

BM BARRETT MAHONY
CONSULTING ENGINEERS
CIVIL & STRUCTURAL



SITE SPECIFIC FLOOD RISK ASSESSMENT REPORT

Claremont Project, Howth

Barrett Mahony Consulting Engineers Civil . Structural . Project Management Sandwith House, 52 – 54 Lower Sandwith Street, Dublin 2, Ireland. Tel: (01) 677 3200 Fax: (01) 677 3164 Email: bmce@bmce.ie Web: www.bmce.ie	DOCUMENT LEAD SHEET	PAGE 1 OF 52
--	------------------------------------	---------------------------------

PROJECT: Claremont Development, Howth, Dublin

PROJECT NO. 18.386

DOCUMENT TITLE: SITE SPECIFIC FLOOD RISK ASSESSMENT
REPORT FOR PLANNING

DOCUMENT NO: 18.386 – FR – 01

Issue	Date	Description	Orig.	PE	PD	Issue Check
P1	23.04.19	Preliminary	MC	MC	VB	
P6	16.10.19	DRAFT	MC	MC	VB	
P7	11.11.19	DRAFT	MC	MC	VB	
P8	19.11.19	DRAFT	MC	MC	VB	
P9	25.11.19	DRAFT	MC	MC	VB	
PL1	05.12.2019	PLANNING	MC	MC	VB	<i>jak</i>

18.386

MIXED USE DEVELOPMENT AT CLAREMONT SITE, HOWTH, DUBLIN
CIVIL ENGINEERING INFRASTRUCTURE REPORT FOR PLANNING

TABLE OF CONTENTS

1.	Executive Summary	3
2.	Introduction	4
2.1	General Description	4
2.2	Development Proposal.....	5
2.3	Scope of this Report	7
2.4	Local Authority Correspondence.....	7
3.	Site Specific Flood Risk Assessment	8
3.1	Introduction	8
3.2	Stage 1: Flood Risk Identification	8
3.3	Stage 2: Initial Flood Risk Assessment	8
3.3.1	Appraisal of the availability and adequacy of existing information.....	10
3.3.2	Determination of what technical studies are appropriate.....	10
3.3.3	Examination of potential flooding sources that can affect the site	10
3.3.4	Description of what residual risks will be assessed and how they might be mitigated and potential impacts of development on flooding elsewhere.....	16
3.4	Stage 3: Detailed Flood Risk Assessment	18
3.4.1	Maximum Flood Levels.....	18
4.	Conclusion.....	20
	APPENDIX I.....	
	Flood Reports – OPW.....	
	APPENDIX II.....	
	Bloody Stream Storm Water Assessment.....	
	APPENDIX III.....	
	Fluvial Flood Plan & Coastal Flood Plan.....	
	APPENDIX IV	
	Site Flood Assessment Drawings	

1. EXECUTIVE SUMMARY

- Barrett Mahony Consulting Engineers has been commissioned by Atlas GP Limited to undertake a Site Specific Flood Risk Assessment (SSFRA) to support the planning application for the proposed mix use development at the Claremont Site, Howth Road, Howth.
- The FRA considers the current policy relating to flood risk, including the Operation of Public Works (OPW) publication “The Planning System and Flood Risk Assessment Guidelines for Planning Authorities”.
- The site is located in Flood Zone C for coastal flooding - “Irish Coastal Protection Strategy Study Phase III - North East Coast Flood Extent Map”
- The site is located in Flood Zone C for fluvial flooding – “RPS Strategic Flood Risk Assessment – Fluvial Flood Zone Mapping pg. 22”
- There is a stream – The Bloody Stream – that is currently culverted across the Techrete site. The OPW list two flood events for the site, both a result of system blockage rather than system capacity.
- The development is classified as “less vulnerable”, as safe exit points from the building are above the 0.1% AEP plus HEFS. Operation of Public Works (OPW) publication - Clause 2.16 of the OPW guidance document states:
‘The classification of different land uses and types of development as highly vulnerable, less vulnerable and water-compatible is influenced primarily by the ability to manage the safety of people in flood events and the long-term implications for recovery of the function and structure of buildings’.
- The minimum finished floor levels for living and sleeping accommodation area must be above the 1 in 1000 year event HEFS (High End Future Scenario – OPW), which equals 3.340m plus 1 metre freeboard. In the proposed development habitable areas start at 5.2m OD, providing a freeboard of 1.860m.
- Groundwater levels measured (Golder) range from 1.05mOD (BH05, 13/09/19) to 1.76 m OD (BH09, 18/09/19), therefore proposed development provides a minimum freeboard of 3.44m.
- The site is located beside the sea, therefore the need for attenuation storage is not necessary as the water is discharged directly into the sea and will have no impact on the watercourse. However green roofs will be used to reduce the flow rates and increase quality.
- A management company will be appointed to maintain the roads, landscaping and SuDs systems throughout the development.
- The proposed development includes the introduction of a surface level watercourse through the site. The proposed development has been designed to mitigate flood risk that the new watercourse may introduce to the site, such as:
 - All openings are set at 4.5m OD or above - (figure based on 0.1% AEP HEFS)
 - Water grill positioned at the end of the open channel to stop large debris entering the underground system.
 - Backup drain provided in the event the open channel is fully blocked, providing alternative means of escape.
- In conclusion, this SSFRA demonstrates that the proposals are consistent with the aims of the Operation of Public Works (OPW) and Fingal County Council Development Plan 2017-2023.

2. INTRODUCTION

2.1 GENERAL DESCRIPTION

Barrett Mahony Consulting Engineers has been commissioned by Atlas GP Limited to undertake a Site Specific Flood Risk Assessment (SSFRA) to support the planning application for the proposed mix use development at the Claremont Site, Howth Road, Howth.



Figure 2.1 - Site Location

The development site is made up of three sites, a precast manufacturing plant - formerly Techrete, a motor garage- formerly Teeling Motors and a garden center, site area approx. c.2.672 hectares. Figure 2

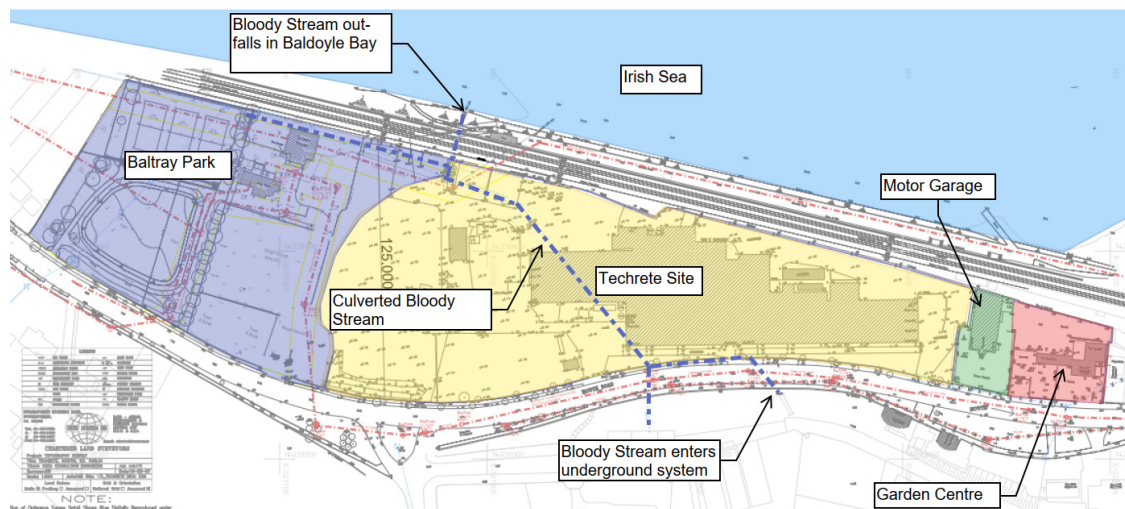


Figure 2 - Site Brake Down

Figure 2 also show the Bloody Stream. This is currently culverted under the site, rises in the Hill of Howth and navigates it way towards Howth Castle. Presently there are water control measure in place, via three large retaining walls, which attenuate the flow before entering a piped system that traverses the site and outfalls via the “Bob Davis Culvert” into Baldoyle Bay. This stream is tidal influenced but only during high tide. During medium to low tide it is clear of sea water.

2.2 DEVELOPMENT PROPOSAL

The proposed development will occur at a site bounded to the south by the Howth Road, to the east by a private dwelling, to the north by the DART line, and to the west by Local Authority lands. The site incorporates the former Techrete manufacturing facility, the former Beshoff's Motors showroom, and the former Howth Garden Centre.

The proposed development will include the demolition of all structures on site (c.8,162sqm GFA) and excavation of a basement. The proposed development comprises of the provision of a mixed use development of residential, retail/restaurant/cafe uses and a creche in 4 no. blocks (A to D), over part basement. Blocks A, B, C and D with a height up to a maximum of seven storeys of apartments over lower ground floor and basement car parking levels (a total of eight storeys over basement level). The residential component will consist of 512 no. residential units. The proposed development includes the provision of two vehicular entrances on to Howth Road, excavation of basement to provide for car parking, plant, waste storage and ancillary use. Additional car parking spaces shall be provided at lower ground floor level. A total of 439 no. car parking spaces and 1,335 no. bicycle parking spaces, including 49 no. bicycle spaces to cater for the retail units and creche shall be provided. One vehicular access is located at Block A, serving car parking spaces. The second is at Block C, providing access to the basement, residential and retail parking, and a service area for the retail units. A service route will be provided along part of the northern perimeter of the site with access from the western end of the site at a junction with Howth Road and at the main vehicular entrance at Block C;

A publicly accessible walkway/cycleway to the north of the site shall be provided at podium level. A civic plaza will be provided between Blocks D and C, and a landscaped park to the west of Block A. A channel to the sea for the Bloody Stream with associated riparian strip shall be incorporated as a feature within a designed open space between Blocks A and B. Communal gardens will be provided for Blocks A, B and C;

The residential component consists of 512 no. residential units, which includes 4 no. studio, 222 no. one bed, 276 no. two bed, 10 no. three bed apartments, and communal facilities of 708 sqm. Ground floor units onto the Howth Road will have own door access. The units will be served by balconies or terraces on all elevations;

Block A, with a maximum height of seven storeys of apartments over lower ground level car park (a total of eight storeys), will provide for 234 residential units, with residents' amenities to include a gym, residents' lounge, residents' support office, and 2 no. residents' multi-purpose rooms. Block B, with a maximum height of seven storeys of apartments over lower ground floor and basement car park (a total of eight storeys over basement), shall provide for 154 no. units, residents' lounge, residents' multi-purpose room, and creche of 236 sqm with outdoor play area. Own door access will be provided at ground floor. Block C, with a maximum height of seven storeys over basement car parking (a total of seven storeys) will provide for 83 no. residential units in two wings over a retail unit and Block D, with a maximum of 6 storeys over basement, shall provide for 41 no. residential units over retail units;

The commercial component in Blocks C and D consists of 4 no. units with 2,637 sqm gross floor area. In Block C, it consists of a 1,705 sqm anchor unit, accessed from the

civic plaza. In Block D, it consists of a restaurant (243 sqm) and retail unit (603 sqm) and café (86 sqm). The restaurant and retail units are accessed from Howth Road, and the café is accessed from the upper level of the civic plaza.

The proposed development includes the provision of public and communal open space, green roofs, landscaping, boundary treatments, set down locations, substations, meter rooms, waste management and all ancillary site works, including upgrading of the public paths along Howth Road and relocation of bus stop in new setback with a bus shelter. Two set down areas are provided at either end of the site;

The gross floor area of the proposed development is 48,252 sqm (excluding enclosed car parking) on a site of 2.68 ha.

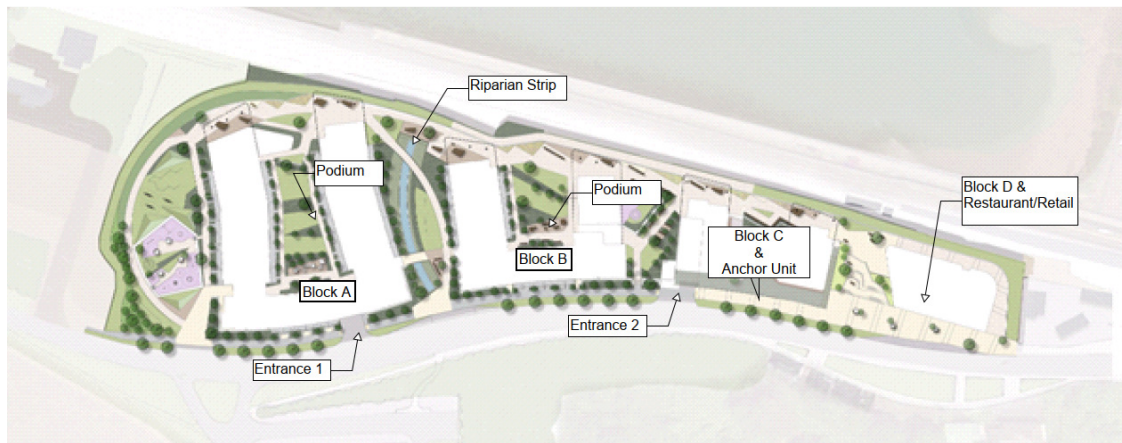


Figure 3 - Proposed

2.3 SCOPE OF THIS REPORT

The flood risks associated with the proposed development are addressed in this report and area based on existing available information at the time of writing the report. This report should be read in conjunction with the following drawings submitted with the planning application.

- 18.386-C1001 Basement Foul and SW Drainage
- 18.386-C1002 Ground Foul and SW Drainage
- 18.386-C1003 Roof & Podium Level Drainage
- 18.386-C1004 Suds Strategy
- 18.386-C1005 Watermain Layout
- 18.386-C1010 Bloody Stream Details/Section
- 18.386-C1022 Road Layout Sheet 1 of 2
- 18.386-C1023 Road Layout Sheet 2 of 2
- 18.386-C1200 Standard Drainage Details
- 18.386-C1205 SuDS Details
- 18.386-C1210 Road and Hardstanding Details

2.4 LOCAL AUTHORITY CORRESPONDENCE

A number of pre planning meeting have been had between the Engineers (BMCE) and representatives of Fingal County Council Planning Section (Niall McKiernan, Shane Keane, Niall Thornton), between November 2018 and March 2019. Along with site visits in November and July with Niall McKiernan. The outcomes of these meeting relevant to the Civil Infrastructure for the site are outlined below:

- Flood Drawings -showing extent of flooding for existing and proposed development.
- Site Specific Flood Risk Assessment, including a Breach analysis.
- De-culverting of the Bloody Stream

Observations and comments made have been considered and incorporated into the development plans.

3. SITE SPECIFIC FLOOD RISK ASSESSMENT

3.1 INTRODUCTION

The proposed scheme plans to de-culvert the stream to create a feature within the development. The main focus of this report is to investigate the flood risk associated with the Irish Sea and the Bloody Stream.

The assessment is carried out in accordance with guidelines outlined in the OPW publication “The Planning System and Flood Risk Assessment Guidelines for Planning Authorities”. The stages involved in the assessment of flood risk are listed in that publication as follows:

Stage 1: Flood Risk Identification

Stage 2: Initial Flood Risk Assessment

Stage 3: Detailed Flood Risk Assessment

The OPW publication also outlines a Sequential Approach for determining whether a particular development is appropriate for a specified location in terms of flood risk. The categorization of the subject site in terms of the OPW’s sequential approach is further outlined in section 3.3 below.

3.2 STAGE 1: FLOOD RISK IDENTIFICATION

Stage 1 identifies whether there are any flooding or surface water management issues related to the site i.e. it identifies whether a flood risk assessment is required.

- 1) Irish Coastal Protection Strategy Study Phase III - North East Coast Flood Extent Map identify the site as Flood Zone C – the lowest probability of coastal flooding. (Appendix III)
- 2) RPS Strategic Flood Risk Assessment – Fluvial Flood Zone Mapping pg. 22 – Identify the site as Flood Zone C- the lowest probability of fluvial flooding. (Appendix III)
- 3) The OPW map report for the site area (included in Appendix I) identifies 2 flood events near the site in recent history, both between October and November of 2002. One report discusses flooding in the Techrete grounds and the other reports flooding of a nearby pub. Both incidents are a result of system blockages rather than system capacity. There have been no further reports of flooding.
- 4) A CCTV survey undertaken of the existing drainage system was inconclusive due to blockages encountered, such as street cones, sediment build up or surcharged sections.

