APPENDICES: CHAPTER 8 – HYDROLOGY

APPENDIX 8.1: FLOOD RISK ASSESSMENT

Health Service Executive

The National Maternity Hospital at St. Vincent's University Hospital

Flood Risk Assessment

235754-00

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Contents

Executive Summary

Arup was commissioned by the Health Service Executive (HSE) to undertake a Flood Risk Assessment (FRA) for inclusion as part of the planning application for a proposed National Maternity Hospital on the grounds of St. Vincent's University Hospital, Elm Park, Merrion Rd, Dublin 4. The FRA has been carried out in accordance with 'The Planning System and Flood Risk Management: Guidelines for Planning Authorities" published in November 2009, jointly by the Office of Public Works (OPW) and the then Department of Environment, Heritage and Local Government (DoEHLG).

The St. Vincent's University Hospital campus is located at Elm Park in South County Dublin. It lies at the junction of Merrion Road and Nutley Lane (opposite the Merrion Shopping Centre) and adjacent to Elm Park Golf Club. The site of the proposed National Maternity Hospital lies within the St. Vincent's University Hospital campus and is bounded by buildings to the north and to the west, street level car parking to the south and an internal hospital road to the east.

The proposed development comprises the construction of a building that rises to 5 and 6 storeys above ground level, with one partial basement level, plus additional ancillary plant areas at the roof level. The proposed development also includes an extension to the existing multi-storey car park at the north of the campus. The proposed development will be constructed in a sequential manner that allows for the continual operation of the hospital campus and, as such, includes the phased demolition of existing buildings at St. Vincent's University Hospital campus to facilitate clearing the site for the proposed development and the construction of temporary accommodation to facilitate construction sequencing (including a single storey temporary canteen, catering staff changing facilities, household services store and carpenters workshop). The full detail of the nature and extent of the proposed development is set out in Chapter 2 of this EIS and the Outline Construction Management Plan is appended to same.

In broad terms the potential sources of flooding to the subject site can be categorised as Tidal/Coastal flooding, Fluvial flooding, Pluvial/Urban drainage flooding and Groundwater flooding.

The risk of both tidal and fluvial flooding of the site is very low. There is a minor risk of pluvial flooding. This risk of groundwater flooding is low.

The site lies within Flood Zone C (outside the 1 in 1000 year floodplain) and a justification test is therefore not required.

It is proposed to set the ground floor of the building at 6.0m OD.

Surface water discharges from the proposed development will be restricted in accordance with the Greater Dublin Regional Code of Practice for Drainage Works. Storm attenuation will therefore be required on site. The allowable greenfield run-off rate from the site will be based on 2 litres/second/hectare in line with the Code of Practice and Dublin City Council Drainage Division's requirements.

In the event of a very extreme high-intensity rainfall event, the capacity of the drainage system for the proposed development could be exceeded leading to surface runoff collecting on the site and entering the building.

This risk will be minimised by ensuring that the ground slopes away from all the entrances to the building to a low point in the landscape which is serviced by gullies draining into the attenuation tank under the landscaping.

The surface water drainage system will be subject to a maintenance programme ensuring that the risk of blockage is greatly minimised.

It is considered that the proposed development should be classified as a "Highly Vulnerability Development" as OPW's vulnerability classification. As the proposed development lies within Flood Zone C, a Justification Test is not required and it is necessary only to identify mitigation measures for any residual risks.

1 Introduction

1.1 Project Background

Arup was commissioned by the Health Service Executive (HSE) to undertake a Flood Risk Assessment (FRA) for the proposed development of the National Maternity Hospital at St. Vincent's University Hospital campus. The FRA is to form part of the planning application for the development.

This report details the FRA carried out as part of the planning application. It has been undertaken in accordance with the Guidelines for Planning Authorities on 'The Planning System and Flood Risk Management' published in November 2009, jointly by the Office of Public Works (OPW) and the then Department of Environment, Heritage and Local Government (DEHLG).

1.2 Scope of Study

The scope of the study includes the following:

- Review the risk of tidal, fluvial, groundwater and pluvial flooding;
- Review of all relevant information and data from:
  - The Irish Coastal Protection Strategy Study (ICPSS);
  - OPW Preliminary Flood Risk Assessment Mapping (PFRA);
  - The Dublin Coastal Flooding Protection Project (DCFPP);
  - Any available historic flood information on the site;
- Review of the proposed building layout and advise on a suitable finished floor level;
- Review of available site investigation data;
- Review of access/egress routes;
- Development of potential mitigation measures, if necessary;
- Preparation of the Flood Risk Assessment Report.

1.3 Summary of data used

In preparing this report, the following data was collected and reviewed:

- Review of the available maps and reports from the Eastern CFRAM project (www.cfram.ie).
- Flood history of the site from the OPW National Flood Hazard Mapping website (www.floodmaps.ie);
- OPW Irish Coastal Protection Strategy Study (ICPSS) Mapping
- Guidelines for Planning Authorities on 'The Planning System and Flood Risk Management' published in November 2009, jointly by the Office of Public Works (OPW) and the then Department of Environment, Heritage and Local Government (DEHLG);
- 'Rivers of Dublin' Book, Sweeney, 1991;
- Drainage drawings from the archives of Dublin City Council;

- Topographical data from the site;
- Site Investigation data for the site from 2014;
- Site Geological and Hydrogeological data from the Geological Survey of Ireland Website (www.gsi.ie);
- Architectural drawings of the proposed development;
- Aerial photography and mapping from Bing Maps and Google Maps.

All levels referred to in this report are to Malin Head Ordnance Datum unless otherwise stated.

1.4 Site Description

St Vincent's University Hospital camous is located at Elm Park in South County Dublin as shown in Figure 1. It lies at the junction of Merrion Road and Nutley Lane (opposite the Merrion Shopping Centre) and adjacent to Elm Park Golf Club. The site of the proposed National Maternity Hospital lies within the St. Vincent's University Hospital campus and is bounded by buildings to the north and to the west, street level car parking to the south and an internal hospital road to the east.

Dublin Bay lies approximately 400m east of the proposed maternity hospital and Elm Park stream lies approximately 370m south of the site. The fully culverted Nutley stream and Nutley Stream Tributary lie to the West and North of the development. The approximate route of these watercourses are highlighted below in Figure 1.

Existing ground levels vary across the site of the proposed development as indicated in Figure 3. Along the Northern boundary levels vary from circa 6.0m OD to 7.0m OD. Along the Southern boundary they vary from circa 6.7m OD to 8.0m OD. The lowest elevation of the site is set at circa 5.8m OD.

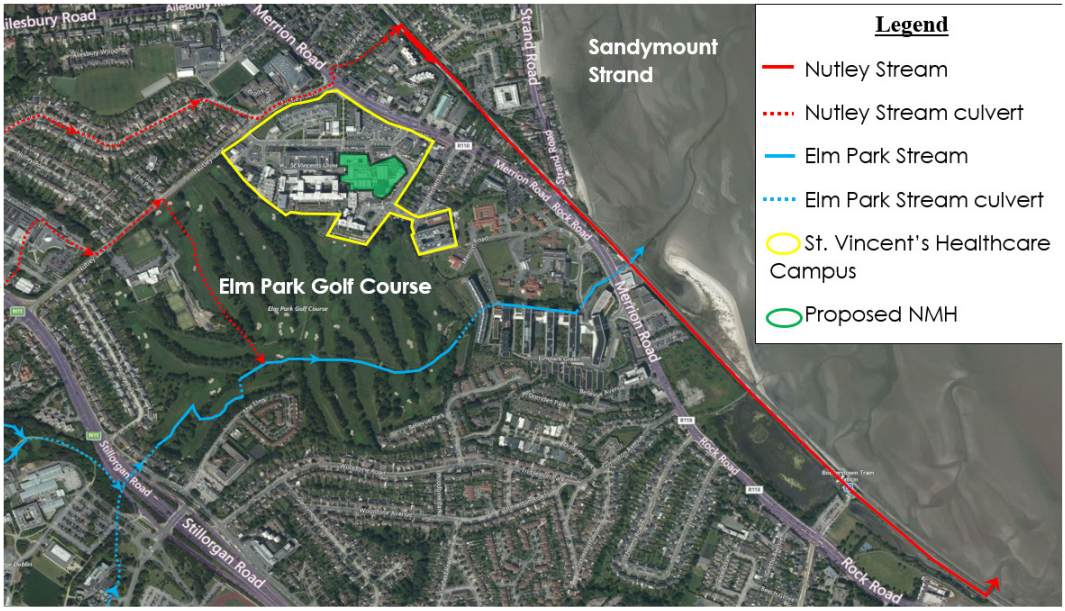

Figure 1 Site Location and local watercourses

Note: *The site area outlined is approximate only and is intended to generally confirm the extent of the site.*

