13. WATER: WATER SUPPLY & DRAINAGE

13.1 Introduction

13.1.1 Methodology

The aim of this EIAR Chapter is to establish the following:

- Baseline conditions in relation to Water Supply and Drainage Material Assets
- Assessment of potential impacts to the Water Supply and Drainage Material Assets which can reasonably be expected to occur as a result of the proposed development;
- Mitigation measures to address significant adverse impacts.

The Methodology used for Impact assessment is as follows:

- Conduct a desk study to ascertain all available background information relevant to Water Supply and Drainage within the site boundary, and the local surrounding area;
- Undertake field investigations where appropriate;
- Assess the potential impacts of the proposed works on the Water Supply and Drainage Material Assets and recommend suitable mitigation measures where appropriate.

Data sources included UCD Layout Drawings for Campus Wide Drainage, DLRCC public records for the surrounding areas and Foul Sewer Flow Monitoring Data for May & September 2016.

13.2 Existing Infrastructure

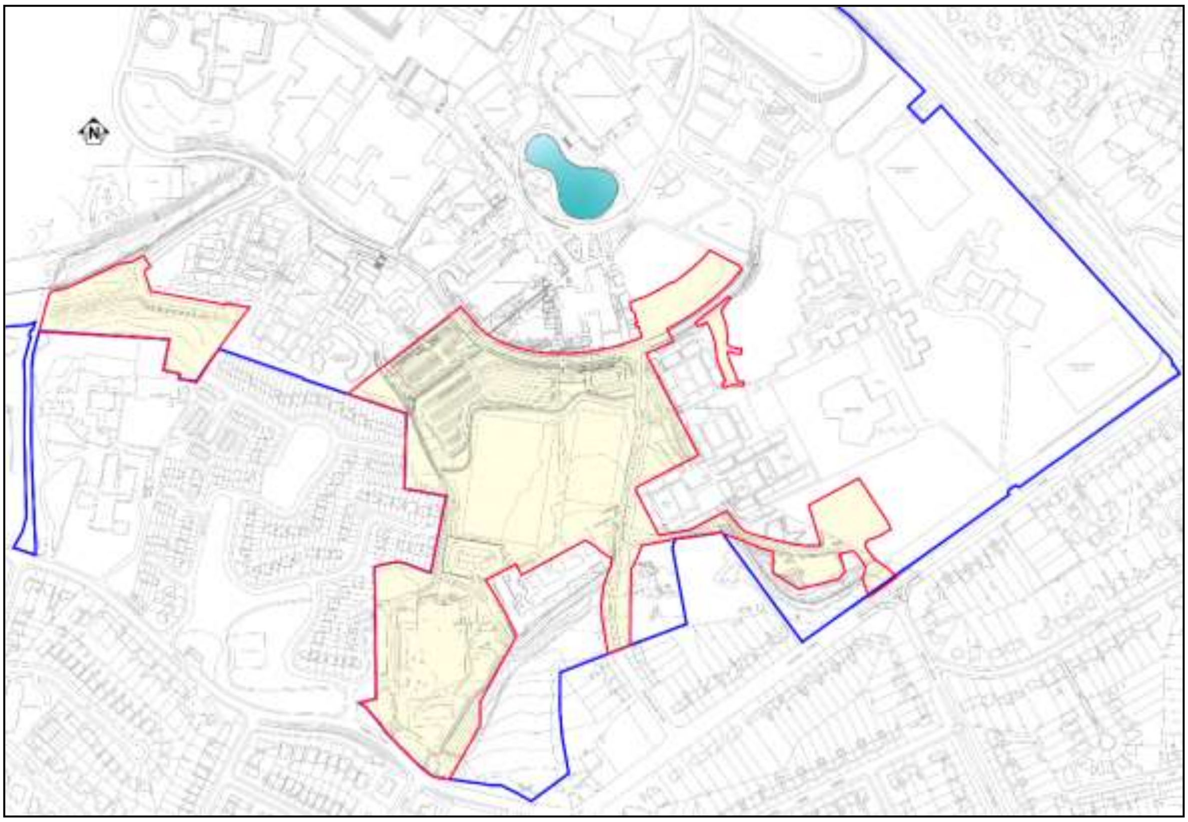
13.2.1 Existing Surface Water Infrastructure

There is an existing surface water Attenuation/Treatment Storage lake on the UCD campus, which was constructed in conjunction with the UCD Sutherland School of Law Building. The attenuation lake was designed to provide attenuation and treatment storage for the Sutherland Building development, as well as allowing for further developments in the areas nearby the lake including the site for the proposed student residences. The lake was designed to provide attenuation storage for a 100 year storm event, with a 10% allowance for climate change. Figure 13.1 below indicates the location of the lake relative to the proposed development.

A hydro-brake flow control device was installed in the outlet from the attenuation lake, and restricts the outflow from the lake to 8.45 l/s. = QBar for the Sutherland Building Site. The working level of the lake was set at 24.0m AOD, with the top water level of the lake during the 100 year event predicted to reach at 24.30m. An overflow weir was provided in the lake to prevent overtopping, with the weir level set at the 100 year flood level. A free-board of 700mm was provided from the top water level in the lake to the lake edge in order to protect all the adjacent buildings.

