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

# Engineer's Reports

Energy Statement -
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# The National Maternity Hospital
at St. Vincent's University Hospital

# Energy Statement

Health Services Executive

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

Energy Statement

235754-00

Issue 3 | 7 February 2017



Job number 235754-00

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# Contents

# 1 Introduction

The Project Brief calls for the development to achieve an environmental performance well above the minimum standards of current legislation. The development will significantly exceed the requirements of the current Part L of the Building Regulations and will achieve an A3 Building Energy Rating. These measures help ensure that the relevant energy credits required as part of obtaining a BREEAM Excellent rating are embedded in the design.

In order to satisfy the level of excellence required in low energy design the design team and Client have started from first principles and applied sustainable tenets throughout each of the design stages to develop a scheme which delivers the optimum level of energy efficiency and utility conservation.

# 2 Energy Standards and Regulations

There are a number of standards and regulations applicable to the project in relation to energy efficiency. These cover energy efficiency, energy performance in buildings and renewable energy.

The current Building Regulation for conservation of fuel and energy in non-domestic buildings is Part L 2008. Under the National Energy Efficiency Action Plan non-domestic buildings are required to achieve a 40% improvement in energy performance over the current part L. The new National Maternity Hospital will achieve this through achieving an A3 building energy rating which reflects a 50% improvement over the current Part L.

The recast Energy Performance of Buildings Directive and Energy Efficiency Directive S.I. 426 2014 set new targets for building energy performance including a move towards near zero energy buildings and requires a study of the technical, environmental and economic feasibility of installing high efficiency alternative energy systems. This study has been carried out for the National Maternity Hospital via a Low Zero Carbon Feasibility Study the results of which are summarised in this document.

Dublin City Council have targeted a further improvement of 20% on the EU policy of a 20% reduction in energy use from 1990 levels to be achieved by 2020. The proposed design will meet, and in many cases exceed, these targets and act as an exemplar project in the public sector.

BREEAM is not a statutory requirement rather a global sustainability assessment methodology which incorporates energy performance as one of its categories. A target of Excellent has been applied to this project within the Project Brief and requires a minimum standard in energy performance and awards further credits thereafter based on improved performance beyond this.

All of the above drive a low energy strategy within the design and operation of the development looking at, not just the new build elements, but the ongoing, sustainable operation of the development.

# 3 Low Energy Design Strategy

The Project Brief calls for the development to provide internal environments and engineering services installations which combine appropriately for a high quality solution using minimum energy in a cost effective and environmentally sensitive manner. The low energy aspect of the Brief is achieved through the following hierarchical sequence:

- Passive design: The use of the building's form, structure and facade to minimise energy demand.
- Active design: The use of low energy active systems to generate and distribute energy as efficiently as possible. Appropriate controls and metering will ensure that energy is used only when and where it is required and allow the facilities team to target further reductions.
- Application of appropriate low carbon energy technology.

## 3.1 Passive Design

The *passive design* stage is crucial in helping to achieve a low energy building as it looks to reduce the need for energy to be generated in the first instance. During design development, close attention has been paid to co-ordinating and integrating the design to:

- Consider orientation, form and internal layout to optimize the design considering planning / operational requirements and the site constraints.
- Provide the potential for natural ventilation and/or mixed mode ventilation solutions where practical. The opportunities to utilise natural ventilation effectively for In Patient Accommodation have been developed with the client and natural ventilation will also be maximised for non-clinical areas such as offices, meeting rooms, education spaces etc..
- Reduce direct solar gain to reduce the energy consumption for comfort cooling or air conditioning. A performance target has been set for the shading parameter of the facade system to minimise solar gain and cooling loads. This will be achieved through glazing performance (g value of 0.22 for air conditioned rooms and 0.44 for non air conditioned rooms) and/or external shading.
- Maximise the daylight in the majority of areas.

- Improve the building thermal envelope performance (reducing air permeability, U-values and g values)
- Appropriate locations for plant to minimise distribution routes and associated energy losses
- Target Building air permeability of 3.0m$^3$/hr per m$^2$ at 50Pa

## 3.2 Active Design

Following the passive design stage the design considers options to reduce energy use and to use and supply energy efficiently, e.g.:

- High efficiency LED lighting systems and appropriate artificial lighting levels.
- Lighting controls with perimeter areas switched separately from internal areas with daylight and occupancy (presence/absence) linking where appropriate.
- Strategies to improve the utilisation of plant and systems.
- Strategies to improve control and flexibility of the installations including provision of local user controls.
- Energy efficient equipment including the use of premium efficiency motors with variable frequency drives where practical (e.g. fans, pumps, lifts etc.).
- High efficiency, low emission gas fired boilers.
- Specification of high efficiency chillers.
- Zoning of equipment to allow plant to be turned off or enable out of hours setback in appropriate unoccupied spaces
- High efficiency energy recovery for ventilation systems where practical
- Provision of a Building Energy Management System (BEMS).
- Smart Metering
- Low velocity pipework / ductwork and low pressure air filters to reduce fan and pump power consumption.
- Provision of user guidance, training and support to the building occupiers to increase awareness and to ensure that systems are operated as intended.

## 3.3 Low Carbon Energy

To meet the BER and BREEAM targets, a significant contribution from Low and Zero Carbon (LZC) technologies will be required. A number of LZC technologies have been discussed within the LZC report to ascertain the preferred solution of the building level technologies as required.

The LZC report provides a formal assessment of the feasibility of each applicable *renewable energy technology*. The report examines the practicality and benefits realised from technologies such as those listed below:

- Solar Photovoltaics
- Solar Thermal
- Combined Heat & Power
- Wind Energy
- Ground Source Heat Pumps

The feasibility study has shown a combined heat and power plant to be the most appropriate technology to adapt for the development given the year round demand for heating in the generation of hot water.

| Low or Zero Carbon Technology | Capital Cost | Annual Carbon Savings ($CO_2$) | Carbon Reduction | Payback Period (Life Cycle Analysis) | Potential BREEAM Ene 04 credits |
|---|---|---|---|---|---|
| **Combined Heat & Power Unit (500kW electrical)** | €670,000 | 1,167 tonnes | 6.86% | 3 years | 1 |

**Table 1** Summary of Combined Heat and Power Payback Analysis

Simple payback suggests that a sufficiently sized CHP could payback within 5-6 years. A further study (based on developed building thermal modelling) will be undertaken during detailed design to investigate the size, capital cost and running costs for the CHP unit.

# 4 Achieving the targets

The following addresses the compliance of the critical targets.

## 4.1 Building Regulations Part L

The Simplified Building Energy Modelling (SBEM) software is used to simulate compliance with Building Regulations Part L. The following sections demonstrate compliance with a number of parameters therein.

### 4.1.1 Compliance with Carbon Emissions

The Part L *target* $CO_2$ emission rate is 125.5 kg$CO_2$/m$^2$/year

The *calculated* $CO_2$ emission rate for the proposed development is 72.9 kg$CO_2$/m$^2$/year.

The above demonstrates that the building is Part L compliant in terms of carbon emissions.

### 4.1.2 Compliance with Energy Consumption

The Part L *target* Primary Energy Consumption Rate of an equivalent development is 581.2 kWh/m$^2$/year

The *calculated* Primary Energy Consumption Rate of the proposed development is 325.1 kWh/m$^2$/year.

The above demonstrates that the building is compliant in terms of energy consumption.

#### 4.1.3 Compliance with average U values

The maximum allowable *(target)* average U value is 1.1W/m$^2$K.

The average U value of the building is *calculated* to be 0.3W/m$^2$K.

The above demonstrates compliance with overall heat loss parameters.

#### 4.1.4 Compliance with solar overheating

For naturally ventilated rooms, the room temperature should not exceed 25°C for not more than 5% of the occupancy period and should not exceed 28°C for more than 1% of the occupancy period.

Efficient glazing and sufficient window opening area which minimises the solar gain into the rooms and optimises natural ventilation have been chosen to achieve this target.

For mechanically ventilated spaces the solar gain has to be limited to 25 W/m$^2$ in the 6m perimeter zone.

The Solar Gain compliance calculations were performed using the Integrated Environmental Solutions (IES) dynamic thermal simulation with Dublin weather data.

For each ventilation strategy, rooms have been simulated to check Part L compliance.

The simulation demonstrates that all rooms are compliant with solar overheating requirements.

### 4.2 BER A3

In order to check that the BER target is achievable an iSBEM model using the approved SEAI software has been created. A simulation model generates the energy consumption profile which is compared with a notional and a reference building and a Building Energy Rating is produced for the specific building being modelled.

Technical issues arise from the quantum of rooms within the building and the ability of the prescribed software to process same. Consultation with SEAI and Dublin City Council developed a grouping strategy for the rooms which allowed the software to analyse the building.

The calculated Primary Energy Consumption Rate of the actual building is 325.1 kWh/m$^2$/year.

The calculated Primary Energy Consumption Rate for the notional building is 669.3 kWh/m$^2$/year.

The *calculated* Energy Performance Coefficient is 0.49 which confirms compliance with an A3 Building Energy Rating (BER).

The BER figures above are based on the current design and are subject to modification as the design develops but the design team and client are committed to achieving an A3 rating.

### 4.3 BREEAM 'Excellent'

The BREEAM assessment is a formal methodology which benchmarks a project design and construction using pre-defined environmental criteria including the following:

- Management
- Health
- Energy
- Transport
- Materials
- Land Use
- Ecology
- Pollution

When the design and construction assessments are complete a rating is allocated based on the number of "credits" achieved. For this project a rating of 'Excellent' has been set as a minimum criteria which requires a rating of 70%. BREEAM 'Excellent' requires a minimum of 6 credits with a maximum of 15 achievable under the Energy efficiency category.

The targeted credits under relevant categories have been agreed with the sustainability consultant and these are being monitored as we proceed through design development. Detailed calculations during detailed design will verify the credits and evidence will then be provided to the certification body BRE for a design stage submission.

## 5 Conclusion

The energy performance of the development will exceed all statutory requirements and deliver on targets set out in the Brief including Part L Compliance, a BER of A3 and BREEAM 'Excellent'.

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

# Drainage and Watermain Report

Health Services Executive

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

## Drainage and Watermain Planning Report

235754-00

Issue 3 | 16 February 2017



Job number 235754-00

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# Contents



## Appendices

# 1 Introduction

This report has been prepared to accompany drainage drawings as prepared by Arup and architectural drawings prepared by O'Connell Mahon Architects for the planning application for 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.

The redeveloped site area is 10.5 hectares. An area of approximately 1.8 hectares will be demolished for the proposed new National Maternity Hospital, of which 95% is existing roof and hardstanding. See Figure 1 below for site location.


**Figure 1** Site location (Map data © 2017 Google)

# 2 Existing Drainage Systems

The existing drainage systems on the hospital campus are mainly separate foul and surface water drains with some combined drains remaining historically. The foul drainage system discharges by gravity at 3 locations to the combined sewers on the Merrion Road and Nutley Lane. See Arup drawing C001 in Appendix A for the location of the existing drainage system and connections to the public sewers. The campus to the southwest, including Mortuary, Convent / Chapel, New Ward Block and Education & Research Centre discharges to the Nutley Lane sewer, while Carew House, to the northeast of the campus, discharges to the sewer on Merrion Road. However the majority of the St. Vincent's University Hospital campus discharges northwards and connects with the public sewer on the Merrion Road through the main drain outfall adjacent to St Rita's. There is an existing 300/375mm combined sewer along Nutley Avenue flowing into a 940 x 770mm combined sewer at the junction of Nutley Avenue and Merrion Road. There is an existing 1080 x 770mm combined sewer along Merrion Road flowing in a westerly direction towards the City. This sewer eventually discharges into the Municipal Waste Water Treatment Plant at Ringsend. The Dodder Valley Sewer also traverses the hospital grounds along the boundary with Nutley Lane to the west of the campus. The sewer is a twin piped culvert of 1350mm and 900mm diameters and is located between the hospital Multi-Storey Car Park and the boundary wall. See Appendix C for DCC Drainage Division record drawings of the sewerage systems adjacent to the site.

Surface water run-off from the hospital campus discharges by gravity to the existing 300/375mm surface water sewer on Merrion Road located at the northeast corner of the site. This surface water sewer discharges northwards before connecting into a 1200mm, south of the DART line. This surface water sewer flows in an easterly direction and parallel to the DART line, towards the Merrion Gates and outfalling into the sea at the Merrion Strand adjacent to the Elm Park Stream outfall. There is a 450mm surface water sewer on Nutley Lane discharging northwards into an 800 x 680mm surface water culvert through Merrion Village. This sewer connects into the 1200mm south of the DART line. There is a 300mm surface water sewer on Merrion Road discharging westwards into this culvert. The head of this surface water sewer is located at the junction of the Merrion Road and the vehicular entrance to the hospital campus. See Arup drawing C001 in Appendix A.

As part of Dublin City Council's Drainage Divisions "Storm Water Management Policy" 1998 - 2005, surface water run-off from the previous Phase 1 redevelopment of the hospital campus was restricted to 5 litres/second/hectare. This agreed drainage strategy was submitted for planning in 1998 and the redevelopment was completed in 2003. This drainage requirement meant that surface water run-off from any new additional roofs or paved areas in excess of the existing hardstanding areas was attenuated on site. An attenuation tank was constructed as part of the Phase 1 redevelopment and is situated under the Multi-Storey Car Park. The volume of this tank is 825m$^3$ equivalent storage for a 1 in 100 year event. Surface water discharges from St. Vincent's Private Hospital, completed in 2010, are also restricted to 7 litres/second with storm attenuation provided in 2 separate tanks of 490m$^3$, equivalent storage for a 1 in 100 year event. Refer Arup drawing C006 in Appendix A for surface water attenuation catchment areas. At present 47% of the Hospital Campus is subject to flow restriction with storm attenuation facilities.

# 3 Proposed Drainage

Drainage from the proposed New Maternity Hospital development will be drained by a completely separate system, with separate foul and surface water drains connecting to the proposed outfall manholes located on the Campus. Existing outfalls to the sewerage systems will be utilised with separate outfalls to both the foul and surface water sewerage systems on the Merrion Road. Any existing combined drains on the designated site will be separated.

Due to the footprint of the proposed new Maternity Hospital Building, existing foul and surface water drains traversing the site will require to be diverted by gravity around the new development to the east and west of the new building to maintain the integrity of the hospital drainage system and continuity of supply to the existing hospital facilities. See Arup drawing C002, C003 in Appendix A.

Surface water discharges from the proposed development will be restricted in line with DCC Drainage Divisions requirements. Surface water discharges from the site will be restricted to 2 litres/second/hectare with flows in excess of the allowable discharge rate being retained on site in underground attenuation tanks for storms up to and including the 1 in 100 year event.

The proposed drainage strategy was agreed at a meeting with Mr. Gerry Doherty, DCC Drainage Division, on 7 December 2015. A copy of the minutes are included in Appendix E of this report.

The drainage systems shall be designed in accordance with Part H of the Building Regulations, BS EN 752 Drain and Sewer Systems outside Buildings, the Greater Dublin Regional Code of Practice for Drainage Works and the Greater Dublin Strategic Drainage Study (GDSDS) and to the requirements of Dublin City Council Drainage Division and Irish Water.

## 3.1 Proposed Foul Drainage

Foul drainage from the proposed National Maternity Hospital shall be drained by a separate system to that of the surface water drainage system. Foul drainage from the proposed development shall drain by gravity and discharge to the existing 225mm drainage system on the campus before discharge to the 1080 x 770mm combined sewer on the Merrion Road. See Arup drawing C002 and C003 in Appendix A for the drainage layout and location of connections. Basement drainage from the proposed National Maternity Hospital, including toilets and plant rooms, will be pumped up to the external foul gravity system on the campus before discharge by gravity to the public sewerage system. See Arup drawing C005 in Appendix A.

The foul drainage system will be designed to take discharges from toilet blocks. Waste drainage from laboratories will discharge into a separate waste system. Current best practice will be used to deal with all effluent waste from laboratories at source. All discharges will comply with the hospital's Trade Effluent Discharge Licence requirements. Drainage from kitchen / canteen facilities will discharge through a grease separator designed in accordance with BS EN 1825 Part 1 and Part 2 and / or to Irish Water/ Dublin City Council's Drainage Division's requirements.

The removal and separation of historical surface water run-off from the existing hospital campus foul drainage system will release capacity in the receiving sewerage system to deal with increased foul discharges.

An estimated total hydraulic loading of 122$m^3$ per day of foul effluent will be generated on completion of the National Maternity Hospital. This is based on 232 new beds at 350 litres/bed/day (EPA Guidelines) and estimated 907 new staff at 45 litres/head/day. This equates to an average flow of 1.41 litres/second (over a 24 hour period) and a peak flow of 8.5 litres/second based on 6 x Dry Weather Flow (DWF).

The final average daily BOD5 loading would be 36 kg/day based on 20 grams of BOD5/head/day for office/administration staff and 75 grams of BOD5/bed/day.

The foul loading figures represent the maximum possible occupancy levels of the new hospital development and in reality may be lower.

Foul discharges from the new basement areas will drain by gravity through a below ground drainage system to a foul pumping chamber and be pumped out via a rising main to the external foul gravity drainage system. See Arup drawing C005 in Appendix A.

## 3.2 Proposed Surface Water Drainage

Surface water run-off from the proposed development shall drain by gravity and discharge to the existing 300/375mm surface water sewer on Merrion Road at the northeast corner of the Hospital Campus. Surface water discharges from the proposed National Maternity Hospital and extension to the Multi-Storey Car Park sites will be restricted in line with Dublin City Council's Code of Practice with storm attenuation provided in separate underground storage tanks.

SuDS measures will be incorporated into the development to reduce the quantity and improve the quality of water discharging into the receiving surface water sewerage systems, see Section 3.2.2 below.

Peak discharges from the sites (particularly during storm events) will be substantially reduced (by up to 95% for the Maternity site) due to the restricted outflow from the development and the SuDS features proposed thereby reducing the impact on the receiving sewerage infrastructure.

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 is 6 litres/second.

As discussed in Section 2, approximately 40% of the existing hospital campus site area is subject to surface water flow restriction and storm attenuation in line with Dublin City Council Drainage Divisions requirements. The new development will increase the site area, subject to flow restriction and attenuation, to 60% of the hospital campus.

### 3.2.1 Storm Attenuation and Off-Line Control

The proposed storm attenuation tanks for the proposed National Maternity Hospital development are located in the new service yard to the east of the Maternity Hospital and between the new hospital building and existing campus access road to the north. See Arup drawing C002 and C003 in Appendix A. The dual attenuation tank system is designed to store a volume with equivalent storage for a 1 in 100 year storm event. See Appendix B for Micro-drainage source control attenuation tank calculations. The outflow from the tanks will be gravitational and at a controlled rate of 2 litres/second. The tank in the service yard which has a volume of 575m$^3$ while the tank to the front of the new building which has a volume of 340m$^3$. This provides a total volume of 915m$^3$ equivalent storage for a 1 in 100 year event plus 10% for climate change based on restricted outflows of 2 litres/second per outfall, total restricted outflow 4 litres/second. The outfall manholes S9 and S26 will be installed with hydro-brakes or similar approved flow control devices to limit discharge as above to the existing surface water sewerage system on Merrion Road.

The storm attenuation tank at the Multi-Storey Car Park Extension is 60m$^3$, equivalent storage for a 1 in 100 year event with a restricted outflow of 2 litres/second. The outfall manhole S43 will be fitted with a hydrobrake or similar approved flow control device. See Arup Drawing C002 and C004 in Appendix A.

### 3.2.2 SuDS

SuDS features incorporated into the development include increased soft landscaping with landscaped courtyards, roof terrace gardens and extensive greenroofs. The existing car park between the new Hospital and St Rita's will be removed and replaced with a landscaped area as part of a new pedestrianised plaza to the front of the new Hospital. The greenroofs will be the sedum and is approximately 27% of the roof area. See O'Connell Mahon drawing in Appendix D. Greenroofs will intercept and absorb the first 5-10mm of rainfall thereby reducing the volume of run-off into the receiving systems. Greenroofs are effective in providing attenuation by absorbing rainfall within the substrate and plant layers and releasing it back into the atmosphere by transpiration and evaporation thereby reducing the annual percentage run-off by up to 40%. Greenroofs also filter water as it passes through the layers thereby reducing pollutants and improving the quality of water discharging. They also provide a time delay between when the rainfall event occurs and when the reduced amount of run-off flows into the systems thereby reducing peak discharge rates.

Proprietary surface water treatment systems like "Downstream Defenders" or "UpFlow Filters" including Class I petrol interceptors will be incorporated into the drainage design to intercept run-off and improve the quality of surface water discharging into the receiving systems in compliance with best drainage practice and SuDS requirements. These systems will provide interception of run-off and deliver removal efficiency rates of up to 80% for oil and total suspended solids.

### 3.2.3 Flood Risk Assessment

A separate Flood Risk Assessment Report has been provided by Arup for the proposed development. This is submitted with the planning application documentation.

# 4 Watermains

There are DCC / Irish Water watermains in the vicinity of the development and include, a 150mm on Nutley Avenue and a 225mm and 100mm on the Merrion Road. The main water supply connection to the existing hospital campus is from a valved connection from the 150mm on Nutley Avenue, see attached DCC Watermain Record Drawing. There is a valved back supply connection (which is blanked off) from the 225mm main on the Merrion Road.

The existing campus is currently served by a 150mm ring main with sluice valves strategically located to isolate sections of main if required. There are fire hydrants located on the campus adjacent to the proposed National Maternity Hospital and include two hydrants in the north, one to the west, two in the east and two in the south. There are hydrants adjacent to the extension to the Multi-Storey Car Park one to the west, one to the south and one to the east

Pressure and flow tests have been carried out, by Larsen Water Management in November 2014, to hydrants north and south of the proposed National Maternity Hospital. Static network pressure was recorded over a period of 6 days prior to flow testing by fitting pressure loggers to the hydrants. The results confirmed that the maximum pressure recorded was 5.8 bar a minimum pressure of 2.1 bar and an average pressure of 3 bar. Flow tests from the hydrants to the north of the hospital indicated 910 litres/minute while to the south of the hospital 760 litres/minute.

Static water storage are available on the hospital site campus in the form of underground pre-cast concrete tanks provided to supplement fire-fighting requirements. These tanks were installed as part of the Phase 1 redevelopment of the hospital campus back in 2003, as a requirement of the Local Fire Officer. The tanks have a total on site storage capacity of 465,000 litres (465m$^3$) and are located at three separate locations, one west of the A&E Department (240m$^3$), the second south of the Psychiatry Building (90m$^3$) and the third north of the Outpatients Building (135m$^3$) under the existing access road which will be adjacent to the proposed National Maternity Hospital.

As part of the proposed development, sections of the existing watermain will require to be diverted around the new building footprints with links back into the existing ring main system north and south of the proposed National Maternity Hospital and west of the MSCP extension to maintain the integrity of the existing hospital supply and ring-main system. The new systems will be constructed in compliance with Part B of the Building Regulations and the Local Fire Officer's requirements.

Recorded water meter readings on the bulk meter into the hospital campus off Nutley Lane confirm an average water demand/usage of 465m$^3$/day.