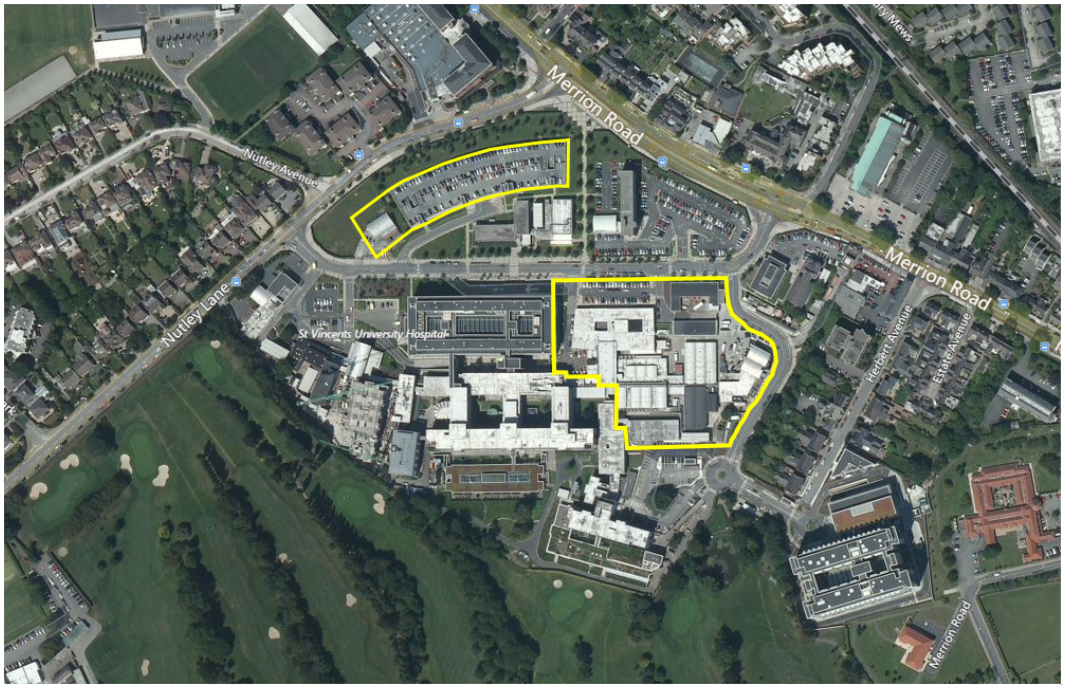

Figure 2 Arial view of the proposed development. The approximate outline of the site of the proposed development is indicated in red.

Figure 3 Existing ground levels for the site of the proposed development. The buildings in the figure are the existing buildings on the site.

1.5 Proposed Development

The proposed development comprises the development of The National Maternity Hospital at St. Vincent's University Hospital campus, Elm Park, Dublin 4. The proposed new National Maternity Hospital building will be located at the eastern side of the hospital campus and comprises the construction of a building that rises to 5 and 6 storeys above ground level, with one partial basement level, plus additional ancillary plant areas at the roof level. The proposed development also includes an extension to the existing multi-storey car park at the north of the campus. The proposed development will be constructed in a sequential manner that allows for the continual operation of the hospital campus and, as such, includes the phased demolition of existing buildings at St. Vincent's University Hospital campus to facilitate clearing the site for the proposed development and the construction of temporary accommodation to facilitate construction sequencing (including a single storey temporary canteen, catering staff changing facilities, household services store and carpenters workshop). The full detail of the nature and extent of the proposed development is set out in Chapter 2 of this EIS and the Outline Construction Management Plan is appended to same.

A site layout plan is presented in Figure 4.

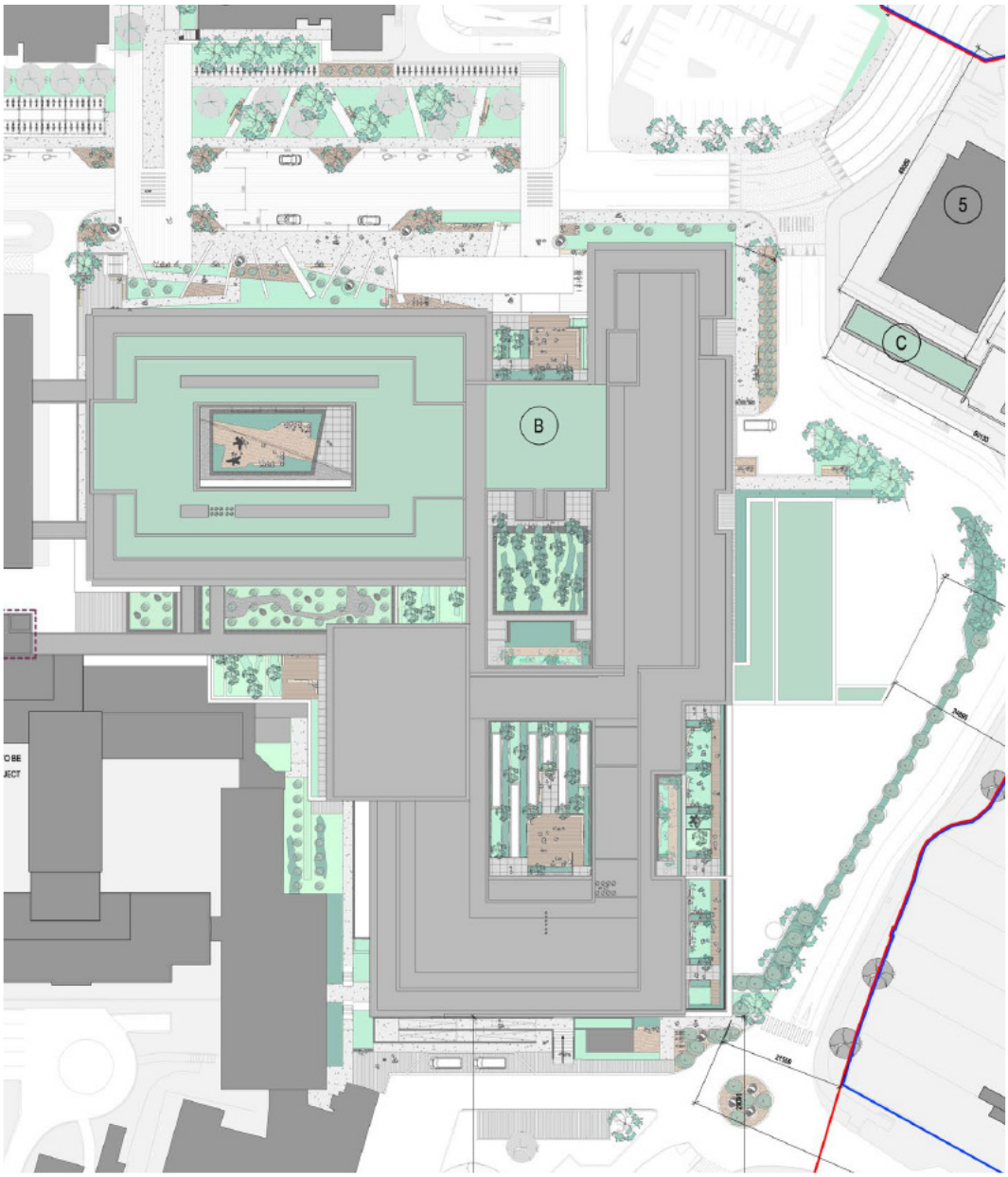

Figure 4 Landscape plan

2 The Planning context

The following policy documents are relevant to the assessment of the proposed development at St. Vincent's University Hospital.

- The national planning guidelines published by the OPW and the Department of the Environment, Heritage and Local Government in November 2009 entitled 'The Planning System and Flood Risk Management: Guidelines for Planning Authorities' are particularly pertinent and are discussed in the following section.
- Dublin City Development Plan 2016 – 2022;

2.1 The Planning system and Flood Risk Management

In November 2009, the Department of Environment, Heritage and Local Government and the Office of Public works jointly published a Guidance Document for Planning Authorities entitled "The Planning System and Flood Risk Management".

The guidelines are issued under Section 28 of the Planning and Development Act 2000 and Planning Authorities and An Bord Pleanála are therefore required to implement these Guidelines in carrying out their functions under the Planning Acts.

The aim of the guidelines is to ensure that flood risk is neither created nor increased by inappropriate development.

The guidelines require the planning system to avoid development in areas at risk of flooding, unless they can be justified on wider sustainability grounds, where the risk can be reduced or managed to an acceptable level.

They require the adoption of a Sequential Approach (to Flood Risk Management) of Avoidance, Reduction, Justification and Mitigation and they require the incorporation of Flood Risk Assessment into the process of making decisions on planning applications and planning appeals.

Fundamental to the guidelines is the introduction of flood risk zoning and the classifications of different types of development having regard to their vulnerability.

The management of flood risk is now a key element of any development proposal in an area of potential flood risk and should therefore be addressed as early as possible in the site master planning stage.

2.1.1 Definition of Flood Zones

Flood Zones are geographical areas within which the likelihood of flooding is in a particular range.

There are three types of flood zones defined in the Guidelines as follows:

Flood Zone A	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	Probability of flooding from rivers and the sea is moderate (between 0.1% or 1 in 1000 year 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); and
Flood Zone C	Probability of flooding from rivers and the sea is low (less than 0.1% or 1 in 1000 for both river and coastal flooding). Flood Zone C covers all areas of the plan which are not in zones A or B.

Table 1 Definition of Flood Zones

2.1.2 Definition of Vulnerability Classes

The following table summarises the Vulnerability Classes defined in the Guidelines and provides a sample of the most common type of development applicable to each.

Highly Vulnerable Development	Includes Garda, ambulance and fire stations, hospitals, schools, residential dwellings, residential institutions, essential infrastructure, such as primary transport and utilities distribution and SEVESO and IPPC sites, etc.
Less Vulnerable Development	Includes retail, leisure, warehousing, commercial, industrial and non-residential institutions, etc.
Water Compatible Development	Includes Flood Control Infrastructure, docks, marinas, wharves, navigation facilities, water based recreation facilities, amenity open spaces and outdoor sport and recreation facilities

Table 2 Definition of Flood Zones

2.1.3 Types of Vulnerability class appropriate to each Zone

The following table illustrates the different types of Vulnerability Class appropriate to each Zone and indicates where a Justification Test will be required.