Following the attenuation lake, the restricted flow discharges to the existing surface water drainage system on the campus which outfalls to the Elm Park Stream which is partially culverted as it flows through the centre of the Campus.

Figure 13.1 Attenuation Lake Location



The Storm water run-off which is generated from the existing Roebuck Student Residences is attenuated in a separate Stormtech attenuation system. Based on the original design calculations which were submitted with the planning application, the Stormtech system was sized to store the storm water run-off from a 1 in 100 year event [planning reference D08A/0603]. A hydro-brake was provided on this system also, and restricts the outflow from the attenuation tank to 9.32 l/s during the 1 in 100 year event. The attenuated flow discharges to the existing 600mm diameter storm water pipeline that runs through this corner of the Campus exiting into the nearby Roebuck Castle Housing Estate.

13.2.2 Existing Foul Sewer Infrastructure

There is an existing foul sewer network on the UCD campus, which ultimately discharges to a Dun Laoghaire Rathdown County Council public sewer located close to the N11 entrance to the campus. There is also an existing 225mm public foul sewer which enters the campus from the Roebuck Castle Housing Estate to the southwest of the site. The sewer turns within the campus before exiting to the same boundary. The foul drainage from the buildings located around Roebuck Castle on the college campus currently discharge to this public sewer. The relatively new Roebuck Student Residential Development, however, discharges to the campus system and ultimately to the N11 outfall.

An application was initially made to Irish Water in April 2016 regarding the proposed development and they confirmed that the receiving public system has adequate capacity to accommodate the proposed development without upgrade - see IW Pre–Connection Enquiry Feedback Statement given in Appendix 13A. The pre-connection enquiry submitted at that time, was based on a total of 2,900 student beds and an assumed demand of 120l/student/day.

Following a number of design amendments, and a slight increase in the number of overall student beds proposed, Irish Water were consulted again in February 2017 and a revised Pre-Connection Enquiry Application (also included in Appendix 13A) was submitted to confirm adequacy of capacity in the receiving public network. However, a more conservative figure of 150l/student/day was proposed which is typical of residential developments. Irish Water confirmed by return email dated 6th March 2017 that the revised figures should have minimal impact on the receiving public system. A copy of this correspondence is included in Appendix 13A.

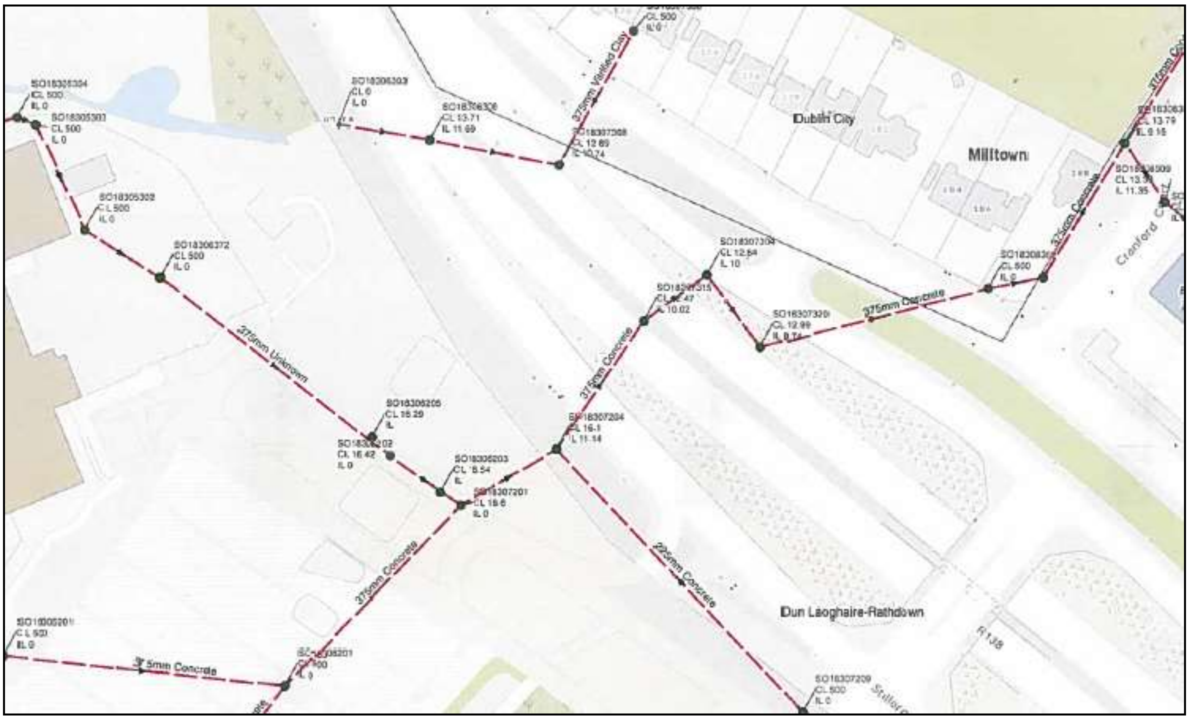
In addition, UCD commissioned LowFlo Ltd. to carry out flow monitoring at the campus outfall near the N11 entrance during May and September 2016. This data shows that the peak flow measured during these periods was = 119 m3/hr = 33 l/s which corresponded to a significant rainfall event with 12mm of rainfall. Peak flow during dry weather = 75m^3/hr =21 l/s. The results of the monitoring are provided in Appendix 13B.