We expect the peak flow demand for the proposed development to be in the region of 125litres / second. This is approximately a 25% increase in the existing daily consumption at the hospital. The expected peak flow demand for the proposed development is estimated to be 6.9 litres/second.

To address water conservation issues for the development dual flush toilets will be installed with low flow rate fittings with basin taps separated by water saving self-closing timed flow fittings or infra-red detection. Passive Infra-Red (PIR) control valves will be installed on urinals to regulate flushing. The installation of low flow fittings will reduce the demand on the existing water supply network

New connections will be required to the existing campus mains however no new connections to the public mains network is required.

Discussions with Dublin City Council Water Division and Irish Water has confirmed that there are no known constraints on the watermains network that would suggest a difficulty in providing a connection to the development. However, a more detailed analysis will be required to establish the specific effects of the development on the network to ensure the additional water demand can be supplied.

# Appendix A

Arup Drainage Drawings


| Issue | Date | By | Chkd | Appd |
|---|---|---|---|---|
| PL1 | 10/02/17 | SB | KD | KD |
| Planning Issue | | | | |

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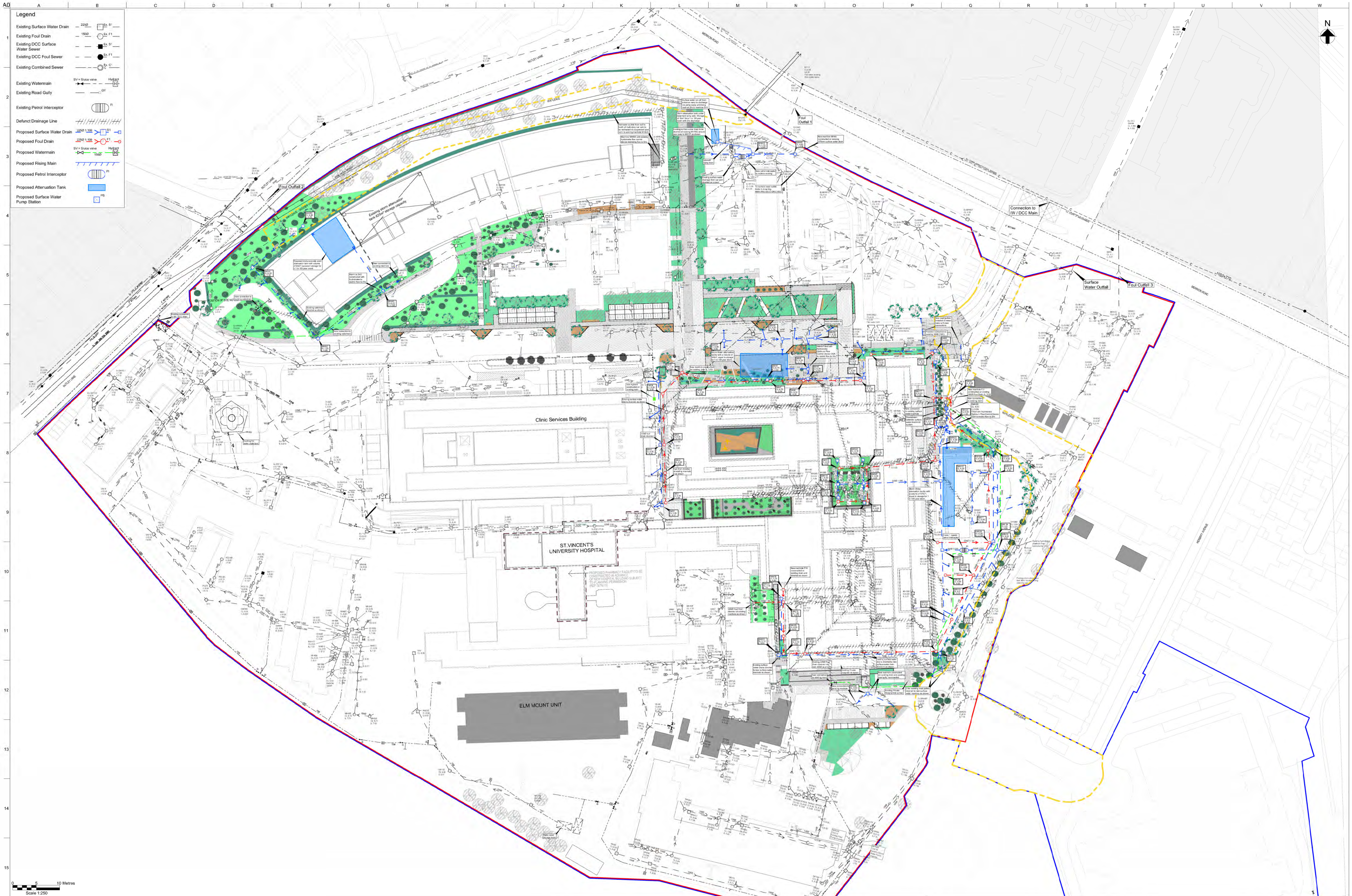
HSE

Job Title
New Maternity Hospital at SVUH

Existing Drainage & Watermain Layout

Scale at A0: 1:500
Discipline: Civil
Job No: 235754
Drawing Status: Planning
Drawing No: NMH-ARU-00-00-DR-C-0001
Issue: PL1

Do not scale




| Issue | Date | By | Chkd | Appd |
|---|---|---|---|---|
| PL3 | 08/03/17 | SB | KD | KD |
| | Wayleave Added | | | |
| PL2 | 07/03/17 | SB | KD | KD |
| | Red / Blue Boundary Line Revised | | | |
| PL1 | 16/02/17 | SB | KD | KD |
| | Planning Issue | | | |

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

New Maternity Hospital & Multi-story Carpark Extension Propsed Drainage & Watermain Site Plan Layout

Scale at A0: 1:500
Discipline: Civil
Job No: 235754
Drawing Status: Planning
Drawing No: NMH-ARU-00-00-DR-C-0002
Issue: PL3

Do not scale


| Issue | Date | By | Chkc | Appd |
|---|---|---|---|---|
| PL3 | 08/03/17 | SB | KD | KD |
| | Wayleave Added | | | |
| PL2 | 07/03/17 | SB | KD | KD |
| | Red / Blue Boundary Line Revised | | | |
| PL1 | 16/02/17 | SB | KD | KD |
| | Planning Issue | | | |

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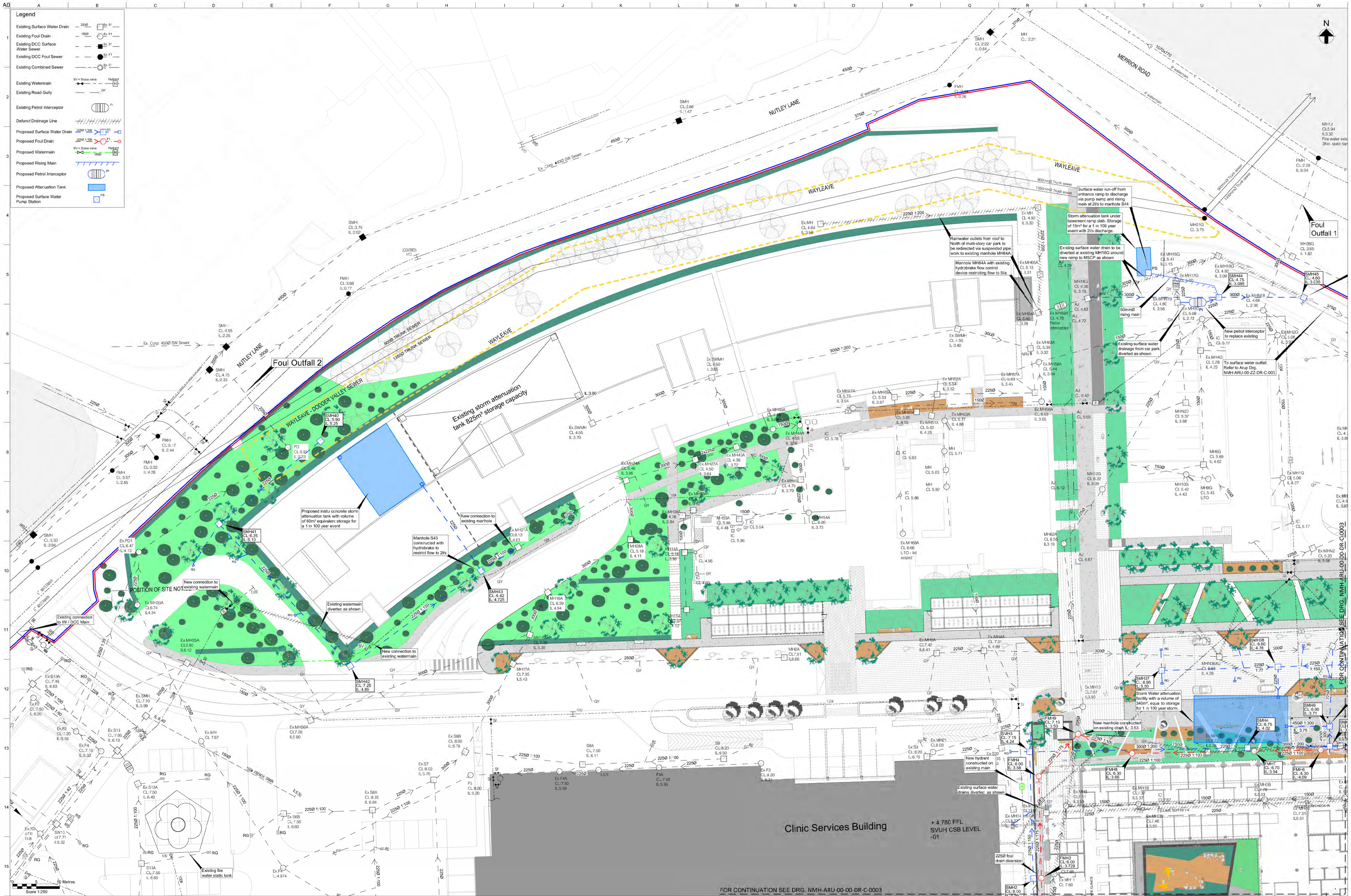
Client: HSE

Job Title: The National Maternity Hospital at St. Vincent's University Hospital

New Maternity Hospital
Proposed Drainage & Watermain Layout

Scale at A0: 1:250
Discipline: Civil
Job No: 235754
Drawing Status: Planning
Drawing No: NMH-ARU-00-00-DR-C-0003
Issue: PL3




| Issue | Date | By | Chkd | Appd |
|---|---|---|---|---|
| PL2 | 08/03/17 | SB | KD | KD |
| | Wayleave Revised | | | |
| PL1 | 16/02/17 | SB | KD | KD |
| | Planning Issue | | | |

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

New Maternity Hospital & Multi-story Carpark Extension Proposed Drainage & Watermain Layout

Scale at A0: 1:250
Discipline: Civil
Job No: 235754
Drawing Status: Planning
Drawing No: NMH-ARU-00-00-DR-C-0004
Issue: PL2


N

0 5 10 Metres
Scale 1:250

## Legend

| | |
|---|---|
| Proposed Foul Drain | 150Ø 1:60 F1 |
| Proposed Foul Rising Main | |
| Proposed Foul Pump Chamber | |

| Issue | Date | By | Chkd | Appd |
|---|---|---|---|---|
| PL1 | 10/02/17 | SB | KD | KD |
| Planning Issue | | | | |

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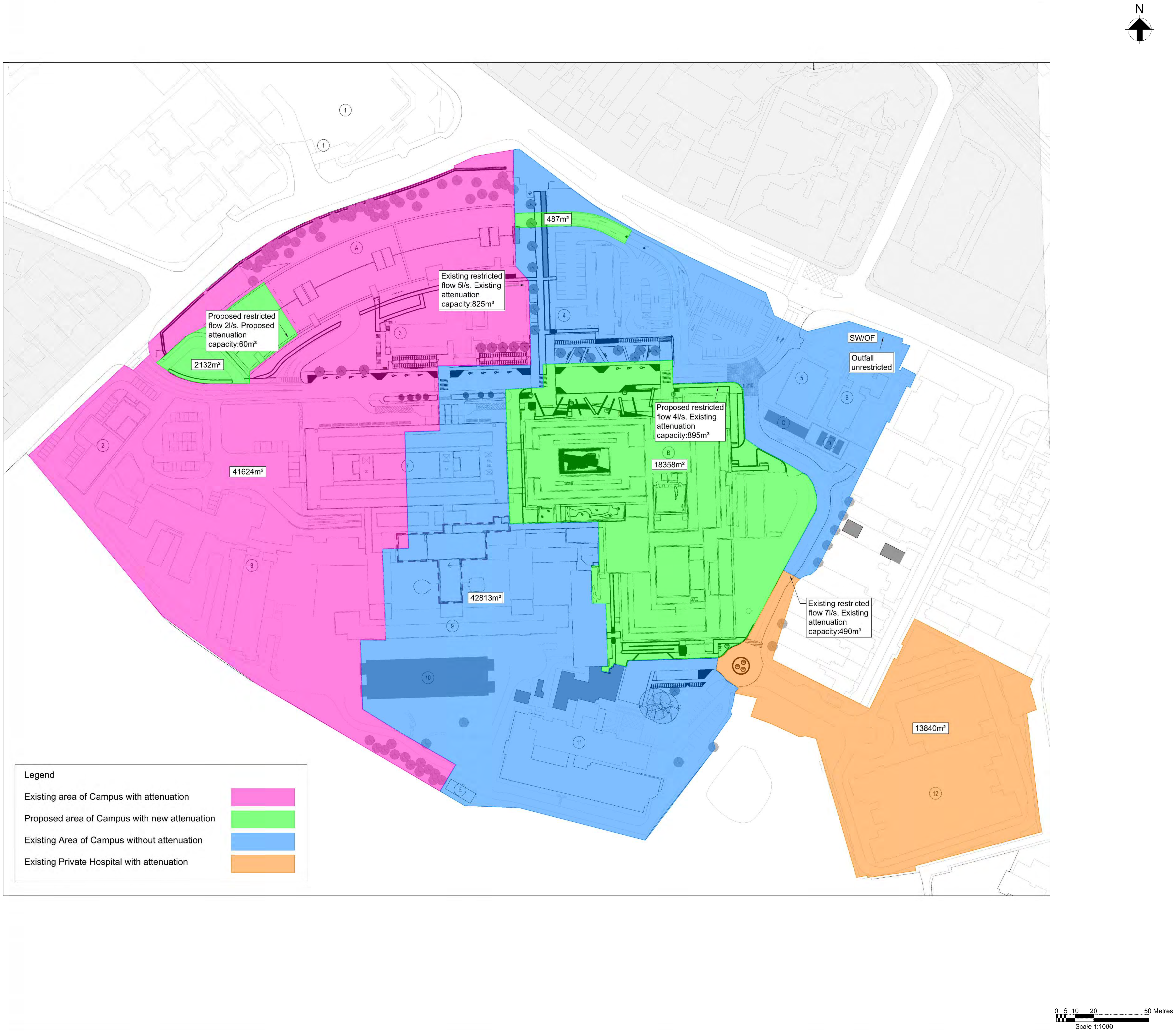
Client
HSE

Job Title
New Maternity Hospital at SVUH

Proposed Basement Drainage Layout

Scale at A0 1:250
Discipline Civil
Job No 235754
Drawing Status Planning
Drawing No NMH-ARU-00-B1-DR-C-0005
Issue PL1

Do not scale




| Issue | Date | By | Chkd | Appd |
|---|---|---|---|---|
| PL1 | 10/02/17 | SB | KD | KD |
| | Planning Issue | | | |

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Client
HSE

Job Title
New Maternity Hospital at SVUH

## Surface Water Attenuation Catchment Areas

Scale at A1: 1:1000

Discipline: Civil

Job No: 235754

Drawing Status: Planning

Drawing No: NMH-ARU-00-00-DR-C-0006

Issue: PL1

Do not scale

# Appendix B

Storm Water Attenuation
Calculations

# Technical Note

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| | | | |
|---|---|---|---|
| Project title | New Maternity Hospital at St Vincents University Hospital | Job number | 235754-00 |
| cc | | File reference | |
| Prepared by | Alex Nutley | Date | 08 December 2015 |
| Subject | Proposed Surface Water Drainage Design | | |

## 1 Microdrainage Simulation Summary

The proposed surface water drainage system is designed for a 2 year storm return period. The system is simulated and indicates no surface flooding at any part of the site for storms up to and including the 1:100 year return period plus 10% for climate change. Refer to Arup drawing C002, C003 and C004 for the proposed surface water drainage layouts.

## 2 Introduction

Microdrainage design software is based on the Wallingford procedure. It has the ability to model and analysed fully integrated drainage systems. The rainfall and runoff variables required are explained under the following headings.

## 3 Design Criteria and Loading

The proposed surface water drainage system is designed in accordance with Part H of the Building Regulations, BS EN 752 Drain and Sewer System, the Greater Dublin Regional Code of Practice for Drainage Works.

The Flood Studies Report (FSR) rainfall methodology is used in the programme. Rainfall is calculated using Region, Return Period, M5-60, and Ratio R as explained further below.





The programme uses the M5-60 (60 minutes storm duration of 5 year return period) and ratio R (M5-60/M5-2 day) to calculate the intensity/duration/ frequency characteristics for any location in Ireland.

A rainfall depth of 17.0mm on 60 minutes storm duration of 5 year return period and a ratio of 0.280 was applied as design criteria on Windes Microdrainage 2015.1. Refer to Appendix B for a copy of the Met Office Rainfall Statistics for the location.

Based on the Wallingford Procedure and depending on the site slope, a recommended value of 4 minutes global time of entry (Te) was applied.

A total of approximately 1.836 ha of impermeable area has been added to the drainage network for design and simulation.

## 4 Storm Network Details

The storm network is designed on Microdrainage 2014.1.1 using a 2 year return period. The pipe network and gradient are assigned using the Modified Rational Method where:

Q (l/s) = Cv*Cr*(2.78*I (mm/hr)*A (ha))

Cv= 0.75 and Cr= 1.3 (as recommended by the Wallingford Procedure)

The programme uses the M5-60 (17.0mm) and ratio 0.280 to calculate the intensity/duration/ frequency characteristics for any location in Ireland.

The storm network has three online flow control devices which are hydrobrake flow restriction devices. Each of these will have a design flow discharge of 2 l/s. This is in line with extract from Table 6.3 of the Greater Dublin Regional Code of Practice for Drainage Works and Dublin City Council (DCC). The proposed redevelopment site area is 10.5 ha.

| | | | |
|---|---|---|---|
| | 4.3 | 100 | Maximum discharge rate of QBAR or 2 l/s/ha, whichever is the greater, for all attenuation storage where separate "long term" storage cannot be provided. |

*Table 6.3 Criteria for New Development Drainage*

The network has three offline storm attenuation tanks, one for use at the multi-storey car park extension and two for use at the new Maternity Hospital. This dual tank arrangement splits the proposed surface water network for the New Maternity Hospital into two proposed networks and utilises two connections to the existing surface water network onsite. One tank will be located near the main entrance to the Maternity Hospital to the North, and a second tank located alongside the waste and service yard area to the East. Further details of the locations can be seen on the relevant Arup drainage layout drawings.

The dual tank system has one tank ( Tank A) of 200m2 with a 1.6m depth to give a volume of 340m3, and a second tank (Tank B) of 230m2 and 2.5m depth to give a volume of 575m3. The network has been simulated to attenuate storms up to and including a 1 in 100 year storm event + 10% for climate change. The outfall manhole downstream of these tanks would each be fitted with a hydrobrake which limits discharge to a maximum of 2 litres per second. Please refer to attached copy of storm attenuation simulation on Source Control/Simulation for further details.

A single tank system has been selected for use at the multi-storey car park extension. This will utilise a single connection to the existing system. This will be located within the carpark extension at lower ground level.

The tank for the car park extension will be 60m2 with a 1.0m depth to give a volume of 60m3. The network has been simulated to attenuate storms up to and including a 1 in 100 year storm event + 10% for climate change. The outfall manhole downstream of this tank would be fitted with a hydrobrake which limits discharge to a maximum of 2 litres per second. Please refer to attached copy of storm attenuation simulation on Source Control/Simulation for further details.

## 5 Network Simulation

The level of service includes no surface flooding for return periods up to 1:100 year plus 10% for climate change. Detailed summary of critical results of the 1 year+10%, 30 year+10% and 100 year + 10% is included in this report in Appendix B, Microdrainage Simulation.