3.3 STAGE 2: INITIAL FLOOD RISK ASSESSMENT

Clause 2.16 of the OPW guidance document ‘The Planning System and Flood Risk Management’

“The initial Flood Risk Assessment should ensure that all relevant flood risk issues are assessed in relation to the decisions to be made and potential conflicts between flood risk and development are addressed. It should assess the adequacy of existing information and any flood defenses.”

As outlined in the OPW publication, new developments are divided into three categories which are as follows:

- ‘Highly Vulnerable Development’ – hospitals, schools, houses, student halls of residence etc.;
- ‘Less Vulnerable Development’ – retail, commercial, industrial, agriculture etc.; and
- ‘Water-compatible Development’ – docks, marinas, amenity open space etc.

The proposed development initially came under the heading of Highly Vulnerable developments as the ground floor and basement are below the 1 in 1000 year event, 3.341m OD. However, a more detailed inspection of the proposed development leads to a classification of less vulnerable development. This is on the bases that the people can safely exit onto Howth road using the podium at +6.4m OD or for a small proportion of units who have direct access onto Howth road.

This rationale is allowed in Clause 2.16 of the OPW guidance document ‘The Planning System and Flood Risk Management’ which states;

‘The classification of different land uses and types of development as highly vulnerable, less vulnerable and water-compatible is influenced primarily by the ability to manage the safety of people in flood events and the long-term implications for recovery of the function and structure of buildings’

The later part is not a concern in the context of the overall site, given that the lower areas are parking facilities.

The units that have direct access to Howth road are set at 5.2m OD, providing a freeboard of 1.859m. These units are not seen as a flood risk compared to other areas as they are not in the riparian strip, are furthest away from the sea and have direct access to Howth road which varies around 4.0m OD. The escape route is higher than the 1 in 1000 year event, 3.34m OD and therefore not seen as a flood risk.

Geographical areas are similarly divided into three categories, based on their risk of river and tidal flooding. The three categories are 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 year 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 i.e. all areas which are not within zone A or B).

Irish Coastal Protection Strategy Study and the RPS Fluvial Flood Risk Assessment both put the Site in the Flood Zone C category. (Appendix III)

The matrix below, which is an extract from the OPW document, states whether a project is deemed ‘Appropriate’ for a geographical location. This development falls into the “Appropriate” category and a justification test is not required.

	Flood Zone A	Flood Zone B	Flood Zone C
Highly vulnerable development	Justification Test	Justification Test	Appropriate

Less vulnerable development	Justification Test	Appropriate	<u>Appropriate</u>
Water compatible development	Appropriate	Appropriate	Appropriate

Figure 4 –Matrix of vulnerability versus flood zone

3.3.1 Appraisal of the availability and adequacy of existing information

- 1) Flood Zone - The possibility of Fluvial flooding on the site is considered utilizing the guidelines outlined in Chapter 3 of the OPW publication referenced in section 3.1, Strategic Flood Risk Assessment for Fingal Development Plan.
- 2) The flow of the Bloody Stream is calculated using the Institute of Hydrology Report No. 124 method.

$$Q_{\text{bar}} = 0.00108 \times \text{Area}^{0.89} \times \text{SAAR}^{1.17} \times \text{SOIL}^{2.17}$$

The catchment area is approximately 1.3km² and a factor of 1.3 is applied for climate change.

- 3) Tide levels – Tidal levels are sourced from the marine website.
- 4) Ground Water Level - Site Investigation have been carried out to determine existing ground water levels.

The above information meets the standards required for a detailed assessment.

3.3.2 Determination of what technical studies are appropriate

A joint probability analysis has been undertaken for various scenarios to determine the worst-case scenario for combined fluvial and tidal effects.

- 1) *combined 1 in 200 year coastal + 1 in 2 year fluvial for High End Future Scenario*
- 2) *combined 1 in 2 year coastal + 1 in 200 year fluvial for High End Future Scenario*

These will be analysed to allow for HEFS climate change, as per the Fingal County Council – Surface Water Management Report set out in Table 1.

Parameter	MRFS	HEFS
Extreme Rainfall Depths	+ 20%	+ 30%
Peak Flood Flows	+ 20%	+ 30%
Mean Sea Level Rise	+ 500 mm	+ 1000 mm
Land Movement	- 0.5 mm / year ¹	- 0.5 mm / year ¹
Urbanisation	<i>No General Allowance – Review on Case-by-Case Basis</i>	<i>No General Allowance – Review on Case-by-Case Basis</i>
Forestation	- 1/6 Tp ²	- 1/3 Tp ² + 10% SPR ³

Table 1- Flood Parameters taken from Fingal County Council - Surface Water Management

3.3.3 Examination of potential flooding sources that can affect the site

The possible sources of flood water are assessed in the following tables below using the “**Source – Pathway – Receptor Model**” for the existing site and proposed scheme.

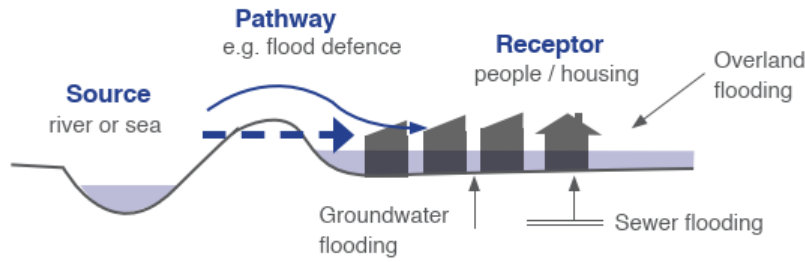


Figure 5- Source Pathway - Receptor Model (OPW)

3.3.3.1 Existing Site

Possible sources of flood water

Source	Pathway	Receptor	Likelihood	Consequence	Risk
Tidal	Overtop Breach	People Property	Very unlikely	High	Low
Fluvial	Overtop Breach	People Property	likely	High	Low
Pluvial Surface water Snow Melt	Overflow/ Blockage	People Property	Likely	Low	Low
Groundwater	Rising groundwater levels	People Property	Unlikely	medium	Low
Embankment Breach	Bank Failure/Slippage	People Property	Unlikely	Low	Low
Watermain Burst	Excavation Works	People Property	Likely	Low	Low

Table 2- Existing Site Sources of flood Water

Tidal

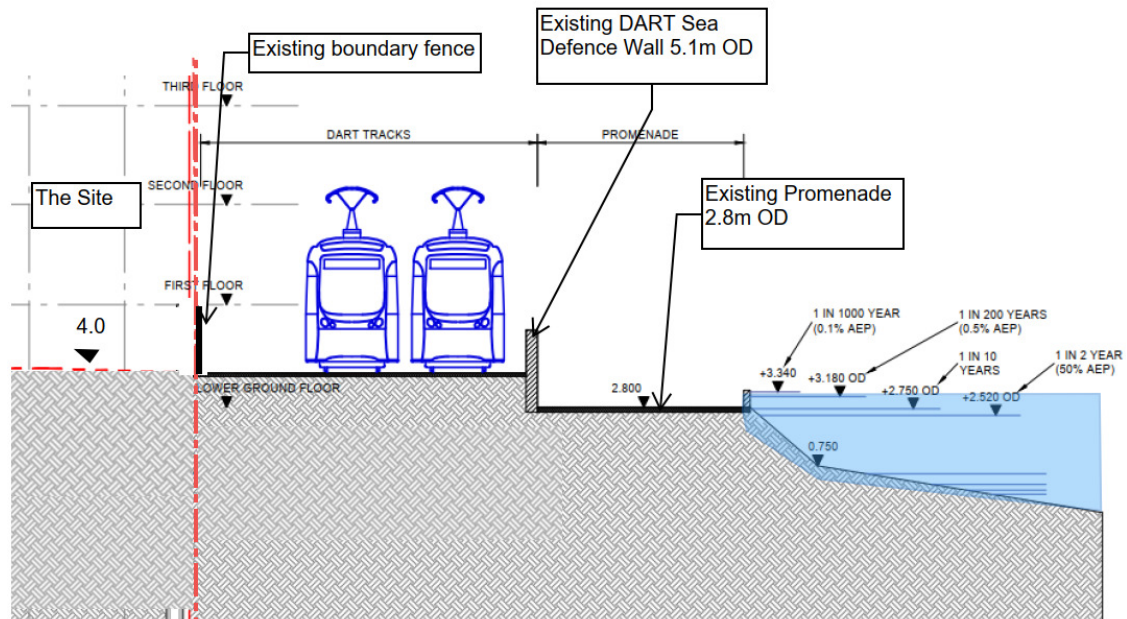


Figure 6 – Current Sea Defense

The site is currently protected by the existing promenade and DART line defense wall. The promenade is at 2.8m OD and the defense wall at 5.1m OD, therefore providing a freeboard of 1.76m. (Figure 6 – Current Sea Defense). Therefore, the current likelihood of flooding is very unlikely.

Fluvial/Pluvial

The Bloody stream is currently culverted across the site. Overflow can only happen if the underground system is blocked and the manholes surcharges.

Currently all surface water is collected without attenuation storage and is discharged into the culverted Bloody Stream and discharges through a series of settlement tanks and outfalls into the Bob Davis culvert which flows under the DART line and into Baldoyle Bay.

These settlement tanks are located on the north west corner of the development and were necessary because of the existence of two Irish water assets, 1500mm and the 1200mm concrete sewers, and which necessitated the stream to flow effectively under these. A survey was carried out to establish the exact location of these pipes and this survey was overseen by members from Fingal County Council and BMCE. The survey involved a series of excavations to determine the exact route of the pipes. The excavation found that the pipes were laid together and encased in concrete, forming a 3m to 4.7m wide mound @ 2.360m OD, at a gradient of 1:150 towards the DART line.

A CCTV survey was carried out on the existing stream drainage to understand the current underground drainage system around these settlement tanks. The effectiveness of the existing configuration results in a very poor hydraulic gradient for flows out falling through the Bob Davis Culvert. Figure 7 below shows the existing outfall configuration. It can be seen that the Bloody Stream goes below the Irish Water Assets and as a result is below the outfall levels in the Bob Davis Culvert. This means that in the current configuration, for water to discharge, a certain amount of surcharge has to occur in the existing surface water network. This results in sediment build up with associated ongoing maintenance issues. Thereby increasing the likelihood of the manholes surcharging.

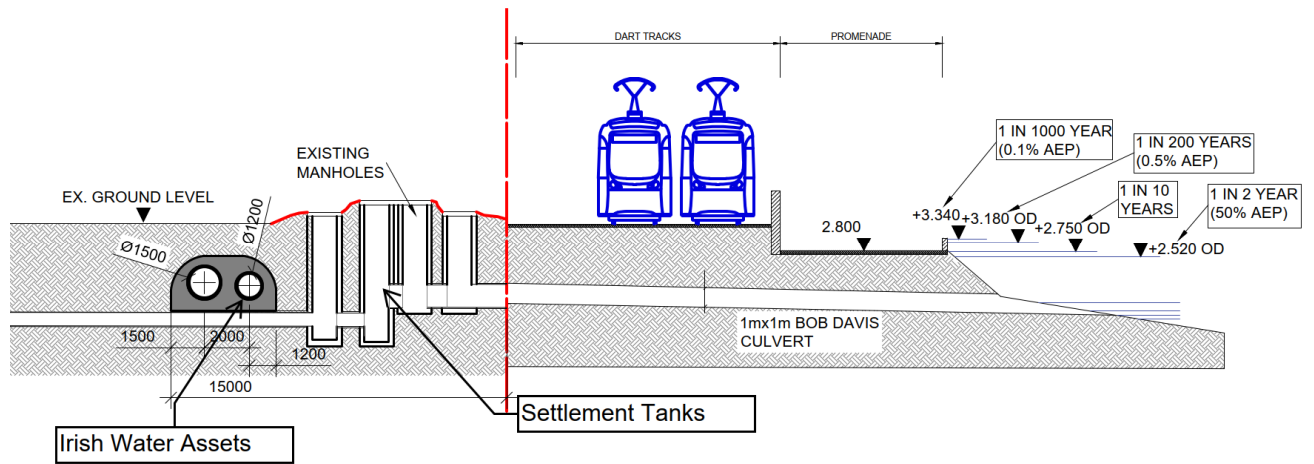


Figure 7 - Existing Outfall Configuration

Ground Water

The site is beside the sea, some tidal response in respect to rising sea levels is expected to influence the water table. Groundwater levels measured (Golder) range from 1.05mOD (BH05, 13/09/19) to 1.76 m OD (BH09, 18/09/19), therefore current freeboard varies between 2.24m-2.95m.

Embankment

Refer to Tidal

Watermain Burst

Excess water would pond on site and drain into the surface water system, which would carry the water into the Bob Davis Culvert and out into Baldoyle Bay.

3.3.3.1 Proposed Scheme

Possible sources of flood water

Source	Pathway	Receptor	Likelihood	Consequence	Risk
Tidal	Overtop Breach	People Property	Very unlikely	High	Low
Fluvial	Overtop Breach	People Property	Unlikely	High	Low
Pluvial Surface water Snow Melt	Overflow/ Blockage	People Property	Unlikely	Low	Low
Groundwater	Rising groundwater levels	People Property	Unlikely	Medium	Medium
Embankment Breach	Bank Failure/Slippage	People Property	Unlikely	Low	Low
Watermain Burst	Excavation Works	People Property	Unlikely	Low	Low

Table 3 – Proposed development Sources of Flood Water

Tidal

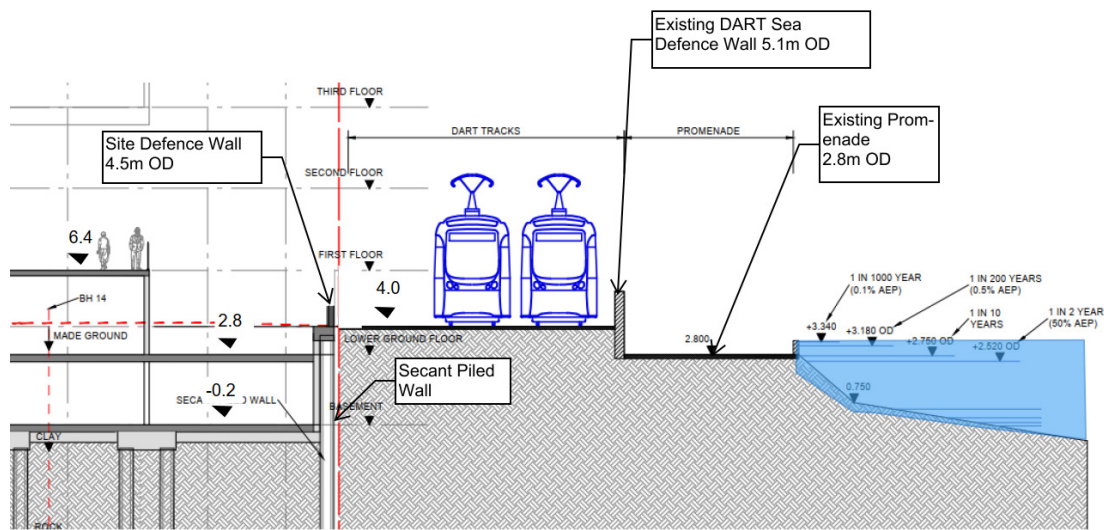


Figure 8 -Proposed Sea Defense

Overtop breach is only possible if the promenade and the DART line sea defence wall is removed. To cater for such event, a retaining wall is to be constructed along the coastal boundary to 4.5m OD (1 in 1000 years plus HEFS). Therefore the likelihood of flooding from a sea breach is low.

Fluvial / Pluvial Surface Water

The new development will have a riparian strip, which will include a section of the Bloody Stream de-culverted in line with previous applications. All surface OD water collected from the development will be discharged into the stream.

In the event that the Bloody Stream conveys larger volumes of storm water during times of extreme rainfall the open channel, Figure 9 has been designed in accordance with the OPW Planning System and Flood Risk Management Guidelines for Local Authorities to take account of this scenario.