	Flood Zone A	**Flood Zone B**	**Flood Zone C**
Highly Vulnerable	Justification Test	Justification Test	Appropriate
Less Vulnerable	Justification Test	Appropriate	Appropriate
Water Compatible	Appropriate	Appropriate	Appropriate

Table 3 Types of vulnerability class appropriate to each zone

The flood risk management guidelines recognise that there is a need to reconcile the desire to avoid development in areas at risk of flooding while also ensuring sequential and compact urban development as several large urban centres are already located in areas that are at risk of flooding. It states:

"*Notwithstanding the need for future development to avoid areas at risk of flooding, it is recognised that the existing urban structure of the country contains many well established cities and urban centres, which will continue to be at risk of flooding. At the same time such centres may also have been targeted for growth in the National Spatial Strategy, regional planning guidelines and the various city and county development plans taking account of historical patterns of development and their national and strategic value. In addition, development plans have identified various strategically located urban centres and particularly city and town centre areas whose continued growth and development is being encouraged in order to bring about compact and sustainable urban development and more balanced regional development. Furthermore, development plan guidelines, issued by the Minister for the Environment, Heritage and Local Government under Section 28 of the Planning and Development Act 2000, have underlined the importance of compact and sequential development of urban areas with a focus on town and city centre locations for major retailing and higher residential densities*".

2.2 Dublin City Development Plan 2016-2022

The Dublin City Development Plan 2016-2022 came into effect in October 2016.

The Plan sets out policies and objectives to create a sustainable and vibrant city at the heart of the Greater Dublin Region and is a guide to how and where development will take place in the city over the years covered. The following paragraphs summarise the relevant provisions contained within the Plan which deal with Flood Risk Management.

Section 9.5.3 of the Plan deals with Flood Management and outlines the key policies and objectives of Dublin City Council in relation to flood risk.

The policies are listed as:

SI9: To assist the Office of Public Works in developing catchment-based Flood Risk Management Plans for rivers, coastlines and estuaries in the Dublin city area and have regard to their provisions/recommendations.

SI10: To have regard to the Guidelines for Planning Authorities on the Planning System and Flood Risk Management, and Technical Appendices, November 2009, published by the Department of the Environment, Community, and Local Government as may be revised/updated when assessing planning applications and in the preparation of plans both statutory and non-statutory.

SI11: To put in place adequate measures to protect the integrity of the existing Flood Defence Infrastructure in Dublin City Councils ownership and identified in the Strategic Flood Risk Assessment and to ensure that the new developments do not have the effect of reducing the effectiveness or integrity of any existing or new flood defence infrastructure and that flood defence infrastructure has regard also to nature conservation, open space and amenity issues.

SI12: To implement and comply fully with the recommendations of the Strategic Flood Risk Assessment prepared as part of the Dublin City Development Plan.

SI13: That development of basements or any above-ground buildings for residential use below the estimated flood levels for Zone A or Zone B will not be permitted.

SI14: To protect the Dublin City coastline from flooding as far as reasonably practicable, by implementing the recommendations of the Dublin Coastal Flood Protection Project and the Dublin Safer Project.

SI15: To minimise the risk of pluvial (intense rainfall) flooding in the city as far as is reasonably practicable and not to allow any development which would increase this risk.

SI16: To minimise the flood risk in Dublin City from all other sources of flooding, including fluvial, reservoirs and dams and the piped water system. SI17: To require an environmental assessment of all proposed flood protection or flood alleviation works

The Objective of Dublin City Council are listed as:

SIO8: All development proposals shall carry out, to an appropriate level of detail, a Site Specific Flood Risk Assessment (SSFRA) that shall demonstrate compliance with:

The Planning System and Flood Risk Management, Guidelines for Planning Authorities, Department of the Environment, Community and Local Government, November 2009, as may be revised/updated and the Strategic Flood Risk Assessment (SFRA) as prepared by this Development Plan.

The site-specific flood risk assessment (SSFRA) shall pay particular emphasis to residual flood risks, site-specific mitigation measures, flood-resilient design and construction, and any necessary management measures (the SFRA and Appendix B4 of the above mentioned national guidelines refer). Attention shall be given in the site-specific flood risk assessment to building design and creating a successful interface with the public realm through good design that addresses flood concerns

but also maintains appealing functional streetscapes. All potential sources of flood risk must be addressed in the SSFRA.

SIO9: Proposals which may be classed as 'minor development', for example small-scale infill, small extensions to houses or the rebuilding of houses or paving of front gardens to existing houses, most changes of use and small-scale extensions to existing commercial and industrial enterprises in Flood Zone A or B, should be assessed in accordance with the Guidelines for Planning Authorities on the Planning System and Flood Risk Management & Technical Appendices, November 2009 as may be revised/updated, with specific reference to Section 5.28 and in relation to the specific requirements of the Strategic Flood Risk Assessment. The policy shall be not to increase the risk of flooding and to ensure risk to the development is managed.

SIO10: That recommendations and flood maps arising from the Fingal-East Meath CFRAM Study, the Dodder CFRAM Study and the Eastern CFRAM Study are taken into account in relation to the preparation of statutory plans and development proposals. This will include undertaking a review of the Strategic Flood Risk Assessment for Dublin city following the publication of the Final Eastern CFRAM Study, currently being produced by the OPW.

SIO11: To work with neighbouring Local Authorities when developing cross-boundary flood management work programmes and when considering cross-boundary development.

SIO12: To ensure each flood risk management activity is examined to determine actions required to embed and provide for effective climate change adaptation as set out in the Dublin City Council climate change adaption policy and in the OPW Climate Change Sectoral Adaptation Plan Flood Risk Management applicable at the time.

Regarding the provision of SuDS, the Plan also outlines specific policies and objectives. The policies are listed as:

SI18: To require the use of Sustainable Urban Drainage Systems in all new developments, where appropriate, as set out in the Greater Dublin Regional Code of Practice for Drainage Works. The following measures will apply:

- The infiltration into the ground through the development of porous pavement such as permeable paving, swales, and detention basins
- The holding of water in storage areas through the construction of green roofs, rainwater harvesting, detention basins, ponds, and wetlands
- The slow-down of the movement of water.
- The Objectives regarding SuDs are given as:
- **SIO13:** To provide additional and improved surface water networks to both reduce pollution and allow for sustainable development.

SIO14: To require that any new paving of driveways or other grassed areas is carried out in a sustainable manner so that there is no increase in storm water run-off to the drainage network.

2.2.1 Land Use Zoning for the site

Figure 5 presents an extract from the Dublin City Development Plan 2016-2012. It identifies the site of the proposed development at St Vincent's Healthcare Campus as Z15: "*To provide for the institutional, educational, recreational, community, green infrastructure and health uses*".

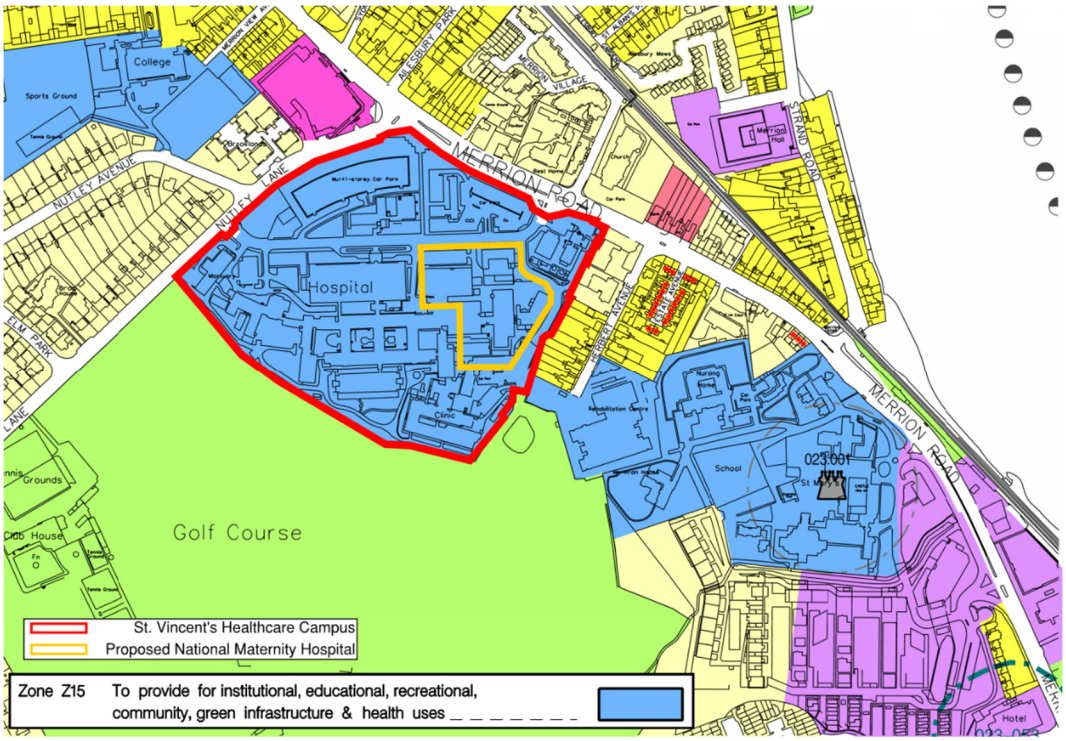

Figure 5 Zoning for the site

3 Flood Mechanisms and Historic Flooding at the Site

3.1 Flood Mechanisms at the site

In broad terms the potential sources of flooding to the subject site can be categorised as follows:

- **Tidal/ Coastal Flooding** - Tidal flooding may occur during a surge event in the Irish Sea;
- **Fluvial (River) Flooding** - The fluvial flood risk at the site is from the two streams in the vicinity of the site – the Nutley and Elm Park stream;
- **Pluvial Flooding/ Urban drainage** - Pluvial flooding occurs when the capacity of the local urban drainage network is exceeded during periods of intense rainfall. At these times, water can collect at low points in the topography and cause flooding;
- **Groundwater Flooding -** This type of flooding can occur during lengthy periods of heavy rainfall, typically during late winter/early spring when the groundwater table is already high. If the groundwater level rises above ground level, it can pond at local low points and cause periods of flooding.