Figure 13.2 gives details of the receiving public pipe system infrastructure. The least effective section is a short length of 375mm diameter pipe 20m long with a flat gradient of 1:1000 approx. which has a theoretical capacity = 50 l/s. Even minor surcharging of the upstream manhole of this section to 80mm above crown level will increase the capacity further to 128 l/s due to an effective hydraulic gradient of 1:200 which is the flattest gradient of the nearby existing downstream pipes.

13.2.3 Existing Water Supply Infrastructure

The UCD campus is primarily served by an existing 225mm diameter ring water-main system, which supplies the UCD Water Tower and distributed to the academic area of the campus. There is also a 100mm diameter feed off the water main on the N11 which is used to supply the existing student accommodation on Campus.

Figure 13.2 Existing Foul Network Outfall to DLRCC Public System



13.3 Characteristics of the Proposed Development – Proposed Surface Water and Foul Drainage Systems and Proposed Water Supply

13.3.1 Proposed Surface Water Drainage System

Proposed Pipe diversions

There is an existing 600mm diameter public surface water pipeline which enters the campus south of Roebuck Castle and runs under several existing buildings before exiting the site into the nearby Roebuck Castle Housing Estate. It is proposed to divert this pipeline to the west so that it avoids all existing and proposed new buildings. The diverted route is approximately the same distance as the existing so there will be no reduction in gradient or capacity of the diverted pipeline.

The storm water from the existing Roebuck student residential development is currently attenuated in a Stormtech attenuation system which discharges to the public pipeline that runs to the nearby Roebuck Castle Housing Estate. This Stormtech system is impacted by the footprint of the proposed development and will have to be decommissioned. It is proposed, therefore, to divert the surface water from the Roebuck residences into the new system being proposed for the residences and to consolidate the attenuation volumes for these areas in the Lake which will also provide treatment storage for all the flow. This will result in a reduction of Surface water flow to the nearby Housing Estate.

Proposed New Surface Water System

The proposed surface water drainage system for the development will comprise a combination of interception, treatment and attenuation storage features, including several 'soft' SuDS measures. It is proposed that the existing lake will be used to provide the necessary attenuation and treatment storage for the new development.

As noted in Section 13.2.1 the Sutherland School of Law development already discharges to the lake. Due to the required decommissioning of the 'Stormtech' attenuation tank system, run-off from the Roebuck Student Residences will be diverted to the lake. The lake will also be required to cater for the Confucius Institute, and for the Future Learning Building which will discharge to the lake via the Sutherland School of Law network outfall. The table below provides a summary of the lake catchment areas and summarises the calculated impermeable areas contributing to the lake.

Summary of Lake Catchment Areas	
Location	**Catchment Area**
Existing SSOL + Proposed Future Learning Building	1.756ha
Confucius Institute	0.444ha
Existing Roebuck Student Residences	1.100ha
Proposed Development Site*	10.148ha
Total Lake Catchment Area	**13.448ha**

*Proposed Development Site Catchment = Site area within red line boundary – Areas not draining to lake catchment (i.e. areas excluded are the proposed Sutherland School of Law Car Park, Little Sisters Car Park, & Construction Haul Road)

Summary of Impermeable Areas Contributing to Lake	
Location	Impermeable Area
Existing SSOL + Proposed Future Learning Building	0.835ha
Confucius Institute	0.132ha
Existing Roebuck Student Residences	0.690ha
Proposed Development Site	5.179ha
Total Impermeable Area Contributing to Lake	**6.836ha**

13.3.2 Proposed Foul Sewer System

It is proposed to connect the all of the foul drainage generated from the new development to the existing campus system including the drainage from the new blocks around Roebuck Castle which will be built in the area currently occupied by the Roebuck Castle ancillary buildings which are to be demolished. Given that these buildings are currently draining to the Roebuck castle system, which outfalls to the nearby Housing Estate, this will result in a reduction of flow to the estate.

13.3.3 Proposed Basement Car Park Drainage System

The basement Car Park will have a series of drainage channels cast into the floor slab which will cater for the limited amount of run-off that enters the basement through ramps, service openings and from vehicles. These channels will connect to a buried gravity pipe network that will fall to a petrol interceptor located at the northeast corner of the basement. The outflow from the petrol interceptor will flow to a sump with duty and standby pumps and the effluent will be pumped from there through a rising main to the nearest Foul manhole on the gravity system.

13.3.4 Proposed Water Supply System

It is proposed to take a new 180mm diameter feed new off the existing 200mm diameter water main on Foster’s Avenue to supply a new 150mm diameter ring main that will serve the development. An application for this new supply has been made to Irish Water and their assessment report is positive with no capacity issues foreseen for the public system. See Appendix 13.A for Irish Water Pre Connection Enquiry Feedback Statement.