**DOCUMENT CHECKING (not mandatory for File Note)**

| | Prepared by | Checked by | Approved by |
|---|---|---|---|
| Name | Alex Nutley | Kieran Dowdall | Kieran Dowdall |
| Signature | | | |



| Ove Arup & Partners International Ltd | | Page 1 |
|---|---|---|
| The Arup Campus<br>Blyth Gate<br>Solihull B90 8AE | Prelim Design- Offline Tank<br>235754-10<br>St. Vincents NMH | Micro Drainage |
| Date 12/05/16<br>File DUAL TANK A 340.MDX | Designed by AN<br>Checked by KD | |
| XP Solutions | Network 2015.1 | |

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

| | | | |
|---|---|---|---|
| Return Period (years) | 2 | Add Flow / Climate Change (%) | 10 |
| M5-60 (mm) | 17.000 | Minimum Backdrop Height (m) | 0.200 |
| Ratio R | 0.280 | Maximum Backdrop Height (m) | 1.500 |
| Maximum Rainfall (mm/hr) | 150 | Min Design Depth for Optimisation (m) | 1.200 |
| Maximum Time of Concentration (mins) | 30 | Min Vel for Auto Design only (m/s) | 1.00 |
| Foul Sewage (l/s/ha) | 0.000 | Min Slope for Optimisation (1:X) | 500 |
| Volumetric Runoff Coeff. | 0.750 | | |

Designed with Level Soffits

Time Area Diagram for Storm

| Time (mins) | Area (ha) | Time (mins) | Area (ha) |
|---|---|---|---|
| 0-4 | 0.462 | 4-8 | 0.166 |

Total Area Contributing (ha) = 0.628

Total Pipe Volume (m³) = 17.121

Network Design Table for Storm

| PN | Length (m) | Fall (m) | Slope (1:X) | I.Area (ha) | T.E. (mins) | Base Flow (l/s) | k (mm) | HYD SECT | DIA (mm) | Auto Design |
|---|---|---|---|---|---|---|---|---|---|---|
| S1.000 | 25.640 | 0.171 | 150.0 | 0.151 | 4.00 | 0.0 | 0.600 | o | 225 | |
| S1.001 | 27.034 | 0.180 | 150.0 | 0.042 | 0.00 | 0.0 | 0.600 | o | 225 | |
| S1.002 | 46.149 | 0.224 | 205.6 | 0.073 | 0.00 | 0.0 | 0.600 | o | 300 | |
| S1.003 | 17.439 | 0.125 | 139.5 | 0.216 | 0.00 | 0.0 | 0.600 | o | 300 | |
| S2.000 | 30.501 | 0.203 | 150.0 | 0.013 | 4.00 | 0.0 | 0.600 | o | 225 | |
| S2.001 | 10.644 | 0.071 | 150.0 | 0.072 | 0.00 | 0.0 | 0.600 | o | 225 | |

Network Results Table

| PN | Rain (mm/hr) | T.C. (mins) | US/IL (m) | Σ I.Area (ha) | Σ Base Flow (l/s) | Foul (l/s) | Add Flow (l/s) | Vel (m/s) | Cap (l/s) | Flow (l/s) |
|---|---|---|---|---|---|---|---|---|---|---|
| S1.000 | 54.01 | 4.40 | 4.594 | 0.151 | 0.0 | 0.0 | 2.2 | 1.07 | 42.4 | 24.3 |
| S1.001 | 52.27 | 4.82 | 4.423 | 0.193 | 0.0 | 0.0 | 2.7 | 1.07 | 42.4 | 30.1 |
| S1.002 | 49.66 | 5.53 | 4.168 | 0.266 | 0.0 | 0.0 | 3.6 | 1.09 | 77.2 | 39.4 |
| S1.003 | 48.91 | 5.75 | 3.943 | 0.482 | 0.0 | 0.0 | 6.4 | 1.33 | 94.0 | 70.2 |
| S2.000 | 53.68 | 4.48 | 4.430 | 0.013 | 0.0 | 0.0 | 0.2 | 1.07 | 42.4 | 2.1 |
| S2.001 | 52.99 | 4.64 | 4.227 | 0.085 | 0.0 | 0.0 | 1.2 | 1.07 | 42.4 | 13.4 |

## Network Design Table for Storm

| PN | Length (m) | Fall (m) | Slope (1:X) | I.Area (ha) | T.E. (mins) | Base Flow (l/s) | k (mm) | HYD SECT | DIA (mm) | Auto Design |
|---|---|---|---|---|---|---|---|---|---|---|
| S2.002 | 23.762 | 0.132 | 180.0 | 0.061 | 0.00 | 0.0 | 0.600 | o | 300 | |
| S1.004 | 4.263 | 0.015 | 289.2 | 0.000 | 0.00 | 0.0 | 0.600 | o | 450 | |
| S3.000 | 24.807 | 0.322 | 77.0 | 0.000 | 4.00 | 0.0 | 0.600 | o | 225 | |
| S4.000 | 13.975 | 0.093 | 150.3 | 0.000 | 4.00 | 0.0 | 0.600 | o | 225 | |
| S3.001 | 12.823 | 0.085 | 150.0 | 0.000 | 0.00 | 0.0 | 0.600 | o | 225 | |
| S3.002 | 8.800 | 0.039 | 225.6 | 0.000 | 0.00 | 0.0 | 0.600 | o | 450 | |
| S1.005 | 19.408 | 0.131 | 148.3 | 0.000 | 0.00 | 0.0 | 0.600 | o | 450 | |

## Network Results Table

| PN | Rain (mm/hr) | T.C. (mins) | US/IL (m) | Σ I.Area (ha) | Σ Base Flow (l/s) | Foul (l/s) | Add Flow (l/s) | Vel (m/s) | Cap (l/s) | Flow (l/s) |
|---|---|---|---|---|---|---|---|---|---|---|
| S2.002 | 51.65 | 4.98 | 4.081 | 0.146 | 0.0 | 0.0 | 2.0 | 1.17 | 82.6 | 22.5 |
| S1.004 | 48.71 | 5.81 | 3.744 | 0.628 | 0.0 | 0.0 | 8.3 | 1.19 | 189.3 | 91.1 |
| S3.000 | 54.54 | 4.28 | 5.500 | 0.000 | 0.0 | 0.0 | 0.0 | 1.49 | 59.3 | 0.0 |
| S4.000 | 54.80 | 4.22 | 4.875 | 0.000 | 0.0 | 0.0 | 0.0 | 1.06 | 42.3 | 0.0 |
| S3.001 | 53.68 | 4.48 | 4.782 | 0.000 | 0.0 | 0.0 | 0.0 | 1.07 | 42.4 | 0.0 |
| S3.002 | 53.23 | 4.59 | 3.750 | 0.000 | 0.0 | 0.0 | 0.0 | 1.35 | 214.6 | 0.0 |
| S1.005 | 48.08 | 6.00 | 3.711 | 0.628 | 0.0 | 0.0 | 8.3 | 1.67 | 265.2 | 91.1 |





## Area Summary for Storm

| Pipe Number | PIMP Type | PIMP Name | PIMP (%) | Gross Area (ha) | Imp. Area (ha) | Pipe Total (ha) |
|---|---|---|---|---|---|---|
| 1.000 | - | - | 100 | 0.151 | 0.151 | 0.151 |
| 1.001 | - | - | 100 | 0.042 | 0.042 | 0.042 |
| 1.002 | - | - | 100 | 0.073 | 0.073 | 0.073 |
| 1.003 | - | - | 100 | 0.216 | 0.216 | 0.216 |
| 2.000 | - | - | 100 | 0.013 | 0.013 | 0.013 |
| 2.001 | - | - | 100 | 0.072 | 0.072 | 0.072 |
| 2.002 | - | - | 100 | 0.061 | 0.061 | 0.061 |
| 1.004 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 3.000 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 4.000 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 3.001 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 3.002 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 1.005 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| | | | | Total 0.628 | Total 0.628 | Total 0.628 |

## Free Flowing Outfall Details for Storm

| Outfall Pipe Number | Outfall Name | C. Level (m) | I. Level (m) | Min I. Level (m) | D,L (mm) | W (mm) |
|---|---|---|---|---|---|---|
| S1.005 | S | 6.000 | 3.580 | 3.630 | 0 | 0 |

## Simulation Criteria for Storm

| | | | |
|---|---|---|---|
| Volumetric Runoff Coeff | 0.750 | Additional Flow - % of Total Flow | 10.000 |
| Areal Reduction Factor | 1.000 | MADD Factor * 10m³/ha Storage | 2.000 |
| Hot Start (mins) | 0 | Inlet Coeffiecient | 0.800 |
| Hot Start Level (mm) | 0 | Flow per Person per Day (l/per/day) | 0.000 |
| Manhole Headloss Coeff (Global) | 0.500 | Run Time (mins) | 60 |
| Foul Sewage per hectare (l/s) | 0.000 | Output Interval (mins) | 1 |

| | | | |
|---|---|---|---|
| Number of Input Hydrographs | 0 | Number of Storage Structures | 1 |
| Number of Online Controls | 1 | Number of Time/Area Diagrams | 0 |
| Number of Offline Controls | 0 | Number of Real Time Controls | 0 |

## Synthetic Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FSR | Profile Type | Summer |
| Return Period (years) | 2 | Cv (Summer) | 0.750 |
| Region | Scotland and Ireland | Cv (Winter) | 0.840 |
| M5-60 (mm) | 17.000 | Storm Duration (mins) | 30 |
| Ratio R | 0.280 | | |

## Online Controls for Storm

### Hydro-Brake Optimum® Manhole: S16, DS/PN: S1.005, Volume (m³): 5.4

| | |
|---|---|
| Unit Reference | MD-SHE-0061-2000-1500-2000 |
| Design Head (m) | 1.500 |
| Design Flow (l/s) | 2.0 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Diameter (mm) | 61 |
| Invert Level (m) | 3.711 |
| Minimum Outlet Pipe Diameter (mm) | 75 |
| Suggested Manhole Diameter (mm) | 1200 |

| Control Points | Head (m) | Flow (l/s) |
|---|---|---|
| Design Point (Calculated) | 1.500 | 2.0 |
| Flush-Flo™ | 0.269 | 1.6 |
| Kick-Flo® | 0.545 | 1.3 |
| Mean Flow over Head Range | - | 1.5 |

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

| Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) |
|---|---|---|---|---|---|---|---|
| 0.100 | 1.3 | 1.200 | 1.8 | 3.000 | 2.7 | 7.000 | 4.1 |
| 0.200 | 1.5 | 1.400 | 1.9 | 3.500 | 3.0 | 7.500 | 4.2 |
| 0.300 | 1.6 | 1.600 | 2.1 | 4.000 | 3.1 | 8.000 | 4.3 |
| 0.400 | 1.5 | 1.800 | 2.2 | 4.500 | 3.3 | 8.500 | 4.5 |
| 0.500 | 1.4 | 2.000 | 2.3 | 5.000 | 3.5 | 9.000 | 4.6 |
| 0.600 | 1.3 | 2.200 | 2.4 | 5.500 | 3.6 | 9.500 | 4.7 |
| 0.800 | 1.5 | 2.400 | 2.5 | 6.000 | 3.8 | | |
| 1.000 | 1.7 | 2.600 | 2.6 | 6.500 | 3.9 | | |





## Storage Structures for Storm

### Tank or Pond Manhole: STANK A, DS/PN: S3.002

Invert Level (m) 3.750

| Depth (m) | Area (m²) | Depth (m) | Area (m²) | Depth (m) | Area (m²) | Depth (m) | Area (m²) |
|---|---|---|---|---|---|---|---|
| 0.000 | 212.5 | 0.500 | 212.5 | 1.000 | 212.5 | 1.500 | 212.5 |
| 0.100 | 212.5 | 0.600 | 212.5 | 1.100 | 212.5 | 1.600 | 212.5 |
| 0.200 | 212.5 | 0.700 | 212.5 | 1.200 | 212.5 | 1.601 | 0.0 |
| 0.300 | 212.5 | 0.800 | 212.5 | 1.300 | 212.5 | | |
| 0.400 | 212.5 | 0.900 | 212.5 | 1.400 | 212.5 | | |

212.5m2 x 1.6m deep
= 340m3 volume

## 2 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

### Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 10.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Storage Structures 1
Number of Online Controls 1 Number of Time/Area Diagrams 0
Number of Offline Controls 0 Number of Real Time Controls 0

### Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.280
Region Scotland and Ireland Cv (Summer) 0.750
M5-60 (mm) 17.000 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 250.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status OFF
DVD Status ON
Inertia Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 2, 30, 100
Climate Change (%) 0, 0, 0

| PN | US/MH Name | Storm | Return Period | Climate Change | First (X) Surcharge | First (Y) Flood | First (Z) Overflow | Overflow Act. |
|---|---|---|---|---|---|---|---|---|
| S1.000 | S3 | 15 Winter | 2 | +0% | 30/15 Summer | | | |
| S1.001 | S4 | 15 Winter | 2 | +0% | 30/15 Summer | | | |
| S1.002 | S5 | 1440 Winter | 2 | +0% | 30/15 Summer | | | |
| S1.003 | S10 | 1440 Winter | 2 | +0% | 2/15 Summer | | | |
| S2.000 | S11 | 15 Winter | 2 | +0% | 30/240 Winter | | | |
| S2.001 | S12 | 1440 Winter | 2 | +0% | 30/15 Summer | | | |
| S2.002 | S13 | 1440 Winter | 2 | +0% | 2/960 Winter | | | |
| S1.004 | S14 | 1440 Winter | 2 | +0% | 2/15 Summer | | | |
| S3.000 | S9 | 360 Winter | 2 | +0% | | | | |
| S4.000 | S10 | 360 Winter | 2 | +0% | 100/480 Winter | | | |
| S3.001 | S10 | 360 Winter | 2 | +0% | 100/360 Winter | | | |
| S3.002 | STANK A | 1440 Winter | 2 | +0% | 2/180 Winter | | | |
| S1.005 | S16 | 1440 Winter | 2 | +0% | 2/15 Summer | | | |





## 2 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

| PN | US/MH Name | Water Level (m) | Surcharged Depth (m) | Flooded Volume (m³) | Flow / Cap. | Overflow (l/s) | Pipe Flow (l/s) | Status | Level Exceeded |
|---|---|---|---|---|---|---|---|---|---|
| S1.000 | S3 | 4.725 | -0.094 | 0.000 | 0.63 | | 24.8 | OK | |
| S1.001 | S4 | 4.572 | -0.076 | 0.000 | 0.76 | | 29.9 | OK | |
| S1.002 | S5 | 4.391 | -0.077 | 0.000 | 0.04 | | 3.2 | OK | |
| S1.003 | S10 | 4.391 | 0.147 | 0.000 | 0.07 | | 5.5 | SURCHARGED | |
| S2.000 | S11 | 4.464 | -0.191 | 0.000 | 0.05 | | 2.1 | OK | |
| S2.001 | S12 | 4.390 | -0.062 | 0.000 | 0.03 | | 1.0 | OK | |
| S2.002 | S13 | 4.390 | 0.009 | 0.000 | 0.02 | | 1.7 | SURCHARGED | |
| S1.004 | S14 | 4.390 | 0.196 | 0.000 | 0.06 | | 7.1 | SURCHARGED | |
| S3.000 | S9 | 5.500 | -0.225 | 0.000 | 0.00 | | 0.0 | OK | |
| S4.000 | S10 | 4.875 | -0.225 | 0.000 | 0.00 | | 0.0 | OK | |
| S3.001 | S10 | 4.782 | -0.225 | 0.000 | 0.00 | | 0.0 | OK | |
| S3.002 | STANK A | 4.389 | 0.189 | 0.000 | 0.01 | | 1.9 | SURCHARGED | |
| S1.005 | S16 | 4.389 | 0.228 | 0.000 | 0.01 | | 1.6 | SURCHARGED | |

## 30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

### Simulation Criteria

Areal Reduction Factor 1.000  Additional Flow - % of Total Flow 10.000
Hot Start (mins) 0  MADD Factor * 10m³/ha Storage 2.000
Hot Start Level (mm) 0  Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500  Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0  Number of Storage Structures 1
Number of Online Controls 1  Number of Time/Area Diagrams 0
Number of Offline Controls 0  Number of Real Time Controls 0

### Synthetic Rainfall Details

Rainfall Model FSR  Ratio R 0.280
Region Scotland and Ireland  Cv (Summer) 0.750
M5-60 (mm) 17.000  Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 250.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status OFF
DVD Status ON
Inertia Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 2, 30, 100
Climate Change (%) 0, 0, 0

| PN | US/MH Name | Storm | Return Period | Climate Change | First (X) Surcharge | First (Y) Flood | First (Z) Overflow | Overflow Act. |
|---|---|---|---|---|---|---|---|---|
| S1.000 | S3 | 15 Winter | 30 | +0% | 30/15 Summer | | | |
| S1.001 | S4 | 15 Winter | 30 | +0% | 30/15 Summer | | | |
| S1.002 | S5 | 1440 Winter | 30 | +0% | 30/15 Summer | | | |
| S1.003 | S10 | 1440 Winter | 30 | +0% | 2/15 Summer | | | |
| S2.000 | S11 | 1440 Winter | 30 | +0% | 30/240 Winter | | | |
| S2.001 | S12 | 1440 Winter | 30 | +0% | 30/15 Summer | | | |
| S2.002 | S13 | 1440 Winter | 30 | +0% | 2/960 Winter | | | |
| S1.004 | S14 | 1440 Winter | 30 | +0% | 2/15 Summer | | | |
| S3.000 | S9 | 360 Winter | 30 | +0% | | | | |
| S4.000 | S10 | 1440 Winter | 30 | +0% | 100/480 Winter | | | |
| S3.001 | S10 | 1440 Winter | 30 | +0% | 100/360 Winter | | | |
| S3.002 | STANK A | 1440 Winter | 30 | +0% | 2/180 Winter | | | |
| S1.005 | S16 | 1440 Winter | 30 | +0% | 2/15 Summer | | | |





## 30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

| PN | US/MH Name | Water Level (m) | Surcharged Depth (m) | Flooded Volume (m³) | Flow / Cap. | Overflow (l/s) | Pipe Flow (l/s) | Status | Level Exceeded |
|---|---|---|---|---|---|---|---|---|---|
| S1.000 | S3 | 5.172 | 0.353 | 0.000 | 0.94 | | 36.7 | SURCHARGED | |
| S1.001 | S4 | 5.018 | 0.369 | 0.000 | 1.20 | | 47.2 | SURCHARGED | |
| S1.002 | S5 | 4.952 | 0.484 | 0.000 | 0.07 | | 5.1 | SURCHARGED | |
| S1.003 | S10 | 4.951 | 0.707 | 0.000 | 0.12 | | 9.3 | SURCHARGED | |
| S2.000 | S11 | 4.950 | 0.295 | 0.000 | 0.01 | | 0.2 | SURCHARGED | |
| S2.001 | S12 | 4.950 | 0.498 | 0.000 | 0.05 | | 1.8 | SURCHARGED | |
| S2.002 | S13 | 4.950 | 0.569 | 0.000 | 0.04 | | 3.0 | SURCHARGED | |
| S1.004 | S14 | 4.949 | 0.755 | 0.000 | 0.10 | | 12.2 | SURCHARGED | |
| S3.000 | S9 | 5.500 | -0.225 | 0.000 | 0.00 | | 0.0 | OK | |
| S4.000 | S10 | 4.949 | -0.151 | 0.000 | 0.00 | | 0.0 | OK | |
| S3.001 | S10 | 4.949 | -0.058 | 0.000 | 0.00 | | 0.0 | OK | |
| S3.002 | STANK A | 4.949 | 0.749 | 0.000 | 0.01 | | 1.7 | SURCHARGED | |
| S1.005 | S16 | 4.949 | 0.788 | 0.000 | 0.01 | | 1.8 | SURCHARGED | |

No flooding for 30yr event

## 100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

### Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 10.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Storage Structures 1
Number of Online Controls 1 Number of Time/Area Diagrams 0
Number of Offline Controls 0 Number of Real Time Controls 0

### Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.280
Region Scotland and Ireland Cv (Summer) 0.750
M5-60 (mm) 17.000 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 250.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status OFF
DVD Status ON
Inertia Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 2, 30, 100
Climate Change (%) 0, 0, 0

| PN | US/MH Name | Storm | Return Period | Climate Change | First (X) Surcharge | First (Y) Flood | First (Z) Overflow | Overflow Act. |
|---|---|---|---|---|---|---|---|---|
| S1.000 | S3 | 15 Winter | 100 | +0% | 30/15 Summer | | | |
| S1.001 | S4 | 15 Winter | 100 | +0% | 30/15 Summer | | | |
| S1.002 | S5 | 1440 Winter | 100 | +0% | 30/15 Summer | | | |
| S1.003 | S10 | 1440 Winter | 100 | +0% | 2/15 Summer | | | |
| S2.000 | S11 | 1440 Winter | 100 | +0% | 30/240 Winter | | | |
| S2.001 | S12 | 1440 Winter | 100 | +0% | 30/15 Summer | | | |
| S2.002 | S13 | 1440 Winter | 100 | +0% | 2/960 Winter | | | |
| S1.004 | S14 | 1440 Winter | 100 | +0% | 2/15 Summer | | | |
| S3.000 | S9 | 360 Winter | 100 | +0% | | | | |
| S4.000 | S10 | 1440 Winter | 100 | +0% | 100/480 Winter | | | |
| S3.001 | S10 | 1440 Winter | 100 | +0% | 100/360 Winter | | | |
| S3.002 | STANK A | 1440 Winter | 100 | +0% | 2/180 Winter | | | |
| S1.005 | S16 | 1440 Winter | 100 | +0% | 2/15 Summer | | | |





## 100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

| PN | US/MH Name | Water Level (m) | Surcharged Depth (m) | Flooded Volume (m³) | Flow / Cap. | Overflow (l/s) | Pipe Flow (l/s) | Status | Level Exceeded |
|---|---|---|---|---|---|---|---|---|---|
| S1.000 | S3 | 5.715 | 0.896 | 0.000 | 1.16 | | 45.5 | FLOOD RISK | |
| S1.001 | S4 | 5.479 | 0.831 | 0.000 | 1.48 | | 58.3 | SURCHARGED | |
| S1.002 | S5 | 5.314 | 0.846 | 0.000 | 0.08 | | 6.0 | SURCHARGED | |
| S1.003 | S10 | 5.313 | 1.069 | 0.000 | 0.13 | | 10.8 | SURCHARGED | |
| S2.000 | S11 | 5.312 | 0.657 | 0.000 | 0.01 | | 0.3 | SURCHARGED | |
| S2.001 | S12 | 5.312 | 0.860 | 0.000 | 0.05 | | 2.0 | SURCHARGED | |
| S2.002 | S13 | 5.312 | 0.931 | 0.000 | 0.04 | | 3.3 | SURCHARGED | |
| S1.004 | S14 | 5.311 | 1.117 | 0.000 | 0.12 | | 13.7 | SURCHARGED | |
| S3.000 | S9 | 5.500 | -0.225 | 0.000 | 0.00 | | 0.0 | OK | |
| S4.000 | S10 | 5.311 | 0.211 | 0.000 | 0.00 | | 0.0 | SURCHARGED | |
| S3.001 | S10 | 5.311 | 0.304 | 0.000 | 0.00 | | 0.0 | SURCHARGED | |
| S3.002 | STANK A | 5.311 | 1.111 | 0.000 | 0.01 | | 1.9 | SURCHARGED | |
| S1.005 | S16 | 5.311 | 1.150 | 0.000 | 0.01 | | 2.1 | SURCHARGED | |

No flooding for 100yr event

## STORM SEWER DESIGN by the Modified Rational Method

### Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

| | | | |
|---|---|---|---|
| Return Period (years) | 2 | Add Flow / Climate Change (%) | 10 |
| M5-60 (mm) | 17.000 | Minimum Backdrop Height (m) | 0.200 |
| Ratio R | 0.280 | Maximum Backdrop Height (m) | 1.500 |
| Maximum Rainfall (mm/hr) | 150 | Min Design Depth for Optimisation (m) | 1.200 |
| Maximum Time of Concentration (mins) | 30 | Min Vel for Auto Design only (m/s) | 1.00 |
| Foul Sewage (l/s/ha) | 0.000 | Min Slope for Optimisation (1:X) | 500 |
| Volumetric Runoff Coeff. | 0.750 | | |

Designed with Level Soffits

### Time Area Diagram for Storm

| Time (mins) | Area (ha) | Time (mins) | Area (ha) |
|---|---|---|---|
| 0-4 | 0.663 | 4-8 | 0.306 |

Total Area Contributing (ha) = 0.969

Total Pipe Volume (m³) = 25.405

### Network Design Table for Storm

« - Indicates pipe capacity < flow

| PN | Length (m) | Fall (m) | Slope (1:X) | I.Area (ha) | T.E. (mins) | Base Flow (l/s) | k (mm) | HYD SECT | DIA (mm) | Auto Design |
|---|---|---|---|---|---|---|---|---|---|---|
| S4.000 | 33.791 | 0.169 | 199.9 | 0.200 | 4.00 | 0.0 | 0.600 | o | 300 | 🔒 |
| S5.000 | 21.420 | 0.142 | 150.8 | 0.033 | 4.00 | 0.0 | 0.600 | o | 225 | 🔒 |
| S5.001 | 10.648 | 0.071 | 150.0 | 0.033 | 0.00 | 0.0 | 0.600 | o | 225 | 🔒 |
| S5.002 | 32.951 | 0.220 | 150.0 | 0.045 | 0.00 | 0.0 | 0.600 | o | 225 | 🔒 |