Each of these potential sources of flooding are considered in this FRA.

3.2 Historic Data from floodmaps.ie

Reports and maps from the OPW website www.floodmaps.ie have been examined as part of this Flood Risk Assessment. It can be seen that a number of recorded flood events in the vicinity of the site are presented on the flood map website (Figure 6).

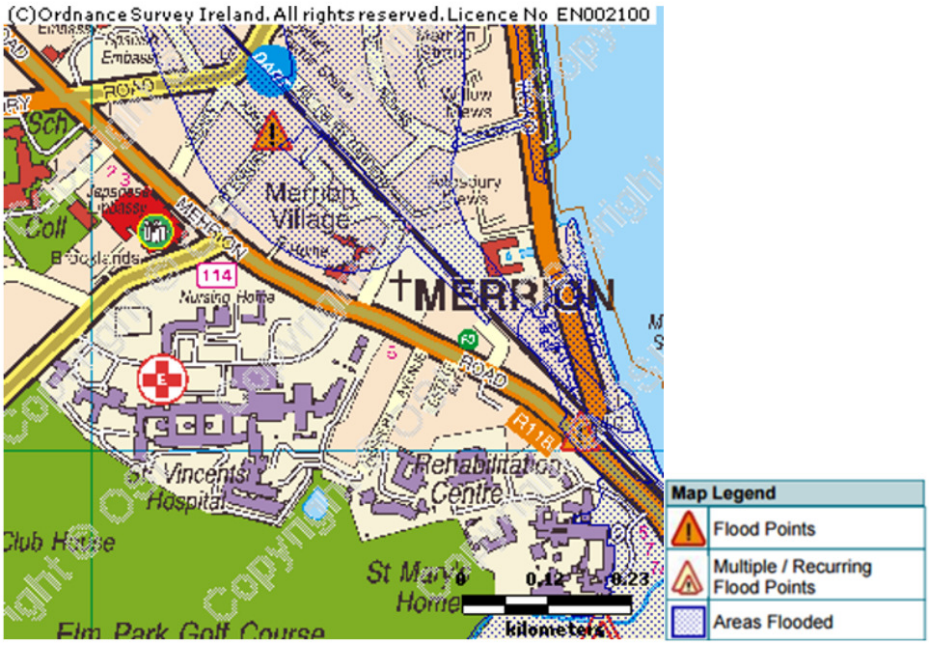

Figure 6 Extract from floodmaps.ie

- **Tidal Flooding** *(2nd February 2002)*: Floodwater driven by a high tide and wave action escaped through an access gap at the Merrion Gates and flooded the Road and Dart line. At its peak the flood water reached a depth of circa 600mm at the gap and 1.2m on the lowest spot on the road. The gardens of 21 properties were flooded and two properties were directly flooded. It is noted however that the subject site was not flooded by this event. See Figure 7 below.

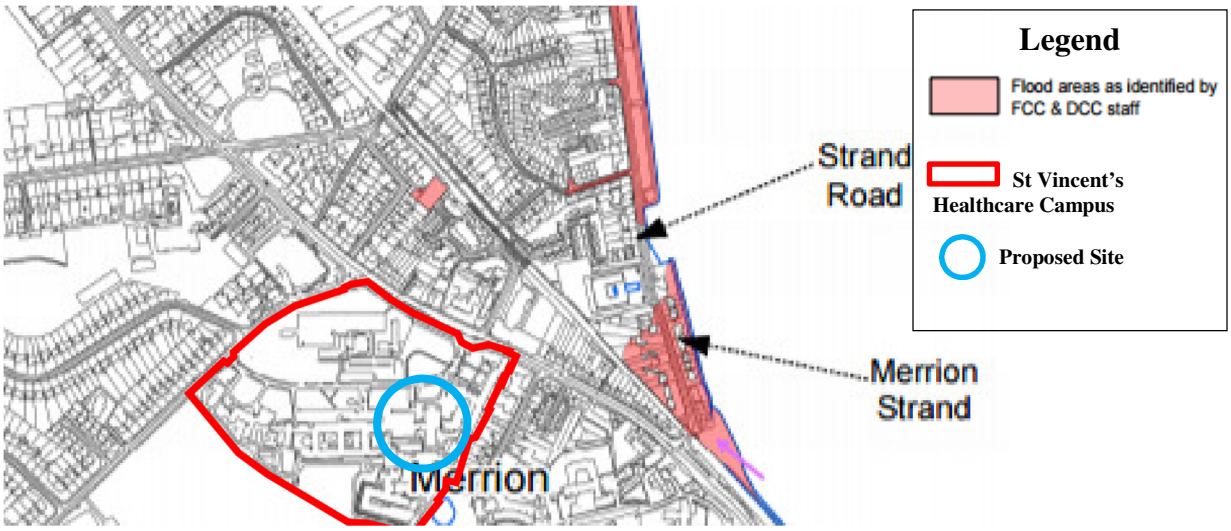

Figure 7 Previous tidal flood extent

- (*1858 and 1963*): There is a historic record of flooding at the Elm Park Development site (previously owned by St. Mary's Nursing Home). Floodmaps.ie indicates that the site is subject to recurring flood events. It is noted however that no flooding has been recorded since the construction of Elm Park Development in 2008 which involved extensive landscaping and stream and culvert works.

4 Tidal Flood Risk

A number of major flood studies have been carried out in recent years which provide predicted coastal flood extents and design maximum water levels for Dublin:

- Eastern CFRAM Study;
- Irish Coastal Protection Strategy Study (ICPSS);

4.1 Eastern CFRAM

The draft predictive flood maps from the Eastern CFRAM study are available from the project website. Figure 8 presents the predicted tidal flood extent map for the 10, 200 and 100 year events for the vicinity of the site. It can be seen that the subject lies outside the predicted tidal flood extent for each of the three return period events.

The wave overtopping flood risk maps for the vicinity of the site were also assessed as part of the FRA and it was shown that the site is not as risk from flooding by wave overtopping.

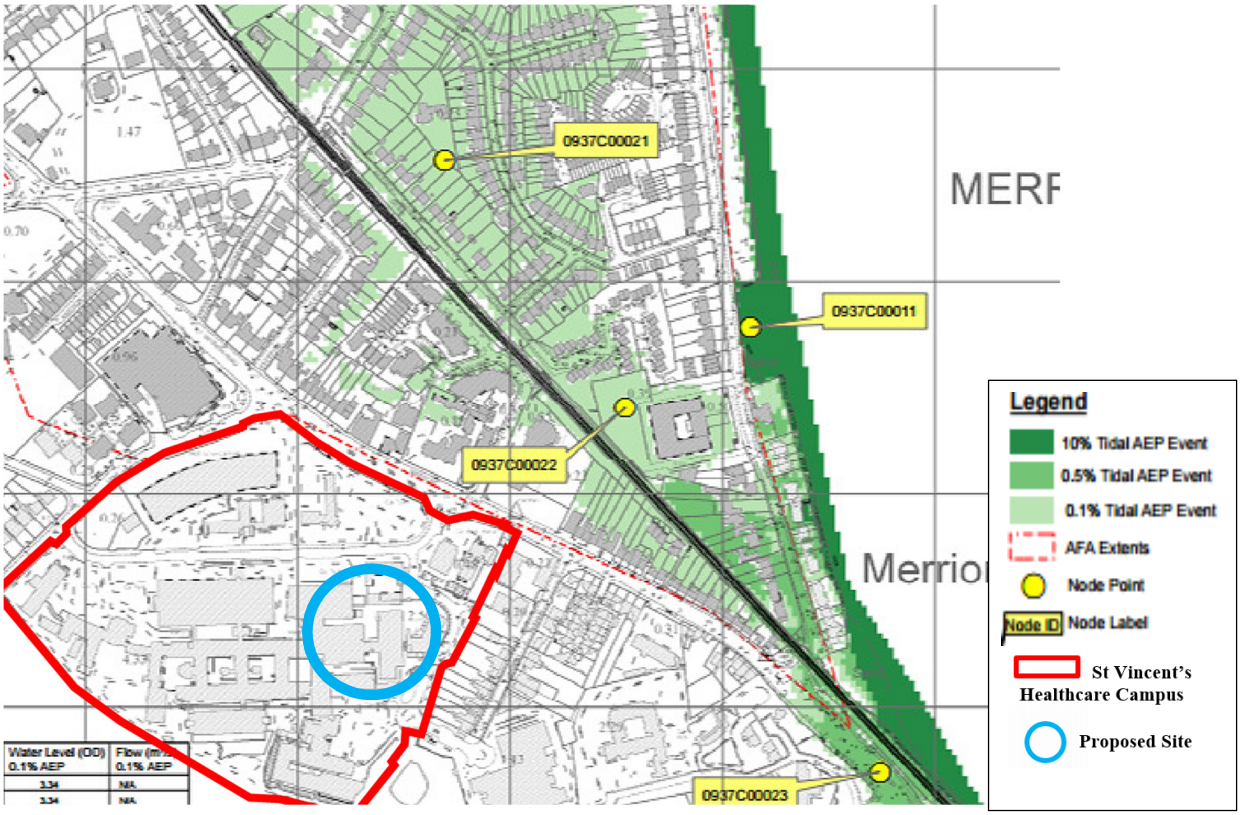

Figure 8 Tidal flood extent map from the ICPSS

4.2 ICPSS

Output from the ICPSS is available from the OPW website. Two datasets for the Dublin area were examined as part of this FRA:

- The predicted 1 in 200 year design tidal water level for a location close to the site of interest;
- Predicted flood extent maps for the design 200 year tidal flood event;

Figure 9 presents the 1 in 200 year tidal floodplain as predicted by the ICPSS for the vicinity of the site. It can be seen from the figure that the site is not within the predicted 1 in 200 year tidal floodplain.