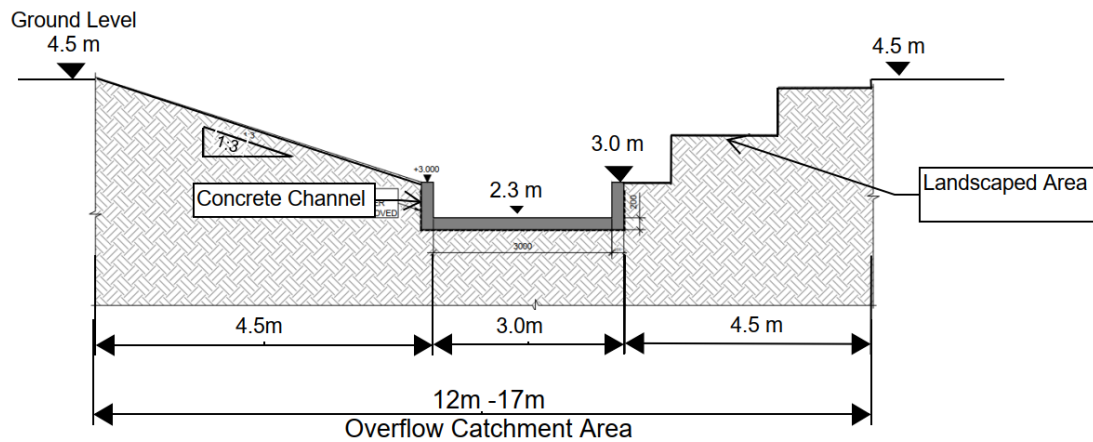


Figure 9 - Typical Section through Riparian Strip

Figure 10 shows the proposed outfall stream configuration around the Irish Water Assets. It can be seen by comparison with Figure 7 that it is proposed to raise the invert of the Bloody Stream as it traverses through the site, so that it discharges over the Irish Water assets. The SD06.FR/Rev P9

introduction of proper inspection chambers will rectify the existing deficiencies in relation to inspection and maintenance. The pre-existing tank arrangement which interrupted the flow, will no longer exist and the hydraulic gradient associated with this configuration will ensure proper flows through the Bob Davis culvert and mitigate against silt build up. It is further proposed to line the base of the existing Bob Davis culvert with the concrete V-channel to ensure self-washing flows.

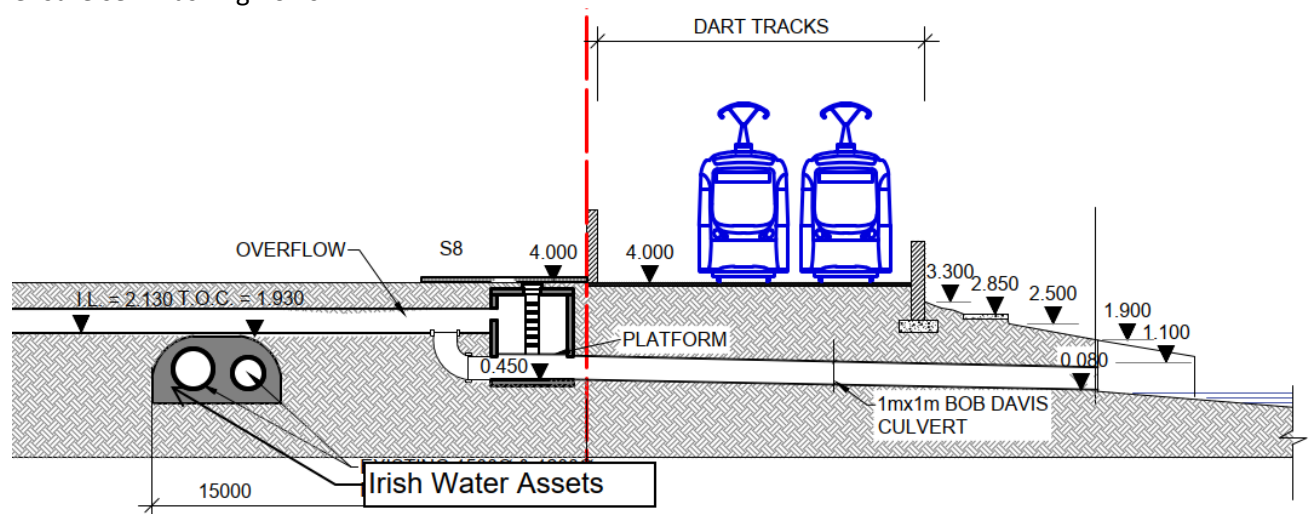


Figure 10- Proposed Outfall Configuration

The new layout provides more access, increased capacity and on the bases that all mitigation measures the flood risk from fluvial, coastal or a combination of both to the site is low.

The area surrounding the development will be graded so that fluvial water is directed to ground drainage network and diverted away from the residential buildings. In the event of a blockage water will flow towards either Baltray Park, the riparian strip or as a last resort to Howth Road. All access ramps to lower areas, are raised at the entrance to prevent water entering from Howth Road.

Groundwater

The site is beside the sea, some tidal response in respect to rising sea levels is expected to influence the water table. Currently the groundwater levels measured (Golder) range from 1.05mOD (BH05, 13/09/19) to 1.76 m OD (BH09, 18/09/19), the residential accommodation starts at 5.2m OD, therefore, providing a minimum freeboard of 3.44m OD, which is significantly higher than the 1 metre requirement and therefore flood from rising groundwater is seen as very unlikely.

Watermain Burst

Refer to Fluvial/Pluvial Surface Water

Embankment Breach

Refer: Tidal

3.3.4 Description of what residual risks will be assessed and how they might be mitigated and potential impacts of development on flooding elsewhere.

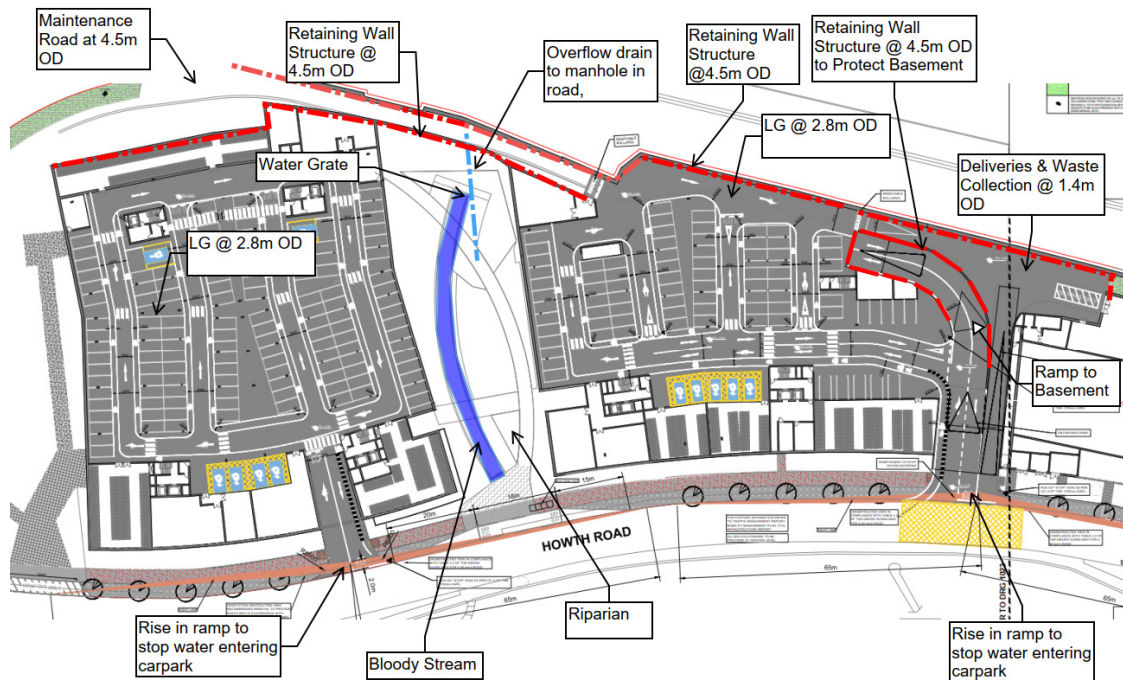


Figure 11 - Flood Mitigation Plan

Tidal

Historical records show there has never been a sea breach at this site. The sea level for 1 in 1000 years (0.1% AEP) from the OPW website is 3.340m OD. Currently the site has protection from the sea via the DART sea defence wall and the promenade.

To assess for the worse-case scenario the flood risk assessment has been carried out for the situation where the current sea defences are removed, and the site is exposed.

The proposed scheme is to provide parking in the basement (-0.2m OD) and lower ground floor (2.8m OD), retail at ground (4.0m OD) and residential accommodation at (5.2m OD and 6.4m OD).

Both car parks are below the 0.1% AEP and would be susceptible to flooding.

To mitigate this risk, it is planned to do the following:

1. Constructed a sea defence wall along the coastal perimeter to 4.5m OD (0.1% AEP + HEFS)
2. The topography on site is to be graded to divert the water away from the development and into the local drainage system, onto Howth Road and into Baltray Park.
3. Access ramps from Howth road to the car parks will be set at 4.3m OD prior to descending. This will prevent water from Howth Road entering the lower areas.
4. All openings will be set at 4.5m OD or above.

All of the above will prevent water entering the lower areas and reduce the possibility of flooding to very unlikely.

Fluvial – The Bloody Stream

The new development plans to raise the stream at the crossing point before Howth road and de-culvert it within the site to become a feature within the development. The level can be raised as the previous level was determined by the now redundant foul sewer in Howth Road. This has since been replaced with a new foul sewer in the centre of Howth Road, at a greater depth.

The stream is introduced to the site via a 3m channel at 2.360m OD traversing the site in a landscaped riparian strip. The riparian strip will be approximately 65m long and varying in width from 12-17m. The banks of the channel will be either sloped @ 1:3 or stepped to a level of 4.5m as shown in Figure 12, increasing the capacity of the channel in the event of high flows.

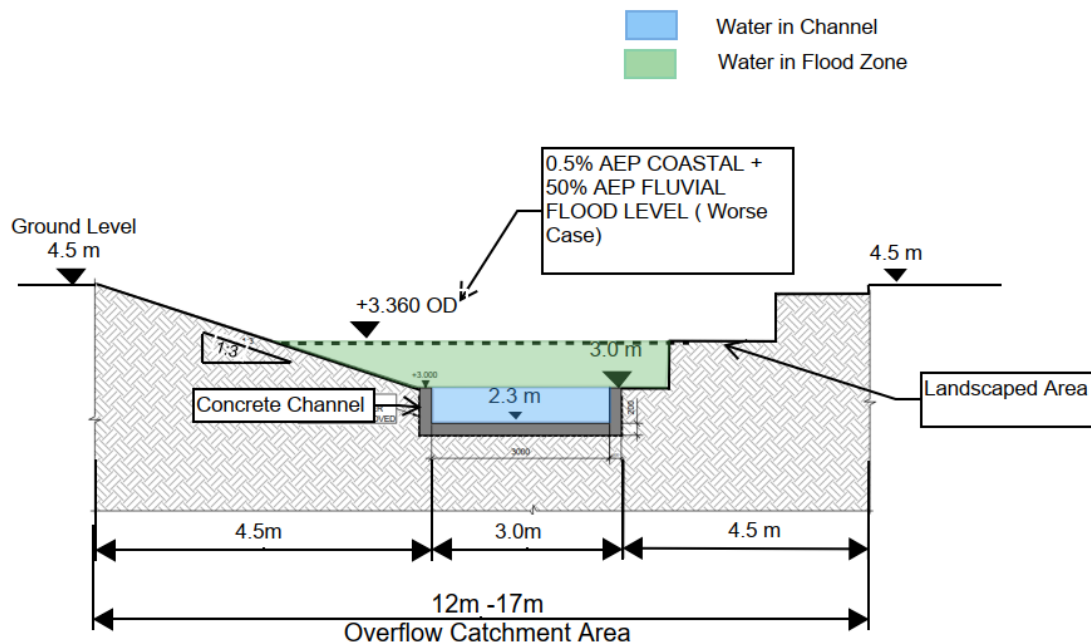


Figure 12- Riparian Strip Section

The level of the channel is below 1 in 2 year high tide (2.52m OD) and the sea will enter the channel on average 2 times a year. Combining the coastal and fluvial, for different situation indicates there will be times the channel will surcharge but will be contained in the overflow catchment area and will never exceed the 4.5m OD.

The following mitigation methods are planned for the Site to reduce risks of flooding to the surrounding areas:

- 1) The capacity of the channel carrying the Bloody Stream across the Howth Road, will be increased from a 450 x 225 culvert to a 450 dia pipe.
- 2) A water grill is to be provided at the end of the riparian strip to ensure that any large items are captured before entering the underground system.
- 3) An overflow drain has been provided in the event of a blockage to provide alternative relief route.
- 4) Opening off riparian strip are set at 4.5m OD.
- 5) Residential accommodation is set at 5.2m OD.
- 6) In the event the overflow is unable to function the surrounding landscape is graded to divert water onto Howth road, away from the development.
- 7) Access points to the lower areas are to have a raised platform to prevent pluvial flow entering from Howth Road.

All the above reduce the risk of flooding and diverts water away from the living areas. (Figure 11 -Flood Mitigation Plan)

Pluvial Surface Water

Surface water drainage is designed for a 1 in 100-year event and a factor of 30% has been added for climate change. To minimise flooding due to blockage, regular maintenance will be carried out by the management company. Drainage design is detailed in the Civil Infrastructure Report completed by Barrett Mahony Consulting Engineers, document No. 18.386-IR-01

3.4 STAGE 3: DETAILED FLOOD RISK ASSESSMENT

A detailed Site Specific Flood Risk Assessment involves the estimation of the level of flooding on the site and the performance of the development under these conditions so that a “fit for purpose” development can be delivered. Once the likely maximum flood level has been estimated, the design should be developed so that as much floor area as possible is above this level. Residual flood risk will remain in other areas that for operational reasons have to be below the maximum flood level (street access, protected structures, etc.) and these areas will have to incorporate flood resilient design features and flood risk management procedures so that the risk is mitigated in so far as possible.

3.4.1 Maximum Flood Levels

The site flood levels for the site are determined as follows:

The riparian strip has been designed to accommodate the following flows to mitigate the flood risk within the building:

- 1 in 1000 year tidal
- 1 in 1000 year fluvial
- Combined 1 in 2 year coastal + 1 in 2 year fluvial (Section 2.4)
- Combined 1 in 2 year coastal + 1 in 200 year fluvial (Section 2.4)

Fluvial High Water Levels

Maximum flood levels for the site have been estimated using the Institute of Hydrology Report No. 124 method outlines as:

$$Q_{\text{bar}} = 0.00108 \times \text{Area}^{0.89} \times \text{SAAR}^{1.17} \times \text{SOIL}^{2.17}$$

The proposed channel will be approximately 3m wide with the banks of the channel either sloped @ 1:3 or stepped to a level of 4.5m OD as shown in Figure 12, increasing the capacity of the channel in the event of high flows.

