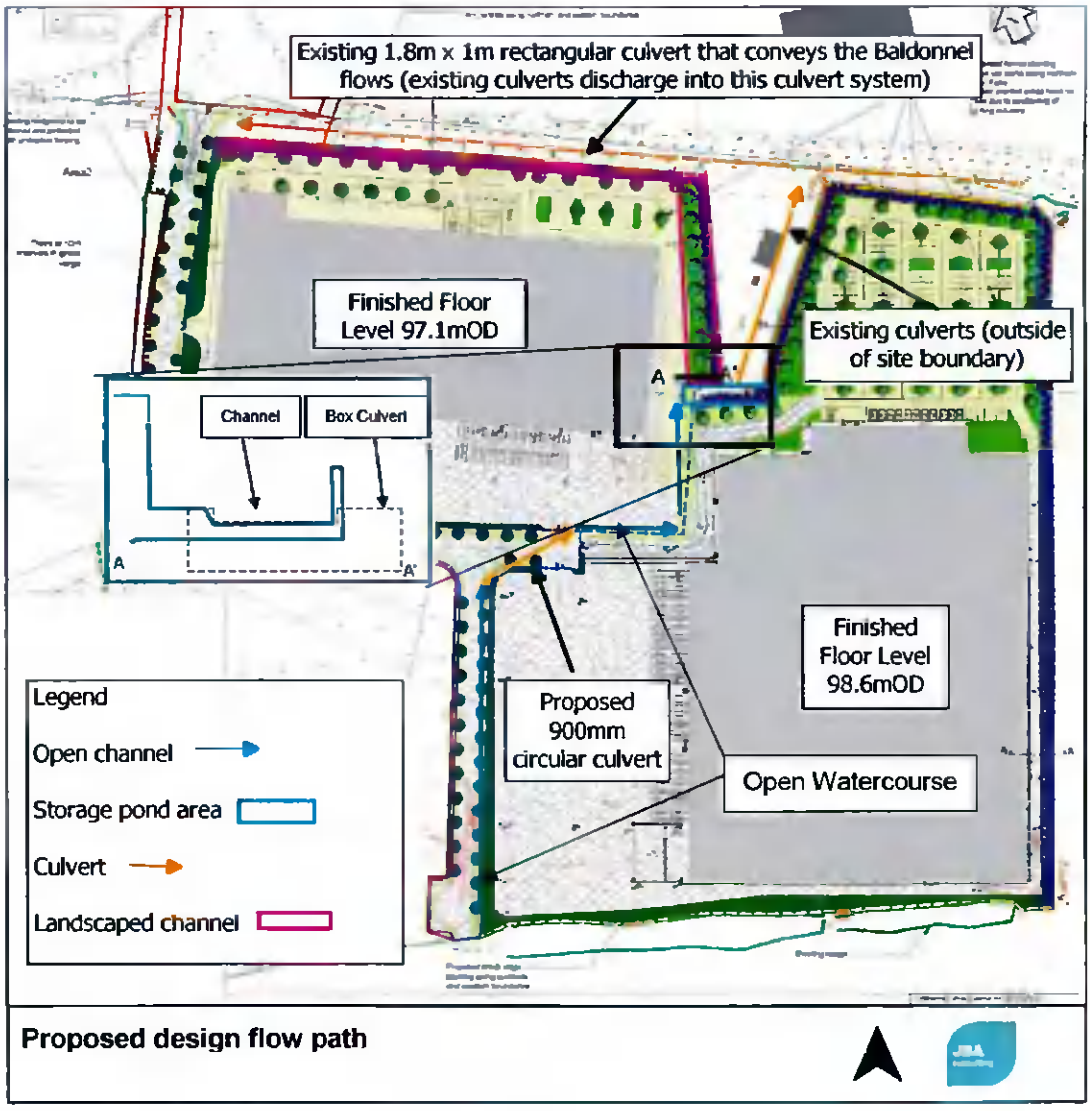


Figure 5-1: Mitigation measures Proposed

Design scenarios were run to simulate the water levels across the site with the proposed development in place. Figure 5-2 shows these flood extents across the site post-development, including the landscaped areas to convey overland flows around the buildings and along the proposed landscaped channel.

There is no flooding occurring across the carpark area and the entrance road to and from the site remains clear. During high flood events vehicular access is unobstructed and flood waters remain independent of the on-site drainage attenuation measures.

Figure 5-3 shows any water level impacts across the site and to adjacent properties when comparing the post construction flood levels with the current conditions.

There are no measurable impacts on flood levels on-site or to adjacent properties. Flood waters can pass through the site around the proposed buildings without impacting access to and from the property. There is a localised increase in water levels onsite where the old flow path across the site is restricted to the proposed landscaped conveyance path around warehouse A. This does not impact adjacent properties.

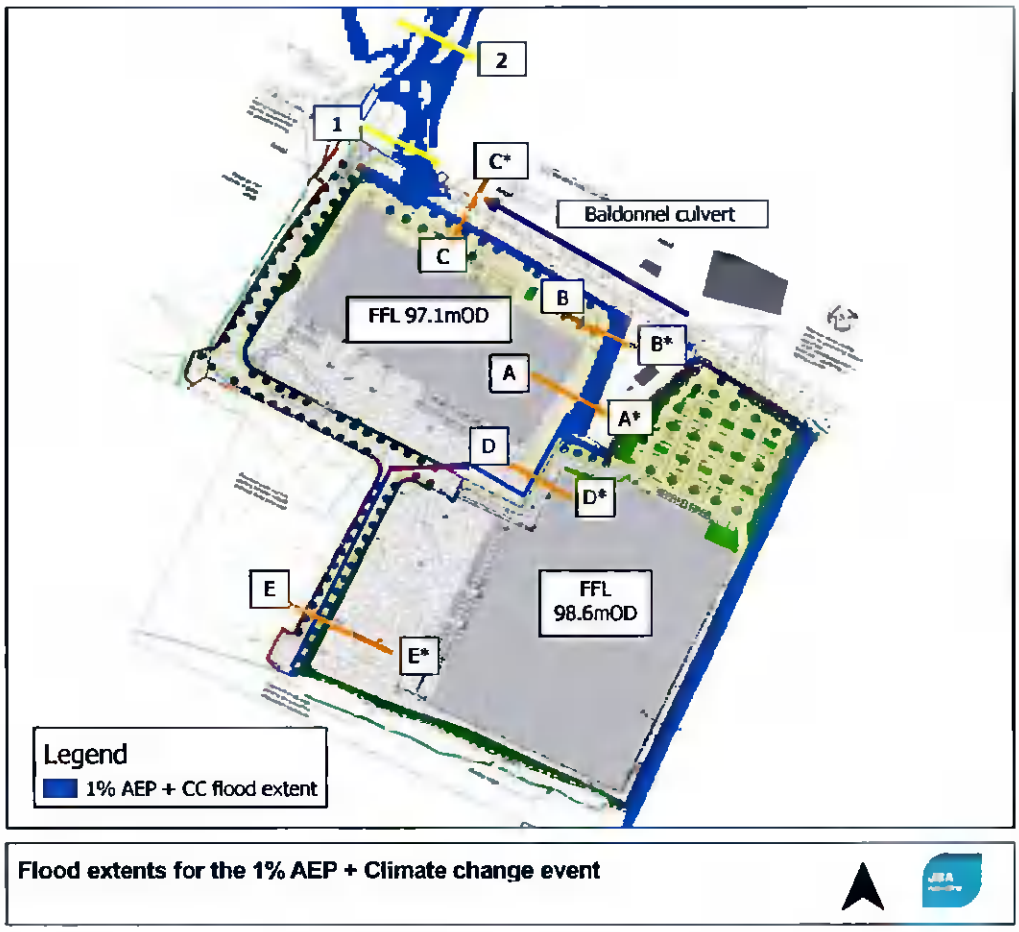


Figure 5-2: Post-Development Scenario - 1% MRFS AEP Event

Further analysis of the post-development flood levels and downstream impacts has been undertaken. Review of Figure 5-3, Figure 5-4, Figure 5-5 and Figure 5-6 provides the relevant flood levels across the site. The cross section locations are presented in Figure 5-2.