### Network Results Table

| PN | Rain (mm/hr) | T.C. (mins) | US/IL (m) | Σ I.Area (ha) | Σ Base Flow (l/s) | Foul (l/s) | Add Flow (l/s) | Vel (m/s) | Cap (l/s) | Flow (l/s) |
|---|---|---|---|---|---|---|---|---|---|---|
| S4.000 | 53.55 | 4.51 | 5.001 | 0.200 | 0.0 | 0.0 | 2.9 | 1.11 | 78.3 | 31.9 |
| S5.000 | 54.29 | 4.34 | 5.150 | 0.033 | 0.0 | 0.0 | 0.5 | 1.06 | 42.2 | 5.3 |
| S5.001 | 53.58 | 4.50 | 5.008 | 0.066 | 0.0 | 0.0 | 1.0 | 1.07 | 42.4 | 10.5 |
| S5.002 | 51.51 | 5.02 | 4.937 | 0.111 | 0.0 | 0.0 | 1.5 | 1.07 | 42.4 | 17.0 |





### Network Design Table for Storm

| PN | Length (m) | Fall (m) | Slope (1:X) | I.Area (ha) | T.E. (mins) | Base Flow (l/s) | k (mm) | HYD SECT | DIA (mm) | Auto Design |
|---|---|---|---|---|---|---|---|---|---|---|
| S6.000 | 29.514 | 0.197 | 150.0 | 0.043 | 4.00 | 0.0 | 0.600 | o | 225 | 🔒 |
| S5.003 | 14.310 | 0.072 | 200.0 | 0.062 | 0.00 | 0.0 | 0.600 | o | 300 | 🔒 |
| S5.004 | 9.030 | 0.045 | 200.0 | 0.000 | 0.00 | 0.0 | 0.600 | o | 300 | 🔒 |
| S4.001 | 27.937 | 0.081 | 344.9 | 0.235 | 0.00 | 0.0 | 0.600 | o | 525 | 🔒 |
| S7.000 | 6.976 | 0.070 | 100.0 | 0.057 | 4.00 | 0.0 | 0.600 | o | 150 | 🔒 |
| S8.000 | 5.779 | 0.058 | 100.0 | 0.046 | 4.00 | 0.0 | 0.600 | o | 150 | 🔒 |
| S7.001 | 13.653 | 0.137 | 99.6 | 0.000 | 0.00 | 0.0 | 0.600 | o | 150 | 🔒 |
| S9.000 | 6.846 | 0.068 | 100.0 | 0.060 | 4.00 | 0.0 | 0.600 | o | 150 | 🔒 |
| S10.000 | 8.085 | 0.081 | 100.0 | 0.047 | 4.00 | 0.0 | 0.600 | o | 150 | 🔒 |
| S7.002 | 29.153 | 0.298 | 97.8 | 0.000 | 0.00 | 0.0 | 0.600 | o | 225 | 🔒 |
| S4.002 | 17.069 | 0.049 | 350.0 | 0.000 | 0.00 | 0.0 | 0.600 | o | 525 | 🔒 |
| S4.003 | 7.911 | 0.023 | 350.0 | 0.000 | 0.00 | 0.0 | 0.600 | o | 525 | 🔒 |

### Network Results Table

| PN | Rain (mm/hr) | T.C. (mins) | US/IL (m) | Σ I.Area (ha) | Σ Base Flow (l/s) | Foul (l/s) | Add Flow (l/s) | Vel (m/s) | Cap (l/s) | Flow (l/s) |
|---|---|---|---|---|---|---|---|---|---|---|
| S6.000 | 53.75 | 4.46 | 4.924 | 0.043 | 0.0 | 0.0 | 0.6 | 1.07 | 42.4 | 6.9 |
| S5.003 | 50.71 | 5.23 | 4.642 | 0.216 | 0.0 | 0.0 | 3.0 | 1.11 | 78.3 | 32.6 |
| S5.004 | 50.22 | 5.37 | 4.346 | 0.216 | 0.0 | 0.0 | 3.0 | 1.11 | 78.3 | 32.6 |
| S4.001 | 48.88 | 5.76 | 4.301 | 0.651 | 0.0 | 0.0 | 8.6 | 1.20 | 259.8 | 94.8 |
| S7.000 | 55.27 | 4.12 | 5.100 | 0.057 | 0.0 | 0.0 | 0.9 | 1.00 | 17.8 | 9.4 |
| S8.000 | 55.36 | 4.10 | 5.100 | 0.046 | 0.0 | 0.0 | 0.7 | 1.00 | 17.8 | 7.6 |
| S7.001 | 54.26 | 4.34 | 5.030 | 0.103 | 0.0 | 0.0 | 1.5 | 1.01 | 17.8 | 16.7 |
| S9.000 | 55.28 | 4.11 | 5.000 | 0.060 | 0.0 | 0.0 | 0.9 | 1.00 | 17.8 | 9.9 |
| S10.000 | 55.18 | 4.13 | 4.974 | 0.047 | 0.0 | 0.0 | 0.7 | 1.00 | 17.8 | 7.7 |
| S7.002 | 52.73 | 4.71 | 4.818 | 0.210 | 0.0 | 0.0 | 3.0 | 1.32 | 52.6 | 33.0 |
| S4.002 | 48.10 | 6.00 | 4.220 | 0.861 | 0.0 | 0.0 | 11.2 | 1.19 | 257.9 | 123.4 |
| S4.003 | 47.74 | 6.11 | 4.171 | 0.861 | 0.0 | 0.0 | 11.2 | 1.19 | 257.9 | 123.4 |

## Network Design Table for Storm

| PN | Length (m) | Fall (m) | Slope (1:X) | I.Area (ha) | T.E. (mins) | Base Flow (l/s) | k (mm) | HYD SECT | DIA (mm) | Auto Design |
|---|---|---|---|---|---|---|---|---|---|---|
| S11.000 | 27.716 | 0.139 | 200.0 | 0.072 | 4.00 | 0.0 | 0.600 | o | 300 | |
| S11.001 | 4.438 | 0.022 | 200.0 | 0.036 | 0.00 | 0.0 | 0.600 | o | 300 | |
| S12.000 | 8.694 | 0.029 | 300.0 | 0.000 | 4.00 | 0.0 | 0.600 | o | 450 | |
| S4.004 | 5.753 | 0.038 | 151.4 | 0.000 | 0.00 | 0.0 | 0.600 | o | 225 | |
| S4.005 | 9.524 | 0.063 | 151.2 | 0.000 | 0.00 | 0.0 | 0.600 | o | 225 | |

## Network Results Table

| PN | Rain (mm/hr) | T.C. (mins) | US/IL (m) | Σ I.Area (ha) | Σ Base Flow (l/s) | Foul (l/s) | Add Flow (l/s) | Vel (m/s) | Cap (l/s) | Flow (l/s) |
|---|---|---|---|---|---|---|---|---|---|---|
| S11.000 | 53.94 | 4.42 | 3.690 | 0.072 | 0.0 | 0.0 | 1.1 | 1.11 | 78.3 | 11.6 |
| S11.001 | 53.66 | 4.48 | 3.551 | 0.108 | 0.0 | 0.0 | 1.6 | 1.11 | 78.3 | 17.3 |
| S12.000 | 55.23 | 4.12 | 2.940 | 0.000 | 0.0 | 0.0 | 0.0 | 1.17 | 185.8 | 0.0 |
| S4.004 | 47.46 | 6.20 | 2.836 | 0.969 | 0.0 | 0.0 | 12.5 | 1.06 | 42.2« | 137.0 |
| S4.005 | 47.00 | 6.35 | 2.798 | 0.969 | 0.0 | 0.0 | 12.5 | 1.06 | 42.2« | 137.0 |





## Area Summary for Storm

| Pipe Number | PIMP Type | PIMP Name | PIMP (%) | Gross Area (ha) | Imp. Area (ha) | Pipe Total (ha) |
|---|---|---|---|---|---|---|
| 4.000 | - | - | 100 | 0.200 | 0.200 | 0.200 |
| 5.000 | - | - | 100 | 0.033 | 0.033 | 0.033 |
| 5.001 | - | - | 100 | 0.033 | 0.033 | 0.033 |
| 5.002 | - | - | 100 | 0.045 | 0.045 | 0.045 |
| 6.000 | - | - | 100 | 0.043 | 0.043 | 0.043 |
| 5.003 | - | - | 100 | 0.062 | 0.062 | 0.062 |
| 5.004 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 4.001 | - | - | 100 | 0.235 | 0.235 | 0.235 |
| 7.000 | - | - | 100 | 0.057 | 0.057 | 0.057 |
| 8.000 | - | - | 100 | 0.046 | 0.046 | 0.046 |
| 7.001 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 9.000 | - | - | 100 | 0.060 | 0.060 | 0.060 |
| 10.000 | - | - | 100 | 0.047 | 0.047 | 0.047 |
| 7.002 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 4.002 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 4.003 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 11.000 | - | - | 100 | 0.072 | 0.072 | 0.072 |
| 11.001 | - | - | 100 | 0.036 | 0.036 | 0.036 |
| 12.000 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 4.004 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 4.005 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| | | | | Total<br>0.969 | Total<br>0.969 | Total<br>0.969 |

## Free Flowing Outfall Details for Storm

| Outfall Pipe Number | Outfall Name | C. Level (m) | I. Level (m) | Min I. Level (m) | D,L (mm) | W (mm) |
|---|---|---|---|---|---|---|
| S4.005 | S | 6.000 | 2.735 | 2.720 | 0 | 0 |

## Simulation Criteria for Storm

| | | | |
|---|---|---|---|
| Volumetric Runoff Coeff | 0.750 | Additional Flow - % of Total Flow | 10.000 |
| Areal Reduction Factor | 1.000 | MADD Factor * 10m³/ha Storage | 2.000 |
| Hot Start (mins) | 0 | Inlet Coeffiecient | 0.800 |
| Hot Start Level (mm) | 0 | Flow per Person per Day (l/per/day) | 0.000 |
| Manhole Headloss Coeff (Global) | 0.500 | Run Time (mins) | 60 |
| Foul Sewage per hectare (l/s) | 0.000 | Output Interval (mins) | 1 |

| | | | |
|---|---|---|---|
| Number of Input Hydrographs | 0 | Number of Storage Structures | 1 |
| Number of Online Controls | 1 | Number of Time/Area Diagrams | 0 |
| Number of Offline Controls | 0 | Number of Real Time Controls | 0 |

## Synthetic Rainfall Details

Rainfall Model FSR Return Period (years) 2

## Synthetic Rainfall Details

| | | | |
|---|---|---|---|
| Region | Scotland and Ireland | Cv (Summer) | 0.750 |
| M5-60 (mm) | 17.000 | Cv (Winter) | 0.840 |
| Ratio R | 0.280 | Storm Duration (mins) | 30 |
| Profile Type | Summer | | |





## Online Controls for Storm

### Hydro-Brake Optimum® Manhole: S26, DS/PN: S4.004, Volume (m³): 8.4

| | |
|---|---|
| Unit Reference | MD-SFP-0053-2000-2500-2000 |
| Design Head (m) | 2.500 |
| Design Flow (l/s) | 2.0 |
| Flush-Flo™ | Calculated |
| Objective | Future Proof |
| Diameter (mm) | 53 |
| Invert Level (m) | 2.909 |
| Minimum Outlet Pipe Diameter (mm) | 75 |
| Suggested Manhole Diameter (mm) | 1200 |

| Control Points | Head (m) | Flow (l/s) |
|---|---|---|
| Design Point (Calculated) | 2.500 | 2.0 |
| Flush-Flo™ | 0.220 | 1.2 |
| Kick-Flo® | 0.469 | 0.9 |
| Mean Flow over Head Range | - | 1.4 |

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

| Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) |
|---|---|---|---|---|---|---|---|
| 0.100 | 1.1 | 1.200 | 1.4 | 3.000 | 2.2 | 7.000 | 3.2 |
| 0.200 | 1.2 | 1.400 | 1.5 | 3.500 | 2.3 | 7.500 | 3.3 |
| 0.300 | 1.2 | 1.600 | 1.6 | 4.000 | 2.5 | 8.000 | 3.4 |
| 0.400 | 1.1 | 1.800 | 1.7 | 4.500 | 2.6 | 8.500 | 3.5 |
| 0.500 | 1.0 | 2.000 | 1.8 | 5.000 | 2.7 | 9.000 | 3.6 |
| 0.600 | 1.1 | 2.200 | 1.9 | 5.500 | 2.9 | 9.500 | 3.7 |
| 0.800 | 1.2 | 2.400 | 2.0 | 6.000 | 3.0 | | |
| 1.000 | 1.3 | 2.600 | 2.0 | 6.500 | 3.1 | | |

## Storage Structures for Storm

### Tank or Pond Manhole: SATTN, DS/PN: S12.000

Invert Level (m) 2.940

| Depth (m) | Area (m²) | Depth (m) | Area (m²) | Depth (m) | Area (m²) | Depth (m) | Area (m²) |
|---|---|---|---|---|---|---|---|
| 0.000 | 230.0 | 0.700 | 230.0 | 1.400 | 230.0 | 2.100 | 230.0 |
| 0.100 | 230.0 | 0.800 | 230.0 | 1.500 | 230.0 | 2.200 | 230.0 |
| 0.200 | 230.0 | 0.900 | 230.0 | 1.600 | 230.0 | 2.300 | 230.0 |
| 0.300 | 230.0 | 1.000 | 230.0 | 1.700 | 230.0 | 2.400 | 230.0 |
| 0.400 | 230.0 | 1.100 | 230.0 | 1.800 | 230.0 | 2.500 | 230.0 |
| 0.500 | 230.0 | 1.200 | 230.0 | 1.900 | 230.0 | | |
| 0.600 | 230.0 | 1.300 | 230.0 | 2.000 | 230.0 | | |

230m2 x 2.5m deep = 575m3 volume





## 2 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

### Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 10.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Storage Structures 1
Number of Online Controls 1 Number of Time/Area Diagrams 0
Number of Offline Controls 0 Number of Real Time Controls 0

### Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.280
Region Scotland and Ireland Cv (Summer) 0.750
M5-60 (mm) 17.000 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 250.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status OFF
DVD Status ON
Inertia Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 2, 30, 100
Climate Change (%) 0, 0, 0

| PN | US/MH Name | Storm | Return Period | Climate Change | First (X) Surcharge | First (Y) Flood | First (Z) Overflow | Overflow Act. |
|---|---|---|---|---|---|---|---|---|
| S4.000 | S10 | 15 Winter | 2 | +0% | 100/15 Summer | | | |
| S5.000 | S11 | 15 Winter | 2 | +0% | 100/1440 Winter | | | |
| S5.001 | S12 | 15 Winter | 2 | +0% | 100/15 Summer | | | |
| S5.002 | S13 | 15 Winter | 2 | +0% | 100/15 Summer | | | |
| S6.000 | S31 | 15 Winter | 2 | +0% | 100/15 Summer | | | |
| S5.003 | S14 | 15 Winter | 2 | +0% | 30/15 Summer | | | |
| S5.004 | SPI | 15 Winter | 2 | +0% | 2/15 Winter | | | |
| S4.001 | S15 | 15 Winter | 2 | +0% | 30/15 Summer | | | |
| S7.000 | S17 | 15 Winter | 2 | +0% | 30/15 Summer | | | |
| S8.000 | S16 | 15 Winter | 2 | +0% | 30/15 Summer | | | |
| S7.001 | S18 | 15 Winter | 2 | +0% | 30/15 Summer | | | |
| S9.000 | S20 | 15 Summer | 2 | +0% | 30/15 Summer | | | |
| S10.000 | S19 | 15 Summer | 2 | +0% | 30/15 Summer | | | |
| S7.002 | S21 | 15 Winter | 2 | +0% | 30/15 Summer | | | |
| S4.002 | S22 | 15 Winter | 2 | +0% | 30/15 Summer | | | |
| S4.003 | S23 | 15 Winter | 2 | +0% | 30/15 Winter | | | |
| S11.000 | S24 | 4320 Winter | 2 | +0% | 2/600 Winter | | | |

2 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

| PN | US/MH Name | Water Level (m) | Surcharged Depth (m) | Flooded Volume (m³) | Flow / Cap. | Overflow (l/s) | Pipe Flow (l/s) | Status | Level Exceeded |
|---|---|---|---|---|---|---|---|---|---|
| S4.000 | S10 | 5.144 | -0.157 | 0.000 | 0.46 | | 33.0 | OK | |
| S5.000 | S11 | 5.206 | -0.169 | 0.000 | 0.14 | | 5.4 | OK | |
| S5.001 | S12 | 5.088 | -0.145 | 0.000 | 0.27 | | 9.7 | OK | |
| S5.002 | S13 | 5.035 | -0.127 | 0.000 | 0.39 | | 15.5 | OK | |
| S6.000 | S31 | 4.988 | -0.161 | 0.000 | 0.18 | | 7.0 | OK | |
| S5.003 | S14 | 4.787 | -0.156 | 0.000 | 0.47 | | 30.4 | OK | |
| S5.004 | SPI | 4.656 | 0.010 | 0.000 | 0.66 | | 29.1 | SURCHARGED | |
| S4.001 | S15 | 4.601 | -0.225 | 0.000 | 0.41 | | 88.2 | OK | |
| S7.000 | S17 | 5.192 | -0.058 | 0.000 | 0.61 | | 9.2 | OK | |
| S8.000 | S16 | 5.184 | -0.066 | 0.000 | 0.50 | | 7.4 | OK | |
| S7.001 | S18 | 5.167 | -0.013 | 0.000 | 1.00 | | 16.3 | OK | |
| S9.000 | S20 | 5.089 | -0.061 | 0.000 | 0.66 | | 10.0 | OK | |
| S10.000 | S19 | 5.050 | -0.074 | 0.000 | 0.51 | | 7.8 | OK | |
| S7.002 | S21 | 4.957 | -0.087 | 0.000 | 0.69 | | 33.6 | OK | |
| S4.002 | S22 | 4.562 | -0.184 | 0.000 | 0.61 | | 117.3 | OK | |
| S4.003 | S23 | 4.526 | -0.170 | 0.000 | 0.79 | | 116.5 | OK | |
| S11.000 | S24 | 4.246 | 0.256 | 0.000 | 0.01 | | 0.4 | SURCHARGED | |





2 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

| PN | US/MH Name | Storm | Return Period | Climate Change | First (X) Surcharge | First (Y) Flood | First (Z) Overflow | Overflow Act. | Water Level (m) |
|---|---|---|---|---|---|---|---|---|---|
| S11.001 | S25 | 4320 Winter | 2 | +0% | 2/360 Winter | | | | 4.246 |
| S12.000 | SATTN | 4320 Winter | 2 | +0% | 2/60 Summer | | | | 4.246 |
| S4.004 | S26 | 4320 Winter | 2 | +0% | 2/15 Summer | | | | 4.246 |
| S4.005 | S27 | 4320 Winter | 2 | +0% | | | | | 2.828 |

| PN | US/MH Name | Surcharged Depth (m) | Flooded Volume (m³) | Flow / Cap. | Overflow (l/s) | Pipe Flow (l/s) | Status | Level Exceeded |
|---|---|---|---|---|---|---|---|---|
| S11.001 | S25 | 0.394 | 0.000 | 0.02 | | 1.1 | SURCHARGED | |
| S12.000 | SATTN | 0.856 | 0.000 | 0.02 | | 2.0 | SURCHARGED | |
| S4.004 | S26 | 1.185 | 0.000 | 0.05 | | 1.5 | SURCHARGED | |
| S4.005 | S27 | -0.195 | 0.000 | 0.04 | | 1.5 | OK | |

## 30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

### Simulation Criteria

| | | | |
|---|---|---|---|
| Areal Reduction Factor | 1.000 | Additional Flow - % of Total Flow | 10.000 |
| Hot Start (mins) | 0 | MADD Factor * 10m³/ha Storage | 2.000 |
| Hot Start Level (mm) | 0 | Inlet Coeffiecient | 0.800 |
| Manhole Headloss Coeff (Global) | 0.500 | Flow per Person per Day (l/per/day) | 0.000 |
| Foul Sewage per hectare (l/s) | 0.000 | | |

| | | | |
|---|---|---|---|
| Number of Input Hydrographs | 0 | Number of Storage Structures | 1 |
| Number of Online Controls | 1 | Number of Time/Area Diagrams | 0 |
| Number of Offline Controls | 0 | Number of Real Time Controls | 0 |

### Synthetic Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FSR | Ratio R | 0.280 |
| Region | Scotland and Ireland | Cv (Summer) | 0.750 |
| M5-60 (mm) | 17.000 | Cv (Winter) | 0.840 |

| | |
|---|---|
| Margin for Flood Risk Warning (mm) | 250.0 |
| Analysis Timestep | 2.5 Second Increment (Extended) |
| DTS Status | OFF |
| DVD Status | ON |
| Inertia Status | ON |

| | |
|---|---|
| Profile(s) | Summer and Winter |
| Duration(s) (mins) | 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080 |
| Return Period(s) (years) | 2, 30, 100 |
| Climate Change (%) | 0, 0, 0 |

| PN | US/MH Name | Storm | Return Period | Climate Change | First (X) Surcharge | First (Y) Flood | First (Z) Overflow | Overflow Act. |
|---|---|---|---|---|---|---|---|---|
| S4.000 | S10 | 15 Winter | 30 | +0% | 100/15 Summer | | | |
| S5.000 | S11 | 15 Winter | 30 | +0% | 100/1440 Winter | | | |
| S5.001 | S12 | 15 Winter | 30 | +0% | 100/15 Summer | | | |
| S5.002 | S13 | 4320 Winter | 30 | +0% | 100/15 Summer | | | |
| S6.000 | S31 | 4320 Winter | 30 | +0% | 100/15 Summer | | | |
| S5.003 | S14 | 4320 Winter | 30 | +0% | 30/15 Summer | | | |
| S5.004 | SPI | 4320 Winter | 30 | +0% | 2/15 Winter | | | |
| S4.001 | S15 | 4320 Winter | 30 | +0% | 30/15 Summer | | | |
| S7.000 | S17 | 15 Winter | 30 | +0% | 30/15 Summer | | | |
| S8.000 | S16 | 15 Winter | 30 | +0% | 30/15 Summer | | | |
| S7.001 | S18 | 15 Winter | 30 | +0% | 30/15 Summer | | | |
| S9.000 | S20 | 15 Winter | 30 | +0% | 30/15 Summer | | | |
| S10.000 | S19 | 15 Winter | 30 | +0% | 30/15 Summer | | | |
| S7.002 | S21 | 4320 Winter | 30 | +0% | 30/15 Summer | | | |
| S4.002 | S22 | 4320 Winter | 30 | +0% | 30/15 Summer | | | |
| S4.003 | S23 | 4320 Winter | 30 | +0% | 30/15 Winter | | | |
| S11.000 | S24 | 4320 Winter | 30 | +0% | 2/600 Winter | | | |