The average upstream invert level of the channel is 2.360m OD which gives a top water level of 3.200m OD during the 0.1% AEP fluvial event. The proposed FFL of residential buildings adjacent to the channel is 6.4m OD, with access points set at 4.5m OD in the cores at a split level, therefore representing a freeboard of 1.30m from the openings. (Figure 13)

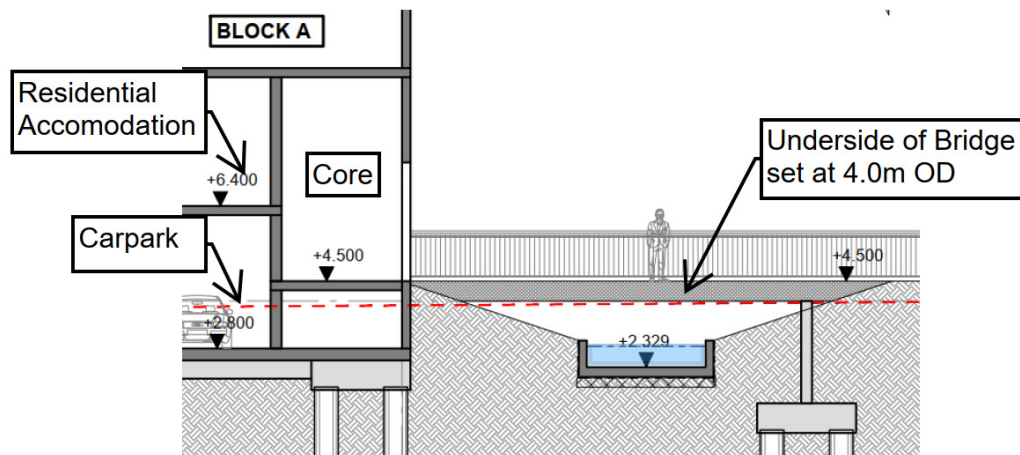


Figure 13 - Cross section through Riparian strip

High Tide Water Levels

High water levels near the site have been taken from Point 17 shown on ICPSS map NE/RA/EXT/17 Rev 1. (Appendix III)

- 1 in 2 year (50% AEP) = 2.52m OD (Extrapolated value)
- 1 in 10 year (10% AEP) = 2.75m OD
- 1 in 200 year (0.5% AEP) = 3.18m OD
- 1 in 1000 year (0.1% AEP) = 3.34m OD

The proposed openings adjacent to the channel is set at 4.5m OD representing a freeboard of 1.16m during the 0.1% AEP coastal event.

Joint Probability Analysis

A joint probability analysis has been undertaken for various scenarios to determine the worst-case scenario for combined fluvial and tidal effects. The detail analysis is completed in Appendix II.

The scenarios investigated are as follows:

- a) 1 in 200 year coastal + 1 in 2 year fluvial = 3.360m OD

The proposed openings adjacent to the channel is set at 4.5m OD representing a freeboard of 1.140m during the combined 0.5% AEP coastal + 50% AEP fluvial event HEFS.

- b) 1 in 2 year coastal + 1 in 200 year fluvial. = 2.920m OD

The proposed openings adjacent to the channel is set at 4.5m OD representing a freeboard of 1.580m during the combined 50 % AEP coastal + 0.5% AEP fluvial event.

Based on the flood levels calculated above, the proposed site is designed for the 0.1% AEP HEFS flood extent. This relates to Flood Zone C and is therefore appropriate for residential and commercial development.

The flood risk from fluvial, coastal or a combination of both to the site is considered to be low.

4. CONCLUSION

The Site Specific Flood Risk Assessment has been carried out in accordance with the OPW publication "The Planning System and Flood Risk Assessment Guidelines for Planning Authorities".

The site according to the OPW and RPS for fluvial and Coastal flooding show the site to be in Zone C.

The development is to be a mixed development with sleeping and living starting at 5.2m OD for the units with direct access to Howth road, all other units start at 6.4m OD. The lower areas to be parking at -0.2m OD & +2.8m OD and commercial at +4.0m OD and all openings set at 4.5m OD. The living areas can safely be evacuated at podium level (6.4mOD) or have direct access to Howth road. Therefore, based on the clause below from the OPW guidance document, the Site is categorised as less vulnerable and therefore a justification test is not required for this development.

'The classification of different land uses and types of development as highly vulnerable, less vulnerable and water-compatible is influenced primarily by the ability to manage the safety of people in flood events and the long-term implications for recovery of the function and structure of buildings'.

The Site is beside the Irish Sea but protected by the existing DART Sea defence wall and the promenade. However, additional precautions have been taken to protect the occupants and the development. In the event that the existing defences are overcome below are the following additional flood protection measures incorporated into the design:

- 1) Living and sleeping quarters are set at 5.2m OD, nearly 3 metres above 1 in 1000 year event.
- 2) The Northern boundary line will have a sea wall at 4.5m OD, forming the third line of defence after the DART sea wall and the promenade.
- 3) All openings for the basement or lower ground carpark will be set at 4.5m or above.
- 4) Access points to the carparks are ramped to 4.3m OD to prevent water entry from Howth road. Excess water from the riparian strip is diverted to Howth road before it reaches carpark entrances, therefore 4.3m is sufficient.
- 5) The riparian strip is landscaped to contain excess water in times of extreme hightide.
- 6) A water grate is to be positioned at the end of the open channel to prevent blockages.
- 7) An overflow drain to be provided in the riparian strip in the event the channel does get blocked.
- 8) The surrounding area is to be landscaped to divert excess water away from the development such as Baltray Park, the riparian strip and Howth Road.
- 9) The management team servicing the development, will implement maintenance practices to ensure surface drainage, manholes, settlement chamber and the riparian strip are serviced regularly.

All of the above ensures the risk of flooding is reduced and measures have been incorporated to ensure excess water is handled correctly and diverted away from the development.

The likelihood of flooding on site is low from either Tidal, Fluvial, Pluvial Surface Water or Groundwater.

Therefore, it can be seen from the above the proposed development is in a low risk flood zone and is acceptable for residential development.

APPENDIX I

Flood Reports – OPW

(A)

FLOODING IN NORTH COUNTY ON 20TH & 21ST OCT '02

Weather Conditions:

Met Eireann issued a weather warning with the following:

- 30mm – 60mm of rainfall from Sun 20th – Tue 22nd Oct.
- Winds of 55-70 mph.
- Leinster & Munster will worst affected.

Drainage Areas Affected by Surface Water:

Swords Area

1) Pinnock Hill:

The surface water screens in _____ property are unable to take the volume of surface water and overflowed (see Area Engineer report 10/2/01), this in turn floods the Little Chef. In order to prevent flooding of Little Chef the surface water is diverted on to Dublin/Belfast Road as can be seen from photographs. The Drainage Section provided sandbags to the Little Chef.



Flooding of Dublin/Belfast Roundabout at Little Chef

2) The Drive, Melrose Park, Swords.

It appears that the development in Organon has stopped the progress of a surface water ditch. This then overflows and floods wasteland between Organon and Melrose Park and resulted in the flooding of No.18 The Drive.

Malahide Area

1) Biscayne, Coast Road.

Surface water run off flowed into sea, with large quantities of silt. This also caused the Coast Road to be flooded in areas.



Surface water run-off in vicinity of Biscayne, Coast Road.

Portmarnock Area

1) Strand Road.

Flooding occurred on the Strand Road because gullies did not function properly. The gullies are connected to soakaways, as a gravity system is not available, which have become blocked.

Kinsaley Area

1) Cul-de-sac off Kinsaley Lane.

Two houses on this road were flooded due to the overflowing of the Sluice River. The Drainage Section provided sandbags, but were unable to prevent river water entering the houses.



Flooding of houses just off Kinsaley Lane

The level of the floodwater from the river was over a foot in the houses. The river also flooded the following roads:-

- (a) Chapel Road
- (b) Kinsaley Lane
- (c) Junction of Drimnigh Road/The Hill
- (d) Station Road

Howth Area

1) The Bloody Stream Pub.

The pub is built over a culvert with a manhole at ground floor level. The culvert is blocked solid with material (silt, debris, etc.) to the outfall, some 200meters. There does not appear to be any manholes other than the one under the pub. For this reason it is extremely difficult to clean or even identify the line of the culvert. The Drainage Section tried, with sandbags and a 6" pump, but were unable to prevent surface water from the manhole entering the pub on the night of Monday the 21st Oct.

2) Techcrete

This is located close to The Bloody Stream Pub and the surface water line surcharged and flooded the entire yard. S.W entered the building, but the Drainage Section provided sandbags to prevent water from entering offices. The Drainage Section are carrying out an investigation as to the cause of surcharging, but as records of drainage layout are poor it may be sometime before we have results.

Baldoyle Area

1) The Grange Road

The surface water screens in Seagrang Park were obstructed with material, which contributed to the flooding of the Grange Road. The main cause of the flooding was blocked gullies. The Drainage Section provided sandbags to some houses on Brookstone Road to prevent surface water from the road entering the house.



Surface Water Screen at Seagrang Park, Baldoyle.

Drainage Areas Affected by Foul Sewer:

Swords Area

1) Dubber Cross, Meakstown

The pumping Station in Dubber Cross was flooded with surface water from a nearby ditch. The S.W. entered the sump via the overflow and flooded the garden and around house with foul sewer. The Drainage Section provided a tanker to remove loads from the sump in an effort to lower the level.

Malahide Area

1) The Coast Road.

Manhole covers lifted due to the surcharging of the foul sewer. The Coast Road was flooded and due to the fact that the gullies were blocked. The Drainage Section used a 6" pump in an effort to reduce F.S. from the system and pumped into the sea. They also unblocked gullies, which eliminated the flooding on the road.

2) Seabank Court.

The gardens of 3 No. houses (in gardens) were flooded with F.S. as a result of the surcharging of the Coast Road. A clean up was carried out on all premises.

3) 14A Parnell Cottages.

The F.S. in this area became surcharged. The manhole from this house is at a low point and was a release for the F.S. The Drainage Section carried out a clean up of the flooding around the house.

4) The Bawn.

This is upstream of Parnell Cottages and the rising mains from Connelly Ave. & Castlefield Manor. The lines surcharge and cause F.S. flooding around a number of houses, the Drairage Section carries out clean ups.

Howth Area

1) The Gem Shop, Harbour Road.

The F.S. became surcharged and caused flooding around the outside of shop. The Drainage Section provided sandbags. The flooding may have been prevented if an overflow on the F.S. was in operation outside the St. Laurence Hotel. This overflow has been damaged for a number of months, by a private contractor and the Drainage Section are to carry out a repair immediately.

Skerries Area

1) Hoar Rock

Due to the volume of F.S. being pumped from the pumping station in Kelly's Bay, a section of the gravity line in Hoar Rock surcharged. This caused flooding around a house, which is located at the low point. The Fire Brigade pumped the F.S. from around the house and the Drainage Section provided sandbags.

Sutton Area

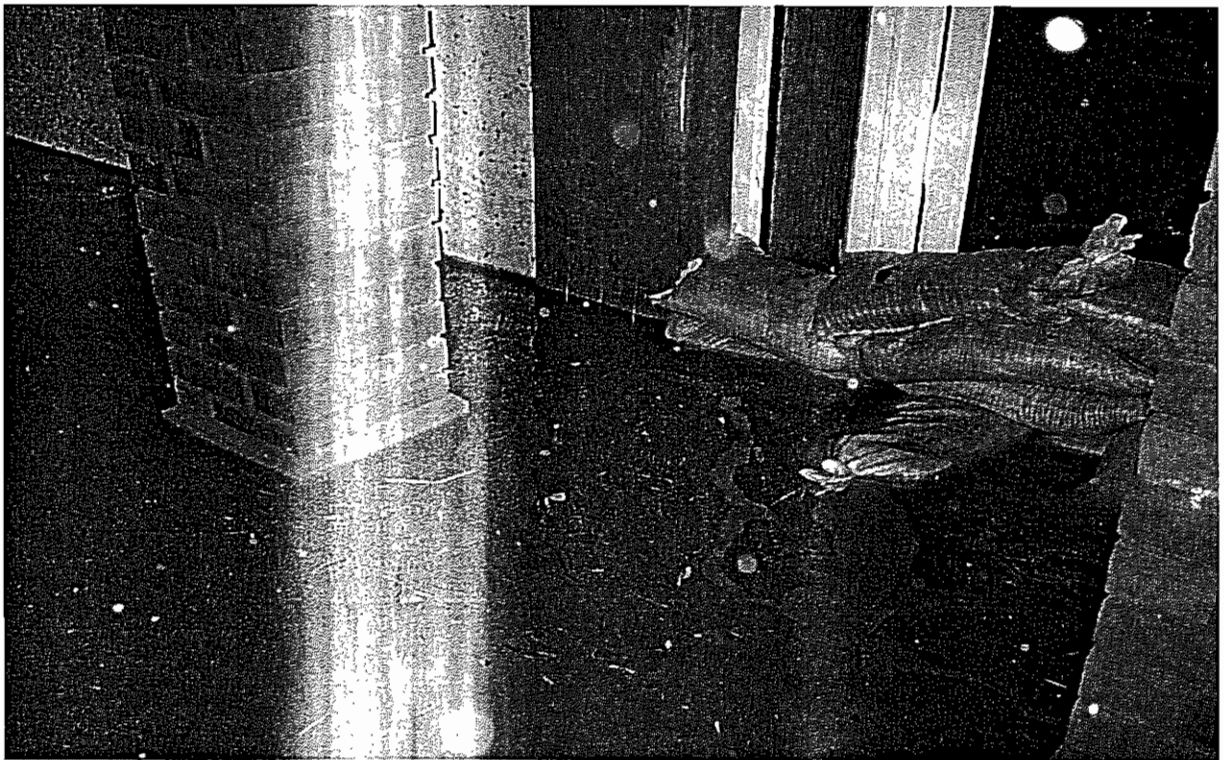
1) No.17 Dublin Road.

There appears to have been some F.S. flooding in the drive of this premises and the Drainage Section are carrying out an investigation as to its cause.

ADDITIONAL PHOTOGRAPHS OF
FLOODED AREAS



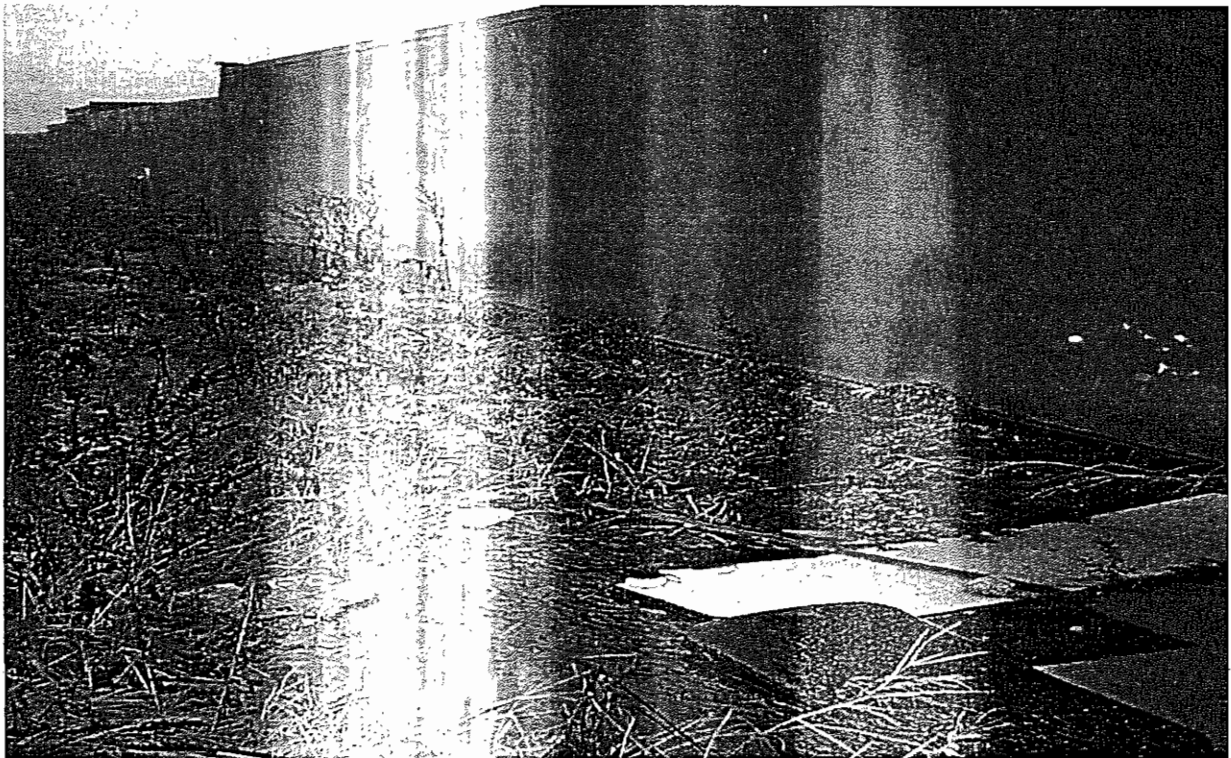
Flooding at Little Chef



Flooding at house off Kinsaley Lane



Flooding at Wasteland between Organon & Melrose Drive



Flooding at Wasteland to Rear of No.18 The Drive, Melrose Park

Report on Flooding in North County Dublin
November 14th & 15th, 2002

Weather Conditions:

Met Eireann issued a weather warning with the following:

- Up to 50mm of rainfall from Thurs 14th – Fri 15th Nov, 2002.