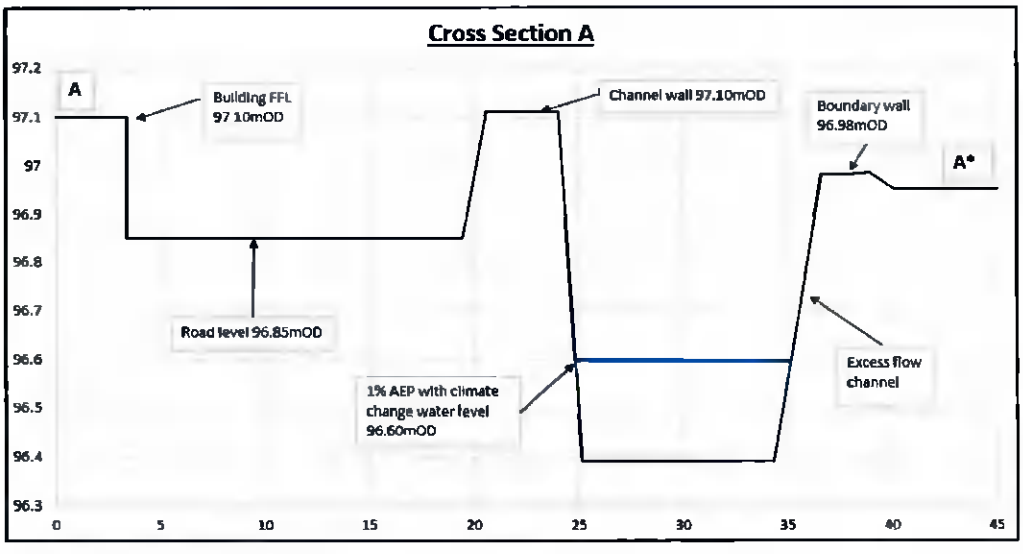


Figure 5-3: Cross Section A

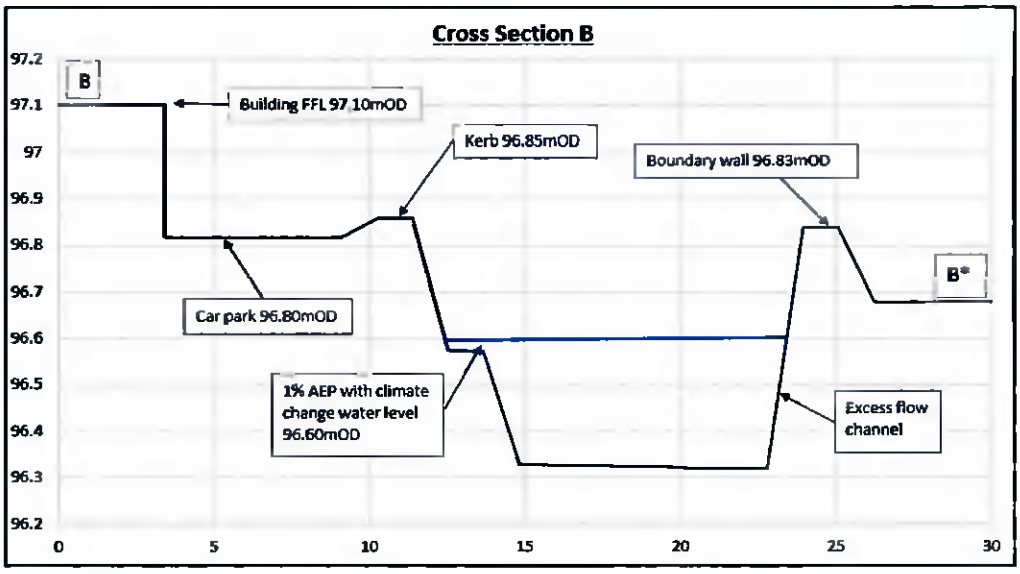


Figure 5-4: Cross Section B

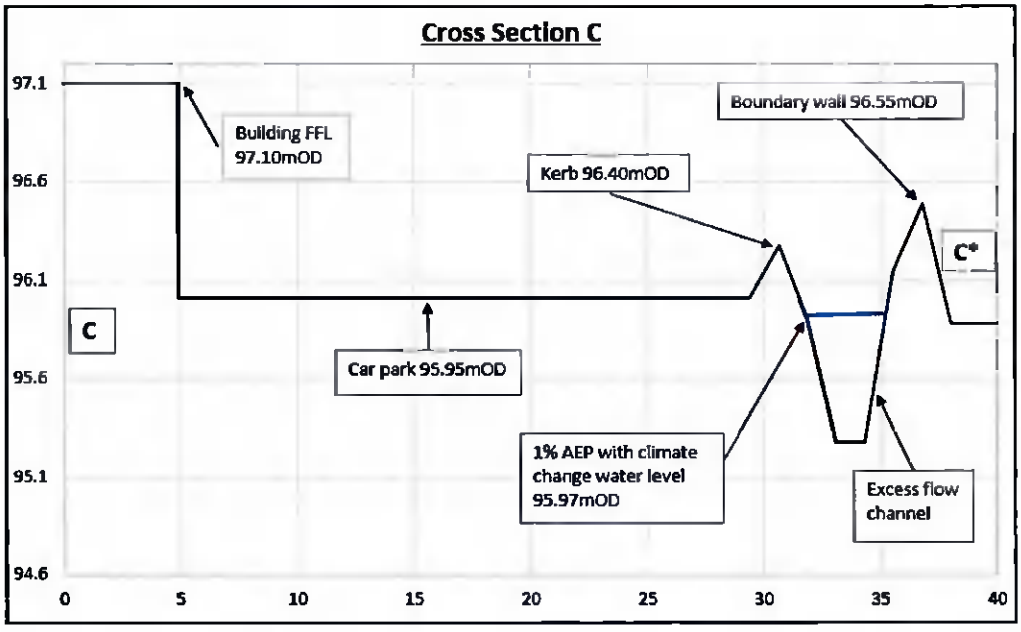


Figure 5-5: Cross Section C

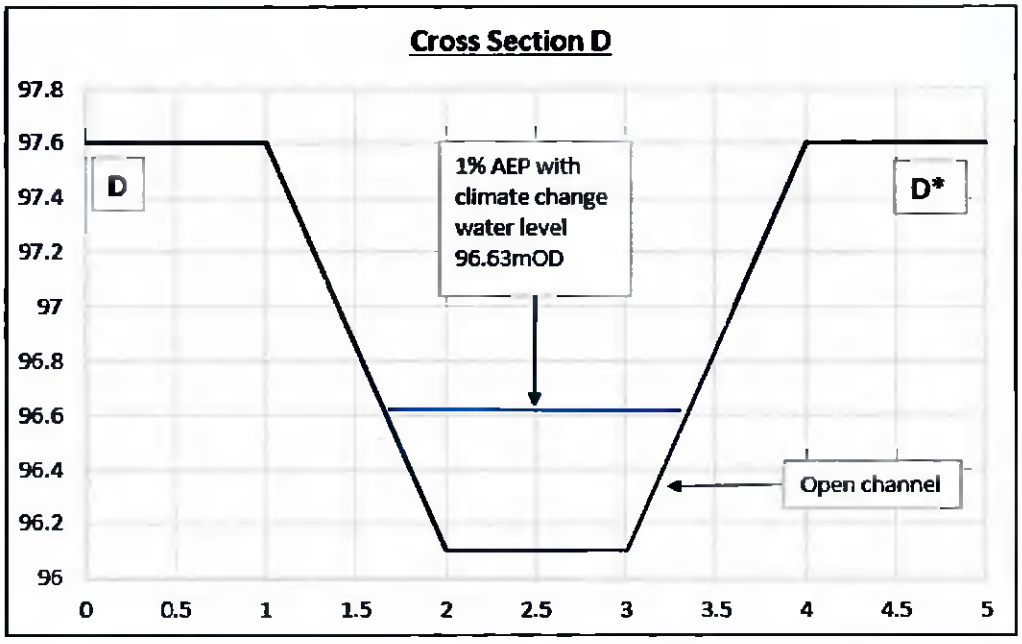


Figure 5-6: Cross Section D

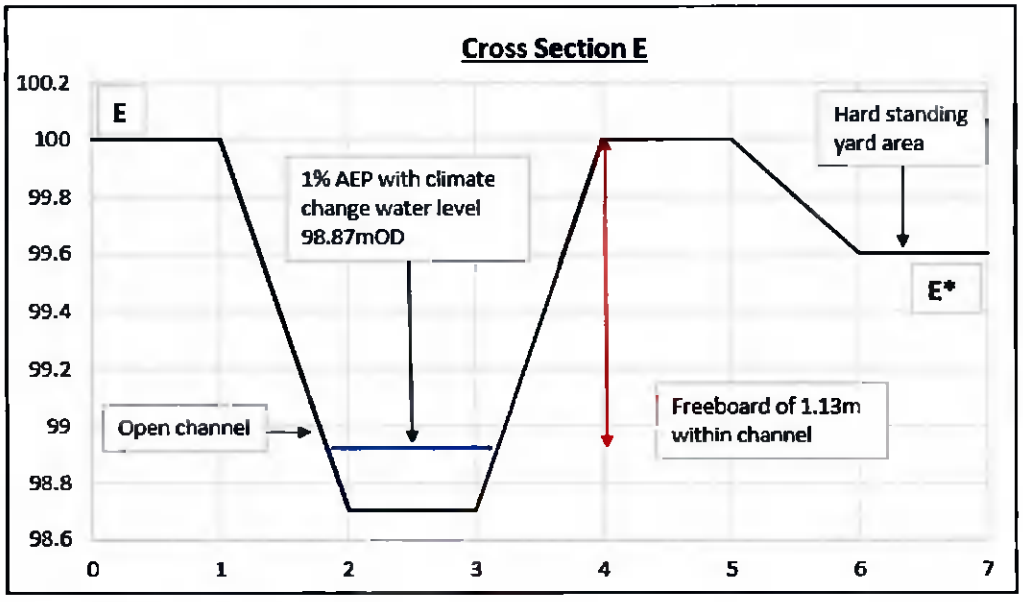


Figure 5-7: Cross Section E

The downstream impacts have been assessed by comparing the water levels downstream of the site boundary along the modelled overland flow route at two monitoring points. Refer to Figure 5-2 for the monitoring point locations. The downstream impacts have been assessed for both water level and peak flow. The results are depicted in Table 5-1. Analysis of Table 5-1, confirms that there is no increase in water levels and peak flows downstream of the site and shows that the proposed mitigation measures adequality manage the flood flows through the site.

Further analysis is provided of the impacts to the flood flows through the Baldonnel Culvert, which is the existing receiving culvert system for riverine flows from the site. A flow hydrograph is presented in Figure 5-8 comparing both the existing and post-development flows through the culvert system. Analysis of Figure 5-8, confirms that there is no increase in flows through the Baldonnel system in the post-development scenario.

Table 5-1: Downstream Impacts

	Monitoring line 1		Monitoring line 2	
	Flow	Level	Flow	Level
Existing scenario	0.26m3/s	94.80mOD	0.22m3/s	94.10mOD
Design scenario	0.26m3/s	94.80mOD	0.22m3/s	94.10mOD

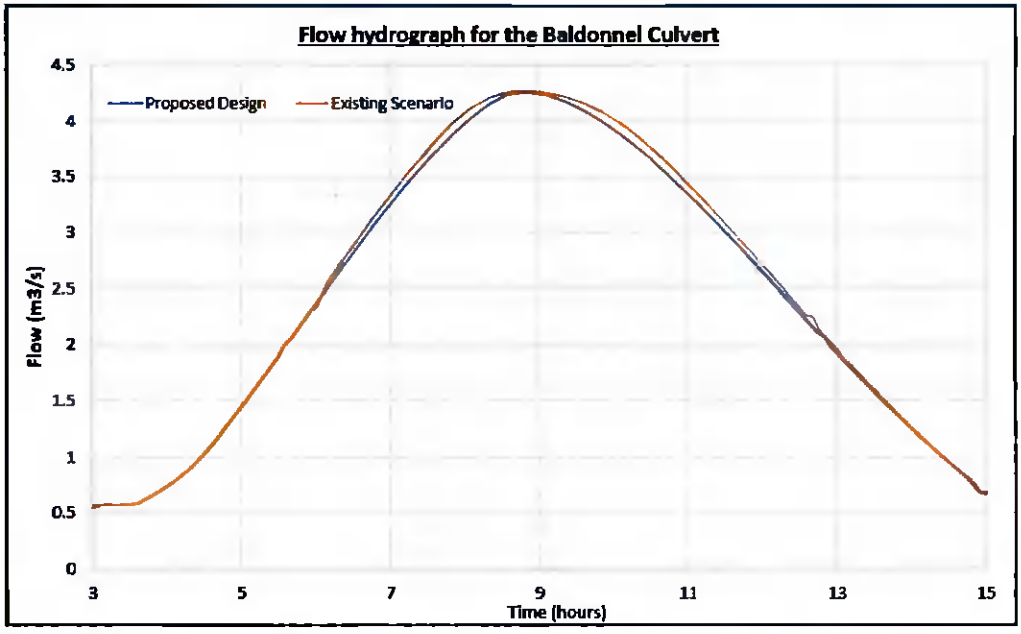


Figure 5-8: Flow hydrograph for the Baldonnel Culvert (see Figure 5.2 for culvert location)

5.2.1 Finished Floor Levels

The proposed finished floor levels for the warehouse buildings are 97.1mOD for Warehouse Block A and 98.6.0mOD for Warehouse Block B. The peak water level at the outlet of the existing 900mm diameter culvert is 96.6moD in the 1% MRFS AEP flood event. The corresponding ground level of the adjacent hardstanding area is 97.1mOD, providing 0.5m freeboard to Warehouse Block A. Flood levels are maintained at 95.95mOD across the flow channel ensuring that sufficient freeboard is maintained along the full length of the flow route adjacent to Warehouse Block A. The proposed FFL for Warehouse B provides a minimum freeboard of 0.5m for the 1% and 1% MRFS AEP flood events (see Figure 5-7 for levels).

5.3 Access and Egress

The primary access route onto the site is from the Newcastle Road (R120) at the northwest corner of the site where there is an existing entrance to the existing greenfield site. During the 1% AEP + CC post-development some inundation is noted through the roundabout located along the Newcastle Road, however flood depths are models as <100mm. Therefore, access to and from the site will remain unobstructed onto the Newcastle Road.

5.4 Drainage Design

This is currently an existing greenfield site; the development works will increase the hardstanding area at the site. This increase will result in a corresponding increase in surface water run off post development, if not mitigated against.