## 30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

| PN | US/MH Name | Water Level (m) | Surcharged Depth (m) | Flooded Volume (m³) | Flow / Cap. | Overflow (l/s) | Pipe Flow (l/s) | Status | Level Exceeded |
|---|---|---|---|---|---|---|---|---|---|
| S4.000 | S10 | 5.214 | -0.087 | 0.000 | 0.85 | | 60.8 | OK | |
| S5.000 | S11 | 5.228 | -0.147 | 0.000 | 0.26 | | 10.0 | OK | |
| S5.001 | S12 | 5.131 | -0.102 | 0.000 | 0.56 | | 19.8 | OK | |
| S5.002 | S13 | 5.115 | -0.047 | 0.000 | 0.02 | | 1.0 | OK | |
| S6.000 | S31 | 5.115 | -0.034 | 0.000 | 0.01 | | 0.4 | OK | |
| S5.003 | S14 | 5.115 | 0.172 | 0.000 | 0.03 | | 1.9 | SURCHARGED | |
| S5.004 | SPI | 5.114 | 0.468 | 0.000 | 0.04 | | 1.9 | SURCHARGED | |
| S4.001 | S15 | 5.114 | 0.288 | 0.000 | 0.03 | | 5.8 | SURCHARGED | |
| S7.000 | S17 | 5.481 | 0.231 | 0.000 | 0.92 | | 13.9 | SURCHARGED | |
| S8.000 | S16 | 5.455 | 0.205 | 0.000 | 0.75 | | 11.0 | SURCHARGED | |
| S7.001 | S18 | 5.421 | 0.241 | 0.000 | 1.52 | | 24.8 | SURCHARGED | |
| S9.000 | S20 | 5.182 | 0.032 | 0.000 | 1.19 | | 18.0 | SURCHARGED | |
| S10.000 | S19 | 5.152 | 0.028 | 0.000 | 0.88 | | 13.6 | SURCHARGED | |
| S7.002 | S21 | 5.115 | 0.072 | 0.000 | 0.04 | | 1.9 | SURCHARGED | |
| S4.002 | S22 | 5.114 | 0.369 | 0.000 | 0.04 | | 7.7 | SURCHARGED | |
| S4.003 | S23 | 5.113 | 0.417 | 0.000 | 0.05 | | 7.7 | SURCHARGED | |
| S11.000 | S24 | 5.113 | 1.123 | 0.000 | 0.01 | | 0.6 | SURCHARGED | |

No flooding for 30yr event

<u>30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm</u>

| PN | US/MH Name | Storm | Return Period | Climate Change | First (X) Surcharge | First (Y) Flood | First (Z) Overflow | Overflow Act. | Water Level (m) |
|---|---|---|---|---|---|---|---|---|---|
| S11.001 | S25 | 4320 Winter | 30 | +0% | 2/360 Winter | | | | 5.113 |
| S12.000 | SATTN | 4320 Winter | 30 | +0% | 2/60 Summer | | | | 5.113 |
| S4.004 | S26 | 4320 Winter | 30 | +0% | 2/15 Summer | | | | 5.113 |
| S4.005 | S27 | 4320 Winter | 30 | +0% | | | | | 2.831 |

| PN | US/MH Name | Surcharged Depth (m) | Flooded Volume ($m^3$) | Flow / Cap. | Overflow (l/s) | Pipe Flow (l/s) | Status | Level Exceeded |
|---|---|---|---|---|---|---|---|---|
| S11.001 | S25 | 1.262 | 0.000 | 0.03 | | 1.3 | SURCHARGED | |
| S12.000 | SATTN | 1.723 | 0.000 | 0.02 | | 2.0 | SURCHARGED | |
| S4.004 | S26 | 2.052 | 0.000 | 0.06 | | 1.9 | SURCHARGED | |
| S4.005 | S27 | -0.192 | 0.000 | 0.05 | | 1.9 | OK | |

No flooding for 30yr event





<u>100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm</u>

<u>Simulation Criteria</u>

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 10.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Storage Structures 1
Number of Online Controls 1 Number of Time/Area Diagrams 0
Number of Offline Controls 0 Number of Real Time Controls 0

<u>Synthetic Rainfall Details</u>

Rainfall Model FSR Ratio R 0.280
Region Scotland and Ireland Cv (Summer) 0.750
M5-60 (mm) 17.000 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 250.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status OFF
DVD Status ON
Inertia Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 2, 30, 100
Climate Change (%) 0, 0, 0

| PN | US/MH Name | Storm | Return Period | Climate Change | First (X) Surcharge | First (Y) Flood | First (Z) Overflow | Overflow Act. |
|---|---|---|---|---|---|---|---|---|
| S4.000 | S10 | 2880 Winter | 100 | +0% | 100/15 Summer | | | |
| S5.000 | S11 | 2880 Winter | 100 | +0% | 100/1440 Winter | | | |
| S5.001 | S12 | 2880 Winter | 100 | +0% | 100/15 Summer | | | |
| S5.002 | S13 | 2880 Winter | 100 | +0% | 100/15 Summer | | | |
| S6.000 | S31 | 2880 Winter | 100 | +0% | 100/15 Summer | | | |
| S5.003 | S14 | 2880 Winter | 100 | +0% | 30/15 Summer | | | |
| S5.004 | SPI | 2880 Winter | 100 | +0% | 2/15 Winter | | | |
| S4.001 | S15 | 2880 Winter | 100 | +0% | 30/15 Summer | | | |
| S7.000 | S17 | 15 Winter | 100 | +0% | 30/15 Summer | | | |
| S8.000 | S16 | 15 Winter | 100 | +0% | 30/15 Summer | | | |
| S7.001 | S18 | 15 Winter | 100 | +0% | 30/15 Summer | | | |
| S9.000 | S20 | 2880 Winter | 100 | +0% | 30/15 Summer | | | |
| S10.000 | S19 | 2880 Winter | 100 | +0% | 30/15 Summer | | | |
| S7.002 | S21 | 2880 Winter | 100 | +0% | 30/15 Summer | | | |
| S4.002 | S22 | 2880 Winter | 100 | +0% | 30/15 Summer | | | |
| S4.003 | S23 | 2880 Winter | 100 | +0% | 30/15 Winter | | | |
| S11.000 | S24 | 2880 Winter | 100 | +0% | 2/600 Winter | | | |

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

| PN | US/MH Name | Water Level (m) | Surcharged Depth (m) | Flooded Volume (m³) | Flow / Cap. | Overflow (l/s) | Pipe Flow (l/s) | Status | Level Exceeded |
|---|---|---|---|---|---|---|---|---|---|
| S4.000 | S10 | 5.647 | 0.346 | 0.000 | 0.04 | | 2.9 | SURCHARGED | |
| S5.000 | S11 | 5.648 | 0.273 | 0.000 | 0.01 | | 0.5 | SURCHARGED | |
| S5.001 | S12 | 5.648 | 0.415 | 0.000 | 0.03 | | 1.0 | SURCHARGED | |
| S5.002 | S13 | 5.648 | 0.486 | 0.000 | 0.04 | | 1.6 | SURCHARGED | |
| S6.000 | S31 | 5.647 | 0.498 | 0.000 | 0.02 | | 0.6 | SURCHARGED | |
| S5.003 | S14 | 5.647 | 0.705 | 0.000 | 0.05 | | 3.1 | SURCHARGED | |
| S5.004 | SPI | 5.647 | 1.001 | 0.000 | 0.07 | | 3.1 | SURCHARGED | |
| S4.001 | S15 | 5.647 | 0.821 | 0.000 | 0.04 | | 9.1 | SURCHARGED | |
| S7.000 | S17 | 5.783 | 0.533 | 0.000 | 1.04 | | 15.8 | FLOOD RISK | |
| S8.000 | S16 | 5.749 | 0.499 | 0.000 | 0.83 | | 12.3 | SURCHARGED | |
| S7.001 | S18 | 5.705 | 0.524 | 0.000 | 1.71 | | 27.9 | SURCHARGED | |
| S9.000 | S20 | 5.648 | 0.498 | 0.000 | 0.06 | | 0.9 | SURCHARGED | |
| S10.000 | S19 | 5.648 | 0.524 | 0.000 | 0.04 | | 0.7 | SURCHARGED | |
| S7.002 | S21 | 5.648 | 0.605 | 0.000 | 0.06 | | 3.0 | SURCHARGED | |
| S4.002 | S22 | 5.647 | 0.902 | 0.000 | 0.06 | | 12.0 | SURCHARGED | |
| S4.003 | S23 | 5.646 | 0.950 | 0.000 | 0.08 | | 11.8 | SURCHARGED | |
| S11.000 | S24 | 5.646 | 1.656 | 0.000 | 0.01 | | 1.0 | SURCHARGED | |

No flooding for 100yr event





100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

| PN | US/MH Name | Storm | Return Period | Climate Change | First (X) Surcharge | First (Y) Flood | First (Z) Overflow | Overflow Act. | Water Level (m) |
|---|---|---|---|---|---|---|---|---|---|
| S11.001 | S25 | 2880 Winter | 100 | +0% | 2/360 Winter | | | | 5.646 |
| S12.000 | SATTN | 2880 Winter | 100 | +0% | 2/60 Summer | | | | 5.646 |
| S4.004 | S26 | 2880 Winter | 100 | +0% | 2/15 Summer | | | | 5.646 |
| S4.005 | S27 | 2880 Winter | 100 | +0% | | | | | 2.833 |

| PN | US/MH Name | Surcharged Depth (m) | Flooded Volume (m³) | Flow / Cap. | Overflow (l/s) | Pipe Flow (l/s) | Status | Level Exceeded |
|---|---|---|---|---|---|---|---|---|
| S11.001 | S25 | 1.794 | 0.000 | 0.03 | | 1.6 | SURCHARGED | |
| S12.000 | SATTN | 2.256 | 0.000 | 0.01 | | 1.8 | SURCHARGED | |
| S4.004 | S26 | 2.585 | 0.000 | 0.07 | | 2.1 | SURCHARGED | |
| S4.005 | S27 | -0.190 | 0.000 | 0.06 | | 2.1 | OK | |

No flooding for 100yr event

Met Eireann
Return Period Rainfall Depths for sliding Durations
Irish Grid: Easting: 319451, Northing: 231098,

| | Interval | | Years | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DURATION | 6months, | 1year, | 2, | 3, | 4, | 5, | 10, | 20, | 30, | 50, | 75, | 100, | 150, | 200, | 250, | 500, |
| 5 mins | 2.5, | 3.7, | 4.3, | 5.2, | 5.8, | 6.3, | 8.0, | 9.9, | 11.2, | 13.0, | 14.6, | 15.8, | 17.8, | 19.3, | 20.6, | N/A , |
| 10 mins | 3.5, | 5.1, | 6.0, | 7.3, | 8.1, | 8.8, | 11.1, | 13.8, | 15.5, | 18.1, | 20.3, | 22.1, | 24.8, | 26.9, | 28.7, | N/A , |
| 15 mins | 4.2, | 6.0, | 7.0, | 8.5, | 9.6, | 10.4, | 13.1, | 16.2, | 18.3, | 21.2, | 23.9, | 26.0, | 29.2, | 31.7, | 33.8, | N/A , |
| 30 mins | 5.5, | 7.8, | 9.1, | 11.0, | 12.3, | 13.3, | 16.6, | 20.4, | 22.9, | 26.5, | 29.6, | 32.1, | 35.9, | 38.9, | 41.3, | N/A , |
| 1 hours | 7.3, | 10.2, | 11.8, | 14.1, | 15.7, | 17.0, | 21.0, | 25.6, | 28.7, | 32.9, | 36.7, | 39.7, | 44.2, | 47.7, | 50.6, | N/A , |
| 2 hours | 9.6, | 13.3, | 15.3, | 18.2, | 20.2, | 21.7, | 26.7, | 32.3, | 35.9, | 41.0, | 45.6, | 49.1, | 54.4, | 58.6, | 62.0, | N/A , |
| 3 hours | 11.3, | 15.5, | 17.8, | 21.1, | 23.3, | 25.1, | 30.6, | 36.9, | 41.0, | 46.6, | 51.7, | 55.5, | 61.5, | 66.0, | 69.8, | N/A , |
| 4 hours | 12.7, | 17.3, | 19.8, | 23.4, | 25.9, | 27.8, | 33.8, | 40.6, | 45.0, | 51.1, | 56.5, | 60.6, | 67.0, | 71.9, | 75.9, | N/A , |
| 6 hours | 14.9, | 20.3, | 23.1, | 27.2, | 29.9, | 32.0, | 38.8, | 46.4, | 51.3, | 58.1, | 64.1, | 68.7, | 75.7, | 81.0, | 85.5, | N/A , |
| 9 hours | 17.6, | 23.7, | 26.8, | 31.5, | 34.6, | 37.0, | 44.6, | 53.1, | 58.5, | 66.1, | 72.7, | 77.7, | 85.4, | 91.4, | 96.2, | N/A , |
| 12 hours | 19.7, | 26.4, | 29.9, | 35.0, | 38.4, | 41.0, | 49.2, | 58.4, | 64.2, | 72.4, | 79.5, | 84.9, | 93.1, | 99.5, | 104.7, | N/A , |
| 18 hours | 23.2, | 30.9, | 34.8, | 40.6, | 44.4, | 47.3, | 56.6, | 66.7, | 73.3, | 82.3, | 90.1, | 96.1, | 105.2, | 112.1, | 117.8, | N/A , |
| 24 hours | 26.1, | 34.5, | 38.8, | 45.1, | 49.2, | 52.4, | 62.4, | 73.4, | 80.4, | 90.1, | 98.5, | 104.9, | 114.7, | 122.1, | 128.2, | 149.0, |
| 2 days | 31.9, | 41.3, | 46.1, | 53.0, | 57.4, | 60.8, | 71.6, | 83.1, | 90.5, | 100.5, | 109.2, | 115.7, | 125.6, | 133.1, | 139.2, | 160.0, |
| 3 days | 36.7, | 46.9, | 52.0, | 59.4, | 64.2, | 67.8, | 79.1, | 91.2, | 98.9, | 109.3, | 118.3, | 125.0, | 135.2, | 142.8, | 149.1, | 170.2, |
| 4 days | 40.8, | 51.8, | 57.2, | 65.0, | 70.0, | 73.8, | 85.7, | 98.4, | 106.3, | 117.1, | 126.3, | 133.3, | 143.7, | 151.5, | 157.9, | 179.5, |
| 6 days | 48.1, | 60.3, | 66.3, | 74.8, | 80.3, | 84.4, | 97.2, | 110.7, | 119.2, | 130.6, | 140.4, | 147.7, | 158.6, | 166.8, | 173.5, | 195.8, |
| 8 days | 54.6, | 67.7, | 74.2, | 83.3, | 89.2, | 93.6, | 107.2, | 121.6, | 130.5, | 142.5, | 152.7, | 160.3, | 171.7, | 180.2, | 187.1, | 210.2, |
| 10 days | 60.5, | 74.5, | 81.4, | 91.1, | 97.3, | 102.0, | 116.3, | 131.3, | 140.7, | 153.2, | 163.8, | 171.7, | 183.5, | 192.3, | 199.5, | 223.3, |
| 12 days | 66.0, | 80.9, | 88.1, | 98.3, | 104.9, | 109.7, | 124.7, | 140.4, | 150.1, | 163.1, | 174.0, | 182.2, | 194.4, | 203.5, | 210.8, | 235.3, |
| 16 days | 76.2, | 92.5, | 100.5, | 111.6, | 118.7, | 124.0, | 140.1, | 156.9, | 167.3, | 181.1, | 192.7, | 201.4, | 214.3, | 223.9, | 231.6, | 257.3, |
| 20 days | 85.6, | 103.3, | 111.8, | 123.8, | 131.3, | 136.9, | 154.2, | 171.9, | 182.9, | 197.4, | 209.7, | 218.8, | 232.3, | 242.3, | 250.3, | 277.1, |
| 25 days | 96.6, | 115.8, | 125.0, | 137.8, | 145.9, | 152.0, | 170.4, | 189.3, | 200.9, | 216.3, | 229.2, | 238.8, | 252.9, | 263.4, | 271.9, | 299.8, |

NOTES:
N/A Data not available
These values are derived from a Depth Duration Frequency (DDF) Model
For details refer to:
'Fitzgerald D. L. (2007), Estimates of Point Rainfall Frequencies, Technical Note No. 61, Met Eireann, Dublin',
Available for download at www.met.ie/climate/dataproducts/Estimation-of-Point-Rainfall-Frequencies_TN61.pdf

M5-60m = 17.0 R = (M5-60m )/(M5-2D) = 17.0/60.8

M5-2D = 60.8 R = 0.280

## Appendix C

DCC Drainage Division Record Drawing and DCC Watermain Record Drawing


UISCE ÉIREANN : IRISH WATER

## Boundary Valves

**Valve Normal Position**

- Open
- Closed
- Part Closed

## Non Boundary Valves

**Valve Normal Position**

- Open
- Closed
- Part Closed
- Air Control Valves
- Water Stop Valves

## Non Boundary Meter

**Meter Function**

- Meter
- Group Scheme
- Source

**Meter Function**

- District (Boundary Meter)
- Water Hydrants
- Treatment Plant

## Reservoir

**Liquid Type**

- Potable
- Raw Water
- Pump Stations
- Water Network Structures
- Abstraction Point
- Kiosk

## Water Fittings

**Fitting Type**

- Cap
- Other Fitting
- Water Distribution Chambers

## Water Mains(Irish Water Owned)

**Liquid Type**

- Untreated
- Potable Water

## Water Mains(Non Irish Water Owned)

**Liquid Type**

- Untreated
- Potable Water

## Water Lateral Lines

**Owned By**

- Irish Water
- Non IW
- Water Abandoned Lines
- Water Casings
- Water Network Junctions

## TITLE

| Created by: | Last edited by: Paflynn | Approved by: |
|---|---|---|
| Created date: | Last edited: 21/11/2014 | Approved date: |

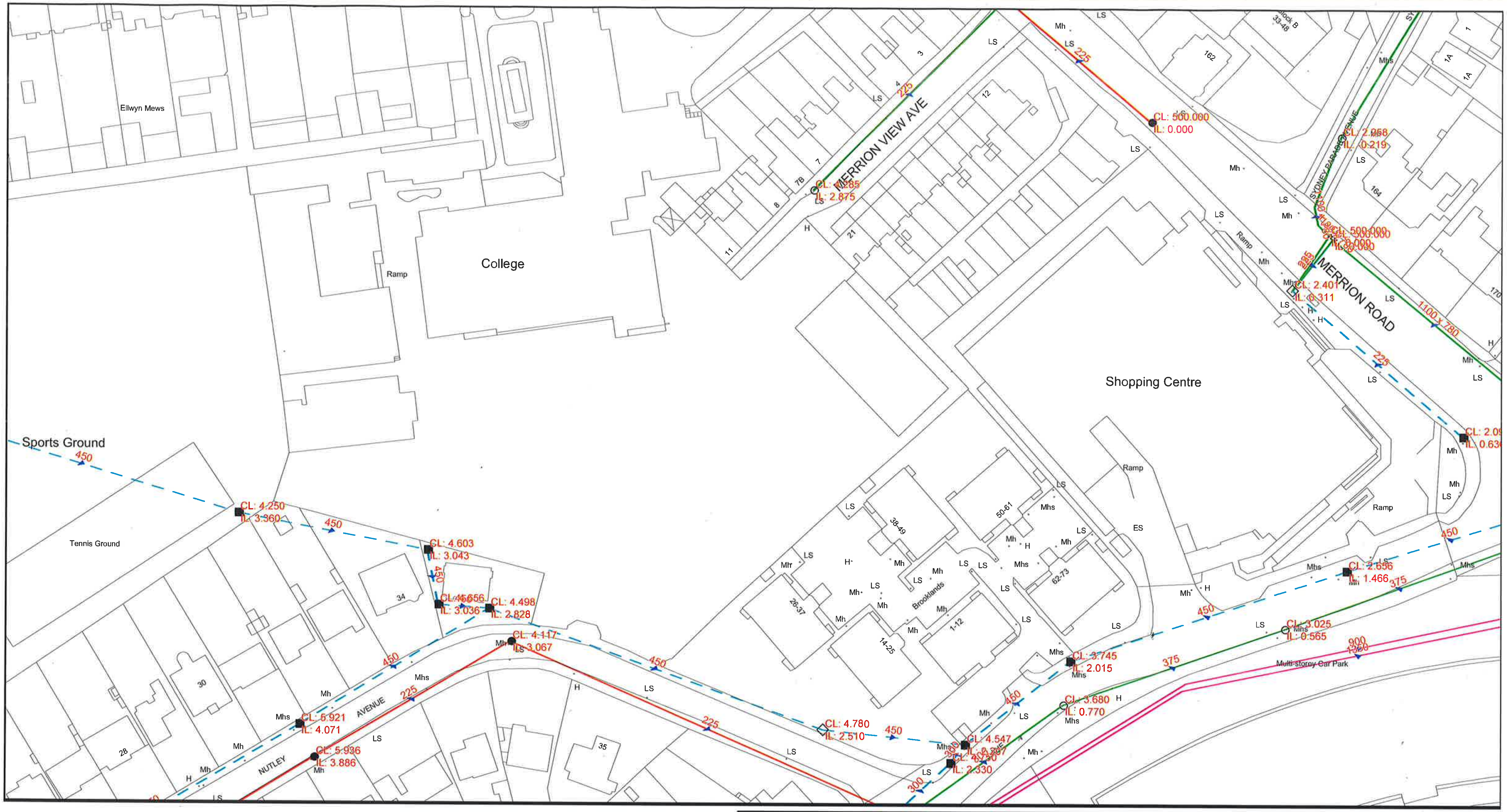
1:1,000

at A1

Metres

0 25 50 100

Whilst every care has been taken in its compilation, Irish Water gives this information as to the position of its underground network as a general guide only on the strict understanding that it is based on the best available information provided by each Local Authority in Ireland to Irish Water. Irish Water can assume no responsibility for and give no guarantees, undertakings or warranties concerning the accuracy, completeness or up to date nature of the information provided and does not accept any liability whatsoever arising from any errors or omissions.This information should not be relied upon in the event of excavations or any other works being carried out in the vicinity of the Irish Water underground network. The onus is on the parties carrying out excavations or any other works to ensure the exact location of the Irish Water underground network is indentified prior to excavations or any other works being carried out. Service connection pipes are not generally shown but their presence should be anticipated.