Drainage Areas Affected by Surface Water:

Swords Area

1) North Street:

At approximately 11:30pm on Thursday night The Ward River overflowed into the park adjacent to North Street and flooded the Road between North St. and Watery Lane.

The flooding of the premises occurred instantly and although the Drainage Section were present on Thursday night, but could not prevent the flooding occurring. On Friday morning a crew pumped the water from the road to the river and unblocked the road gullies.

Flooding in Estuary Pub & two other premises.



Flooding at North Street/Watery Lane, Swords.

2) Pinnock Hill:

The surface water screens in _____ property are unable to take the volume of surface water and overflowed (see Area Engineer report 10/2/01), this in turn floods the Little Chef. In order to prevent flooding of Little Chef the surface water was diverted on to Dublin/Belfast Road.

3) Santry Close:

The culvert on the Santry River at the Old Swords Road was unable to take the quantity of water in the river and overflowed. It flowed from the Old Swords Road into Santry Close, which was under one and a half feet of water.

The Drainage Section provided a 6" Whispa pump and hoses to Santry Close at approximately 8:30pm on Thursday. The Roads Section provided a crew to man the pump.

1No. house flooded internally, flooding in grounds of several houses.

4) Ballyboughal Road:

A stream runs through a new Golf course adjacent to the Ballyboughil Road. The culvert under the road was unable to cater for the volumes of water and flooded the main road, which in turn caused flooded around 1No. house.

5) *Dubber Cross, Meakestown:*

The ditch adjacent to the pump station overflowed into the station. The volume of water in the ditch was unable to flow through the pipes under the road. The Drainage Section had a gully sucker to reduce the level in the ditch.

Donabate/Portrane/Rush Areas

1) Portrane Treatment Plant:

The Treatment Plant in Portrane was unable to take the large quantities of material from Donabate/Portrane catchment. Pumping Station No.4, which comes from the hospital was shut off and put into overflow.



S.W. flooding at Railway in Ballisk.

2) Ballisk, Donabate:

Surface water floods the road under the main Dublin-Belfast railway line. The S.W. is overflowing from ditch onto the road and also causes the foul sewer to surcharge. The Drainage Section cut an open channel from the road to a dry ditch, with a J.C.B, which solved the problem. The drives of a number of houses were flooded and the use of toilets was not possible.

3) Hearst Road, Donabate:

There was major flooding on the Hearst Road.

4No. houses on Hearst Road, flooded.

4) Beaverstown:

A large number of fields in the Beaverstown Area were flooded due to the heavy rains.

5) Rush:

Road Flooding

- Spout Road: Very bad flooding; Impossible.
- Whitestown Road at Graveyard: Very bad flooding.
- Skerries Road: Very bad flooding; Impossible.
- Lusk-Rush Road: Very bad flooding; Impossible.
- Ministers Lane/Killhedge Lane Very bad flooding; Impossible.

Malahide Area

1) Coast Road:

The foul sewer on St. James Terrace and Coast Road was surcharged, which caused F.S. flooding around shop & a number of houses in Seabank Court. The Drainage Section provided a 4" pump at St. James Terrace to pump F.S. from system to sea, to reduce pressure on system. A clean-up was carried out at Seabank Court.

Howth Area

1) The Bloody Stream:

The surface water culvert at the Bloody Stream Pub was surcharged and was in danger of flooding the pub. The Drainage Section provided a 6" pump to keep the level in the culvert down.

Balbriggan Area

1) Covetown:

The foul sewer on Drogheda Street became surcharged and caused F.S. flooding on the roads and drives of Covetown. The overflow on the foul sewer at the Stream at St. Moliga's National School was in full operation. The F.S. was close to overflowing in the toilet of house opposite National School.

2) Bath Road:

There was surface water flooding in the vicinity of the Railway bridge on Bath Road. The S.W. drainage was unable to take the water away.

Skerries Area

1) Millers Lane:

Millers Lane was closed due to surface water flooding. The foul sewer became surcharged, but it is not known if this is as a direct result of the road flooding. In the past No.2 Millers Lane was flooded with F.S. when the main sewer became surcharged, but it did not occur on this occasion as a result of network improvements by the Drainage Section. The Drainage Section had a J.C.B. removing pond weed from the Mill Stream and clearing the outfall on the beach.

Drainage Operations on Thursday 14th November

Staff:

8:30am – 5:00pm	8No. Drainage Maintenance crew
8:30am – 12:00am	4No. Drainage Maintenance Crew 7No. Direct Labour Crew
8:30am – 3:00am	2No. Drainage Maintenance Crew
8:30am – 4:00am	3No. Drainage Maintenance Crew

Works:

1. Sewer Crew	Clearing blockages & chokes
2. Crew	Delivering sandbags & clearing screens
3. Crew	Delivering sandbags & clearing screens
4. Crew	With 6” pump at The Bloody Stream, Howth
5. Crew	Filling Sandbags
6. Gullysucker	Dubber Cross Pumping Station
7. Jetter	Forest Road, Swords; Portrane
8. J.C.B.'s	No.1 North County clearing outfalls, culverts. No.2 South County clearing outfalls, culverts & screens. No.3 Filling sandbags in Depot.

Drainage Operations on Friday 15th November

Staff:

Not at work (worked late Thursday) 5No. Drainage Maintenance

8:30am – 3:00pm 6No. Drainage Maintenance crew

4:00am – 4:00pm 2No. Drainage Maintenance crew

8:30am – 12:00pm 5No. Drainage Maintenance crew

8:30am – 6:00pm 6No. Direct Labour Crew

8:30am – 12:00am 1No. Direct Labour Crew

3:00pm – 12:00am 2No. Environment Section

Work:

1. Sewer Crew Clearing blockages & chokes
2. Crew Clearing screens & clean-ups
3. Crew With 6” pump at The Bloody Stream, Howth
4. Crew 4” pump at Estuary Pub, North Street.
5. Crew Delivering sandbags
6. Crew Filling sandbags
7. Jetter Main sewer chokes
8. J.C.B. No.1 Portmarnock Bridge Sluice Gates
No.2 Clearing outfalls

Photographs of Flooding Areas



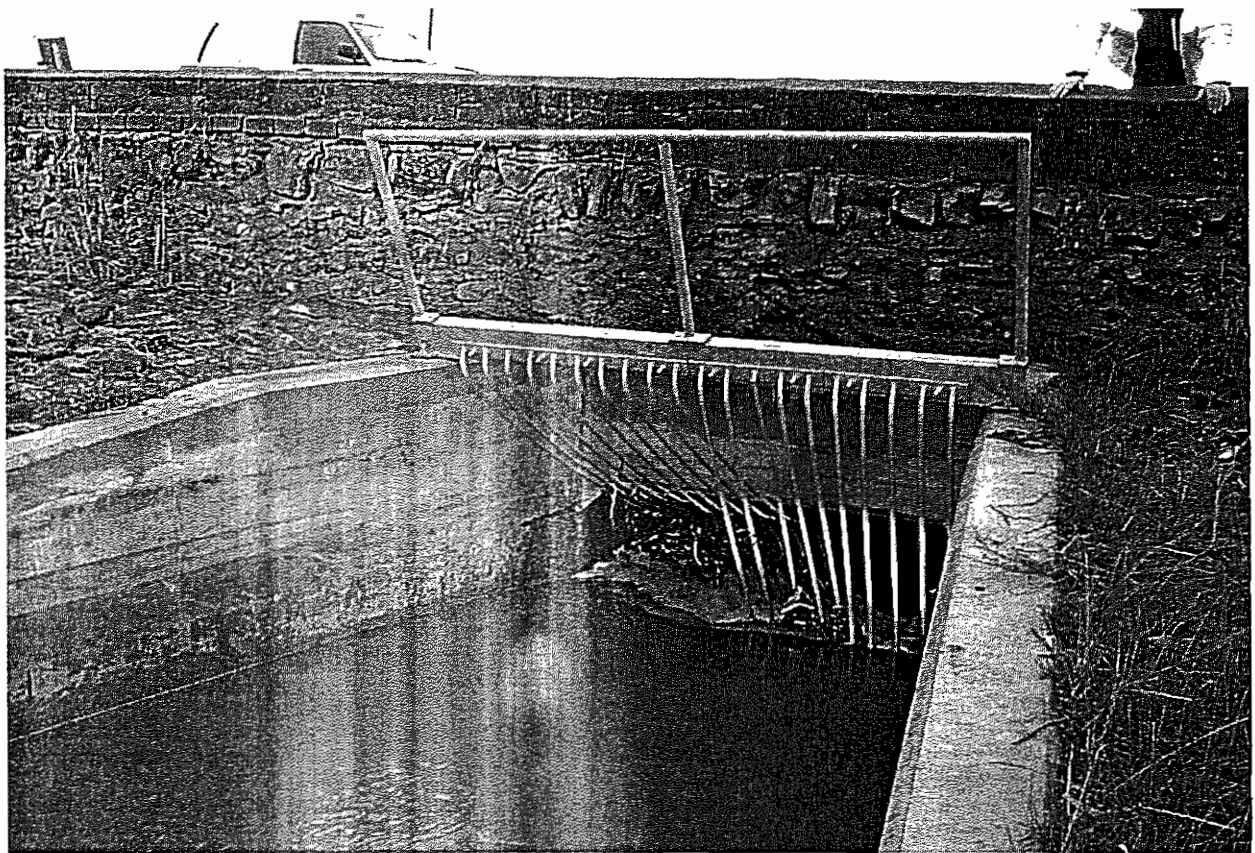
Sluice Gates at Portmarnock Bridge



Flooding of Ditch in Portrane Treatment Plant



Surcharging of Foul Sewer on Kinsaley Lane



Damaged Second Screen at Moyne Bridge

APPENDIX II

Bloody Stream Storm Water Assessment

Bloody Stream Stormwater Assessment

The Bloody Stream flows in a northerly direction from its source on the Hill of Howth, along the boundary between the Deerpark golf course and Howth Castle. Here the stream flows through a valley lined with 4 No. 2.5m retaining walls designed to control the water in events of heavy rainfall. It then enters an underground system that re-appears before Howth road, creating a water feature as it drops below Howth road and into the underground system. It then crosses the Techrete site, enters a settlement tank system which also services drainage from other developments and outfalls under the DART railway line and into Baldoyle Bay.

The channel length is approximately 1.7km with an upstream level of approximately 100m OD. The catchment area is approximately 132 ha.

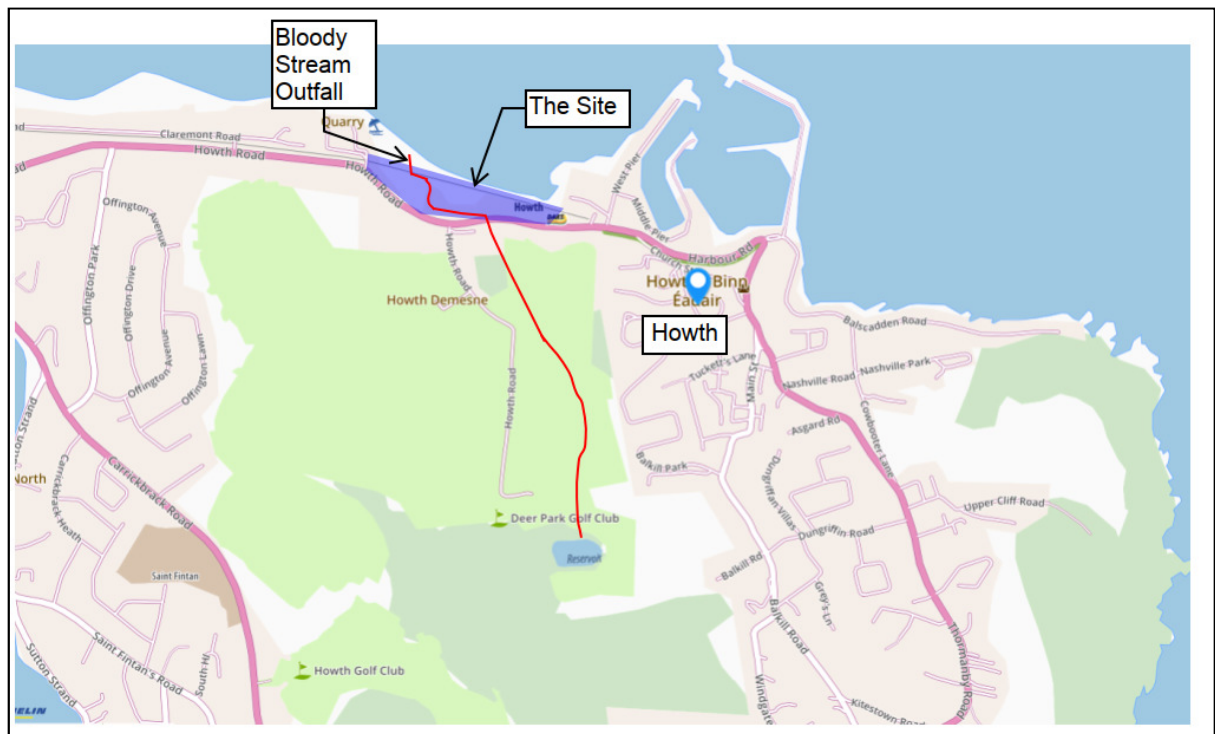


Figure 14-Hydrological and Hydraulic Analysis of Bloody Stream

Hydrological and hydraulic analyses of the Bloody Stream have been undertaken to determine the flow and associated depth in the channel for various return periods.

The flow has been estimated using the Institute of Hydrology Report No. 124 method outlined as below:

$$Q_{bar} = 0.00108 \times Area^{0.89} \times SAAR^{1.17} \times SOIL^{2.17}$$

$$Area = 1.3 \text{ km}^2$$

$$Soil = 0.45$$

$$SAAR = 760 \text{ mm}$$

$$\text{Statistical Error} = 1.65$$

$$\text{Climate Change Factor} = 1.3$$

$$Q_{bar} (\sim 50\% \text{ AEP}) = 1.12 \text{ m}^3/\text{s}$$

$$Q_{100} (1\% \text{ AEP}) = 2.20 \text{ m}^3/\text{s}$$

$$Q_{200} (0.5\% \text{ AEP}) = 3.27 \text{ m}^3/\text{s}$$

$$Q_{1000} (0.1\% \text{ AEP}) = 3.93 \text{ m}^3/\text{s}$$

The proposed channel geometry is approximately 3m wide at the base with 1:3 and 1:2 side slopes at either side.

Using Manning’s Equation, the following flow depths have been calculated:

Qbar (~50% AEP) = 0.433m

Q100 (1% AEP) = 0.620m

Q200 (0.5% AEP) = 0.760m

Q1000 (0.1% AEP) = 0.840m

The proposed upstream invert level of the channel is 2.360m OD which gives a top water level of 3.20m OD during the 0.1% AEP fluvial event. The proposed FFL of residential buildings adjacent to the channel is 4.5m OD representing a freeboard of 1.51m.

High Tide Water Level

High water levels near the site have been taken from Point 17 shown on ICPSS map NE/RA/EXT/17 Rev 1.

1 in 2 year (50% AEP) = 2.52m OD (extrapolated value)

1 in 10 year (10% AEP) = 2.75m OD

1 in 200 year (0.5% AEP) = 3.18m OD

1 in 1000 year (0.1% AEP) = 3.34m O

The proposed FFL of residential buildings adjacent to the channel is 4.5m OD representing a freeboard of 1.16m during the 0.1% AEP coastal event.

Joint Probability Analysis

A joint probability analysis has been undertaken for various scenarios to determine the worst-case scenario for combined fluvial and tidal effects. All to be designed to allow for climate change for High End Future Scenario (HEFS) in accordance with OPW.