Runoff from the development will be collected from road gullies and directed to an on-site Stormtech stormwater attenuation system underground at the proposed carparks. A silt trap and petrol interceptor will be placed upstream and a flow control device placed downstream of the attenuation limiting the discharge from the site.

The attenuation system was calculated by Kavanagh and Burke Consulting Engineers Ltd. using rainfall data for a 1 in 30 year storm event. The tank is designed to a volume capacity of 2,621m^3, this also includes capacity for temporary flood storage occurring from a 100year 6hr duration flood Storm event with an additional 10% added for climate change. This is included as part of the design to ensure there is no increase to flood risk to the surrounding area.

Figure 1-1 outlines the stormwater network for the proposed development. Additional details on the surface water management can be found in the attenuation report provided by Kavanagh and Burke Consulting Engineers.

5.5 Residual Risk

Residual risks are the risks that remain after all risk avoidance, substitution and mitigation measures have been taken. The residual risks for this site are summarised in Table 5-2:

Table 5-2: Summary of Residual Risk

Residual Risk	Mitigation Measure
Blockage of culverts at Residential Property	Scenario runs were carried out to confirm if blockage would increase the flood risk at the site. FFLs recommended are above water levels if blockage of the culverts that may impact the site was to occur (max water level 96.73mOD).
Climate Change impacts - increased water levels.	Climate change model runs have been completed to ensure that the recommended FFLs are appropriate for the possibility increased flows in the future. This extent is shown in Figure 5-2.
Failure of Griffeen Storage Pond	The risk of basin failure through breach of the bund is lower than the risks considered when designing mitigation measures for a development site. In the extreme event of bund breach, overland flows would predominantly flow in a easterly direction over the Newcastle Road The proposed FFL will provide sufficient protection during a possible failure event. The risk of berm failure is extremely low and appropriate given the industrial (warehouse) usage onsite.
Drainage system failure	The system has been designed to contain the 1% AEP storm event and any excess water will be discharged off site. The FFLs of the warehouses are such that they provide sufficient protection should the system fail. Overland flow pathways are available off site which will convey stormwater flows away from the site without impacting upon the Buildings

5.6 The Development and impact to Flood Risk

The measures described in the previous sections ensure that flood risk to the site is managed appropriately and that surrounding sites and roadways and not impacted.

5.7 Section 50

As part of this planning application a Section 50 application was submitted to the OPW for assessment, refer to Appendix C. The Section 50 application cover the previous design that incorporated a proposed culvert running though the full length of the site. This design proposal received approval from the OPW.