13.4 Significant Impacts of the Development

13.4.1 Construction of Large Areas of Impermeable Area on Existing Greenfield Site & Associated Increased Volume & Rate of Surface Water Run Off

The development of this site will result in increased paved and impermeable areas that could create pressure on the environment and existing services due to the generation of increased run-off and pollution. In order to avoid this the development will be designed in accordance with the principles of Sustainable Urban Drainage Systems (SUDS) as embodied in the recommendations of the Greater Dublin Strategic Drainage Study (GDSDS). The GDSDS addresses the issue of sustainability by requiring designs to comply with a set of drainage criteria which aim to minimize the impact of urbanization by replicating the run-off characteristics of the greenfield site. The criteria provide a consistent approach to addressing the increase in both rate and volume of run-off as well as ensuring the environment is protected from pollution that is washed off roads and buildings. These drainage design criteria are as follows:

- Criterion 1 – River Water Quality Protection
- Criterion 2 – River Regime Protection
- Criterion 3 – Flood Risk Assessment

– Criterion 4 – River Flood Protection

A management train of SUDS devices has been proposed to provide source control and site control and to incrementally reduce pollution, flow rates and discharge volumes as shown in the flow chart given in Figure 13.3 (at the end of this section). This management train addresses Criterion 1 to 4 in the context of the subject site as described in the following sections.

With regard to consideration of alternative measures to those set down in the GDSDS which follows the principles of SUDS it is noted that the GDSDS/SUDS approach is the required approach set down by the Local Authority in the Development Plan as being the best way to achieve a sustainable scheme with minimal impact on the environment.

Criterion 1 GDSDS – Mitigation Measures to Protect River Quality

Run-off from natural greenfield areas contributes very little pollution and sediment to rivers and for most rainfall events direct run-off from greenfield sites to rivers does not take place with rainfall percolating into the ground. By contrast urban run-off, when drained by pipe systems, results in run-off from virtually every rainfall event with high levels of pollution, particularly in the first phase of run-off, with little of the rainfall percolating to the ground. To prevent this happening Criterion 1 requires that interception storage and / or treatment storage is provided thereby replicating the run-off characteristics of the pre-development greenfield site.

<u>Interception Storage</u>

Interception storage where provided should ensure that the first 5mm of rainfall is intercepted on site and does not find its way to the site drainage system.

In the context of the subject site interception storage will be provided as follows:

a). Roof areas including roof over basement

- **Intensive Green roof** over all of podium slab area (basement roof). This will be achieved using a cellular drainage mat under the podium hard landscaping finish to give the required retention capacity.
- **rainwater harvesting** from approximately half roof area of all blocks, and **extensive Green Roof (sedum)** on the Fulcrum Building.
- In summary 50% roof area is Green Roof & 30% remaining roof area is harvested = **80% Total Interception Storage** which will retain, filter and attenuate run-off.

b). Paved Areas

- Most paved areas (except for certain road areas) will be finished in **permeable paving.** The ground is boulder clay of limited permeability so discharge to ground will be very limited– see Site Investigation Report in Appendix 6A for percolation test results and also EIAR Section 7.3.9.2 which states that permeability is likely to decrease significantly with depth. The gravel bed under paving will, therefore, be drained and discharge to the main Surface water system.

Notwithstanding the poor sub soil permeability the gravel bed will provide good interception storage which will retain, filter and attenuate run- off.

- The road surfaces will be finished in impermeable surfacing, either DBM or Rigid Bound Paving. Where soft landscaped areas are adjacent, and where practical, these areas are designed as either swales or bio- retention areas and cut kerbs are used to allow the road run-off to flow onto them. Where the soft landscaping is limited, or a footpath has been provided, the road will be drained by gullies that connect to infiltration trenches that use slotted pipes to allow discharge to ground where available but that are also connected to the surface water pipe networks visa silt traps. In areas where the road is surrounded by adjacent buildings and hard landscaping, infiltration trenches are not suitable due to potential softening of the foundation bearing stratum and general congestion of services. In these areas the road gullies are connected directly to the surface water pipe network.

- The proposed surface car parks are designed for the medium term only as they occupy sites valuable for future development. The finish to these car parks will reflect this and it is proposed that impermeable surfacing (DBM) will only be applied to the aisles and that the car spaces are finished in well graded gravel that will be completely permeable. The aisles will drain into the gravel areas to either side thereby resulting in full interception of run-off for these surface car parks with no outfall to the public system.

The Interception storage features will have the effect of providing some initial storage of rainwater, while also reducing the rate at which rainwater, from heavier rainfall events, will discharge to the surface water drainage system. They will also help to filter the run-off, removing any pollutants and resulting in a higher quality of water discharging to the drainage system.

Treatment Storage

The proposed development offers a rare opportunity to provide Treatment Storage in a relatively urban setting. This will be provided in the campus lake which has been designed to have a large volume of permanent water. This provides a perfect settlement pond where suspended solids in surface water run- off can settle to the bottom of the pond and effectively provide a second stage of filtration after the initial filtration inherent in the interception storage process. In accordance with the GDSDS, 15mm treatment storage will be provided by the lake.