Design tidal water levels for the 1 in 10, 200 and 1000 year events for a location close to the site are also indicated on the figure. It can be seen that the 1 in 1000 year design water level is 3.25m OD. This is approximately 2.7m below existing ground levels for the site which are set at circa 6.0m OD. The risk of tidal flooding of the site is therefore very low.

It should be noted that the numerical models used in the ICPSS assume that there are no flood defences present and therefore discounts the benefits of same. The predicted flood extent is therefore for the undefended case.

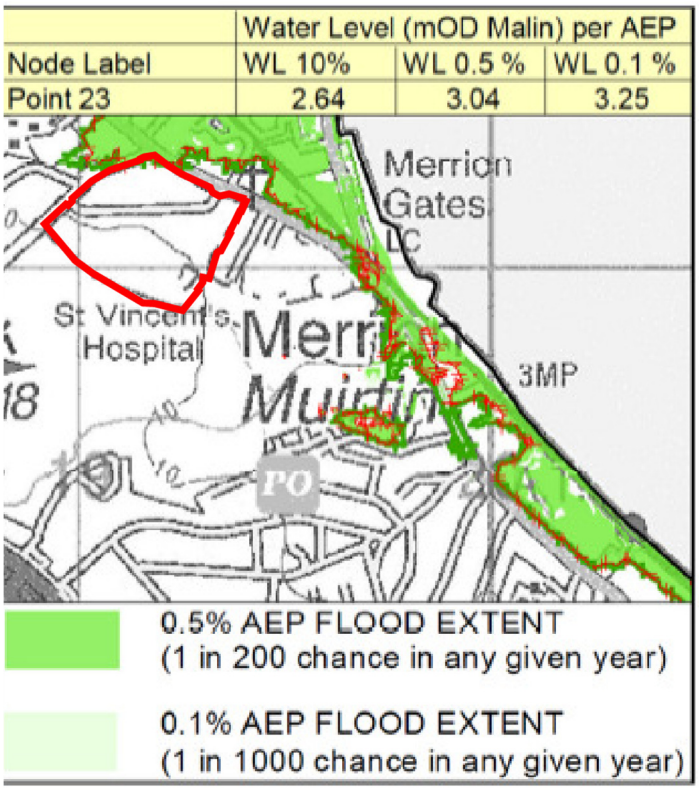

Figure 9 Extract from ICPSS

5 Fluvial Flood Risk

Fluvial flooding in the vicinity of the site was not accessed as part of the Eastern CFRAM project. It is likely that this was on account of there being no significant watercourses in the vicinity of the site.

There are two minor watercourses in the vicinity of the site as indicted in Figure 10: (1) Elm Park Stream and (2) Nutley Stream. The risk of fluvial flooding from both of these watercourses has been accessed as part of this FRA.

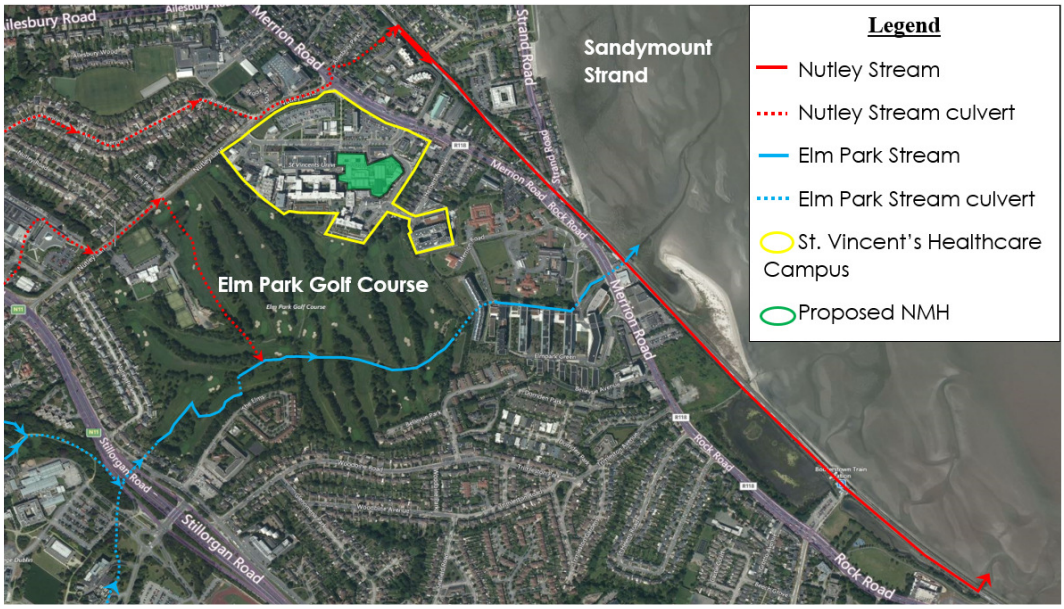

Figure 10 Elm Park and Nutley stream

5.1 Elm Park Stream

Elm Park stream is located approximatley 300m south of the site boundary of St Vincent's Healthcare Campus and flows in a west-east direction into Dublin Bay. An outline of the catchment from OPW's FSU webportal is presented in Figure 11. (It is noted that the catchment outline may be inaccurate.) It can be seen from the figure that the catchment area is circa 1.76 km2 and the estimate of Qmed from the catchment descriptors that accounts for urbanisation is circa 0.7m3/s.

Given the wide expanse of the floodplain and the relatively small flows in the catchment the risk of fluvial flooding to the subject site from the Elm Park stream is considered to be very low.

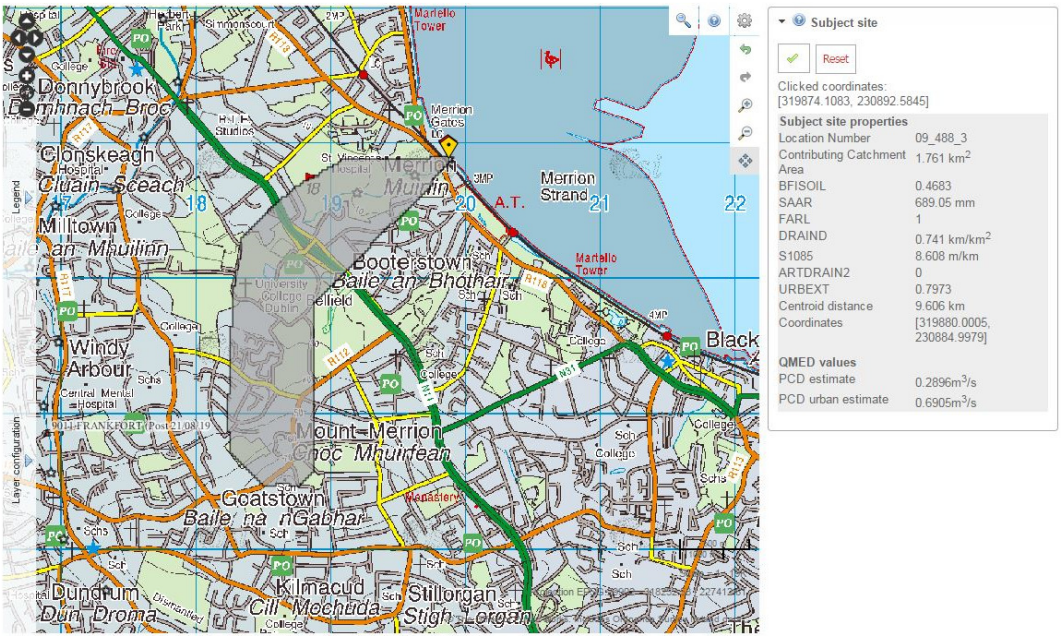

Figure 11 Outline of the Elm Park Catchment from the OPW web portal. Catchment descriptors are listed to the right hand side of the figure.

5.2 Nutley Stream

The Nutley Stream lies approximatley 450m to the West of the site. Based on an inspection of the reach and discussions with Dublin City Council it can be concluded that the Nutley is fully culverted in the vicinity of the site. There are no open channel sections which offer a route for water to flood the surrounding area. The risk of flooding from the culvert is therefore limited to the potential for surcharging at the culvert entrance and pressurised flow within the culvert forcing water out through any connecting back pipes, man holes or connecting culverts.

The risk of flooding to the site from surcharging of the culvert entrance is likely to be very low given the small area of contributing catchment at the upstream end of the culvert. The risk of flooding to the site from pressurised flow is also considered to be very low given the relatively wide expanse of the floodplain.