The updated design involves a significant reduction in the proposed culvert which now only includes a short 25m length to allow vehicles to travers over the watercourse. It is envisaged that a new application will be required to assess the revised design. Due to time constraints, it is requested that this be issued as a condition of planning.

5.8 Justification Test

As the site proposed for industrial development is partially contained within Flood Zone A, the Justification Test for Development Management needs to be applied. The following points outline how the mitigation measures proposed and tested for the site allow the Justification Test to be passed:

1. *The urban settlement is targeted for growth under the National Spatial Strategy, regional planning guidelines, statutory plans as defined above or under the Planning Guidelines or Planning Directives provisions of the Planning and Development Act, 2000, as amended.*

The land being developed with the site is zoned for Enterprise and Employment Zoning (EE) use under both the 2010-2016 and the 2016-2022 South Dublin Development Plan. The zoning and designation of the overall site demonstrates that the development complies with Section 1 of the Justification Test.

2. *A flood risk assessment to an appropriate level of detail has been carried out as part of the Strategic Environmental Assessment as part of the development plan preparation process, which demonstrates that flood risk to the development can be adequately managed and the use or development of the lands will not cause unacceptable adverse impacts elsewhere.*

This proposal has been subject to an appropriate flood risk assessment which shows;

i. The development will not significantly increase flood risk elsewhere.
ii. The development (building FFL) is raised 500mm above the 1% AEP event including climate change with freeboard to minimise the risk to people and property as far as possible. A overflow spill system and proposed landscaping through the site directs potential overland flows around the proposed buildings without impacting adjacent properties.
iii. Residual risk is managed by the setting of appropriate FFLs above the design climate change flows. Model scenarios were also run for two-thirds blockage occurring at culverts through the site to ensure the design levels were appropriate. Blockage water levels at the site were below the recommended FFLs.

The development meets the standards of typical industrial development design

6 Conclusions

JBA Consulting has undertaken a Stage 3 detailed flood risk assessment (FRA) of the proposed warehouse development at College Lane, Greenogue, Rathcoole. The assessment was carried out in order to verify and compare with the flood extents undertaken previously by the Eastern CFRAM draft deliverables and investigate flood mitigation measures for the site

Review of the CFRAM flood maps show possible flood risk from the Baldonnel Stream and overland flow through the site.

To appraise the flood risk to site and aid in the development of mitigation measures, a hydraulic model was developed. The results from the pre-development hydraulic model indicate that the site is at risk from the stream through the centre of the site. No inundation of the site occurs from the Griffeen River or Baldonnel Stream.

Mitigation is achieved by the addition of a concrete box chamber and landscaped channel to convey any out of bank flows from the culvert system around the development and along the northern boundary. Floodwaters will be discharged from the site via the existing flow pathway. Results from the post-development scenario confirms that the mitigation measures successfully convey the flood waters along the designated route without impacting on the warehouse units or adjacent properties.

There is no measurable increased flooding to the surrounding area post-development. The proposed FFLs for Warehouse A and Warehouse B will be above the 1% AEP + climate change levels with an additional freeboard of at least 0.5m.

Surface water flood risk is mitigated by the proposed landscaping design, appropriate finished floor levels and the design of an adequate storm water drainage system. The proposed stormwater attenuation has been designed to a 1 in 30 year storm event with the additional temporary storage allowance for a 100 year 6hr event including 10% for climate change. This is designed to ensure there is no increase in flood risk to the surrounding area. Safe access and egress from the property is maintained through the main entrance at the northwest corner of the site.

Residual risks have been assessed at the site which include climate change, culvert blockage and failure of the Griffeen storage pond. Failure of the storage pond is not considered a likely scenario. However, in the event of potential failure, floodwaters would be expected to flow in an easterly direction over the Newcastle Road and away from the site. Furthermore, the proposed FFL is sufficient to protect the development during such a scenario. The proposed FFL protects against the MFRS climate change scenario, and gives a freeboard above blockage design flood levels.

The previously designed and modelled full length culvert through the site has received Section 50 approval. Following the revised design, there has been a significant reduction in the culvert length through the site. This may require a subsequent Section 50 application. If required, it is requested this is undertaken as a condition of planning.

In line with the planning guidelines, this FRA has applied and passed the Justification Test. This concludes that the Warehouse development is in compliance with the core principles of the Planning System and Flood Risk Management Guidelines.

Appendices

A Proposed Development

PLANNING A1

DEVELOPMENT LANDS AT
GREENOGUE SOUTH,
RATHCOOLE,
Co. DUBLIN

DRAINAGE & WATERMAIN LAYOUT

JOBSTOWN PROPERTIES LTD

KAVANAGH BURKE
CONSULTING ENGINEERS

D1577 03 R2

B Understanding Flood Risk

Flood risk is generally accepted to be a combination of the likelihood (or probability) of flooding and the potential consequences arising. Flood risk can be expressed in terms of the following relationship:

Flood Risk = Probability of Flooding x Consequences of Flooding

B.1 Probability of Flooding

The likelihood or probability of a flood event (whether tidal or fluvial) is classified by its Annual Exceedance Probability (AEP) or return period (in years). A 1% AEP flood has a 1 in 100 chance of occurring in any given year.

In this report, flood frequency will primarily be expressed in terms of AEP, which is the inverse of the return period, as shown in the table below and explained above. This can be helpful when presenting results to members of the public who may associate the concept of return period with a regular occurrence rather than an average recurrence interval, and is the terminology which will be used throughout this report.

Table B-1: Conversion between return periods and annual exceedance probabilities

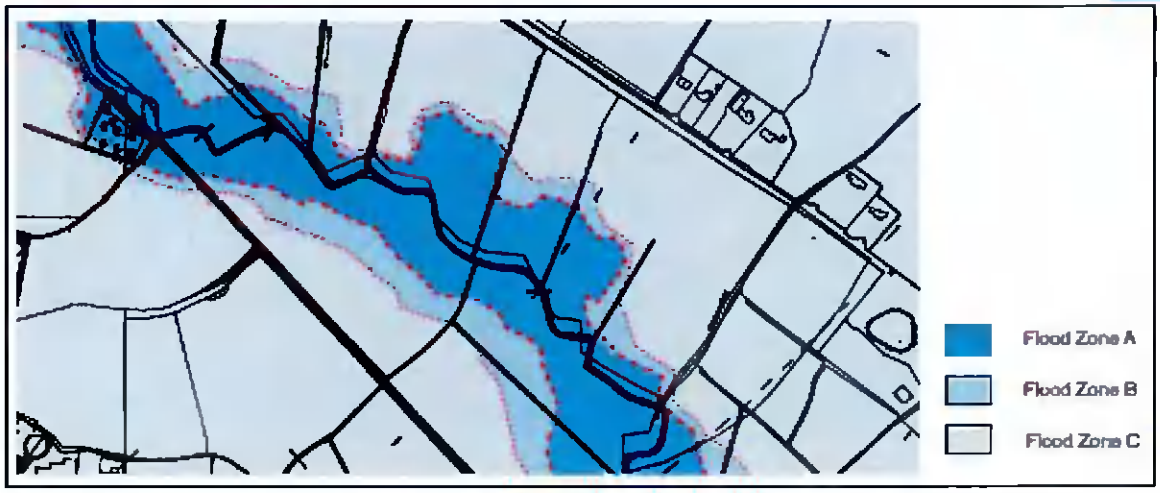
Return period (years)	Annual exceedance probability (%)
2	50
10	10
50	2
100	1
200	0.5
1000	0.1

B.2 Flood Zones

Flood Zones are geographical areas illustrating the probability of flooding. For the purposes of the Planning Guidelines, there are 3 types or levels of flood zones, A, B and C.

Zone	Description
Flood Zone A	Where the probability of flooding is highest; greater than 1% (1 in 100) from river flooding or 0.5% (1 in 200) for coastal/tidal flooding.
Flood Zone B	Moderate probability of flooding; between 1% and 0.1% from rivers and between 0.5% and 0.1% from coastal/tidal.
Flood Zone C	Lowest probability of flooding; less than 0.1% from both rivers and coastal/tidal.

It is important to note that the definition of the flood zones is based on an undefended scenario and does not take into account the presence of flood protection structures such as flood walls or embankments. This is to allow for the fact that there is a residual risk of flooding behind the defences due to overtopping or breach and that there may be no guarantee that the defences will be maintained in perpetuity.