Parameter	MRFS	HEFS
Extreme Rainfall Depths	+ 20%	+ 30%
Peak Flood Flows	+ 20%	+ 30%
Mean Sea Level Rise	+ 500 mm	+ 1000 mm
Land Movement	- 0.5 mm / year ¹	- 0.5 mm / year ¹
Urbanisation	<i>No General Allowance – Review on Case-by-Case Basis</i>	<i>No General Allowance – Review on Case-by-Case Basis</i>
Forestation	- 1/6 Tp ²	- 1/3 Tp ² + 10% SPR ³

Table 4- Flood Parameters taken from Fingal County Council- Surface Water Management Plan

The scenarios investigated are as follows:

- 1 in 200 year coastal + 1 in 2 year fluvial
- 1 in 200-year coastal flood level = 3.18m OD

Depth of water above coastal flood level associated with 1 in 2-year fluvial flow = 0.18m

Combined flood level =3.360 m OD

The proposed FFL of residential buildings adjacent to the channel is 4.5m OD representing a freeboard of 1.14m during the combined 0.5% AEP coastal + 50% AEP fluvial event (HEFS).

- 1 in 2 year coastal + 1 in 200 year fluvial.
- 1 in 2-year coastal flood level = 2.52m OD

Depth of water above coastal flood level associated with 1 in 200-year fluvial flow = 0.4m
 Combined flood level = 2.92m OD

The proposed FFL of residential buildings adjacent to the channel is 4.5m OD representing a freeboard of 1.580m during the combined 50 % AEP coastal + 0.5% AEP fluvial event.

Based on the flood levels calculated above and the provision wall provisions provided, the proposed site is located outside 0.1% AEP flood extent. This relates to Flood Zone C and is therefore appropriate for residential and commercial development.

This analysis is carried out to high end future scenario, which includes an allowance for 1 meter sea rise. All openings are set to 4.5m OD, therefore the risk of flooding to the development is low.

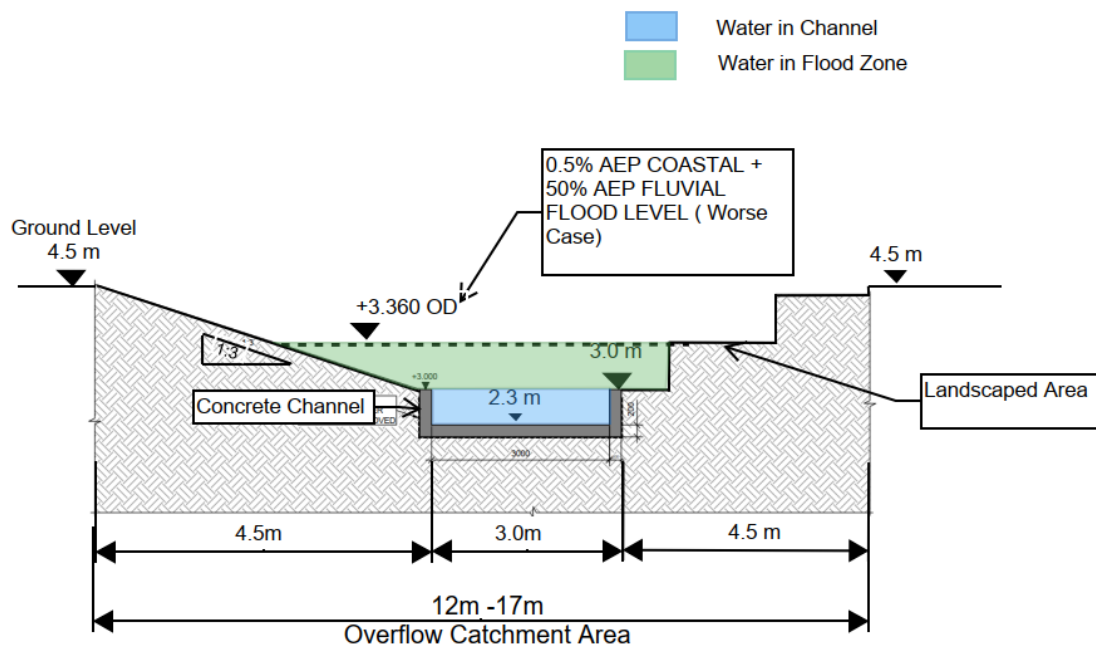


Figure 15- Fluvial & Coastal Flood Levels

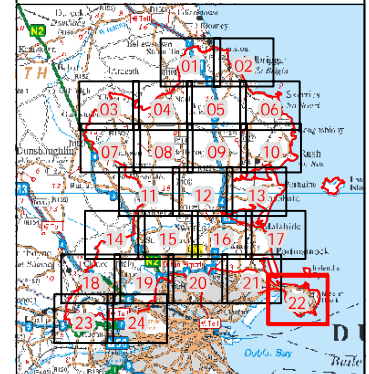
APPENDIX III

Fluvial Flood Plan & Coastal Flood Plan



Legend

- Fingal County Boundary
- Watercourse Centreline
- Defended Area
- Flood Zone A - 1% AEP Flood Extent (1 in 100 chance in any given year)
- Flood Zone B - 1% AEP Flood Extent (1 in 1000 chance in any given year)
- Indicative Flood Extents



Client

Comhairle Contae Fhine Gall
Fingal County Council

Project
Strategic Flood Risk Assessment

Title
Fluvial Flood Zone Mapping

Figure
Map 22 of 24

West Pier Business Campus,
Dun Laoghaire,
Co Dublin,
Ireland.

Tel: +353 (0) 1 4982900
Fax: +353 (0) 1 2835676
Email: Ireland@rpsgroup.com
Web Page: rpsgroup.com/ireland

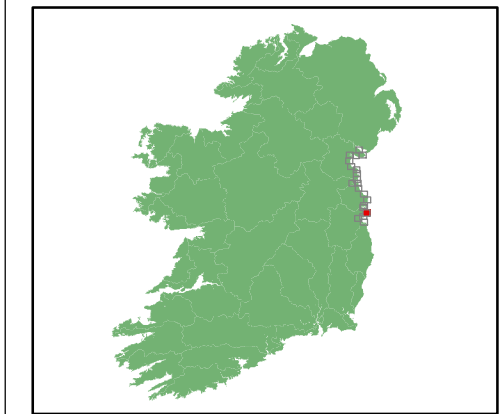
Issue Details			
Drawn By: HF	Project No. MDW0716		
Checked By: BT	File Ref:		
Approved By: SK	MDW0716:001D02	Drawing No.	Rev:
Scale: 1:20,000 @ A3		Arc0001	001
Date: 02/12/2015			

NOTE: 1. This drawing is the property of RPS Group Ltd. It is a confidential document and must not be copied, used, or its contents divulged without prior written consent.
2. All levels are referred to Ordnance Datum, Mean High.
3. Ordnance Survey Ireland Licence FN 0005013
©Copyright Government of Ireland.

© Government of Ireland
Osi permit number EN-002-1010

NOTE: MORE DETAILED MAPS SHOWING COMBINED TIDAL AND FLUVIAL FLOOD HAZARD FOR THIS AREA HAVE BEEN PREPARED UNDER THE FINGAL EAST MEATH FRAM STUDY. PLEASE REFER TO WWW.FINGALEASTMEATHFRAMS.IE FOR MORE INFORMATION

Location Plan :



EXTENT MAP

Legend:

- 0.5% AEP FLOOD EXTENT (1 in 200 chance in any given year)
- 0.1% AEP FLOOD EXTENT (1 in 1000 chance in any given year)
- Very High Confidence (0.1% AEP)
- High Confidence (0.1% AEP)
- Medium Confidence (0.1% AEP)
- Low Confidence (0.1% AEP)
- Very Low Confidence (0.1% AEP)
- Very High Confidence (0.5% AEP)
- High Confidence (0.5% AEP)
- Medium Confidence (0.5% AEP)
- Low Confidence (0.5% AEP)
- Very Low Confidence (0.5% AEP)
- High Water Mark (HWM)
- Node Point
- Point 34 Node Label (refer to table)

USER NOTE :

USERS OF THESE MAPS SHOULD REFER TO THE DETAILED DESCRIPTION OF THEIR DERIVATION, LIMITATIONS IN ACCURACY AND GUIDANCE AND CONDITIONS OF USE PROVIDED AT THE FRONT OF THIS BOUND VOLUME. IF THIS MAP DOES NOT FORM PART OF A BOUND VOLUME, IT SHOULD NOT BE USED FOR ANY PURPOSE.



Elmwood House
74 Boucher Road
Belfast
BT 12 6RZ
Northern Ireland



Office of Public Works
17-19 Lower Hatch Street
Dublin 2
Ireland

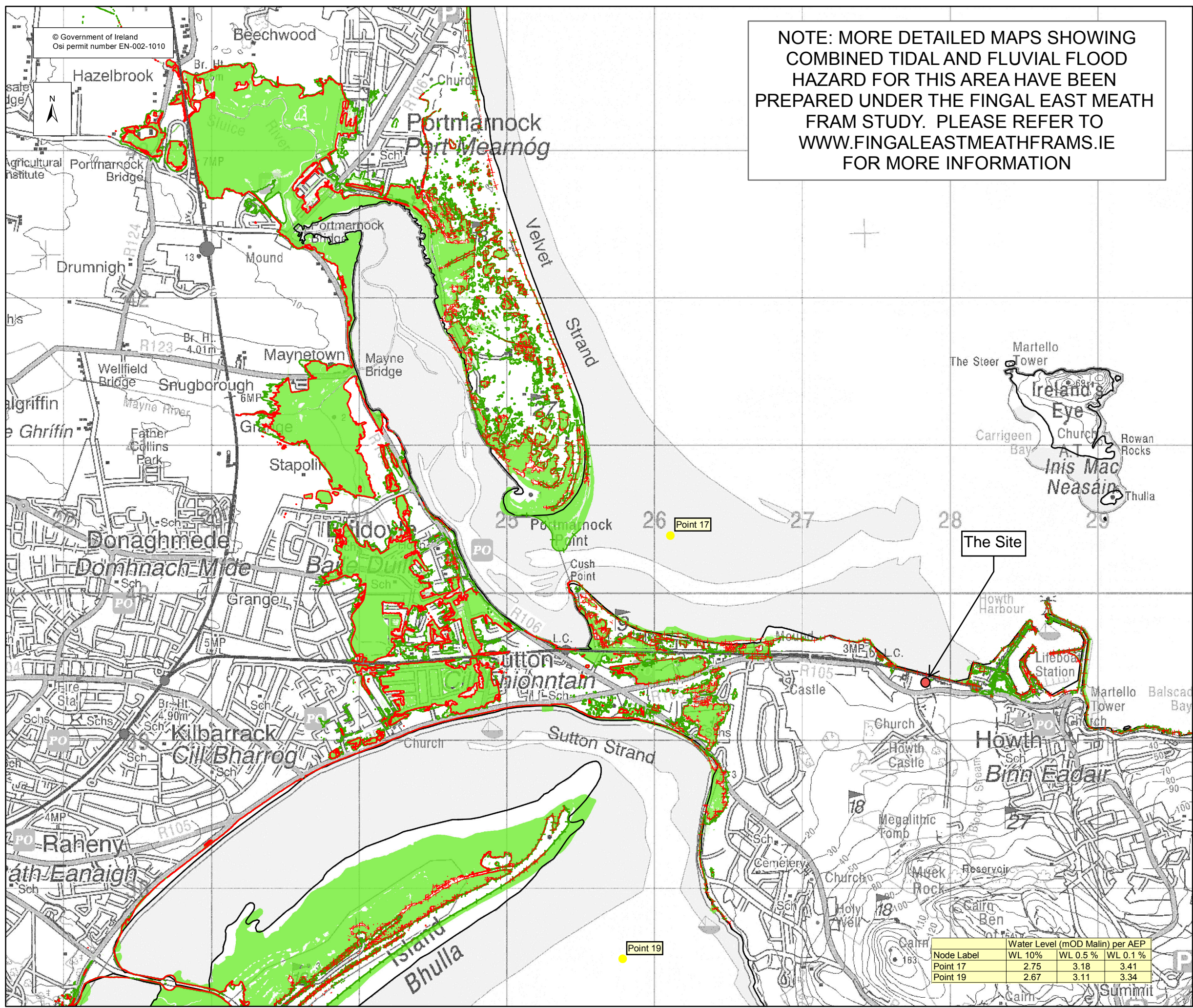
Project :
IRISH COASTAL PROTECTION STRATEGY STUDY - PHASE III

Map :
NORTH EAST COAST FLOOD EXTENT MAP

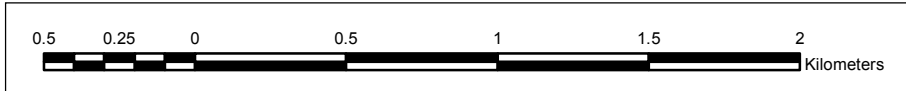
Map Type : FLOOD EXTENT
Source : TIDAL FLOODING
Map area : RURAL AREA
Scenario : CURRENT
Figure By : PJW Date : Jan 2010
Checked By : JMC Date : Jan 2010

Figure No. :
NE / RA / EXT / 17 Revision **1**

Drawing Scale : 1:25,000 Plot Scale : 1:1 @ A3



Node Label	Water Level (mOD Malin) per AEP	WL 10%	WL 0.5%	WL 0.1%
Point 17		2.75	3.18	3.41
Point 19		2.67	3.11	3.34