## LEGEND

| | |
|---|---|
| Trunk Sewer | |
| Combined Sewer | |
| Surface Water Sewer | Manhole |
| Foul Sewer | |
| Overflow | |
| Pumping | |

- gully catch pit cover
- storm overflow
- pumping station
- junction
- other node
- hatch box
- outfall
- high point
- vent column
- catchpit
- cascade
- unknown feature
- flap valve
- rodding eye
- inverted syphon

Scale: 1: 1000
Date: 7 Oct 2015

**PLEASE NOTE:**

- INFORMATION SUPPLIED FROM CORPORATION RECORD SHEETS IS GIVEN WITHOUT PREJUDICE.
- ACCURACY MUST ALWAYS BE VERIFIED ON SITE.
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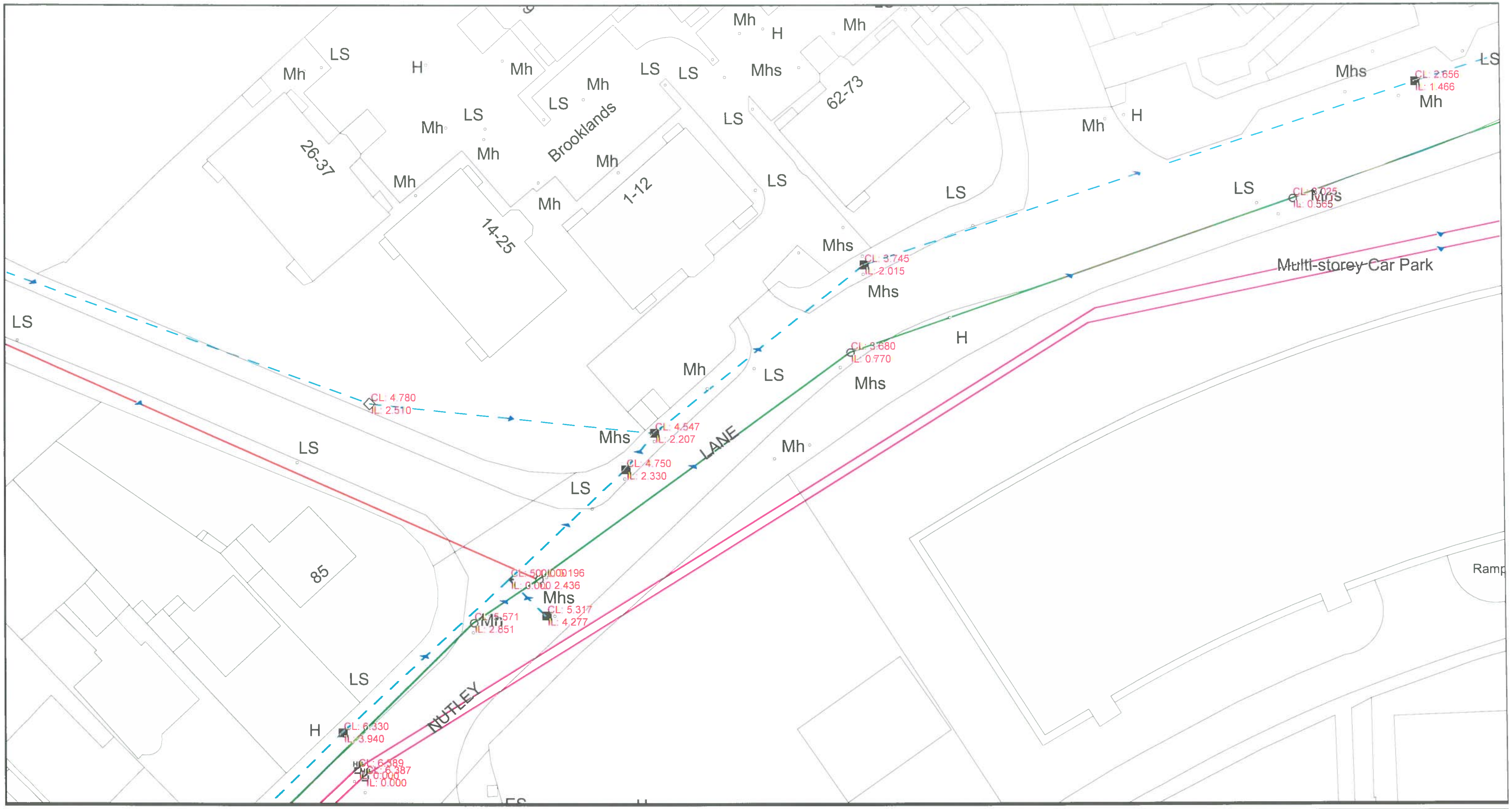
Dublin City
Baile Átha Cliath

DESIGN DIVISION, DRAINAGE DESIGN, ENGINEERING DEPARTMENT, BLOCK 1, FLOOR 2, CIVIL OFFICES, WOODQUAY, DUBLIN 8 Ph:01 6796111 Fax:01 6790809




**LEGEND**

- Trunk Sewer
- Combined Sewer
- Surface Water Sewer
- Foul Sewer
- Manhole
- Overflow
- Pumping
- gully catch pit cover
- storm overflow
- pumping station
- junction
- other node
- hatch box
- outfall
- high point
- vent column
- catchpit
- cascade
- unknown feature
- flap valve
- rodding eye
- inverted syphon

Scale: 1: 500

Date: 1 Dec 2014

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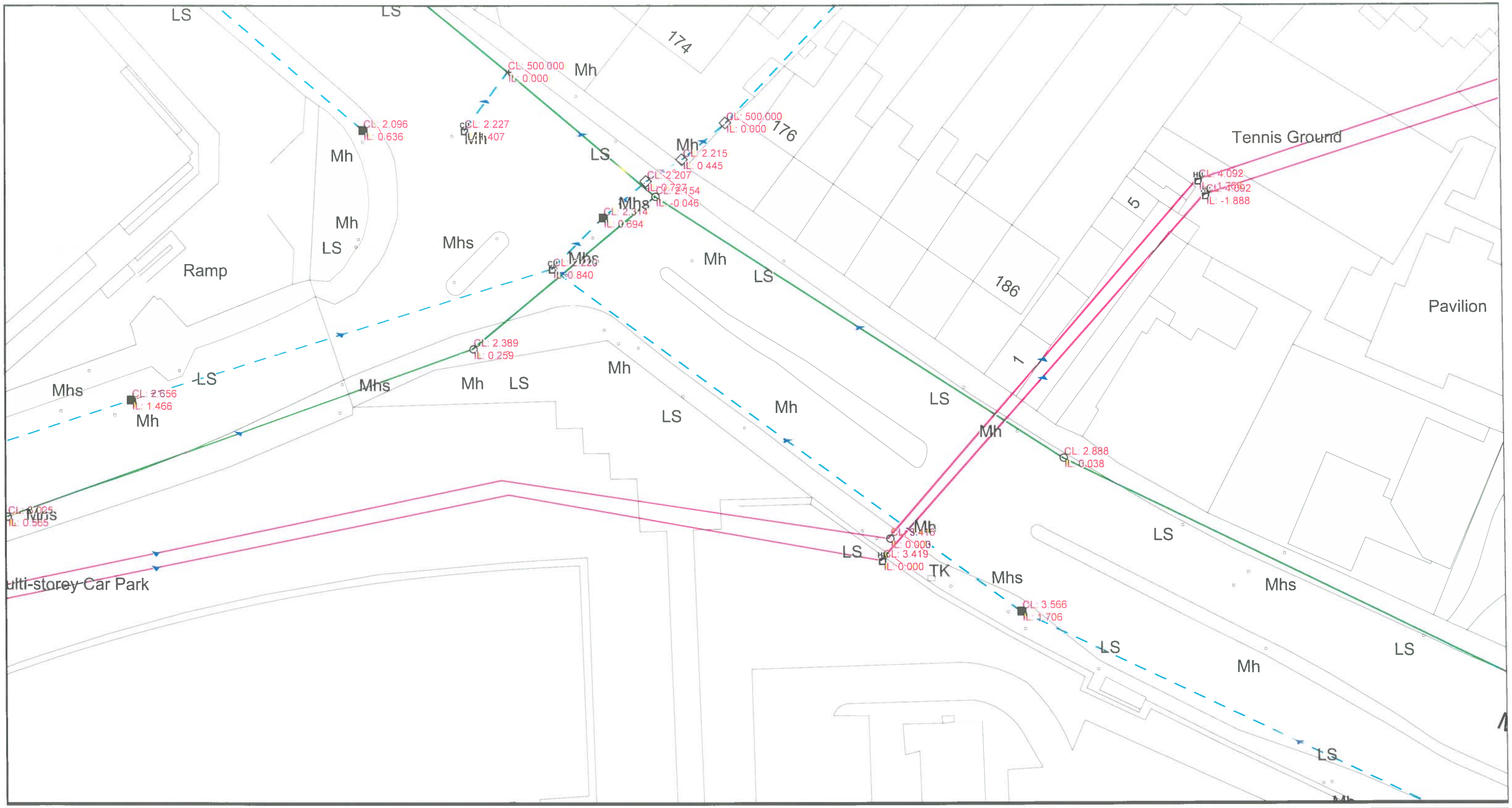


## LEGEND

- Trunk Sewer
- Combined Sewer
- Manhole
- Surface Water Sewer
- Foul Sewer
- Overflow
- Pumping
- gully catch pit cover
- storm overflow
- pumping station
- junction
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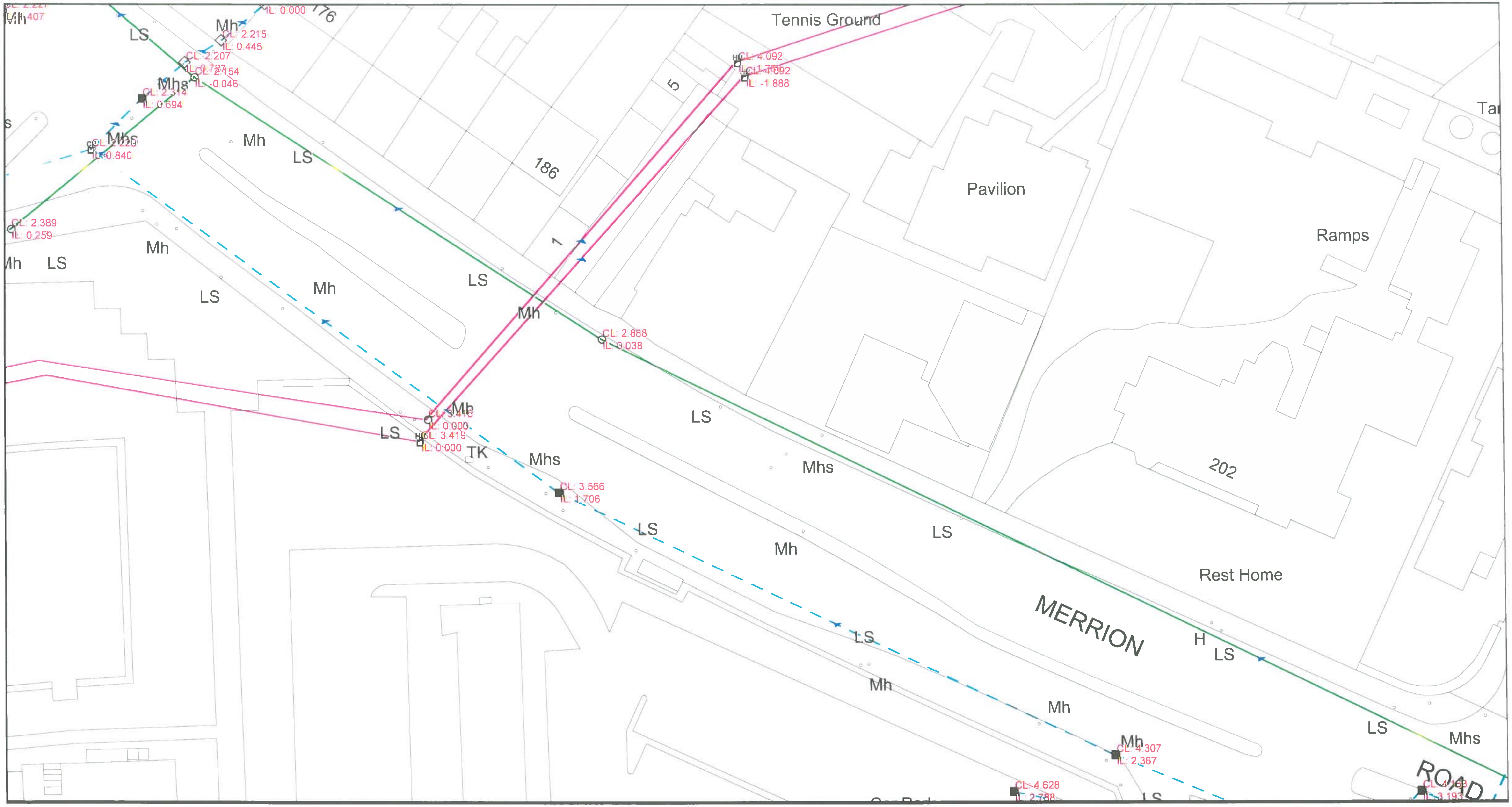


## LEGEND

Trunk Sewer
Combined Sewer
Manhole
Surface Water Sewer
Foul Sewer
Overflow
Pumping

gully catch pit cover
storm overflow
pumping station
junction
other node
hatch box
outfall
high point
vent column
catchpit
cascade
unknown feature
flap valve
rodding eye
inverted syphon

Scale: 1: 500
Date: 1 Dec 2014

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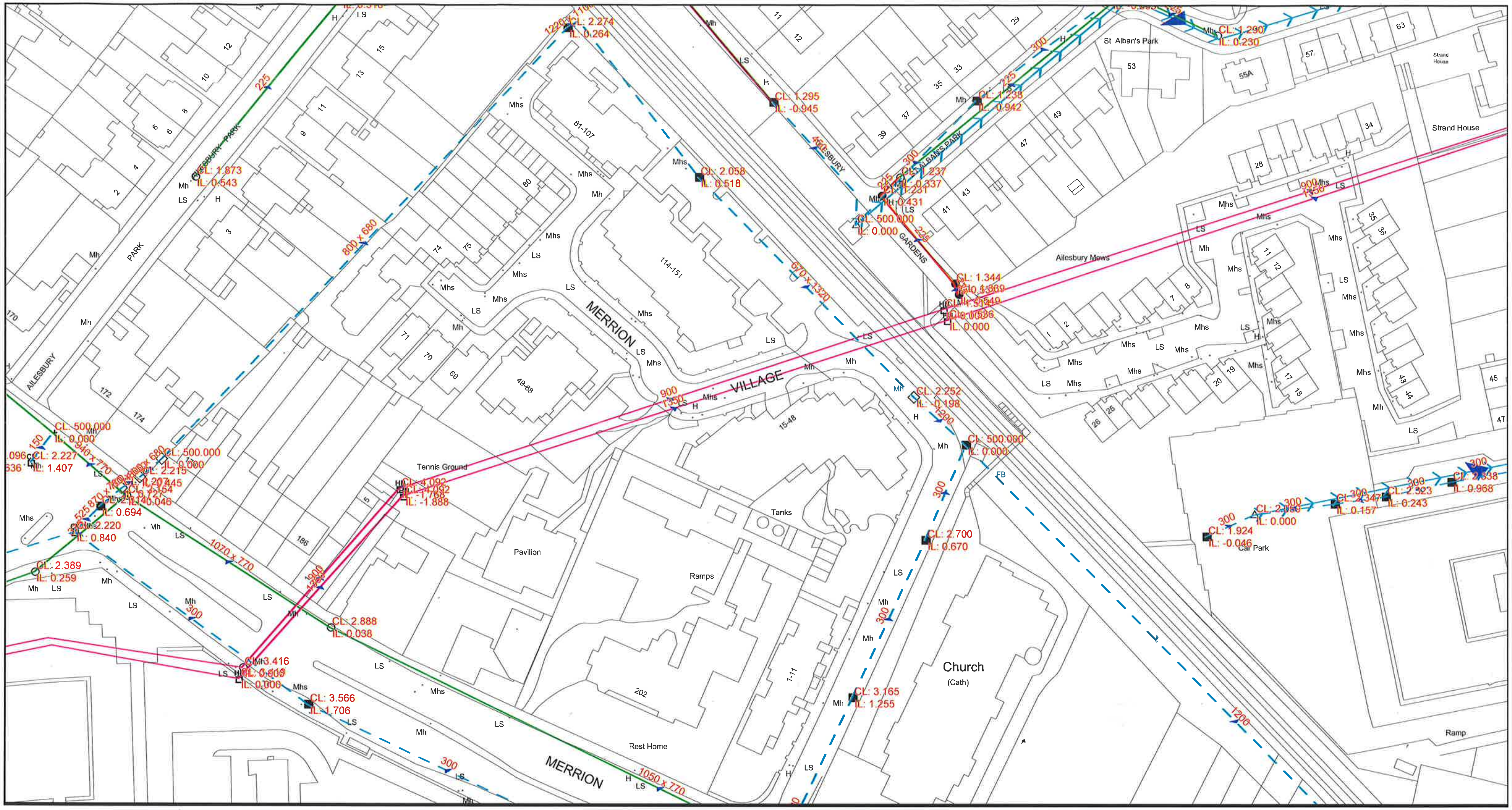


2

## LEGEND

| | |
|---|---|
| Trunk Sewer | gully catch pit cover |
| Combined Sewer | storm overflow |
| Surface Water Sewer | pumping station |
| Foul Sewer | junction |
| Overflow | other node |
| Pumping | hatch box |
| | outfall |
| | high point |
| | vent column |
| | catchpit |
| | cascade |
| | unknown feature |
| | flap valve |
| | rodding eye |
| | inverted syphon |

Manhole

Scale: 1: 1000
Date: 7 Oct 2015

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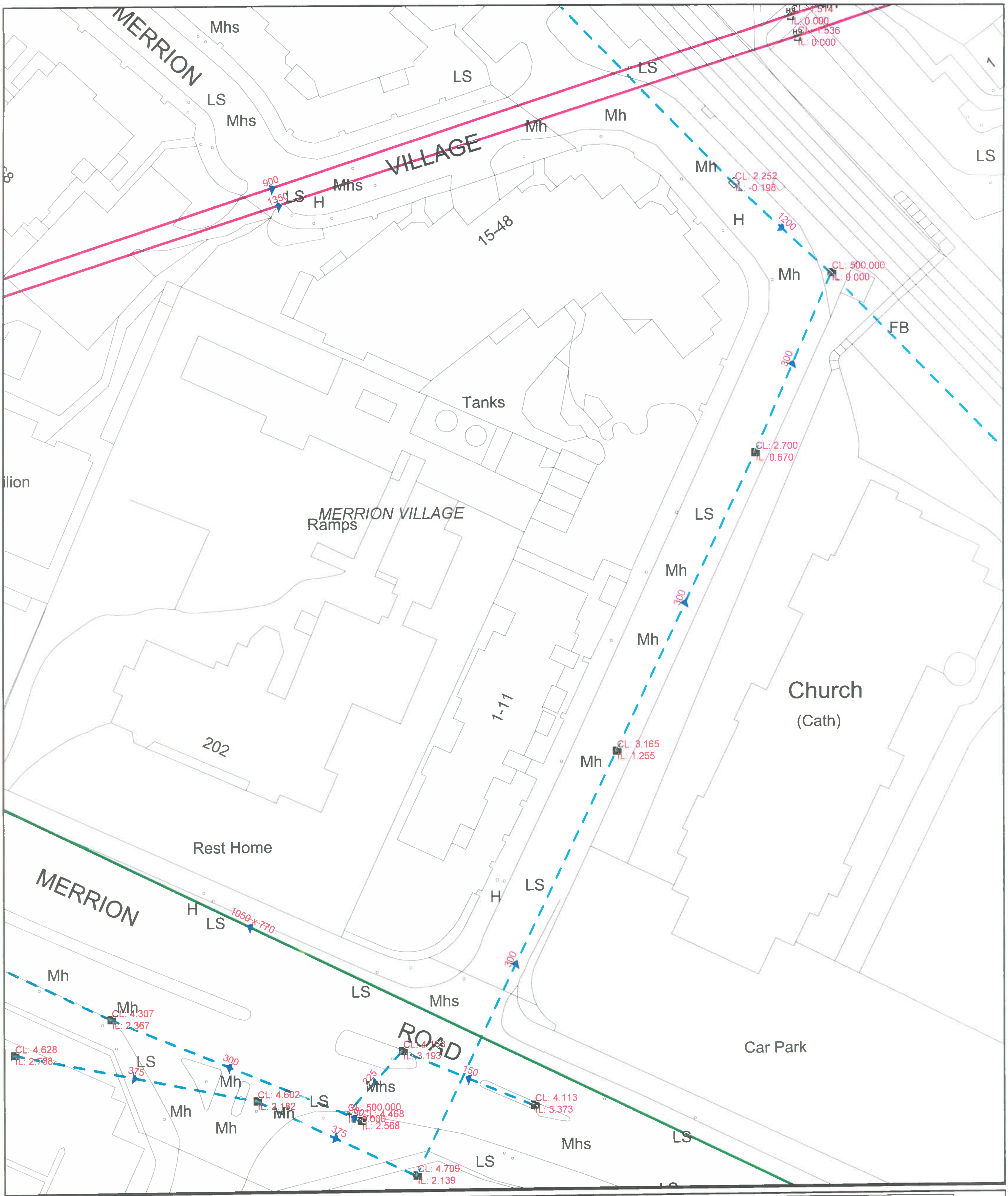


## LEGEND

| | |
|---|---|
| Trunk Sewer | gully catch pit cover |
| Combined Sewer | storm overflow |
| Surface Water Sewer | pumping station |
| Foul Sewer | junction |
| Overflow | other node |
| Pumping | hatch box |
| | outfall |
| | high point |
| | vent column |
| | catchpit |
| | cascade |
| | unknown feature |
| | flap valve |
| | rodding eye |
| | inverted syphon |

Manhole

Scale: 1: 500
Date: 2 Dec 2014

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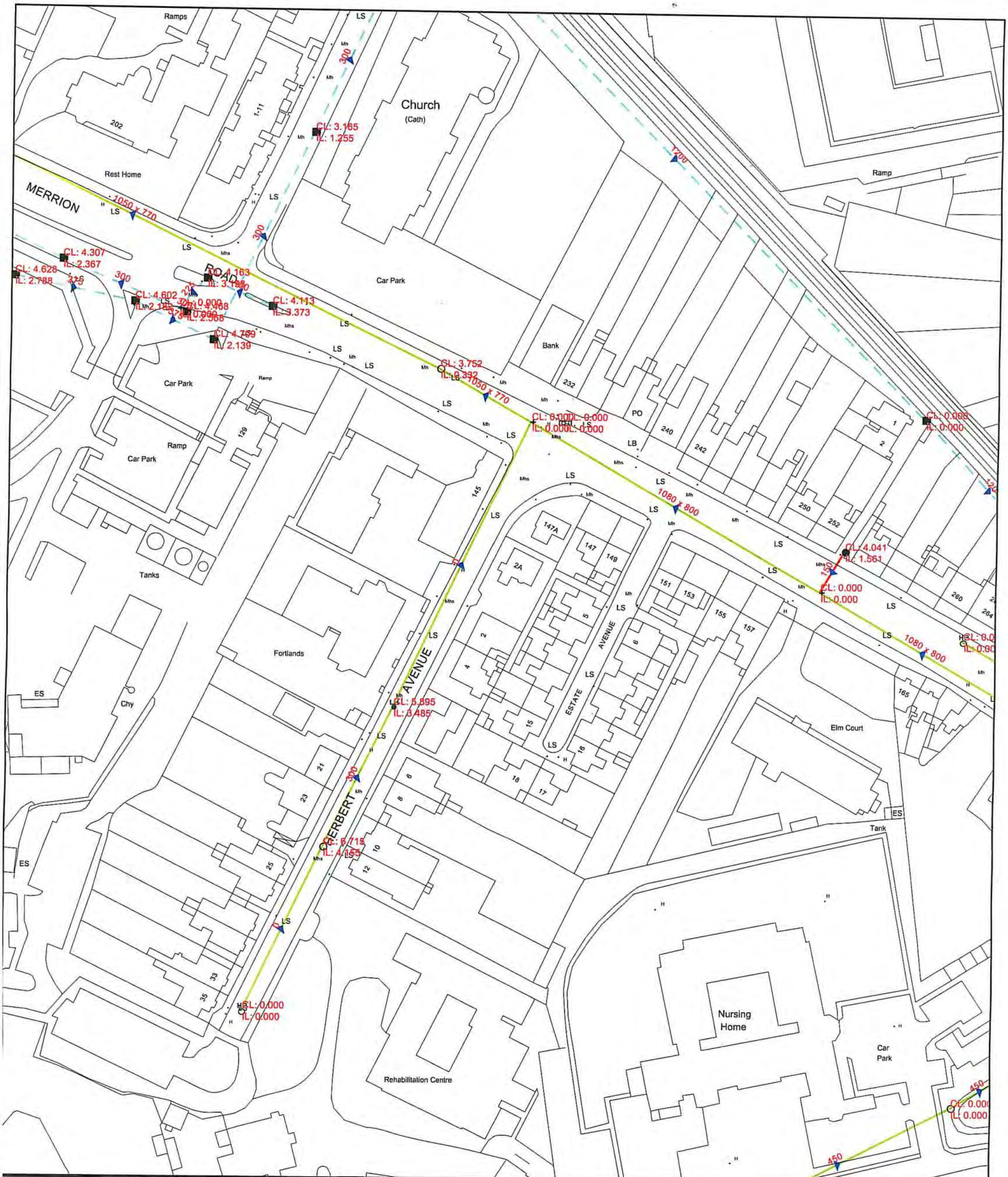


| LEGEND | | | |
|---|---|---|---|
| Trunk Sewer | | gully catch pit cover | |
| Combined Sewer | | storm overflow | |
| Surface Water Sewer | Manhole | pumping station | |
| Foul Sewer | | junction | |
| Overflow | | other node | |
| Pumping | | hatch box | |
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| | | vent column | |
| | | catchpit | |
| | | cascade | |
| | | unknown feature | |
| | | flap valve | |
| | | rodding eye | |
| | | inverted syphon | |

Scale: 1: 1000
Date: 12 Apr 2010



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## Appendix D

Greenroof Drawing


NOTES / LEGEND

GENERAL NOTES:

- DO NOT SCALE. USE FIGURED DIMESIONS ONLY.
- THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT SPECIFICATIONS AND DRAWINGS.
- ALL DIMENSIONS TO BE CHECKED ON SITE.
- IN THE EVENT OF ANY DISCREPANCIES BETWEEN DRAWINGS, THE CONTRACTOR IS TO INFORM THE ARCHITECT IMMEDIATELY.