B.3 Consequence of Flooding

Consequences of flooding depend on the hazards caused by flooding (depth of water, speed of flow, rate of onset, duration, wave-action effects, water quality) and the vulnerability of receptors (type of development, nature, e.g. age-structure, of the population, presence and reliability of mitigation measures etc.).

The 'Planning System and Flood Risk Management' provides three vulnerability categories, based on the type of development, which are detailed in Table 3.1 of the Guidelines, and are summarised as:

- **Highly vulnerable**, including residential properties, essential infrastructure and emergency service facilities;
- **Less vulnerable,** such as retail and commercial and local transport infrastructure;
- **Water compatible**, including open space, outdoor recreation and associated essential infrastructure, such as changing rooms.

C Section 50 Approval Letter

OPW
Oifig na nOibreacha Poibli
The Office of Public Works

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Baile Átha Troim
Co. na Mí
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Suíomh gréasáin/website: www.opw.ie

Mr Tim Cooke
JBA Consulting
Unit 3, Block 660
Greenogue Business Plaza
Greenogue
Rathcoole
Co Dublin

Our Ref: 604 - 2018

Re: Section 50 Application – Proposed New Culvert in Rathcoole, Co. Dublin.

Dear Mr Cooke,

I refer to the above Section 50 application received by this office.

The documentation submitted has been examined and I recommend that the consent of the Commissioners of Public Works under Section 50 of The Arterial Drainage Act, 1945 be given for the proposed culvert as follows:

A new 900mm diameter pipe culvert approx. 280m in length, with a fall of 3.175m in 280m, as per that detailed in the applications and Section 50 Report submitted.

A screen and manhole access points along the length of the culvert should be considered.

It should be noted that consent is given only for the purpose of Section 50 and does not absolve the recipient of responsibility for any adverse effects caused by this installation to any third party.

The Commissioners of Public Works are not responsible and accept no liability for any loss or damage whatsoever caused because of this development.

Yours sincerely

Karen Donovan
Engineering Services Administration Unit
12th December 2018

D Clarification of Additional Information

South Dublin County Council
County Hall Tallaght,
DUBLIN
D24YNN5

For the attention of Brian Harkin

PR/0073/19 Clarification of Additional Information

February 2019

This letter addresses the request for the clarification of additional information in relation to planning application SD18A/0265 for a site in Rathcoole Co Dublin. The proposed development is for two industrial warehouses and associated parking facilities. Please find included below a response to Items 1 through to 4 of the South Dublin County Council Request for Clarification of Further Information.

Contents

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1 SUMMARY RESPONSE TO SDCC REQUEST FOR CLARIFICATION OF FURTHER INFORMATION

Item	SDCC Comment	JBA response
1	In response to the request for further information, the applicant has proposed to reduce the finished floor level of block A by 1 metre. This is not compatible with the necessity to raise the finished floor level to 500mm above the highest known flood levels, which the Planning Authority would require as a measure to mitigate against any flood risk. The applicant is therefore requested to reconfigure the blocks on the site in order to avoid locating within Flood Zones A or B.	The finished floor level (FFL) of block A has been further revised and raised by 300mm from the amended levels to a final FFL of 97.10mOD. In response to Item 3 the flood mitigation design for the site has been updated and assessed within a site-specific hydraulic model. Results from the revised model confirm a freeboard greater than 500mm between the FFL and the maximum water level during the 1% AEP plus climate change flow event on site. The revised flood mitigation design replicates the attenuation and conveyance of overland flow mechanisms as predicted during modelling of existing greenfield conditions. The proposed flood mitigation design confines the overland flow within a specified easement that is routed around all hardstanding area within the development. Both blocks on site are therefore removed from Flood Zone A or B, with all development on site located within Flood Zone C. This approach is consistent with other sites within Greenogue Business Park which have previously been granted permission from SDCC, including; Site 517A, Site 522, Site 527 and Site 662.

2	Having regard to the large footprints of the proposed buildings and the large area of hardstanding associated with the car parking, the Planning Authority is not satisfied that the proposed development would not have significant flooding effects downstream. The applicant is requested to address this issue.	As noted in Section 5.4 of the Flood Risk Assessment, industry best practice is applied to attenuate all stormwater from hardstanding areas on site. This is clarified in email correspondence from Tim Cooke (JBA) to Brian Harkin (SDCC) on Friday 25th January 2019 and included in the response to the initial Additional Information request from SDCC. The stormwater design layout ensures all surface run-off is attenuated completed independently of any flood water mitigation measures or flows across the site, including the watercourse through the site. Surface run-off calculations and the surface water drainage network was provided within the application by Kavanagh Burke Consulting Engineers.
3	The Planning Authority has concern that the proposed culverting of the stream that runs through the centre of the site would have significant effects resulting from the rapid transport of flood waters downstream. Furthermore, the proposed culvert is contrary to Development Plan policy on green infrastructure and retention of landscape features. The applicant is requested to address this issue.	This comment has been noted and taken in to consideration within the revised flood mitigation design. In the revised design the watercourse remains as open channel across the site. A proposed re-alignment of the channel increases it's overall length by c. 30m, increasing travel time and attenuation within the watercourse, thereby reducing potential for negative impacts of flood waters downstream. A culvert 900mm in diameter and c. 25m in length however is still included within the centre of the site as a requirement for internal road access. This culvert has been robustly tested within the hydraulic model which confirms no increase to flood risk.

4	Having regard to the nature and scale of the proposed development, which is situated within flood zones A and B, and the proposed culverting of a natural watercourse, the Planning Authority has concerns that the proposal could result in a significant flood risk both on site, and downstream. Therefore, considering the potential for a pollution event in the watercourse, the Planning Authority is not satisfied that a Stage 2 Appropriate Assessment can be screened out. The applicant is requested to address this issue.	As per responses to Items 1 - 3. All development on site is removed from Flood Zone A or B, with both blocks and associated car parking located within Flood Zone C. This approach is consistent with other sites within Greenogue Business Park which have previously been granted permission from SDCC. The stormwater design layout ensures all surface run-off is attenuated completed independently of any flood water mitigation measures or flows across the site, including the watercourse through the site. Surface run-off calculations and the surface water drainage network was provided within the application by Kavanagh Burke Consulting Engineers. Therefore, a Stage 2 Appropriate Assessment is not considered a necessary requirement.

2 REVISED PROPOSED MITIGATION DESIGN

As depicted in Figure 1, the watercourse is proposed to be realigned through the site. The watercourse will predominantly remain as an open stream as per the requirements of SDCC. It is proposed that a single 900mm culvert c. 25m in length will be included to allow internal traffic flow over the watercourse. The total channel length is increased by 30m compared to the existing channel on site.

During extreme flood events such as the 1% AEP flood event and when the capacity of the existing culverts downstream of the site are exceeded, the excess flow will be directed into a shallow open diversion surface flow channel that runs around the northern boundary of the site. The diversion channel has been designed to replicate the existing greenfield flood behaviour onsite.
The diversion flow channel is activated only during high flow events and is controlled by a set spill height of 96.50mOD. The diversion flow channel is contained by a boundary wall and a raised kerb on the left bank and the site boundary wall on the right bank. All are constructed of reinforced concrete.