The Nutley Stream tributary lies approximatley 150m to the North of the site and conveys flows along underneath Nutley Lane. Based on an inspection of the reach and discussions with Dublin City Council it can be concluded that the Nutley Stream Tribuary is fully culverted in the vicinity of the site. Dublin City Council have also confirmed to Arup that the flows conveyed by the Nutley Stream Tribuary are very minor.

The risk of flooding to the site from surcharging of the culvert entrance is likely to be very low given the small area of contributing catchment at the upstream end of the culvert. The risk of flooding to the site from pressurised flow within the culvert forcing water out through any connections is also considered to be very low given the relatively wide expanse of the floodplain and the low flows within the culvert.

6 Pluvial and Groundwater Flood Risk

6.1 Pluvial flooding

Pluvial flooding occurs when extreme rainfall overwhelms drainage systems or soil infiltration capacity, causing excess rainwater to pond above ground at low points in the topography. In order to assess the risk of pluvial flooding to our subject site we have reviewed The Preliminary Flood Risk Mapping (PFRA) undertaken by the OPW

6.1.1 Preliminary PRFA mapping (OPW)

It can be seen from Figure 12 below that the proposed development partially lies within the 100 hundred year pluvial flood event. There is therefore a minor risk of pluvial flooding at the site.

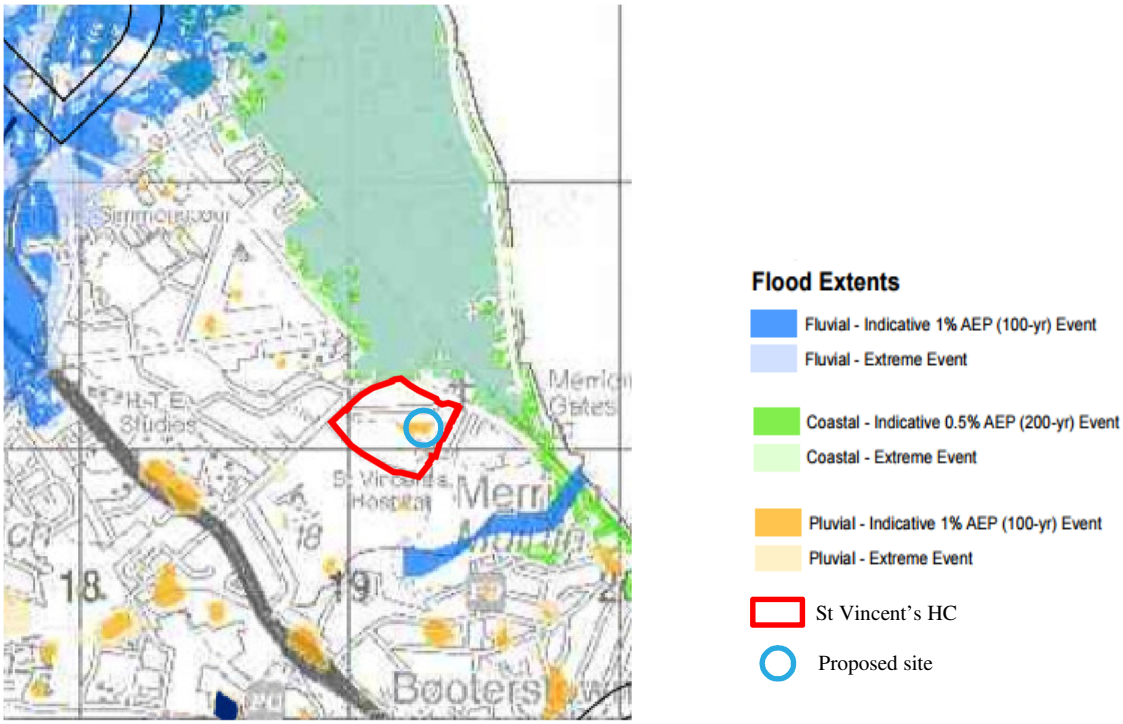

Figure 12 Preliminary PRFA mapping (OPW)

6.2 Groundwater Flooding

Groundwater flooding can occur during lengthy periods of heavy rainfall, typically during later winter/early spring when the ground water table is already high. If the groundwater level rises above ground level, it can pond at local points and cause periods of flooding.

Subsoil and groundwater maps of the site and surrounding areas, have been obtained from the Geological Survey of Ireland (GSI) website (www.gsi.ie) and are shown in the following set of figures.

According to GSI mapping, the subsoil under the site is classified as "made ground" below which the bedrock is primarily that of "Dinatian Upper Impure Limestones". The site is located on a bedrock aquifer classified as a "locally important aquifer", with bedrock which is moderately productive only in local zones. The groundwater vulnerability in the vicinity of the site is classified as "moderate" to "low" which can indicate the possibility of a naturally low groundwater table and/ or impermeable overburden.