Criterion 2 GDSDS – Mitigation Measures to Protect River Regime

Whatever the rainfall event unchecked run-off from the developed site through traditional pipe networks will discharge into receiving waters at rates that are an order of magnitude greater than that prior to development. This can cause flash flow in the outfall river / stream that can cause scour and erosion. Attenuation storage is provided to prevent this occurring by limiting the rate of run-off to that which took place from the pre-development greenfield site. In practice the rate of run-off needs to be appropriately low for the majority of rainfall events and attenuation storage volumes should be provided for the 1 and 100 year storm event and the rate of outflow from such storage should be controlled so that it does not exceed the Greenfield flow = QBAR (41.7 l/s for this site), which can be factored upwards by factors appropriate to the various return periods (given in the Flood Studies report) if long term storage is provided. Notwithstanding that significant long-term storage will be provided in the form of interception storage and rainwater harvesting, the attenuation storage volumes have been designed without applying growth factors to QBAR.

Criterion 3 GDSDS – Mitigation Measures to prevent Site Flooding

The GDSDS requires that no flooding should occur on site for storms up to and including the 30 year event. The pipe network and the attenuation storage volumes will, therefore, be designed for such storms to ensure that no site flooding occurs although partial surcharging of the system is allowed as long as it does not threaten to flood.

For the 100 year event the pipe network can fully surcharge and cause site flooding but the top water level due to any such flooding must be at least 500mm below any vulnerable internal floor levels and the flood waters should be contained within the site. In addition, the top water level in the attenuation pond during the 100-year storm must be at least 500mm below any vulnerable internal floor levels. The pipe network has been designed to comply with these requirements.

Criterion 4 GDSDS–Mitigation Measures to prevent Flooding of Receiving Watercourse.

Criterion 4 is intended to prevent flooding of the receiving system / watercourse by either limiting the volume of run-off to the pre-development greenfield volume using "long term storage" (Option 1) or by limiting the rate of run-off for the 100year storm to QBAR without applying growth factors using "extended attenuation storage" (Option 2).

Significant long-term storage will be provided in the form of interception storage and rainwater harvesting (see Criterion 1 above). This does not, however, equate to full long term storage volumes and, given the poor permeability of the subsoil, it is not feasible to provide additional storage areas elsewhere on site to achieve the required volume. Option 2 has therefore been used to comply with Criterion 4 and an extended attenuation volume will be provided in the lake to limit the rate of discharge in the 100year storm to QBAR without growth factors applied.

Climate Change

It should be noted that in all the computer simulations relating to pipe network design and Criterion 2 (river regime protection), criterion 3(site flooding) and Criterion 4 (watercourse flooding) a 10% allowance for climate change has been included as required by DLRCC.

13.4.2 Significant Increase in Foul Effluent from New Residential Students

An Application has been made to Irish Water and their Pre-Connection Enquiry Feedback Statement – see Appendix 13.A - states that the proposed development is feasible without Irish Water Foul Sewer infrastructure upgrade.

Typical Flow for residential usage would be 150 l /student/day. Consideration must be given, however, to the fact that the 3006 students which will occupy the new residences would otherwise be attending the college as day students and already contribute to the current levels of foul water generation on the campus.

The EPA document "Treatment Systems for Small Communities, Business, Leisure Centres and Hotels" provides guidance on wastewater loading ratings from different commercial premises. A loading of between

40 and 60 l/student/day is recommended for non-residential school buildings. Based on this guidance, an average loading of 50 l/student/day is considered appropriate for the current foul water generation from the existing non-resident student population. Hence, the additional foul water generated as a result of the development and day students becoming residential will be (150 – 50 =) 100 l/student/day.

The preliminary calculation for the foul effluent generated by the additional student accommodation beds is as follows:

Student Accommodation provided	= 3006 student bedrooms
3006 students @ 70 l/person/day	= 300,600 l/day
	= 301 m^3 /day
Increase in Peak Flow = $\frac{6 \times 300{,}600}{24 \times 60 \times 60}$	= 21 l/s

There will also be some foul water generated from the ancillary buildings which are proposed as part of the development. These flows, however, are included in the student accommodation peak flow figure calculated above as no increase in overall Campus population is planned.

The new foul sewer for the development will connect into the existing 375mm Foul Sewer network within the campus which outfalls to the 375mm diameter sewer at the N11 entrance:

The existing peak flow measured = 33 l/s

The additional peak flow due to the proposed development = 21 l/s

Total post development peak flow = 54 l/s

Minimum pipe capacity of the receiving system with minimal (80mm) surcharging of short length of pipe (section 12.2.2) = 128 l/s

Therefore the existing system can comfortable accommodate the proposed increase in flow in accordance with IW independent assessment.

13.4.3 Significant Increase in Water demand for New Residential Students

An Application has been made to Irish water and their Pre-Connection Enquiry Feedback states that the proposed development is feasible without Irish Water Supply infrastructure upgrade. See Appendix 13.A.