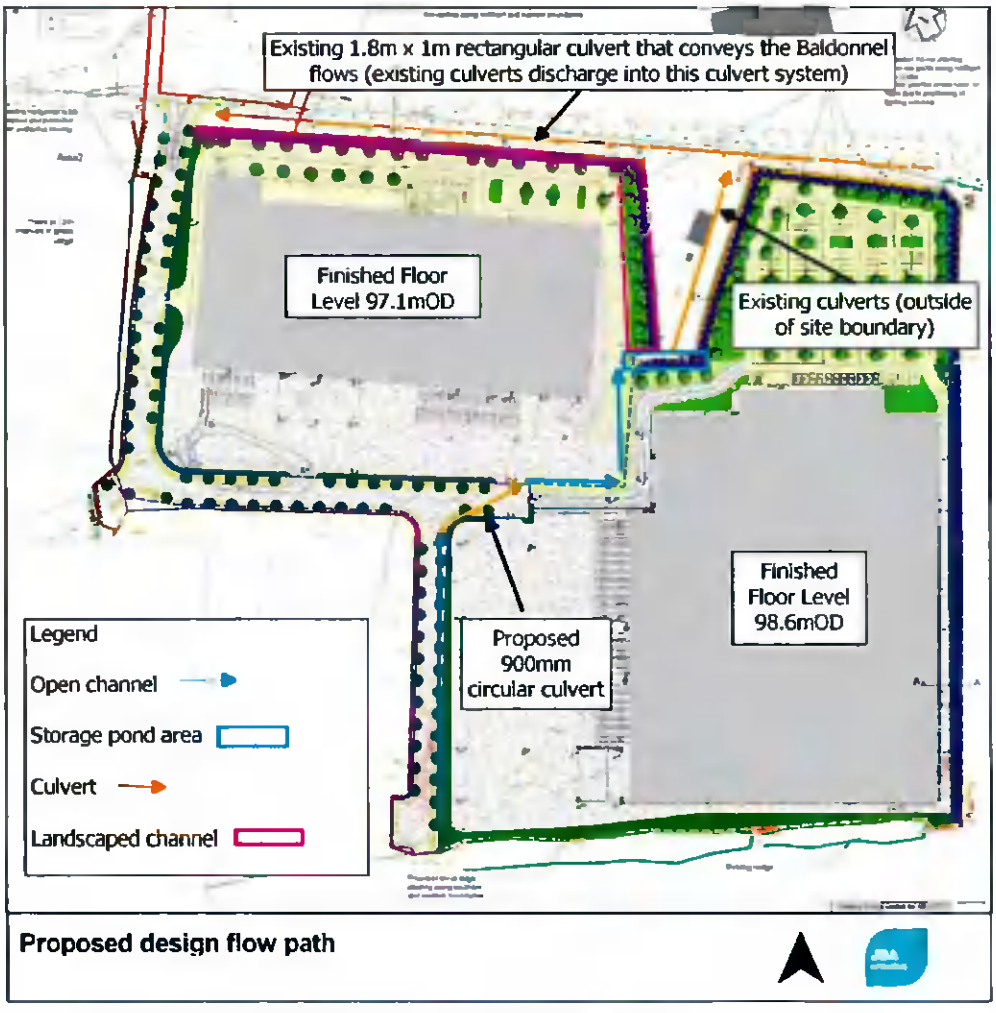


Figure 1: Revised Flood Mitigation Design Schematisation

3 HYDRAULIC MODELLING AND ASSESSMENT

The revised flood mitigation design has been assessed via hydraulic modelling for the 1% AEP, 1% AEP plus climate change and the 0.1% AEP fluvial flood events. The purpose is to ensure that all flood waters are adequately managed through the site without posing a flood risk to the development, adjacent properties or downstream of the site, whilst ensuring a minimum freeboard of 500mm to the Finish Floor Levels (FFLs) onsite.

Review of the CFRAM flood maps for the study area show a shallow flow path across the north-western corner of the site following overtopping of the existing watercourse. The main purpose of the proposed mitigation measures is to retain the floodwaters in channel and subsequently divert the overtopping floodwaters onto a dedicated shallow open diversion channel around the perimeter of the site. The aim is to manage the overland flow while replicating the existing greenfield flow behaviour. It should be noted that the primary source of flood risk to the site are the undersized downstream culverts contained within third party lands between the downstream extent of the site and the culverted Baldonnel Stream. This will not be modified during the proposed development, therefore there will be no increased risk of inundation downstream of the site.

Figure 2, Figure 3, Figure 4, and Figure 5 show the resulting flood water extents and cross sections along the watercourse and diversion channel with the corresponding water levels. From the cross sections provided the highest water level recorded is 96.59mOD (1% AEP CC) which is 500mm below the FFL of the proposed warehouse (97.10mOD). The design therefore provides sufficient freeboard to protect the building from the 1% AEP plus climate change event. Figure 6 and Figure 7 show a cross sections of the open channel upstream and downstream of the proposed culvert to the south of the site with the maximum water level recorded during the 1% AEP plus climate change event and Figure 8 shows the long section profile of the open channel section. The figures show the flow is contained within the channel upstream and poses no risk of flooding to the site.

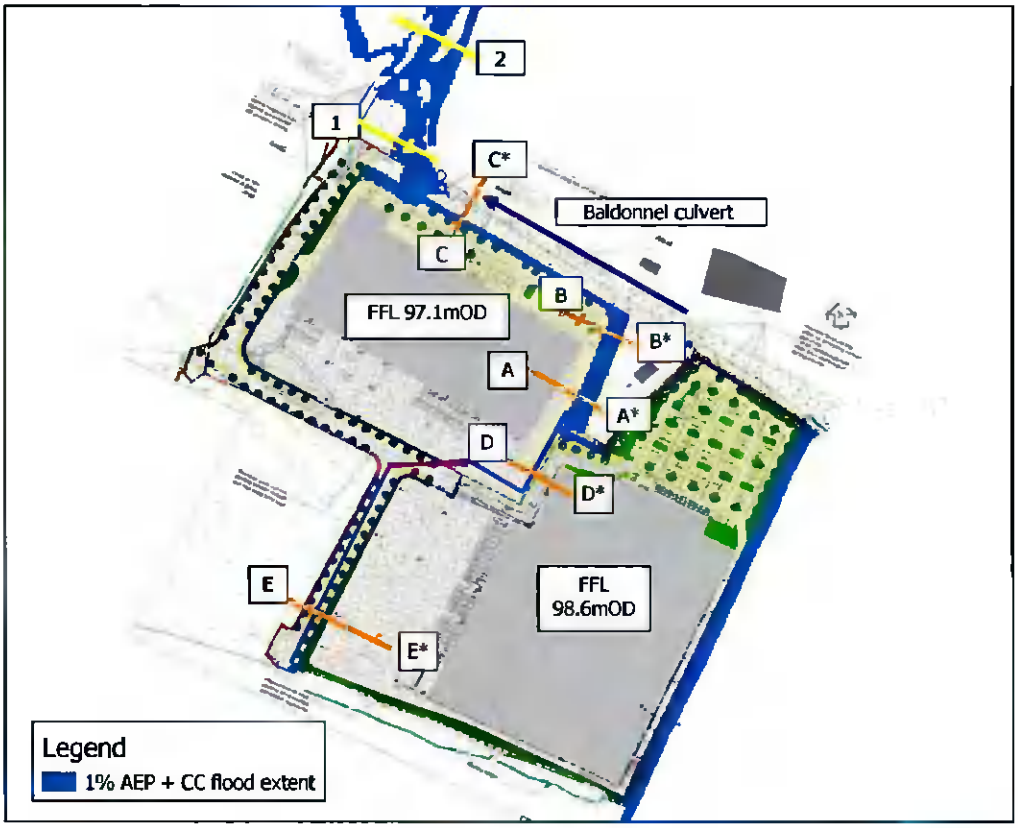
In relation to potential increase in flood risk downstream of the site Figure 9 compares the flow hydrographs modelled in the Baldonnel culvert the existing and proposed design discharge into for both the existing and proposed design scenarios (See Figure 2 for culvert location). The hydrographs show no increase in overall flow in the culvert in the design scenario and therefore, the design does no increase flood risk downstream of the site.

The impact downstream of the site is also highlighted in Table 3-1 which compares the downstream flood levels and flows at the water level comparison line in Figure 2. There is no increase in downstream water level or peak flow observed when the existing and design scenarios are compared.

It should be noted that the cross sections provided are for illustrative purposes only and are a means to highlight the difference in water levels rather than detailed design drawings.

Table 3-1: Comparison of maximum downstream water levels and flows (see Figure 2 for measurement location).