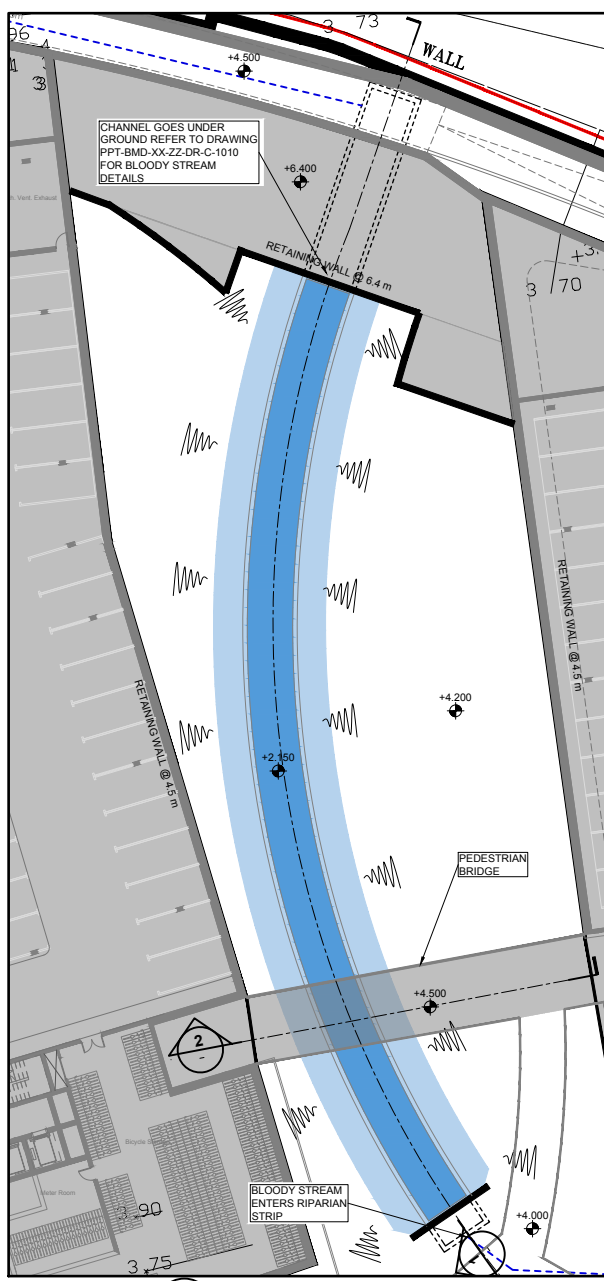


APPENDIX IV

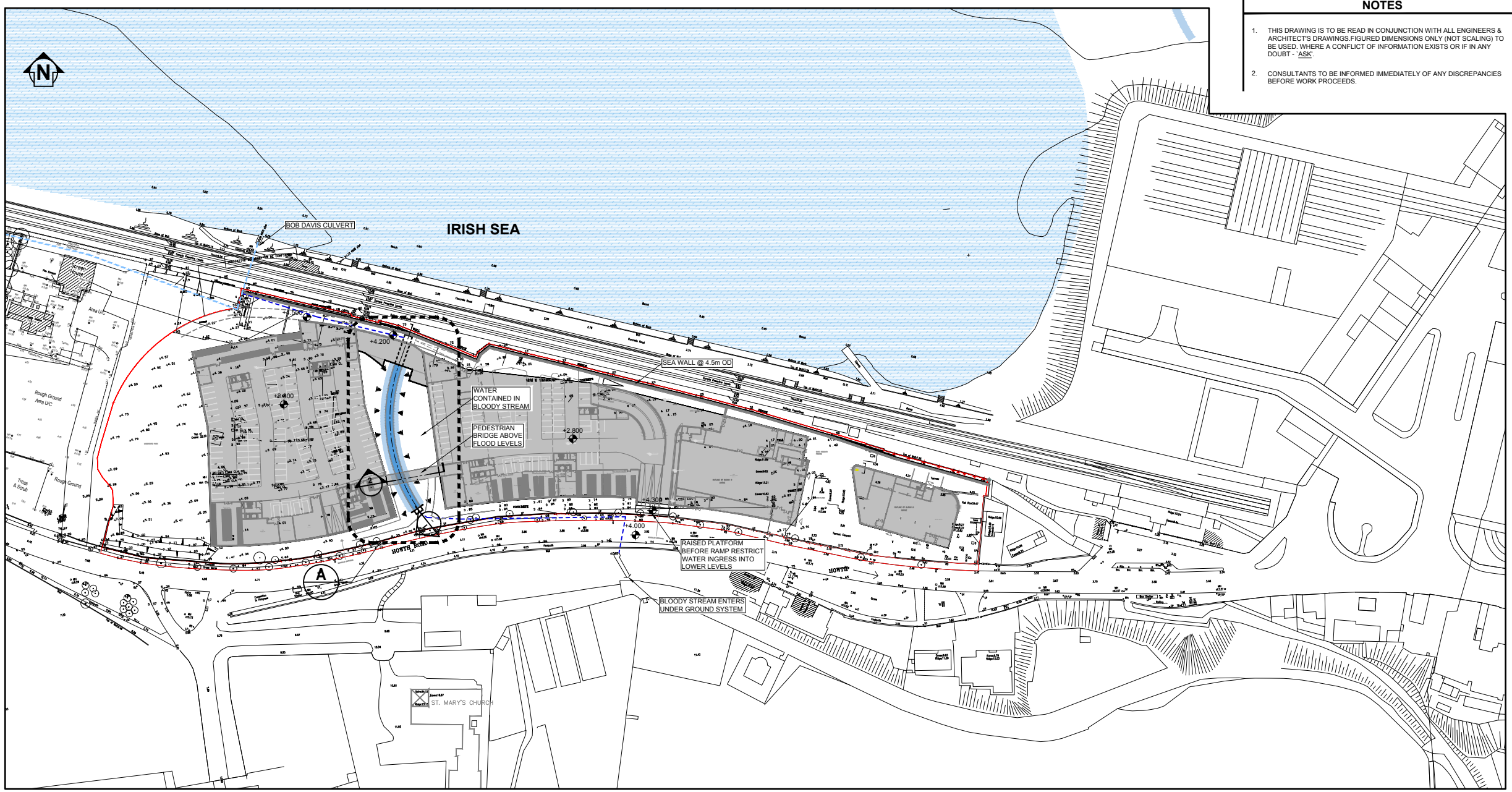
Site Flood Assessment Drawings

NOTES

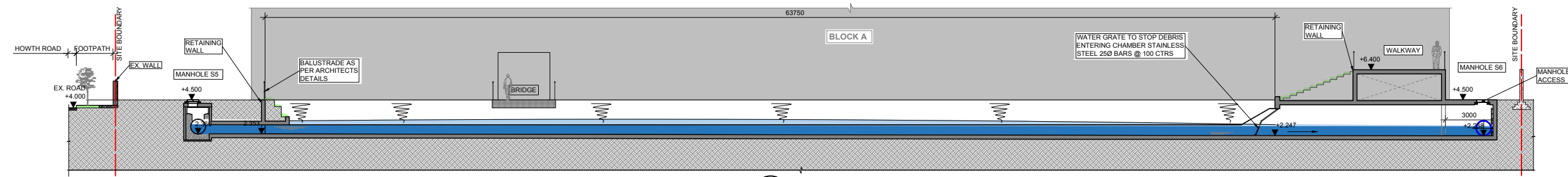
1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL ENGINEERS & ARCHITECT'S DRAWINGS FIGURED DIMENSIONS ONLY (NOT SCALING) TO BE USED. WHERE A CONFLICT OF INFORMATION EXISTS OR IF IN ANY DOUBT - "ASK".
2. CONSULTANTS TO BE INFORMED IMMEDIATELY OF ANY DISCREPANCIES BEFORE WORK PROCEEDS.



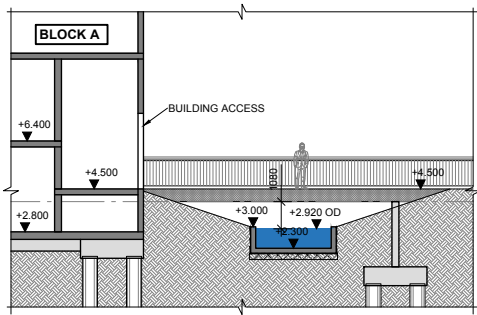
A **DETAIL - RIPARIAN STRIP**
SCALE @ A1: 1:250
SCALE @ A3: 1:500



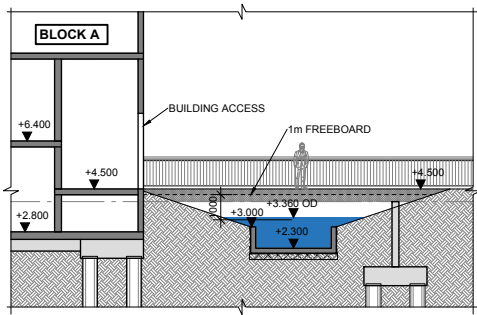
COASTAL & FLUVIAL FLOOD MAP
SCALE @ A1: (NTS)
SCALE @ A3: (NTS)



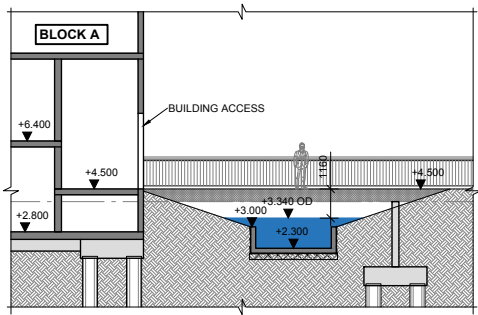
1 **SECTION**
SCALE @ A1: 1:150
SCALE @ A3: 1:300



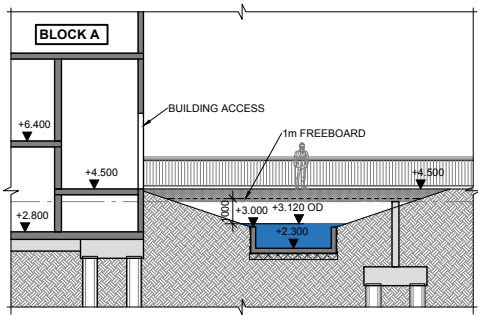
2 **SECTION**
SCALE @ A1: 1:150
SCALE @ A3: 1:300
1 IN 1000 YEAR FLUVIAL



2 **SECTION**
SCALE @ A1: 1:150
SCALE @ A3: 1:300
1 IN 200 YEAR FLUVIAL + 1 IN 2 YEAR TIDAL HIGH END FUTURE SCENARIO (HEFS)



2 **SECTION**
SCALE @ A1: 1:150
SCALE @ A3: 1:300
1 IN 1000 YEAR TIDAL



2 **SECTION**
SCALE @ A1: 1:150
SCALE @ A3: 1:300
1 IN 200 YEAR TIDAL + 1 IN 2 YEAR FLUVIAL HIGH END FUTURE SCENARIO (HEFS)

LEGEND

BOUNDARY LINE	
PROPOSED SW LINE	
EXISTING SW LINE	

NOTE: FOR FURTHER DETAILS OF THE RIPARIAN STRIP REFER TO DRAWING PPT-BMD-XX-ZZ-DR-C-1010

ISSUE	DATE	DESCRIPTION	DRN	P.E.	P.D.
P3	10.10.19	ISSUED FOR INFORMATION	MR	VB	VB
PL3	06.06.19	ISSUED FOR PLANNING	MR	VB	VB
P2	29.05.19	ISSUED FOR COMMENT	MR	VB	VB
PL2	03.04.19	ISSUED FOR PLANNING	MR	VB	VB
PL1	20.03.19	ISSUED FOR PLANNING	MR	VB	VB
P1	08.03.19	ISSUED FOR COMMENT	MR	VB	VB

DRAWING STAGE **FOR INFORMATION**

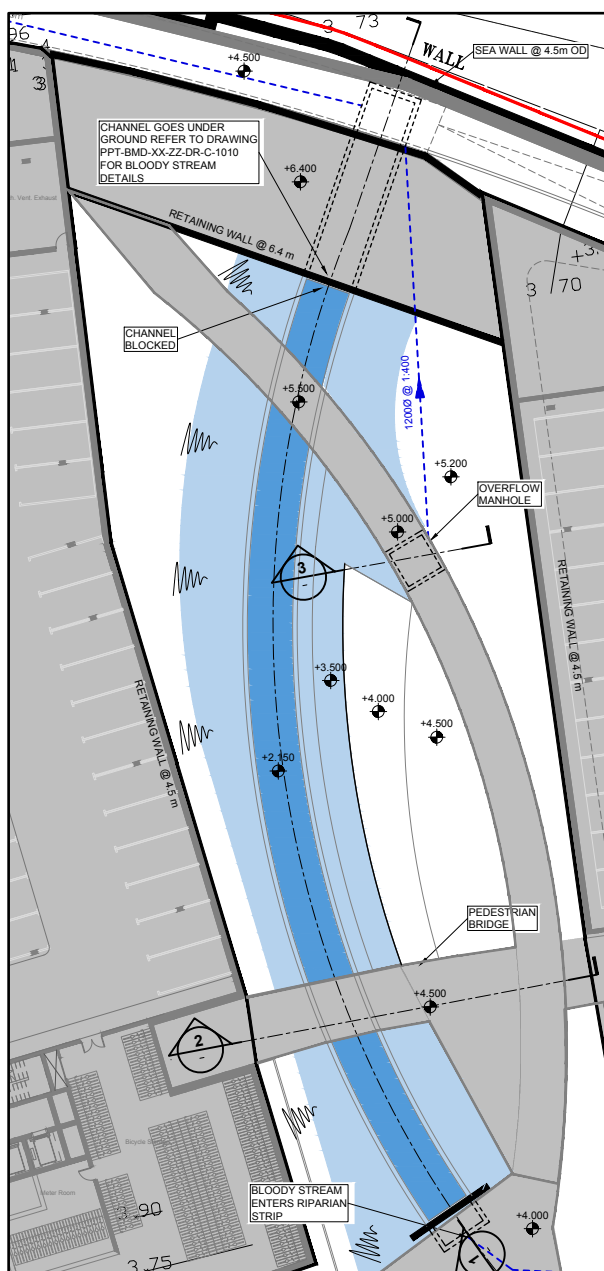
BM Dublin Office: Sandwith House, 52-54 Lower Sandwith Street, Dublin 2, Ireland. Tel: (01) 677 3200 Fax: (01) 677 3164
London Office: 12 Mill Street, London SE1 2AY, United Kingdom Tel: (0044) 084 5413 2722
Consulting Engineers, Civil, Structural, Project Management. E-mail: bmce@bmce.ie Web: www.bmce.ie

BARRETT MAHONY
The Institution of Structural Engineers
ACEI International Federation of Consulting Engineers

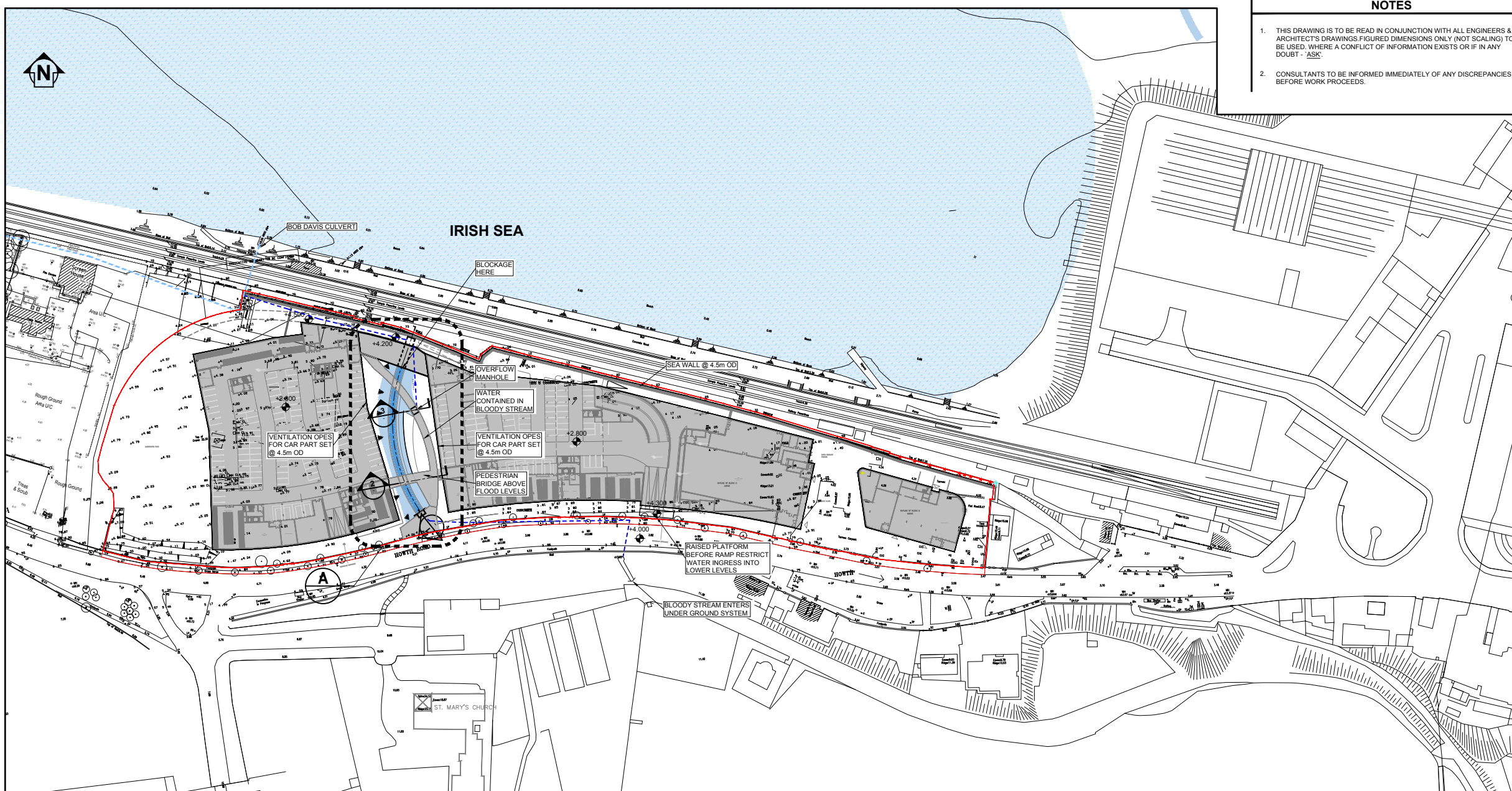
CLIENT ATLAS GP LTD	BM PROJECT No. 18.386
PROJECT TITLE CLAREMONT PROJECT	MODEL REV P01
MODEL REFERENCE PPT-BMD-XX-ZZ-DR-C-1000.dwg	SUITABILITY S0
DRAWING TITLE FLOOD RISK ASSESSMENT COASTAL & FLUVIAL	
DRAWING No. PPT-BMD-XX-ZZ-DR-C-1006	ISSUE P3

NOTES

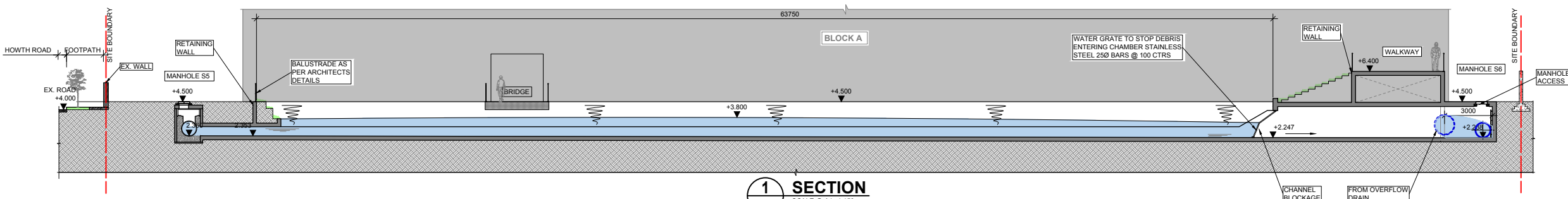
1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL ENGINEERS & ARCHITECT'S DRAWINGS FIGURED DIMENSIONS ONLY (NOT SCALING) TO BE USED. WHERE A CONFLICT OF INFORMATION EXISTS OR IF IN ANY DOUBT - 'ASK'.
2. CONSULTANTS TO BE INFORMED IMMEDIATELY OF ANY DISCREPANCIES BEFORE WORK PROCEEDS.