NORTH

0m 4m 8m 12m 16m 20m

VISUAL SCALE 1:200 @ A0

DIMENSIONS IN MILLIMITERS
LEVELS IN METERS

| REVISION | DATE | DESCRIPTION | BY |
|---|---|---|---|

PROJECT
**NATIONAL MATERNITY HOSPITAL AT SVUH**

CLIENT
HSE

| DRAWING TITLE | SCALE @ A0 | DATE |
|---|---|---|
| BLOCK A+F LEVEL +6 FLOOR PLAN | 1 : 200 | AUG.2016 |
| STATUS | DRAWN BY | CHECKED BY |
| PLANNING APPLICATION | AT | SM |
| DRAWING NUMBER | REVISION | PROJECT NUMBER |
| **NMH_OCM_A_DR_PA_117** | | **3895** |

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Belfast BT7 1NR

t +44 28 9066 3291
f +44 28 9068 2727

architects@isherwood-ellis.com

## Appendix E

Minutes of Meeting with DCC Drainage Division

# Minutes

ARUP

| | | | |
|---|---|---|---|
| Project title | New Maternity Hospital at St Vincent's University Hospital | Job number | 235754-00 |
| Meeting name and number | Dublin City Council Drainage Division | File reference | B |
| Location | Civic Offices | Time and date | 14.30hrs 7 December 2015 |
| Purpose of meeting | Drainage Strategy for Proposed Development | | |
| Present | Gerry Doherty (GD), DCC Drainage Division<br>Maria Treacy (MT), DCC Drainage Division<br>Kevin Barry (KB), Arup<br>Alex Nutley (AN), Arup<br>Kieran Dowdall (KD), Arup | | |
| Apologies | | | |
| Circulation | Those present<br>Dan Moran, Arup<br>Design Team (DT) | | |

| | |
|---|---|
| Prepared by | Kieran Dowdall |
| Date of circulation | 9 December 2015 |
| Date of next meeting | TBA |





Action

**1.** KD outlined development proposals including the New Maternity Hospital Building and extension to the Multi-Storey Car Park (MSCP).

**2. Foul Drainage**

**2.1** KD stated that foul drainage to include discharges from 232 new bedspaces and circa 907 staff/day with estimated hydraulic foul loading 120m$^3$/day and peak flow of 8.4l/s (6 x DWF). KD confirmed foul flow monitoring of existing foul outfall to sewer on Merrion Road confirmed daily average discharges of 116m$^3$/day or 8.1 l/s peak flow rates.

**2.2** KD stated that flow monitoring also indicated surface water discharge to the foul system during rainfall events. These discharges will now be removed / reduced due to the redevelopment and replacement of existing combined drains with new separate drains thereby removing surface water run-off from the receiving foul sewerage system and releasing spare capacity for new foul discharges.

**2.3** DCC confirmed that the combined existing and proposed foul flow rates were acceptable and the existing sewer (1080 x 770mm) on Merrion Road would have capacity to receive the new effluent.

**3. Surface Water Drainage**

**3.1** KD produced a site drainage layout drawing and site catchment drawing indicating the surface water layout and outfall from the Campus on Merrion Road adjacent to the main vehicular entrance. KD explained the extent of the Campus already subject to storm attenuation and restricted outflows which included the western campus of the University Hospital and the Private Clinic to the east. These areas account for approximately 47% of the total Campus subject to restricted discharges and storm attenuation facilities. With the new development this area will increase to 64% of the site Campus. It was agreed that the new Maternity Hospital with a redeveloped site area of approximately 2 hectares will discharge at 2 litres/second/hectare or 4 l/s total.

**3.2** KD outlined that two separate attenuation tanks will be provided to minimise the risk of surface flooding on the drainage network. A third attenuation tank will be provided at the extension to the MSCP with a restricted outflow of 2 l/s. However the new

Action

extension is discharging into the existing system with a hydrobrake downstream which restricts flow to 5 l/s.

Simulation of the drainage system model confirms no issues with flooding to the network.

**3.3** DCC stated they were satisfied with this approach indicating that the attenuation of 64% of the total Campus area was satisfactory and that in the future further SuDS measures could be provided to reduce peak discharges to the receiving systems.

**3.4** KD confirmed that 27% of the roof area was greenroof and approximately 10% was landscaped courtyards and gardens.

DCC were happy with this approach and indicated that increased soft landscaping should be optimised in any further applications.

**3.5** DCC also indicated that a CCTV survey of the 300mm surface water outfall sewer maybe requested in order to confirm the condition of the sewer for receiving flows from the hospital.

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

# Flood Risk Assessment Report

Health Services Executive

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

Flood Risk Assessment

235754-00

Issue 3 | 23 February 2017



Job number 235754-00

**Ove Arup & Partners Ireland Ltd**

**Arup**
50 Ringsend Road
Dublin 4
D04 T6X0
Ireland
www.arup.com

ARUP

# 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.

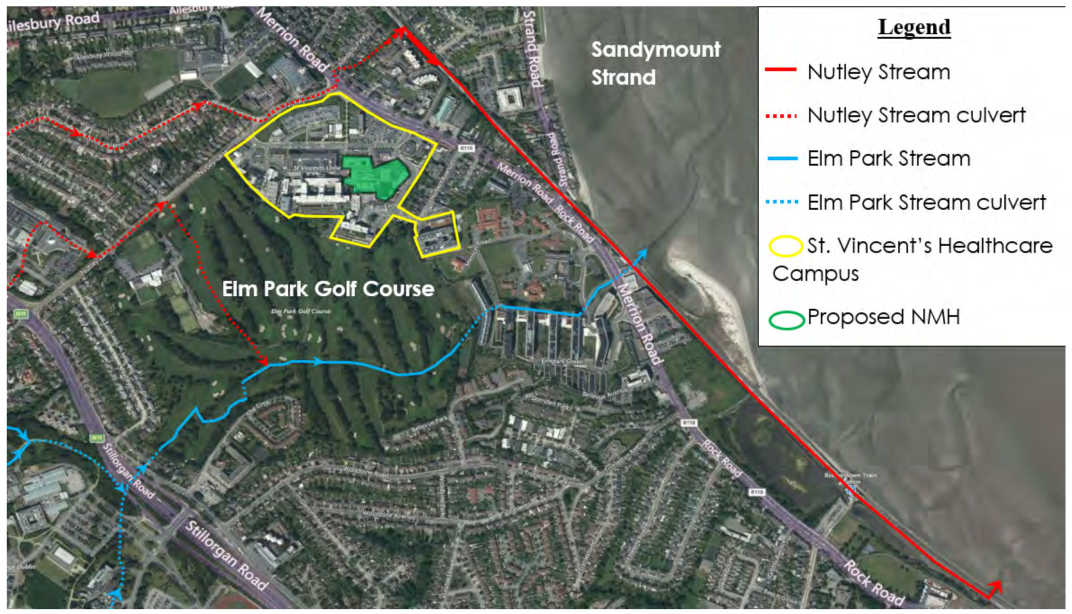


Figure 1 Site Location and local watercourses

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

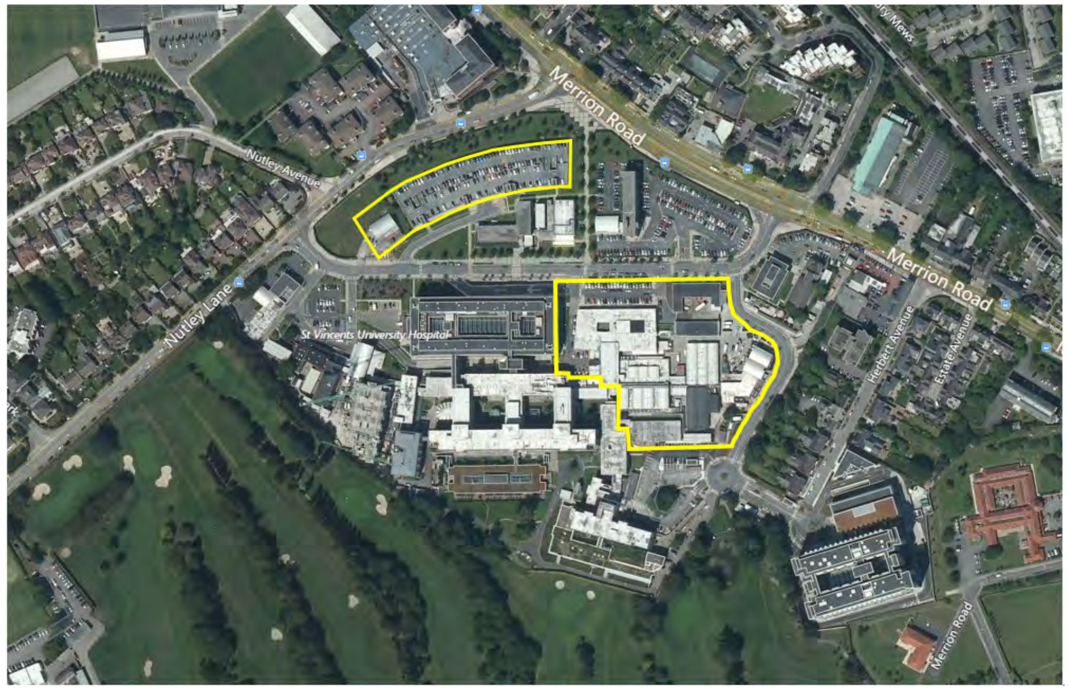


Figure 2 Arial view of the proposed development. The approximate outline of the site of the proposed development is indicated in red.


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.

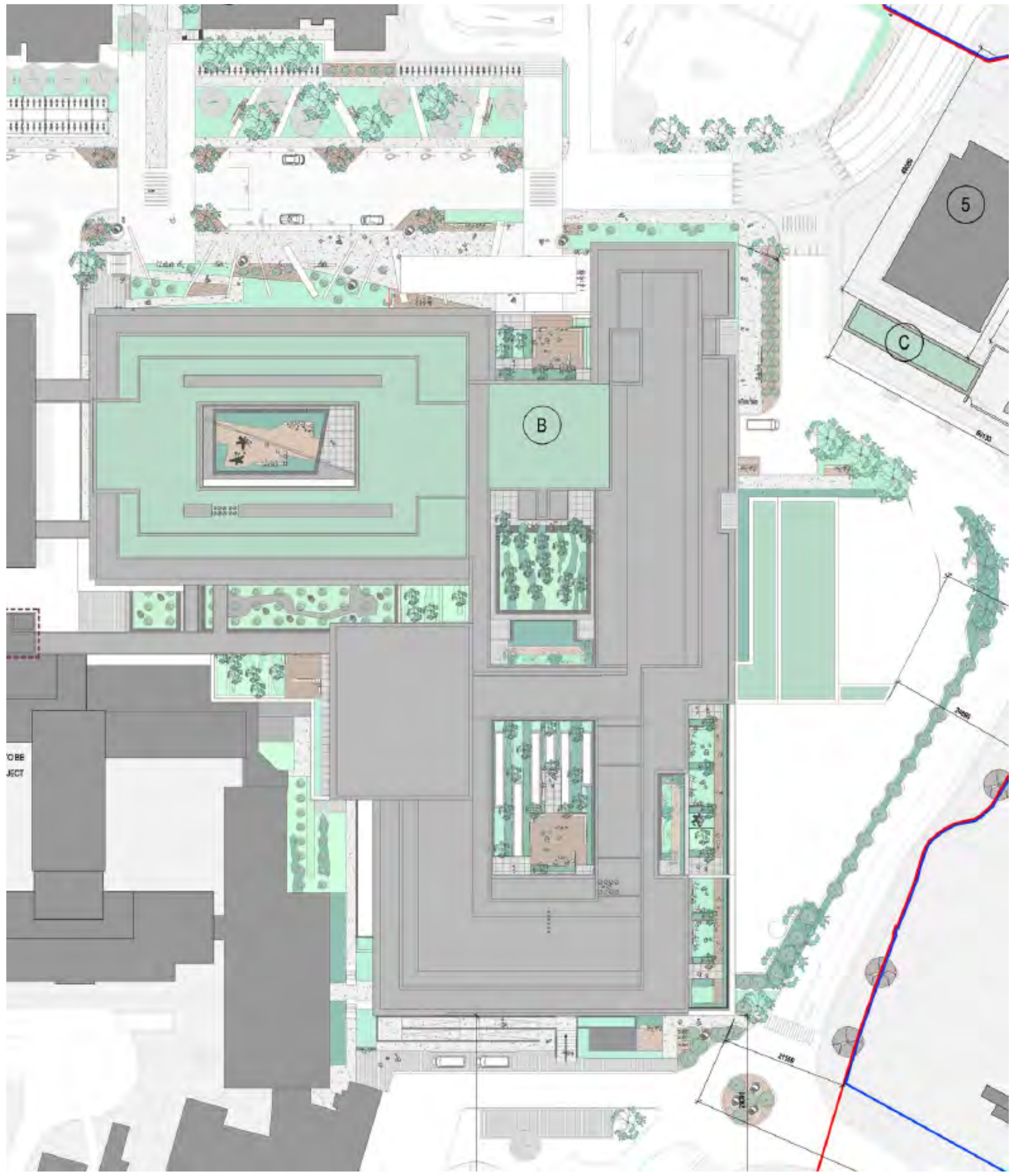


Figure 4 Landscape plan

# 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).<br>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*".

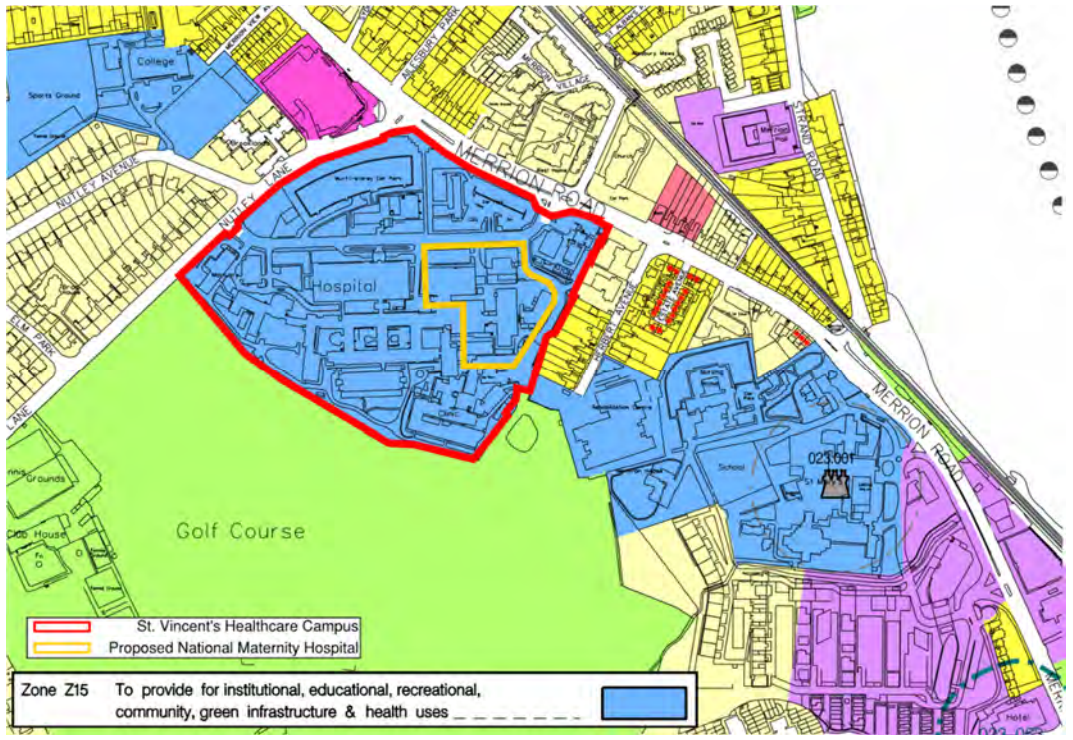


Figure 5 Zoning for the site

# 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).

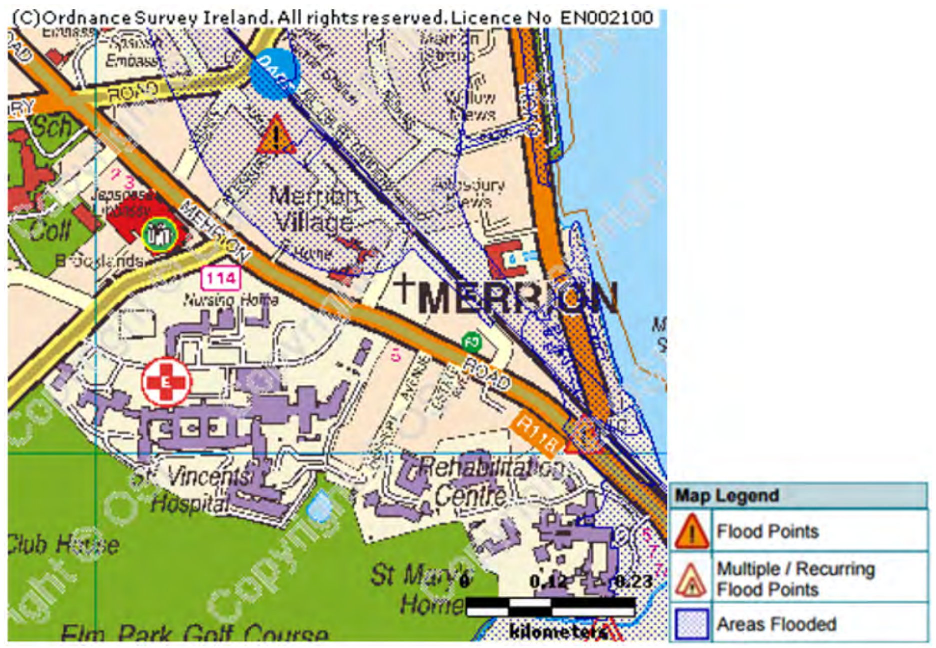


Figure 6 Extract from floodmaps.ie

- **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.

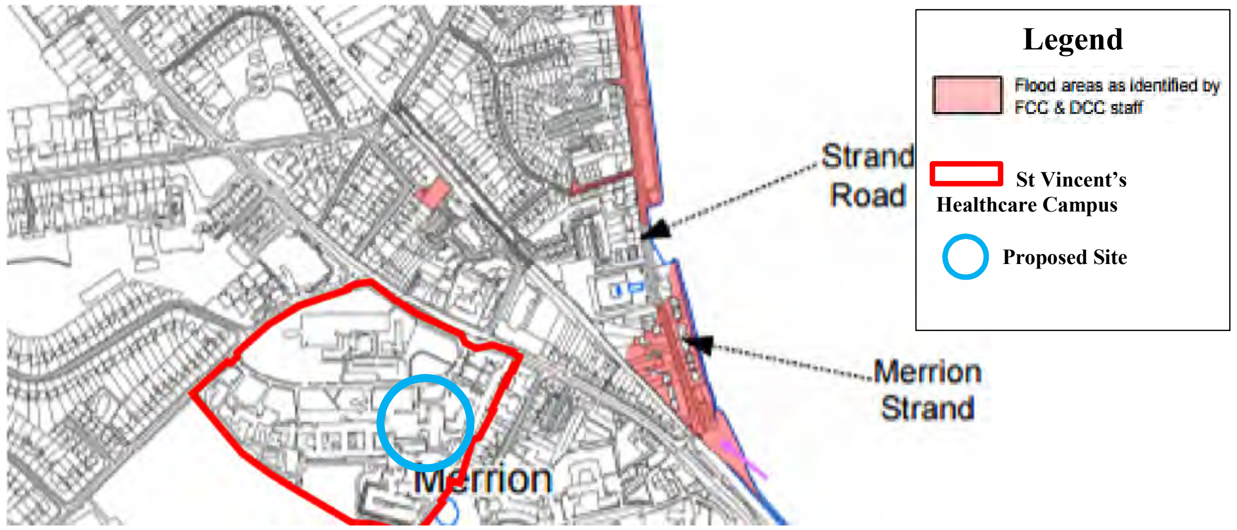


Figure 7 Previous tidal flood extent

- (*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.