	Monitoring line 1		Monitoring line 2	
	Flow	Level	Flow	Level
Existing scenario	0.26m3/s	94.80mOD	0.22m3/s	94.10mOD
Design scenario	0.26m3/s	94.80mOD	0.22m3/s	94.10mOD



Flood extents for the 1% AEP + Climate change event

Figure 2: Flood extents for the 1% AEP plus Climate change event

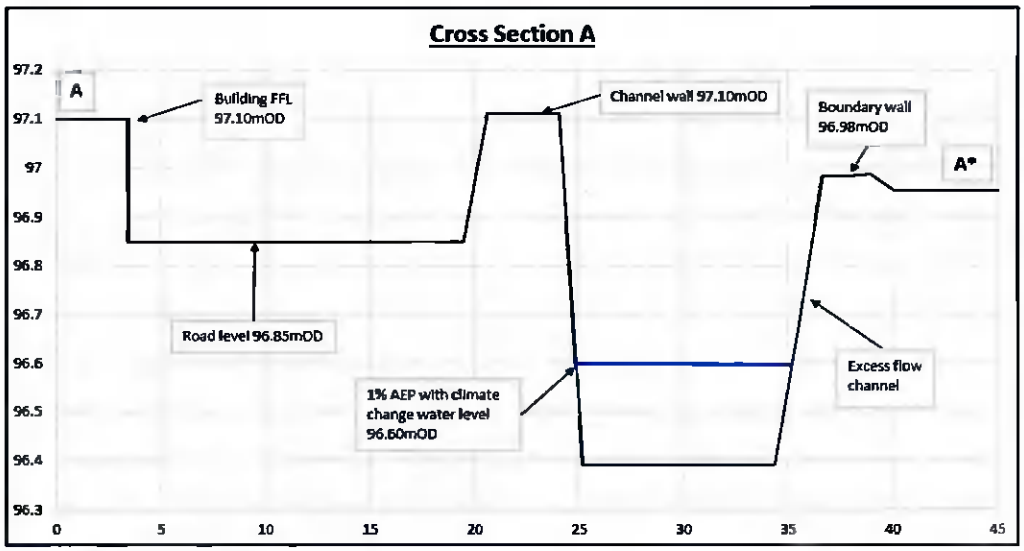


Figure 3: Cross Section A

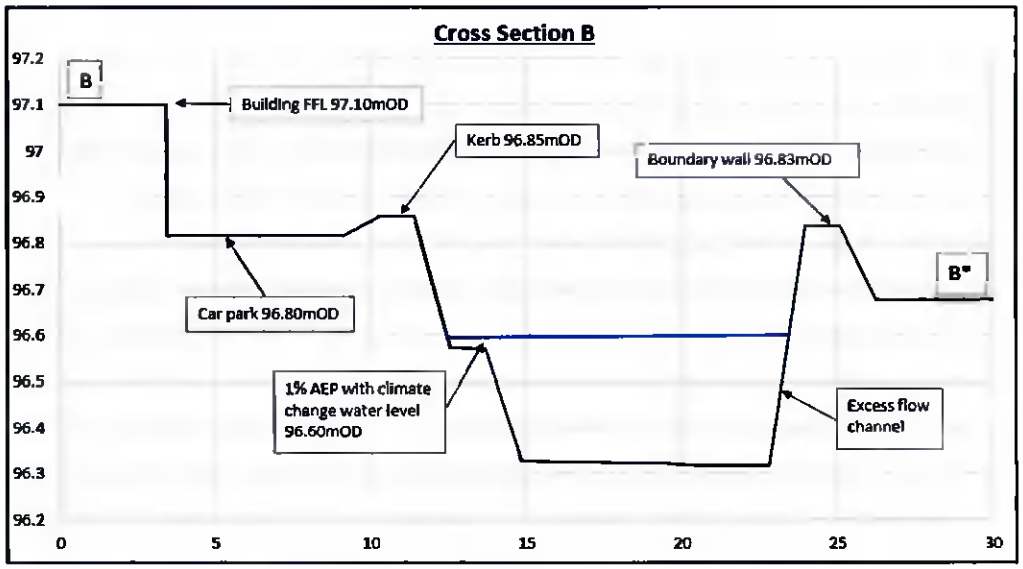


Figure 4: Cross Section B

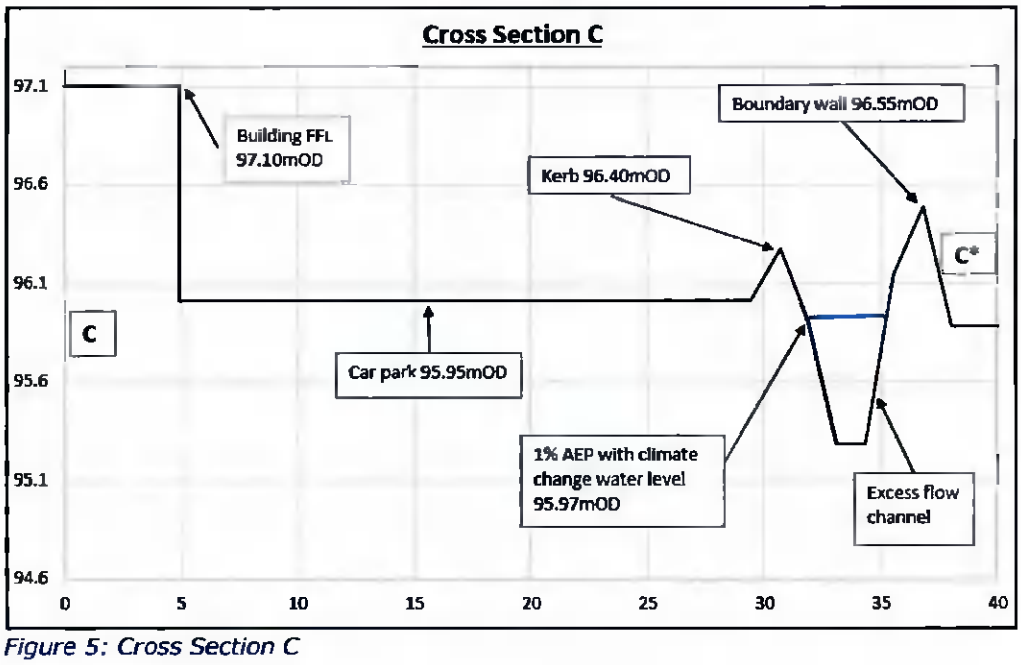


Figure 5: Cross Section C

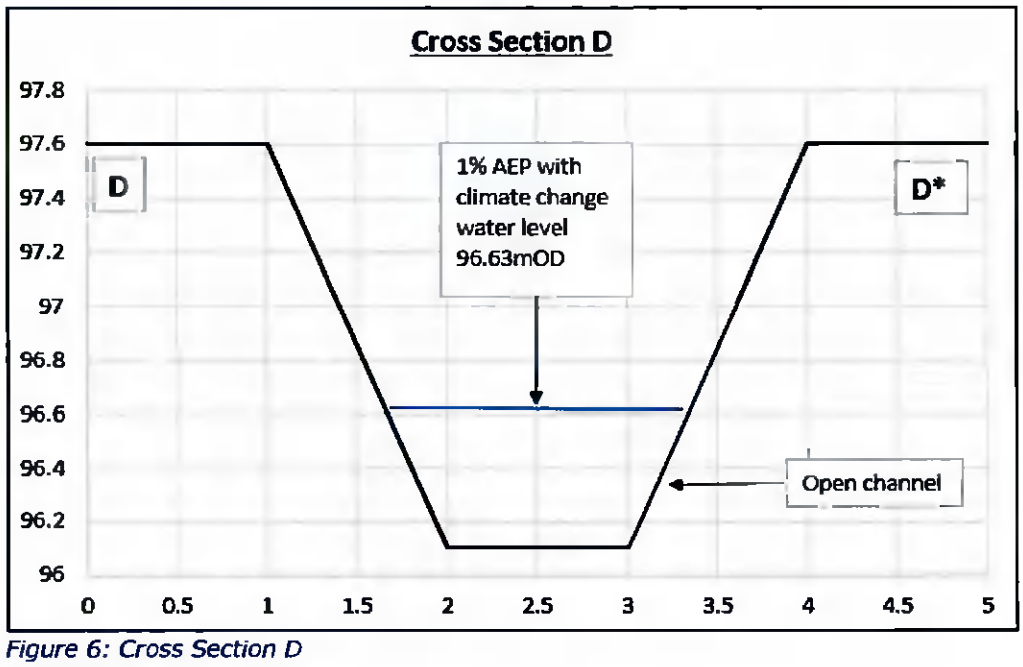


Figure 6: Cross Section D

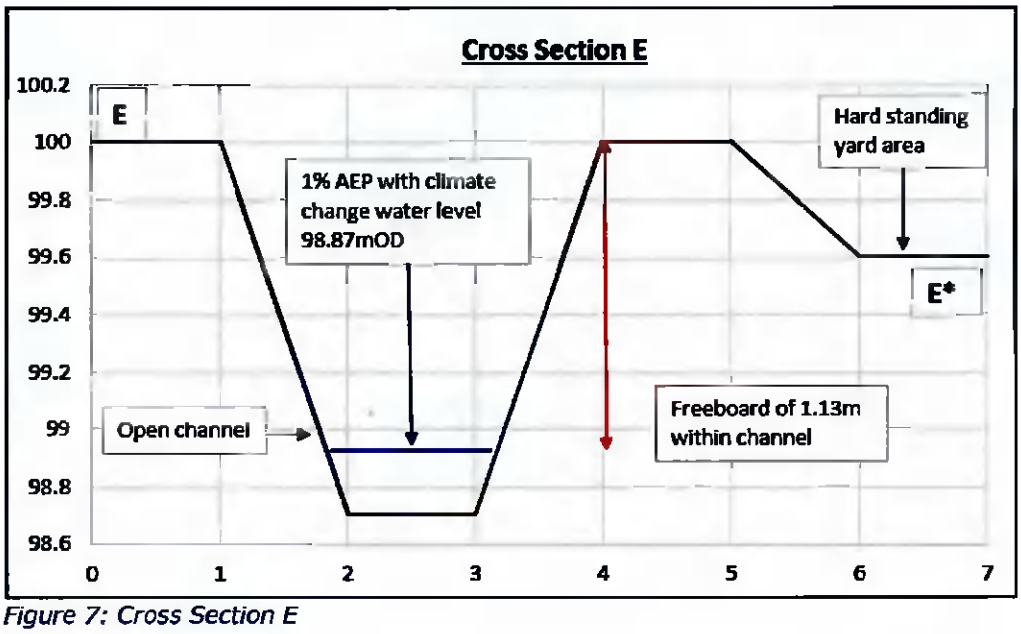


Figure 7: Cross Section E

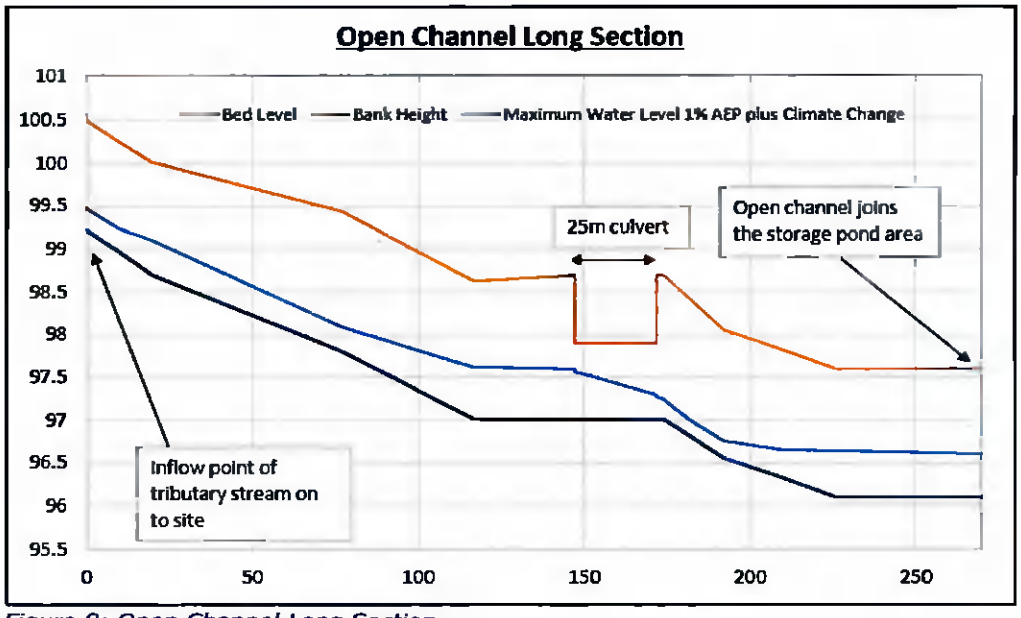


Figure 8: Open Channel Long Section

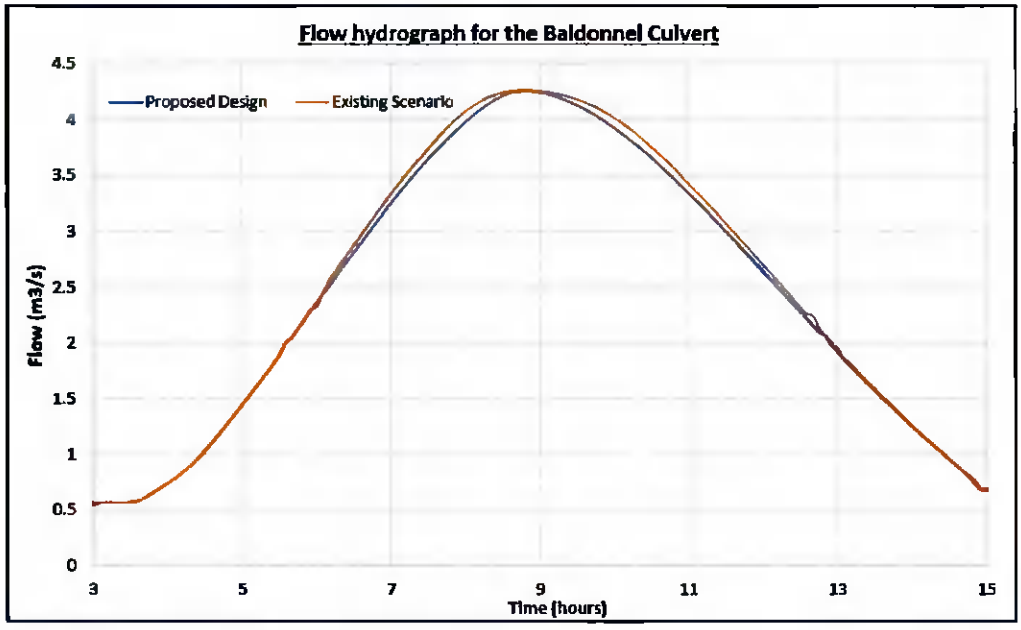


Figure 9: Flow hydrograph for the Baldonnel Culvert (see Figure 2 for culvert location)

4 SITE DRAINAGE DESIGN

This site is currently an existing greenfield site; the development works will increase the hardstanding area at the site. This increase will result in a corresponding increase in surface water run off post development, if not mitigated against.

As noted in Section 5.4 of the Flood Risk Assessment, industry best practice is applied to attenuate all stormwater from hardstanding areas on site.

Runoff from the development will be collected from road gullies and directed to an on-site Storm-tech stormwater attenuation system underground at the proposed carparks. A silt trap and petrol interceptor will be placed upstream and a flow control device placed downstream of the attenuation limiting the discharge from the site.

The attenuation system was calculated using rainfall data for a 1 in 30 year storm event. The tank is designed to a volume capacity of 2,621m3, this also includes capacity for temporary flood storage occurring from a 100year 6hr duration flood Storm event with an additional 10% added for climate change. This is included as part of the design to ensure there is no increase to flood risk to the surrounding area.

This is clarified in email correspondence from Tim Cooke (JBA) to Brian Harkin (SDCC) on Friday 25th January 2019 and included in the response to the initial Additional Information request from SDCC.