Section 13.4.2 has calculated the increased water demand for the development as 301m^3 per day but the increase in demand for potable water from the public system will be less than this because of the use of harvested rainwater to flush the WCs in the proposed development. Of the 100l/head / day increase in water demand used in section 4.2 to calculate effluent quantities approximately 30l of this (say 5x 6l flushes) could be supplied from harvested rainwater. Assuming the rainwater harvesting tank could supply flush water say a minimum of 25% of the time the increase in potable water demand from the public supply will therefore be in the order of 280m^3.

Twenty-four-hour storage will be provided within the residential blocks to cater for possible shut-downs in the system.

13.4.4 Risk of Contamination of Flow in Existing Pipe Networks

There is a potential for the flow in the existing pipe networks to be contaminated by spillages associated with construction activities.

An Outline Construction Management Plan and Waste Management Plan has been submitted with the application and this will be developed by the Contractor and Risk Assessments carried out regarding potential pollution of pipe networks. The Management Plan is to be put in Place to ensure the risk is mitigated insofar as possible.

13.4.5 Reduction in Foul Water Flow to Roebuck Castle Housing Estate

There is a positive impact in the reduction of foul flow to the nearby Roebuck Castle Housing Estate as the new buildings that replace those to be demolished adjacent to Roebuck Castle will drain to the N11 outfall which has adequate capacity

13.4.6 Reduction in Surface Water Flow to Roebuck Castle Housing Estate

There is a positive impact in the reduction of surface water flow to nearby Roebuck Castle Housing Estate as the existing Roebuck Residences Attenuation system that discharges to the estate will be decommissioned and the flow redirected towards the Campus Lake.

13.4.7 Cumulative Impacts

The proposed development is part of a building Plan to produce a more sustainable campus where students are resident rather than travelling to the college. Whilst the progressive development of the Campus has resulted in Greenfield site areas being built on the methods used have been in accordance with the Principles of Sustainable Drainage systems that replicate the response of the Greenfield site post development which will ensure that there are no significant long term cumulate detrimental impacts as a result of the building programme.

The cumulative impact of the increased water demand from progressive campus development and the consequent increase in foul flows has been planned for by both the Campus and the Statutory Authorities as confirmed by the positive response from Irish Water to the development - see IW Pre-Connection Enquiry Feedback Statement at Appendix 13.A.

13.4.8 Do Nothing Scenario

The do-nothing scenario will result in a halt to the progress towards a more sustainable Campus environment with the opportunity to convert a significant number of commuting students to residents being lost. If residential development does not occur on campus it will have to occur somewhere else to meet the growing student accommodation needs. The same impacts would, therefore, have to be addressed on other sites with less available infrastructural capacity and where such a co-ordinated and managed response to mitigate any potentially adverse impacts might not be so easily achieved

Table 13.1 Summary of Potential Impacts

Activity	Attribute	Character of potential impact	Importance of attribute	Magnitude of potential impact	Term	Significance of potential impact
Construction Phase						
General Construction Works	Quality of Flow in both Surface water & Foul networks	Potential contamination of flow in existing gravity drainage networks due to pollution from construction activities / materials.	High	medium	Short term	Significant
Operational Phase of Proposed Development						
Construction of large areas of Impermeable surfacing on existing greenfield site including roof, podium slab and certain road areas.	Permeability of existing site and its capacity to absorb minor rainfall events and preserve groundwater regime and quality of base flow in receiving watercourses	Adverse Potential for new impermeable areas reducing groundwater recharge which preserves base flow in receiving watercourses. Also potential for increased discharge to receiving watercourses after minor rainfall events which increases likelihood of pollution of these watercourses. GDSDS Criterion 1	Medium	Medium	Long term	Moderate/Significa nt
Construction of large areas of Impermeable surfacing on existing greenfield site including roof, podium slab and road areas.	Permeability of existing site and its capacity to attenuate flow and reduce peak flows in receiving site and public pipe network and scour of receiving watercourses	Adverse Potential for new impermeable areas increasing peak rate of surface water run-off to receiving site and public systems thereby causing scour of receiving watercourses GDSGS Criterion 2	Medium	Medium	Long term	Moderate/Significa nt
Construction of large areas of Impermeable surfacing on existing greenfield site including roof, podium slab and road areas.	Permeability of existing site and its capacity to absorb rainfall and prevent flooding of existing site network and flooding of the site itself	Adverse Potential for new impermeable areas increasing surface water run-off to site system thereby causing site flooding. GDSDS Criterion 3	High	Medium	Long term	Significant/Very significant
Construction of large areas of Impermeable	Permeability of existing site and its	Adverse Potential for new impermeable areas increasing volume of surface water	High	Medium	Long term	Significant/Very Significant.