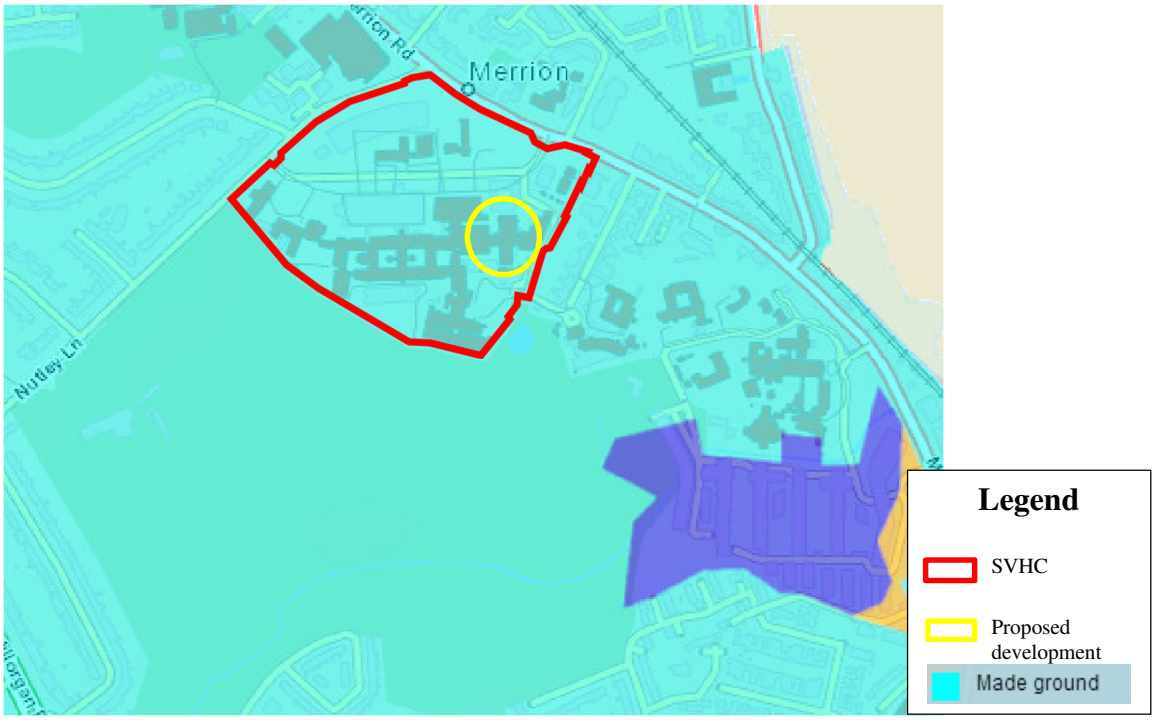

Figure 13 Subsoil classification

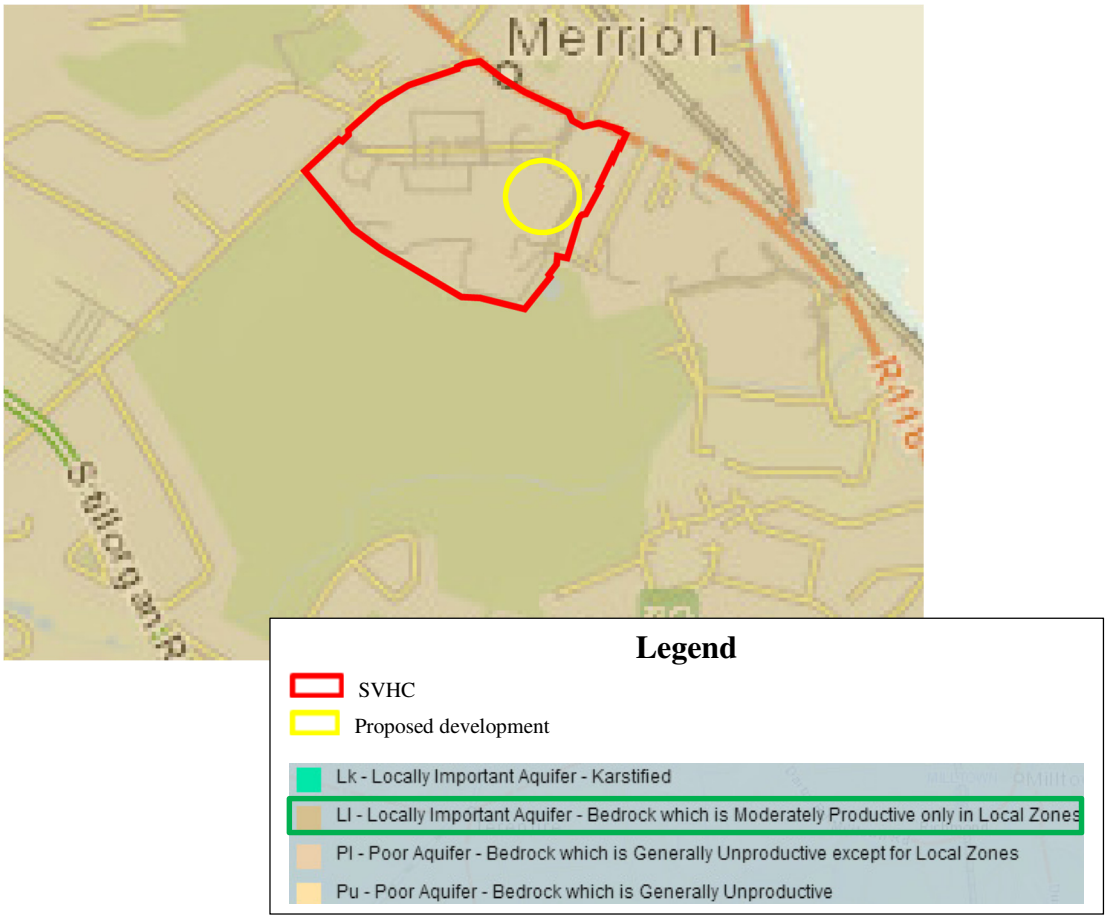

Figure 14 Bedrock aquifers

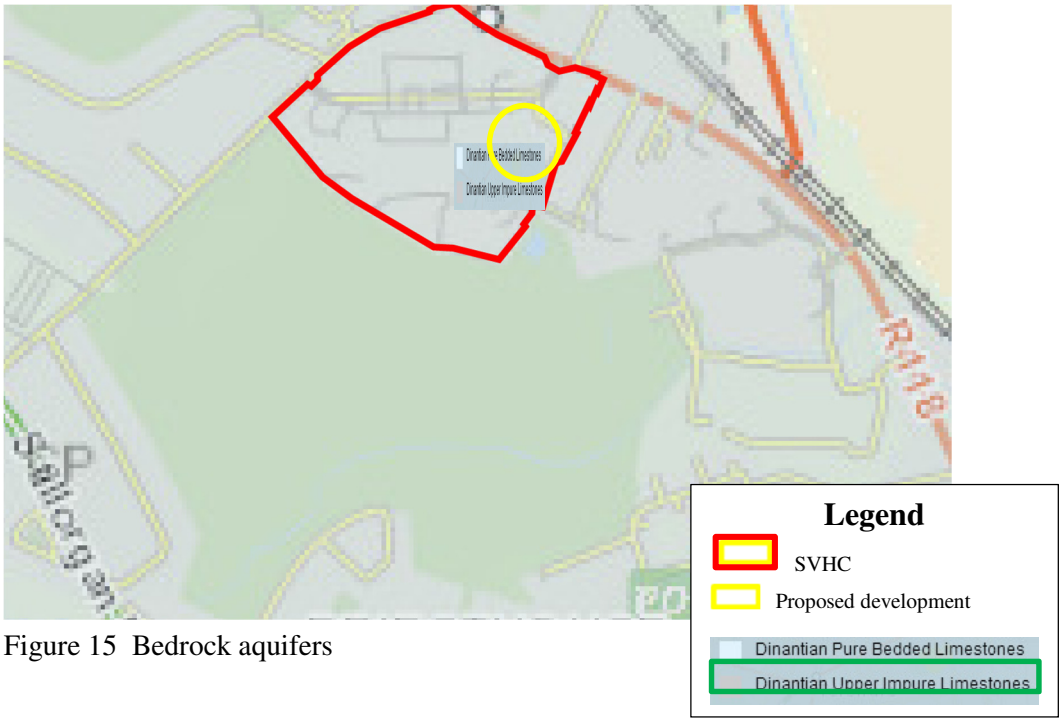

Figure 15 Bedrock aquifers

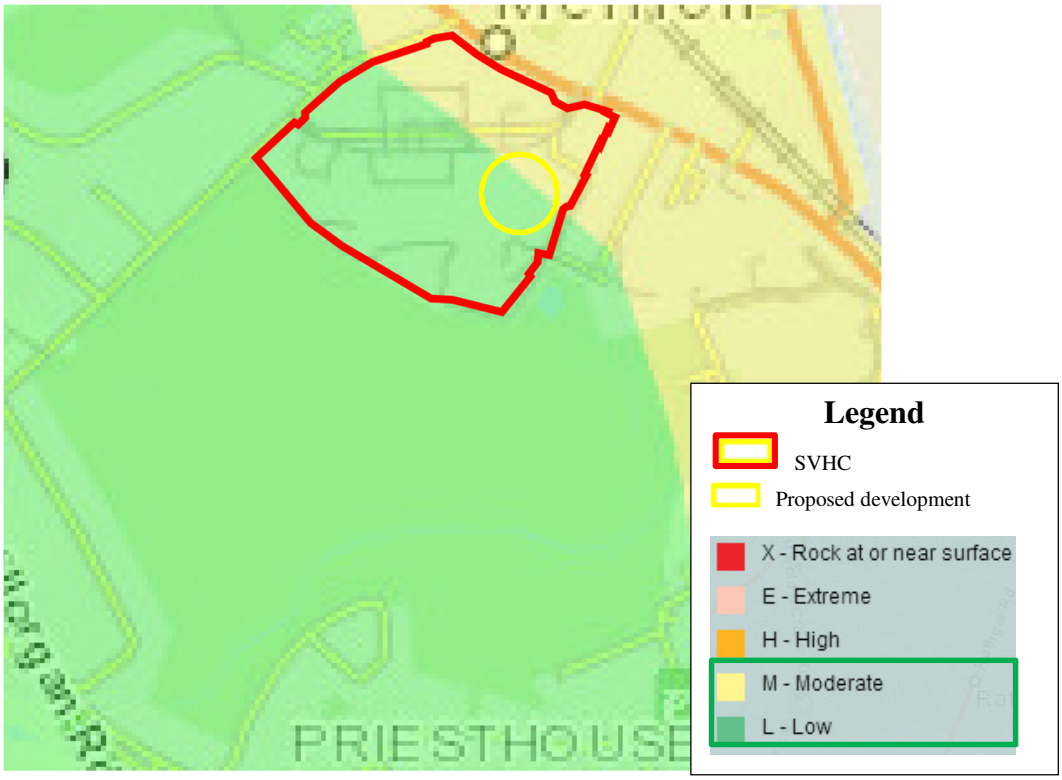

Figure 16 Groundwater vulnerability

6.2.1 Site Investigation

As part of the 2014 site investigation in the vicinity of the building footprint, four trial pits have been excavated and environmental samples have been obtained.

Results of the SI suggest groundwater is typically between 1.0m and 2.0m below ground level. Given this relatively low ground water table and the low to moderate groundwater vulnerability, the risk of groundwater flooding to the site is considered low.

7 Establishment of Suitable Finished Floor Levels

Given the very low risk of tidal flooding and fluvial flooding of the subject site, the finished floor levels of the development need to be considered in the context of the existing ground levels of the site and also of minimising the risk of pluvial flooding.

Existing ground levels in the vicinity of the site vary from circa 6.0m OD along the Northern Boundary to circa 7.95m OD along the Southern Boundary. It is proposed to set the ground floor of the building at 6.0m OD. Pedestrian access to the southern entrances of the building will be set at the higher level of 10.4m OD.

In the event of a very extreme high-intensity rainfall event, the capacity of the drainage system for the proposed development could be exceeded leading to localised surface runoff ponding on the site. This presents a risk of surface water entering the building. Measures to address this risk are presented in the following section.

8 Management of Residual Flood Risk at the Subject site

8.1 Access and Egress Routes to the Site

Given the absence of a significant risk of flooding of the site, access and egress routes is unlikely to be compromised during flood events.

8.2 Storage and Conveyance

The proposed development will have no impact on floodplain storage and conveyance as it is located outside of the 1 in 1000 year flood plain.

8.3 Site Drainage System

The redeveloped site contributing to the Dublin City Council surface water sewer on Merrion Road is 10.5 hectares. An area of approximately 1.8 hectares will be demolished for the New Maternity Hospital of which 95% is existing roof and hardstanding. Surface water peak flow rates from these existing redeveloped hardstanding areas will be dramatically reduced due to the requirement to restrict surface water outflows to the receiving surface water sewerage system.

Surface water discharges from the proposed development will be restricted in accordance with the 'Greater Dublin Regional Code of Practice for Drainage Works'. Therefore storm attenuation will be required on site. The allowable run-off rate from the site will be based on 2 litres/second/hectare in line with the Code of Practice and Dublin City Council Drainage Division's requirements. The developed site area is approximately 10.5 hectares however due to the limited extent of redevelopment within the developed site area the total allowable discharge rate agreed with Dublin City Council Drainage Division will be 6 litres/second. Based on this outflow the required storage for a 1 in 100 year storm event for the Maternity Hospital would be approximately 895m3, and 40m3 for the Multi-storey Car Park. A dual storm attenuation tank system will be incorporated into the Maternity Hospital drainage system which will see one attenuation tank located to the north of the new hospital building and existing Campus access road and the second located between the North façade of the new building and the existing Campus access road. The attenuation tank for the Multi-storey Car Park will be located under the lower ground floor slab.