The stormwater design layout ensures all surface run-off is attenuated completed independently of any flood water mitigation measures or flows across the site, including the watercourse through the site. Surface run-off calculations and the surface water drainage network was provided within the application by Kavanagh Burke Consulting Engineers.

Additional details on the surface water management can be found in the attenuation report provided by Kavanagh and Burke Consulting Engineers.

5 CONCLUSION

In summary the revised flood mitigation design addresses the clarifications requested.

The FFL of Block A has been increased to 97.10mOD to provide the required 500mm freeboard. The open channel flow path design has resulted in an increase in the overall open channel length and provides sufficient freeboard (500mm) to provide appropriate mitigation throughout the entire site for the proposed warehouse units.

The revised design shows no increased flood risk to sites downstream as the flood waters are managed on site and excess flow is discharged from the site along the natural existing flow path, replicating existing greenfield flow behaviour.

Resulting from the revised flood mitigation design, Warehouse A has been removed from Flood Zone A or B, with all proposed development on-site contained within Flood Zone C. Further to the above, the residential property adjacent to the site is no longer at risk of inundation during the 1% AEP and 0.1% AEP flood events, following implementation of the proposed flood protection measures.

To protect the natural watercourse from contamination the stormwater runoff from the site will be managed by a separate drainage network design which does not interact with the revised flood mitigation design. All hard-standing areas are attenuated through an appropriately detailed stormwater attenuation system. Surface run-off calculations and the surface water drainage network was provided within the application by Kavanagh Burke Consulting Engineers.

Yours sincerely/faithfully,

Tim Cooke.

For and on behalf of JBA Consulting Engineers & Scientists Limited

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