surfacing on existing greenfield site including roof, podium slab and road areas.	capacity to absorb rainfall and prevent flooding of existing public network and receiving watercourses.	run-off to receiving public system and potential flooding of that system's receiving watercourses. GDSDS Criterion 4				
Construction of 3006 new student bedspaces and corresponding increase in potable water demand	Existing water supply infrastructure	Adverse potential for creating increased water supply demand due to provision of 3006 new bed spaces on site and the associated increased in water demand from day students converting to residential students. Potential capacity issues with site and public infrastructure.	Medium	Medium	Long term	Moderate /Significant
Construction of 3006 new student bedspaces and corresponding increase in foul effluent outflow.	Existing foul sewer infrastructure	Adverse potential for creating increased Foul water effluent due to provision of 3006 new bed spaces on site and the associated increase in Foul flows caused by day students converting to residential students. Potential capacity issues with site and public infrastructure.	Medium	Medium	Long term	Moderate /Significant
Reduction in Foul water Flow to Roebuck Castle Housing Estate.	Existing foul sewer Infrastructure	Positive potential to reduce foul flow to nearby Roebuck Castle Housing Estate as the new buildings that replace those to be demolished adjacent to Roebuck Castle will drain to the N11 outfall which has adequate capacity	Medium	Medium	Long term	Moderate /Significant
Reduction in Surface water Flow to Roebuck Castle Housing Estate.	Existing Surface Water Infrastructure	Positive potential to reduce surface water flow to nearby Roebuck Castle Housing Estate as the existing Attenuation system that discharges to the estate will be decommissioned and the flow redirected towards the Campus Lake.	Medium	Medium	Long term	Moderate /Significant

Table 13.2 Summary of Mitigation Measures

Activity	Attribute	Character of potential impact	Mitigation measure	Predicted impact
Construction Phase				
General Construction Works	Quality of Flow in both Surface water & Foul networks	Potential contamination of flow in existing gravity drainage networks due to pollution from construction activities / materials.	Construction management Plan to be Developed by the Contractor and risk assessments carried out regarding potential pollution of pipe networks. Management Plan to be put in Place to ensure the risk is mitigated insofar as possible.	negligible
Operational Phase				
Construction of large areas of Impermeable surfacing on existing greenfield site including roof, podium slab and certain road areas.	Permeability of existing site and its capacity to absorb minor rainfall events and preserve groundwater regime and quality of base flow in receiving watercourses	Adverse Potential for new impermeable areas reducing groundwater recharge which preserves base flow in receiving watercourses. Also potential for increased discharge to receiving watercourses after minor rainfall events which increases likelihood of pollution of these watercourses. GDSDS Criterion 1	Design will incorporate full SUDS (Sustainable Urban Drainage Systems). Interception storage including extensive and intensive green roofs, rainwater harvesting and permeable pavements will be included throughout the Design thereby preventing any significant discharge for minor rainfall events. The site investigation confirms that the soil is boulder clay and of limited permeability so re-charge of groundwater table opportunities are limited. Full treatment storage is provided by the existing lake which will allow settlement of any suspended solids in the run-off thereby preventing pollution of the receiving watercourse.	Not significant
Construction of large areas of Impermeable surfacing on existing greenfield site including roof, podium slab and road areas.	Permeability of existing site and its capacity to attenuate flow and reduce peak flows in receiving site and public pipe network and scour of receiving watercourses	Adverse Potential for new impermeable areas increasing peak rate of surface water run-off to receiving site and public systems thereby causing scour of receiving watercourses GDSGS Criterion 2	Design will incorporate full SUDS (Sustainable Urban Drainage Systems). The existing lake was originally designed to have enough freeboard to provide the required attenuation volume and the peak outflow rate of discharge from the site, for storms of up to 100 year return period, will be limited to QBAR or the predicted greenfield run off for the mean annual flood. This will ensure that the receiving watercourses suffer no scour greater than that experienced due to the existing greenfield run -off for the mean annual flood.	neutral
Construction of large areas of Impermeable surfacing on	Permeability of existing site and its capacity to absorb rainfall and prevent	Adverse Potential for new impermeable areas increasing surface water run-off to site system thereby causing site flooding.	Design will incorporate full SUDS (Sustainable Urban Drainage Systems). The design of the new pipework system will be based on it surcharging but not flooding for the 100 year event and that the top water level in the	Neutral