Surface water run-off from the development will discharge by gravity into the new attenuation facilities on the Campus. Run-off from roofs, roads, car parks, service yards and paved areas shall drain by gravity to the attenuation facilities. Discharges from these attenuation facilities shall be by gravity and discharge at a controlled outflow rate for each attenuation tank of 2 litres/second, with a combined total discharge of 6 litres/second to the existing surface water sewer on Merrion Road.

Sedum greenroofs incorporating approximately 27 % of the Maternity Hospital roof area will be provided as part of the proposed development.

8.4 Runoff

In the event of a very extreme high-intensity rainfall event, the capacity of the drainage system for the proposed development could be exceeded leading to surface runoff collecting on the site and entering the building.

This risk will be minimised by ensuring that the ground slopes away from all the entrances to the building to a low point in the landscape which is serviced by gullies draining into the attenuation tank under the landscaping.

A sketch of this arrangement for the front entrance of the building is presented in Figure 17.

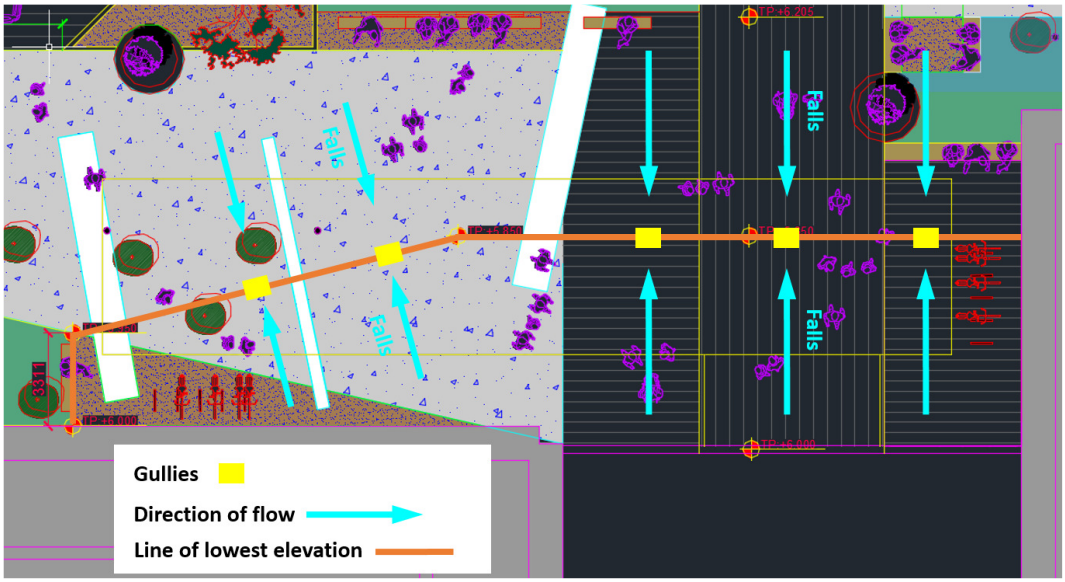

Figure 17 Indicative sketch which details the measures to address the risk of pluvial flooding at the site.

8.5 Maintenance Programme

A maintenance programme for the surface water drainage system will be development for the site. This will ensure that the risk of blockage of the drainage system through the accumulation of debris is greatly minimised.

9 Application of "Flood Risk Management Guidelines"

9.1 Vulnerability Classification

It is considered that the proposed development should be classified as a "Highly Vulnerability Development" as per the vulnerability classification in Figure 18. As indicated in Section 4 and 5 of this report, the proposed development is not indicated as being within the 1000 year fluvial or tidal floodplain. In accordance with the OPW's planning guidelines, the site lies within Flood Zone C. A justification test for the development is therefore not required.

Vulnerability class	Land uses and types of development which include*:
Highly vulnerable development (including essential infrastructure)	Garda, ambulance and fire stations and command centres required to be operational during flooding; Hospitals; Emergency access and egress points; Schools; Dwelling houses, student halls of residence and hostels; Residential institutions such as residential care homes, children's homes and social services homes; Caravans and mobile home parks; Dwelling houses designed, constructed or adapted for the elderly or, other people with impaired mobility; and Essential infrastructure, such as primary transport and utilities distribution, including electricity generating power stations and sub-stations, water and sewage treatment, and potential significant sources of pollution (SEVESO sites, IPPC sites, etc.) in the event of flooding.
Less vulnerable development	Buildings used for: retail, leisure, warehousing, commercial, industrial and non-residential institutions; Land and buildings used for holiday or short-let caravans and camping, subject to specific warning and evacuation plans; Land and buildings used for agriculture and forestry; Waste treatment (except landfill and hazardous waste); Mineral working and processing; and Local transport infrastructure.
Water-compatible development	Flood control infrastructure; Docks, marinas and wharves; Navigation facilities; Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location; Water-based recreation and tourism (excluding sleeping accommodation); Lifeguard and coastguard stations; Amenity open space, outdoor sports and recreation and essential facilities such as changing rooms; and Essential ancillary sleeping or residential accommodation for staff required by uses in this category (subject to a specific warning and evacuation plan).
*Uses not listed here should be considered on their own merits	

Figure 18 Vulnerability Classification

9.2 Sequential Approach

The figure below illustrates the sequential approach to be adopted under the 'Planning System and Flood Risk Management' guidelines.

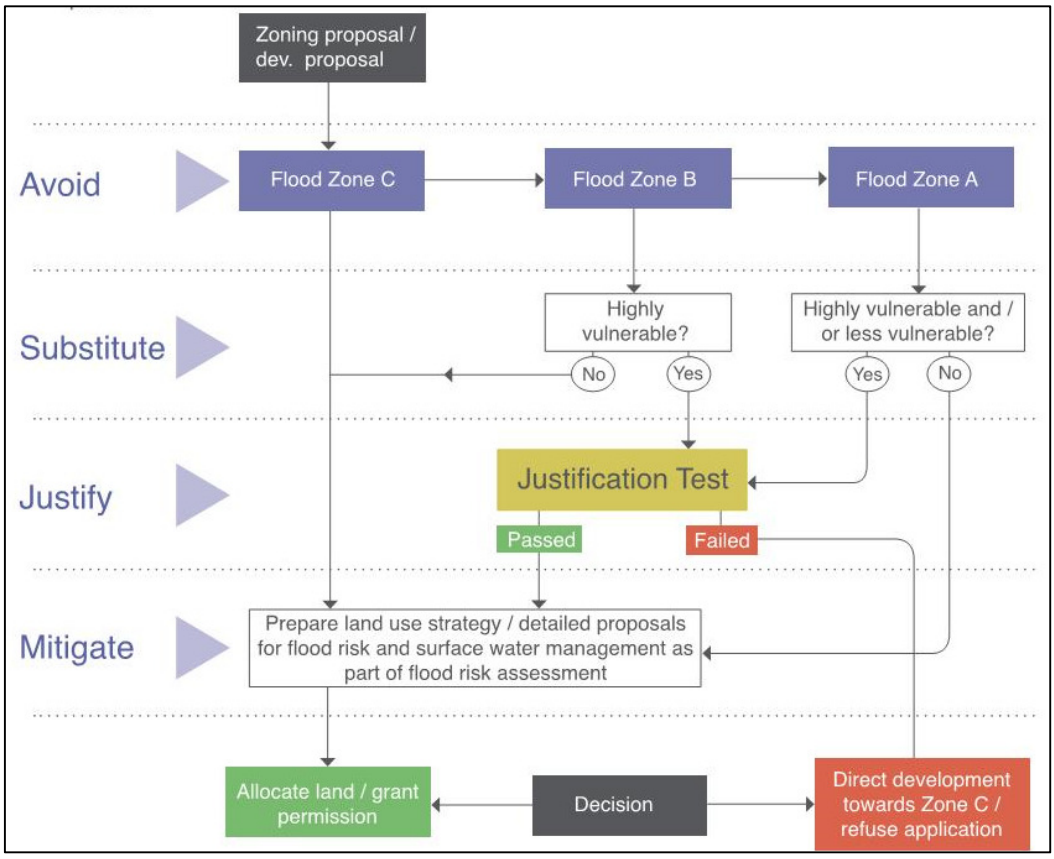

Figure 19 Sequential Approach

As the proposed development lies within Flood Zone C, a Justification Test is not required and it is necessary only to identify mitigation measures for any residual risks. This has been discussed in Section 8 of this report.

10 Conclusions

Arup was commissioned by the Health Service Executive (HSE) to undertake a Flood Risk Assessment (FRA) for inclusion as part of the planning application for a proposed National Maternity Hospital on the grounds of St. Vincent's University Hospital, Elm Park, Merrion Rd, Dublin 4.

The risk of tidal flooding and fluvial flooding of the site is very low. There is a minor risk of pluvial flooding. This risk of groundwater flooding is low.

Surface water discharges from the proposed development will be restricted in accordance with the Greater Dublin Regional Code of Practice for Drainage Works. The allowable greenfield run-off rate from the site will be based on 2 litres/second/hectare in line with the Code of Practice and Dublin City Council Drainage Division's requirements.

In the event of a very extreme high-intensity rainfall event, the capacity of the drainage system for the proposed development could be exceeded leading to surface runoff collecting on the site and entering the building.

This risk will be minimised by ensuring that the ground slopes away from all the entrances to the building to a low point in the landscape which is serviced by gullies draining into the attenuation tank under the landscaping.

It is considered that the proposed development should be classified as a "Highly Vulnerability Development" as OPW's vulnerability classification. As the proposed development lies within Flood Zone C, a Justification Test is not required and it is necessary only to identify mitigation measures for any residual risks.