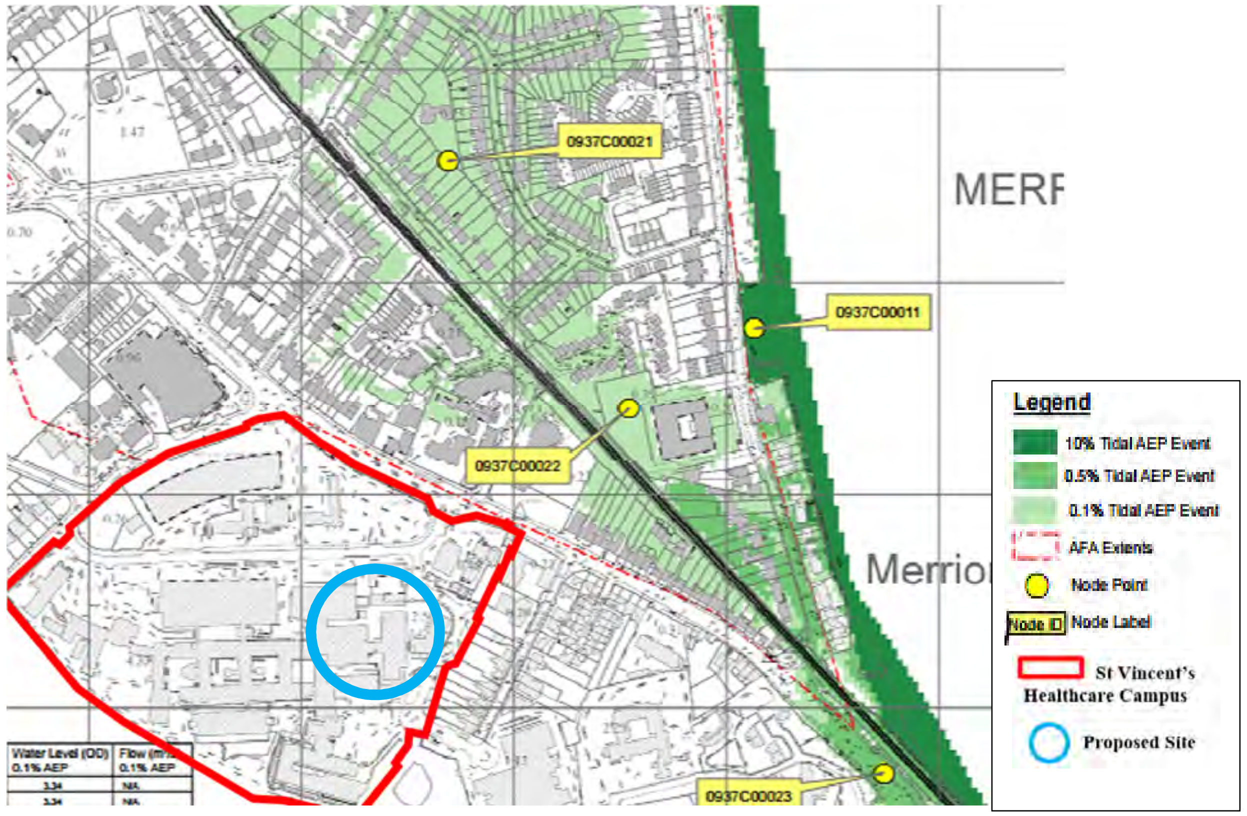


Figure 8 Tidal flood extent map from the ICPSS

## 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.

| | Water Level (mOD Malin) per AEP | | |
|---|---|---|---|
| Node Label | WL 10% | WL 0.5 % | WL 0.1 % |
| Point 23 | 2.64 | 3.04 | 3.25 |

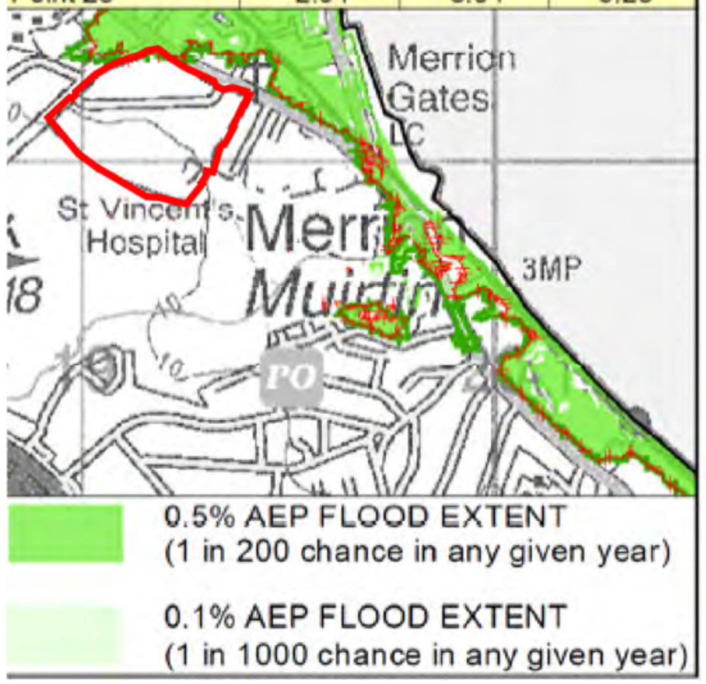


Figure 9 Extract from ICPSS

# 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.

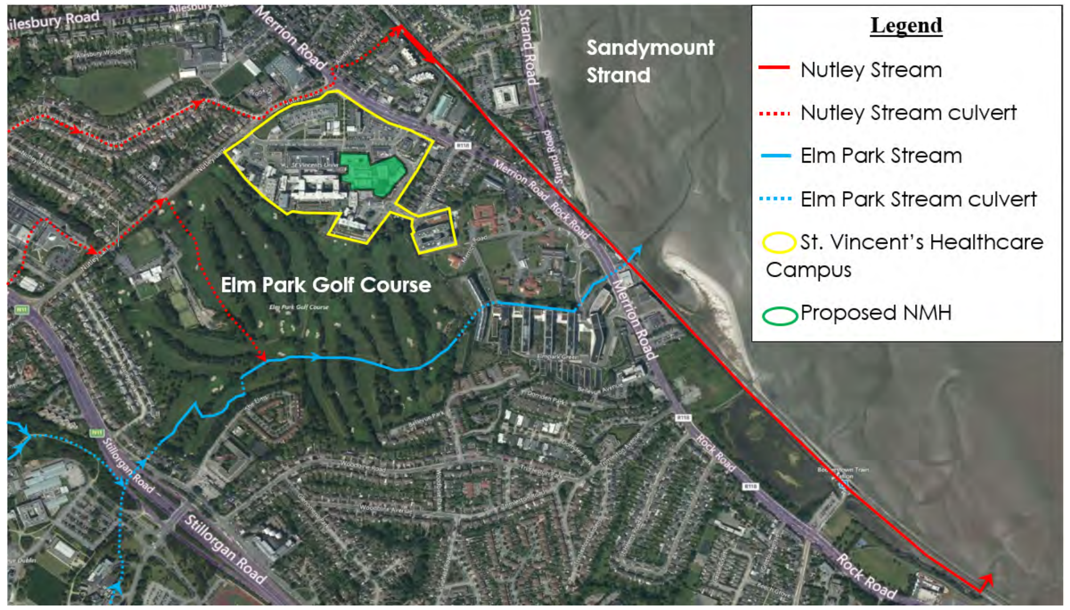


Figure 10 Elm Park and Nutley stream

## 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.

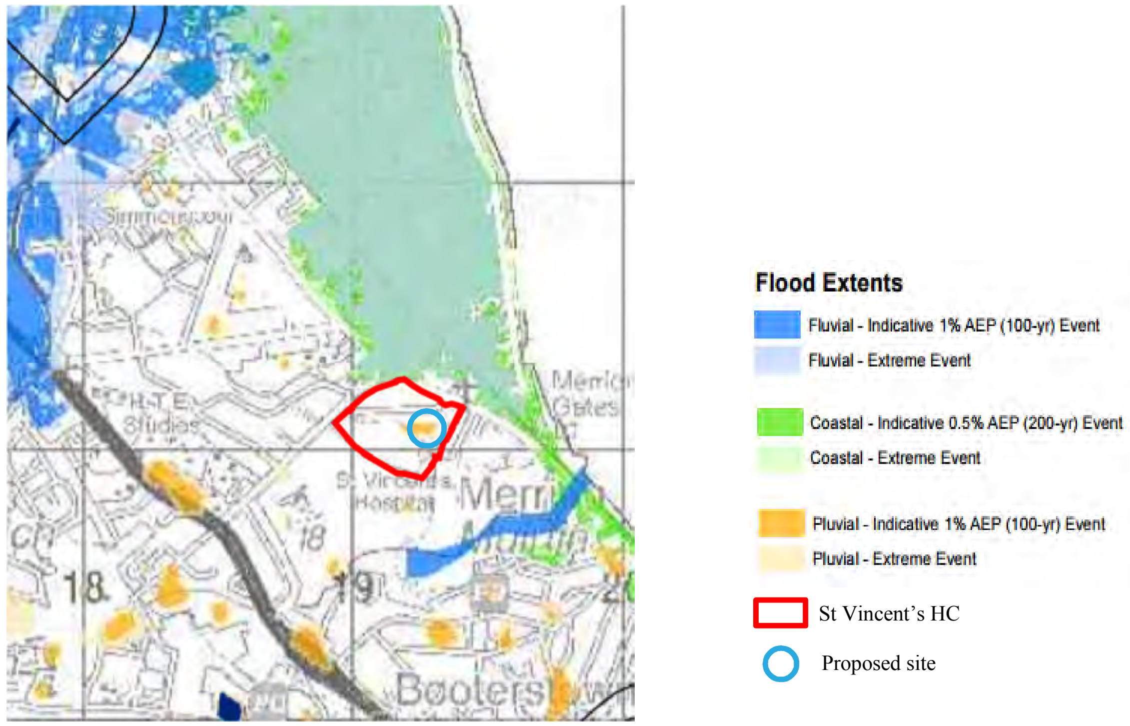


Figure 12 Preliminary PRFA mapping (OPW)

## 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.

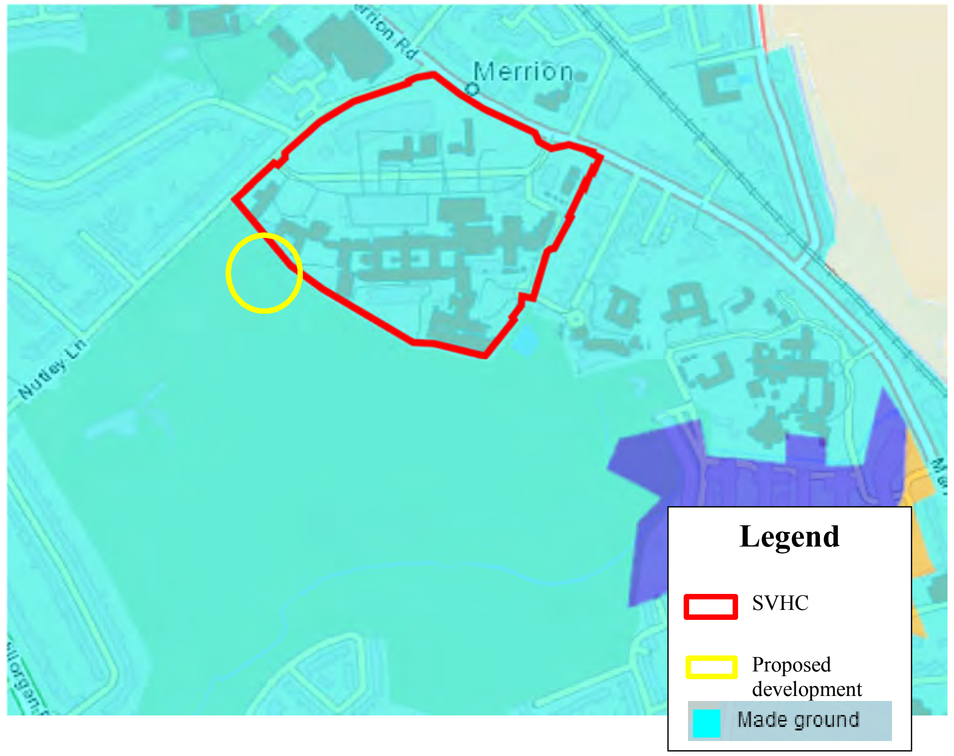


Figure 13 Subsoil classification


Figure 14 Bedrock aquifers

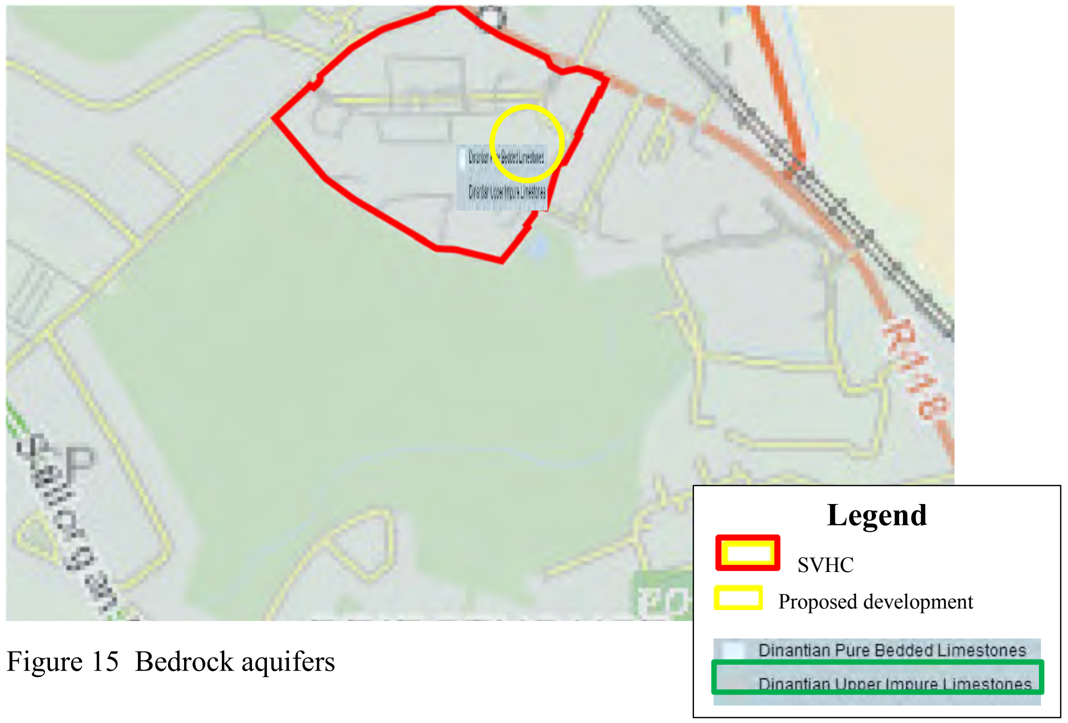


Figure 15 Bedrock aquifers

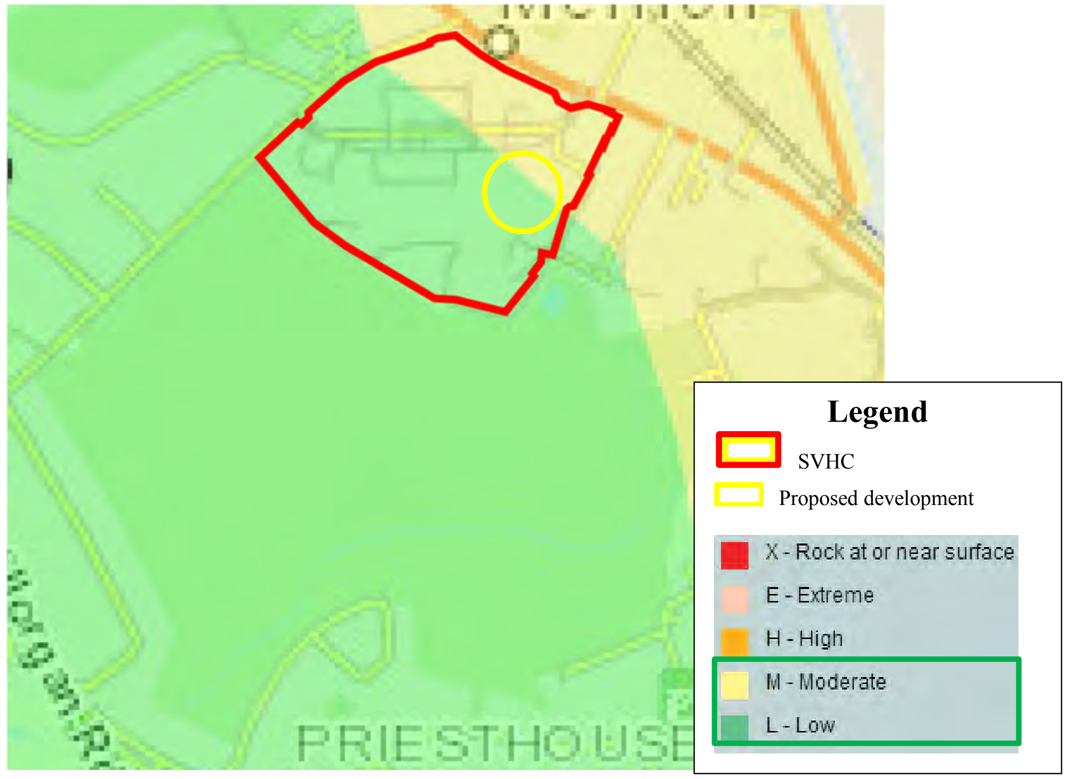


Figure 16 Groundwater vulnerability

### 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.

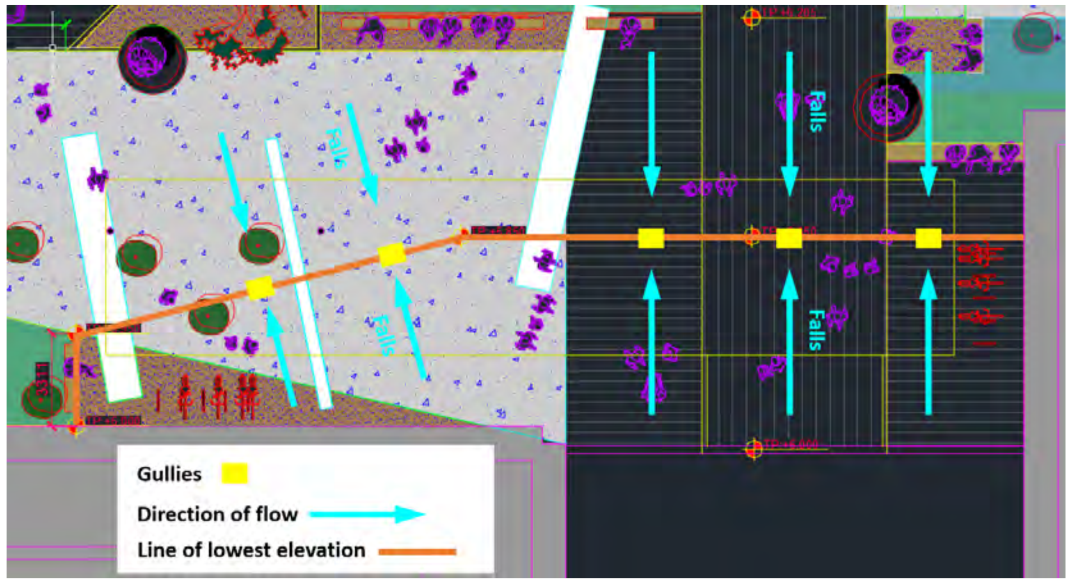


Figure 17 Indicative sketch which details the measures to address the risk of pluvial flooding at the site.

## 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;<br>Hospitals;<br>Emergency access and egress points;<br>Schools;<br>Dwelling houses, student halls of residence and hostels;<br>Residential institutions such as residential care homes, children's homes and social services homes;<br>Caravans and mobile home parks;<br>Dwelling houses designed, constructed or adapted for the elderly or, other people with impaired mobility; and<br>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;<br>Land and buildings used for holiday or short-let caravans and camping, subject to specific warning and evacuation plans;<br>Land and buildings used for agriculture and forestry;<br>Waste treatment (except landfill and hazardous waste);<br>Mineral working and processing; and<br>Local transport infrastructure. |
| Water-compatible development | Flood control infrastructure;<br>Docks, marinas and wharves;<br>Navigation facilities;<br>Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location;<br>Water-based recreation and tourism (excluding sleeping accommodation);<br>Lifeguard and coastguard stations;<br>Amenity open space, outdoor sports and recreation and essential facilities such as changing rooms; and<br>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.

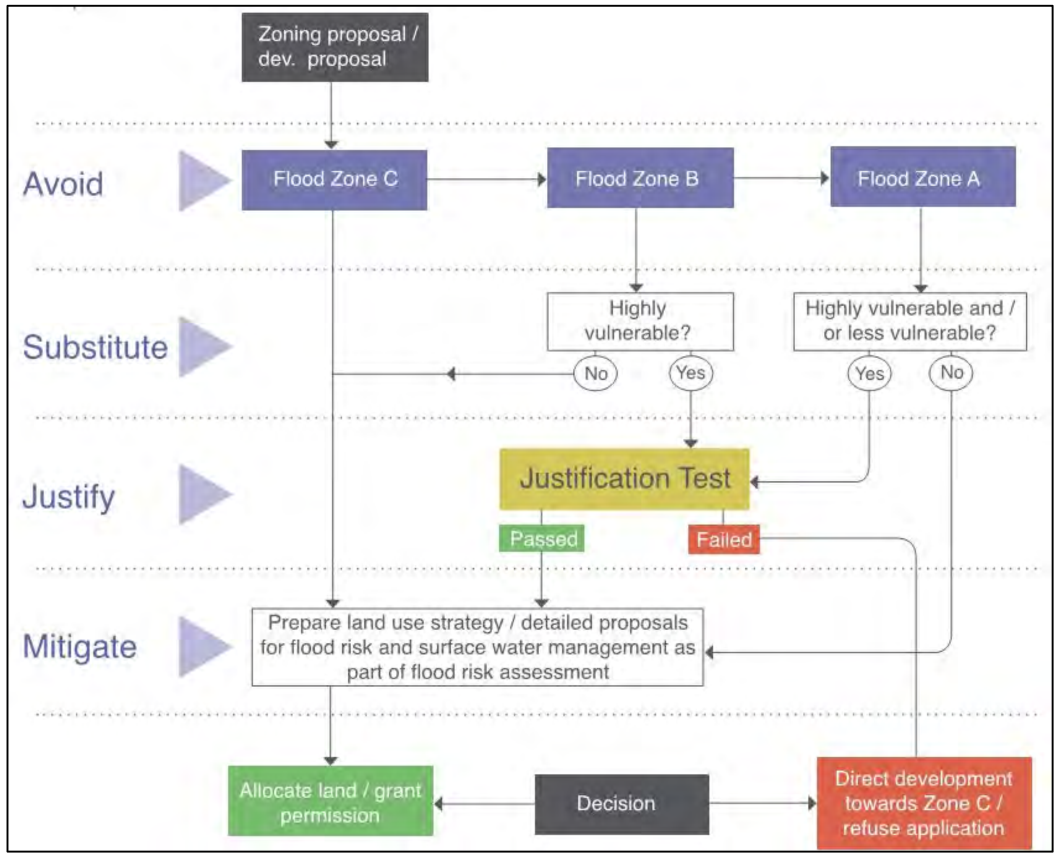


**Figure 19** Sequential Approach

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.