existing greenfield site including roof, podium slab and road areas.	flooding of existing site network and flooding of the site itself	GDSDS Criterion 3	system is never higher than 0.5m below the lowest floor level of any adjacent building thereby ensuring that the site will not flood.	
Construction of large areas of Impermeable surfacing on existing greenfield site including roof, podium slab and road areas.	Permeability of existing site and its capacity to absorb rainfall and prevent flooding of existing public network and receiving watercourses.	Adverse Potential for new impermeable areas increasing volume of surface water run-off to receiving public system and potential flooding of that system's receiving watercourses. GDSDS Criterion 4	Design will incorporate full SUDS (Sustainable Urban Drainage Systems). In addition to the pipe system not flooding the discharge from the site for the 100 year storm will be restricted to QBAR without any growth factors applied as required by the GDSDS when long term storage is not provided on site. This will ensure that the rate of discharge to the receiving watercourse is restricted to a level where flooding downstream will not occur due to the development.	Not significant
Construction of 3006 new student bedspaces and corresponding increase in potable water demand	Existing water supply infrastructure	Adverse potential for creating increased water supply demand due to provision of 3006 new bed spaces on site and the associated increased in water demand from day students converting to residential students. Potential capacity issues with site and public infrastructure.	The increase in Water demand is mitigated by the fact that there will be no increase in the student population and therefor the increase in consumption is only of the order of 100l/head/day less that provided by rainwater harvesting or 280cubic meters additional flow for the total development. An application has been made to Irish water and they have issued their Pre- Connection Enquiry Feedback Statement which shows that there is adequate capacity in the public network to accommodate the development.	Not significant
Construction of 3006 new student bedspaces and corresponding increase in foul effluent outflow.	Existing foul sewer infrastructure	Adverse potential for creating increased Foul water effluent due to provision of 3006 new bed spaces on site and the associated increase in Foul flows caused by day students converting to residential students. Potential capacity issues with site and public infrastructure.	The increase in Foul Effluent flow is mitigated by the fact that there will be no increase in the student population and therefor the increase in outflow is only of the order of 100l/head/day or 301 cubic meters total which gives an increase in peak foul flow of 21l/s. An application has been made to Irish water and they have issued their Pre-Connection Enquiry Feedback Statement which shows that there is adequate capacity in the public network to accommodate the development. In addition, UCD have undertaken monitoring of the foul outfall from the campus which shows that it is flowing well below capacity and can comfortably accommodate the additional flow.	Not significant

13.5 Residual Impacts

As the proposed development has been designed in accordance with the established Principles of Sustainable Urban Drainage Systems, as embodied in the requirements of the Greater Dublin Strategic Drainage Study, the residual impacts due to the increase in impermeable areas will be mitigated such that the response of the site will be similar to the pre-development Greenfield site. No significant residual impacts on the surface water system are therefore predicted.

Similarly, no significant residual impact is predicted with regard to the Foul System and the Water Supply as Irish Water have confirmed the Infrastructure is adequate to accommodate the increase in flow.

13.6 References

EPA 2002: Guidelines on Information to be Contained in Environmental Impact Statements

EPA 2003: Advice Notes on Current Practice in the Preparation of Environmental Impact Statements

EPA 2015: Draft Revised Guidelines on Information to be Contained in Environmental Impact Statements

EPA 2015: Draft Revised Guidelines for preparing Environmental Impact Statements.

EPA 2017: Draft Guidelines on the information to be contained in Environmental Impact Assessment Reports

GDSDS 2005: Greater Dublin Strategic Drainage Study

CIRIA 2015: The SuDS Manual (C753)

IGSL 2015: Site Investigation Report for New Development UCD Campus.

Figure 13.3 SuDS Management Train Flow Chart

(Stage management of surface water run-off to replicate response of green field site)

SOURCES CONTROL ROOF AREAS

(Stage 1)
Intensive Green roof over all of podium slab area (basement roof), **rainwater harvesting** from approximately half roof area of all blocks, and **extensive Green Roof** on Fulcrum Building - see SUDS Strategy Drawing.
In summary 50% roof area is Green Roof & 30% remaining roof area is harvested = **80% Total Interception Storage** which will retain, filter and attenuate run-off.

SOURCE CONTROL PAVED AREAS

(Stage 1)
Most paved areas (except for certain road areas) will be finished in **permeable paving**. Ground is boulder clay of limited permeability so discharge to ground will be very limited and gravel bed under paving will be drained and discharge to main Surface water system.
Notwithstanding the poor sub soil permeability this build- up will provide good interception storage (with a raised outlet invert) which will retain, filter and attenuate run- off.

SOURCE CONTROL SURFACE CAR PARKS

(Stage 1)
The proposed surface car parks are designed for the medium term only as they occupy sites valuable for future development.
The finish to these car parks will reflect that and it is proposed that the aisles only are finished in impermeable surfacing and that the car space are finished in gravel that will be completely permeable.
The aisles will drain into the gravel areas to either side thereby resulting in full interception of runoff for theses surface car parks with no outfall to the public system.

TREATMENT STORAGE

(Stage 2)
The permanent volume of water in the lake below HYDRO-BRAKE outfall level is very significant and can comfortably provide **treatment storage** for the whole of the proposed development. This provides a perfect settlement pond where suspended solids in surface water run off can settle to the bottom of the pond and effectively provides a second stage of filtration after the initial filtration inherent in the interception storage process (see stage 1 above)

No Outfall

ATTENUATION STORAGE

(Stage 3)
The storage volume available between the HYDRO-BRAKE outfall level and the lake overflow level can accommodate the required storage volume to **attenuate** the flow from the proposed development. The overflow level will need to be raised above the existing level to provide the required storage but there is still is still adequate freeboard above the raised overflow and the lake edge to give a comfortable factor of safety against overtopping.

Delivers Filtered Surface Water Outfall at maximum rate = QBAR (Greenfield Run-off for mean annual storm) for 100yr storm event.

Appendix 13.A: Irish Water Pre-Connection Enquiry & Feedback April 2016 & March 2017

Appendix 13.B: Foul Flow Monitoring Results – June 2016 & September 2016