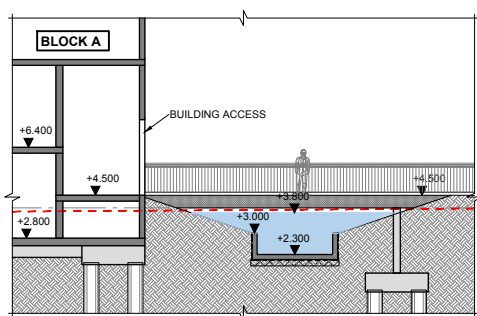
A DETAIL - RIPARIAN STRIP
SCALE @ A1: 1:250
SCALE @ A3: 1:500



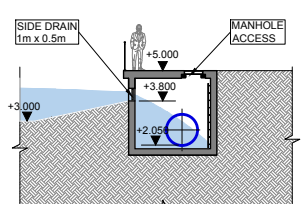
FLOOD MITIGATION RIPARIAN STRIP
SCALE @ A1: (NTS)
SCALE @ A3: (NTS)



1 SECTION
SCALE @ A1: 1:150
SCALE @ A3: 1:300



2 SECTION
SCALE @ A1: 1:150
SCALE @ A3: 1:300
RIPARIAN BLOCKAGE



3 SECTION
SCALE @ A1: 1:150
SCALE @ A3: 1:300
OVERFLOW DRAIN

LEGEND

BOUNDARY LINE	
PROPOSED SW LINE	
EXISTING SW LINE	

NOTE: FOR FURTHER DETAILS OF THE RIPARIAN STRIP REFER TO DRAWING PPT-BMD-XX-ZZ-DR-C-1010

ISSUE	DATE	DESCRIPTION	DRN	ORIG	P.D.
P2	10.10.19	ISSUED FOR INFORMATION	MR	MS	VB
PL1	06.06.19	ISSUED FOR PLANNING	MR	MS	VB
P1	29.05.19	ISSUED FOR COMMENT	MR	MS	VB

FOR INFORMATION

BM Dublin Office: Sandwith House, 52-54 Lower Sandwith Street, Dublin 2, Ireland. Tel: (01) 677 3200 Fax: (01) 677 3164
London Office: 12 Mill Street, London SE1 2AY, United Kingdom. Tel: (0044) 084 5413 2722
Consulting Engineers, Civil, Structural, Project Management. E-mail: bmce@bmce.ie Web: www.bmce.ie

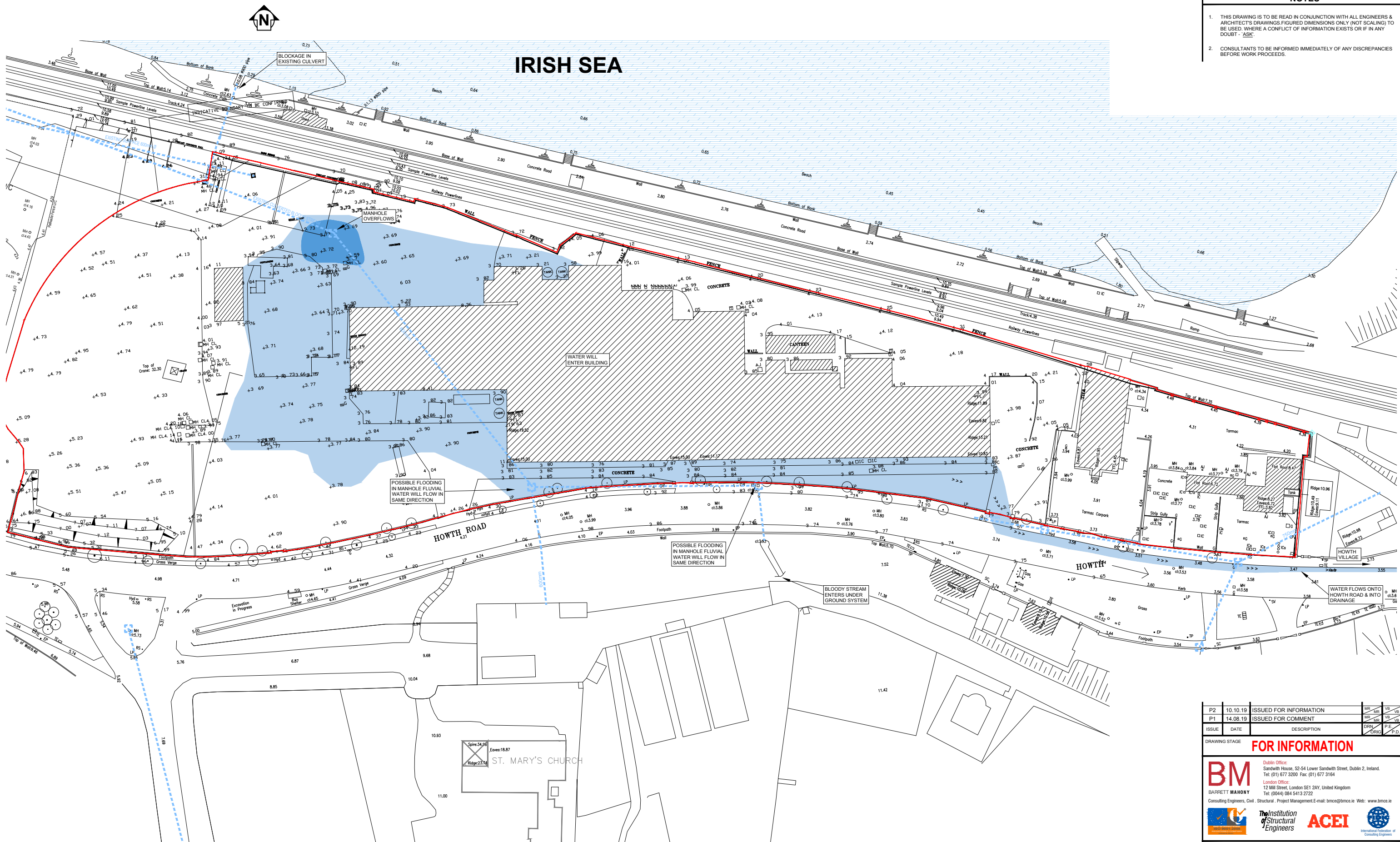
BARRETT MAHONY

The Institution of Structural Engineers **ACEI** International Federation of Consulting Engineers

CLIENT ATLAS GP LTD	BM PROJECT No. 18.386
PROJECT TITLE CLAREMONT PROJECT	MODEL REV. SUITABILITY P01 S0
MODEL REFERENCE PPT-BMD-XX-ZZ-DR-C-1000.dwg	DRAWING TITLE FLOOD RISK ASSESSMENT BLOCKAGE @ WATER GRATE
DRAWING No. PPT-BMD-XX-ZZ-DR-C-1007	ISSUE P2

NOTES

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL ENGINEERS & ARCHITECT'S DRAWINGS FIGURED DIMENSIONS ONLY (NOT SCALING) TO BE USED. WHERE A CONFLICT OF INFORMATION EXISTS OR IF IN ANY DOUBT - 'ASK'.
2. CONSULTANTS TO BE INFORMED IMMEDIATELY OF ANY DISCREPANCIES BEFORE WORK PROCEEDS.



EXISTING LAYOUT BLOCKAGE IN CULVERT FLOOD SITUATION

SCALE @ A1: 1:500
SCALE @ A3: 1:1000

P2	10.10.19	ISSUED FOR INFORMATION	MH	VB	10
P1	14.08.19	ISSUED FOR COMMENT	DRN	VB	10
ISSUE	DATE	DESCRIPTION	DRN	ORIG	P.D.

DRAWING STAGE: **FOR INFORMATION**

BM Dublin Office: Sandwith House, 52-54 Lower Sandwith Street, Dublin 2, Ireland. Tel: (01) 677 3200 Fax: (01) 677 3164
London Office: 12 Mill Street, London SE1 2AY, United Kingdom. Tel: (0044) 084 5413 2722
BARRETT MAHONY Consulting Engineers, Civil, Structural, Project Management. E-mail: bmce@bmce.ie Web: www.bmce.ie



CLIENT: **ATLAS GP LTD**

PROJECT TITLE	BM PROJECT No.
CLAREMONT PROJECT	18.386

MODEL REFERENCE	MODEL REV.	SUITABILITY
PPT-BMD-XX-ZZ-DR-C-1000.dwg	P01	S0

DRAWING TITLE: **FLOOD RISK ASSESSMENT EXISTING LAYOUT BLOCKAGE IN CULVERT FLOOD SITUATION**

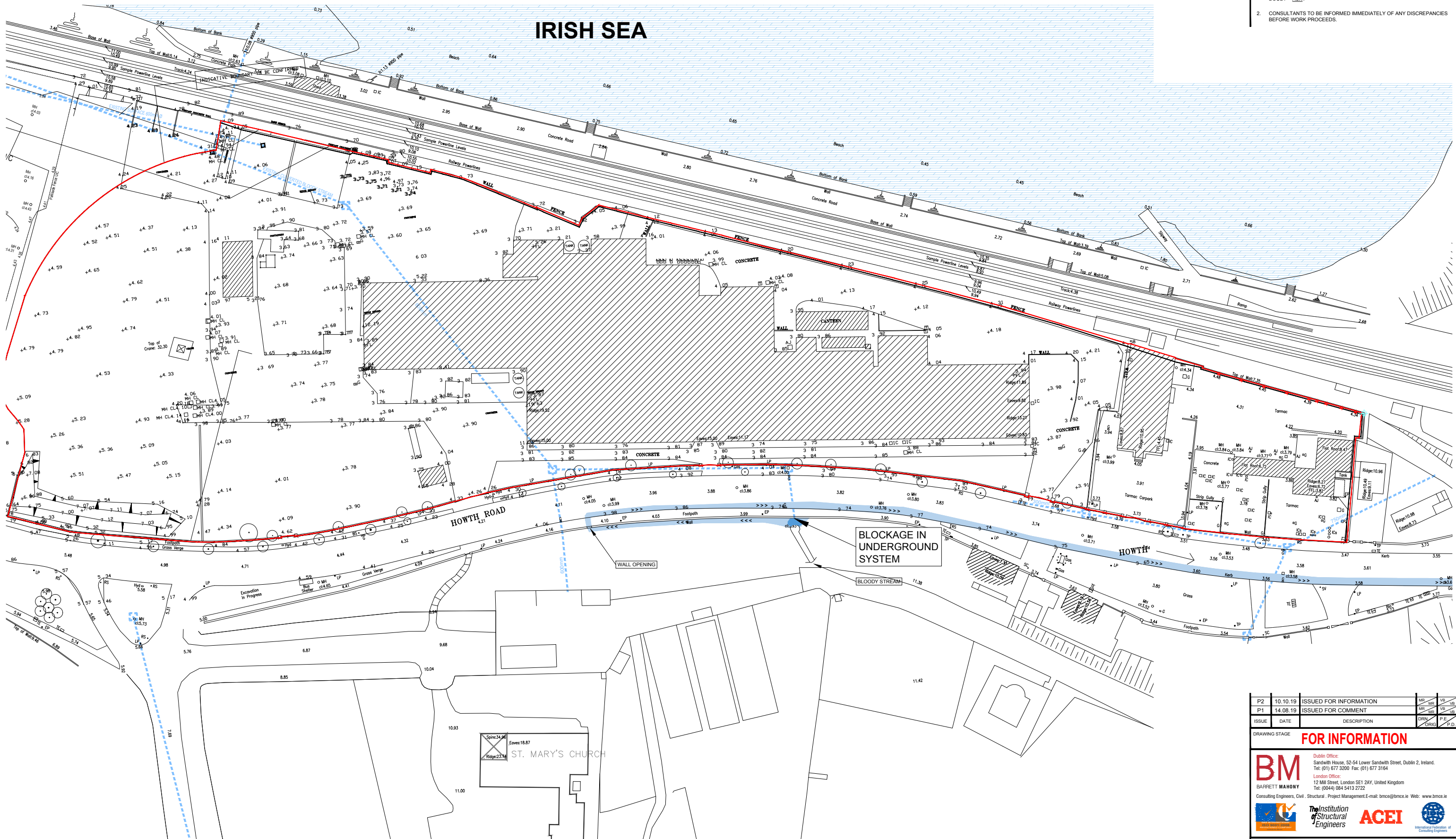
DRAWING No.	ISSUE
PPT-BMD-XX-ZZ-DR-C-1018	P2

NOTES

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL ENGINEERS & ARCHITECTS' DRAWINGS FIGURED DIMENSIONS ONLY (NOT SCALING) TO BE USED. WHERE A CONFLICT OF INFORMATION EXISTS OR IF IN ANY DOUBT - 'ASK'.
2. CONSULTANTS TO BE INFORMED IMMEDIATELY OF ANY DISCREPANCIES BEFORE WORK PROCEEDS.



IRISH SEA



EXISTING BLOCKAGE BEFORE SITE

SCALE @ A1: 1:500
SCALE @ A3: 1:1000

P2	10.10.19	ISSUED FOR INFORMATION	MH	VB	10
P1	14.08.19	ISSUED FOR COMMENT	MS	VB	06
ISSUE	DATE	DESCRIPTION	DRN	P.E	P.D

FOR INFORMATION

BM Dublin Office: Sandwith House, 52-54 Lower Sandwith Street, Dublin 2, Ireland. Tel: (01) 677 3200 Fax: (01) 677 3164
London Office: 12 Mill Street, London SE1 2AY, United Kingdom. Tel: (0044) 084 5413 2722
Consulting Engineers, Civil, Structural, Project Management. E-mail: bmce@bmce.ie Web: www.bmce.ie



CLIENT
ATLAS GP LTD

PROJECT TITLE CLAREMONT PROJECT	BM PROJECT No. 18.386
---	---------------------------------

MODEL REFERENCE PPT-BMD-XX-ZZ-DR-C-1000.dwg	MODEL REV P01	SUITABILITY S0
--	------------------	-------------------

DRAWING TITLE
**FLOOD RISK ASSESSMENT
EXISTING BLOCKAGE BEFORE SITE**

DRAWING No. PPT-BMD-XX-ZZ-DR-C-1019	ISSUE P2
---	--------------------

Barrett Mahony Consulting Engineers

Dublin:

Sandwith House,
52-54 Lower Sandwith Street,
Dublin 2,
D02 WR26, Ireland.
Tel: +353 1 677 3200

London:

12 Mill Street,
London, SE1 2AY,
United Kingdom
Tel: +44 203 750 3530.

Sofia:

19 Yakubitsa Street,
Lozenets,
Sofia 1164,
Bulgaria
Tel: +359 2 494 9772

WWW.BMCE.IE