Planning & Development Act, 2000 - 2020,
European Communities (Environmental Impact Assessment) Regulations 1989 (as amended), Planning & Development Regulations, 2001 (as amended)

ENVIRONMENTAL IMPACT ASSESSMENT REPORT

APPENDICES

Clutterland Substation and transmission lines
Grange Castle South Business Park

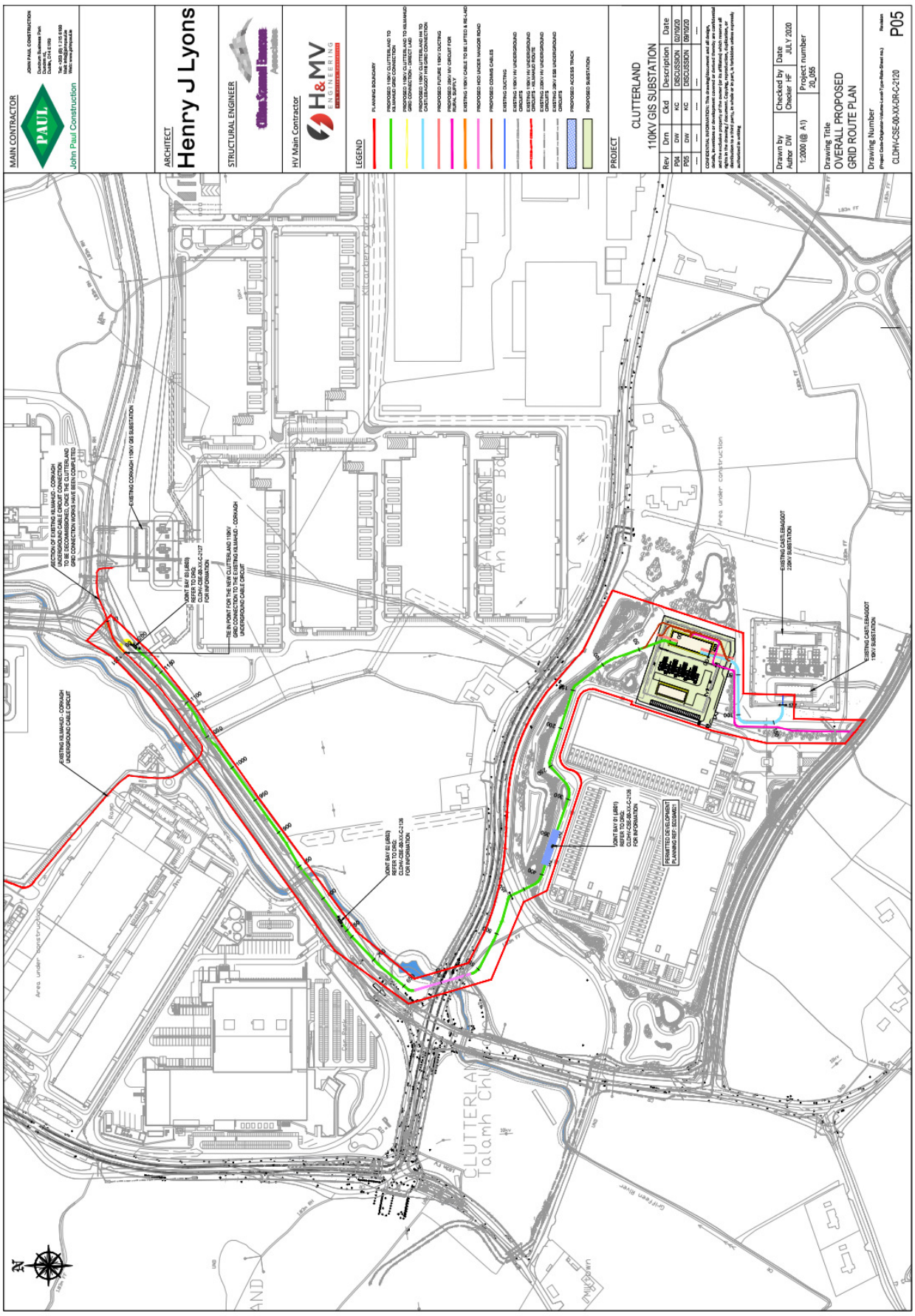
November 2020

MARSTON
PLANNING CONSULTANCY

CONTENTS

CHAPTER 2 DESCRIPTION OF THE PROPOSED DEVELOPMENT

Appendix 2.1 Proposed site layout plan (not to scale) indicating Permitted Development



Appendix 2.2 Schedule of mitigation measures

Project Phase	Mitigation Measures
	Biodiversity
Construction ***- Pollution prevention***	As outlined in the Outline Construction Management Plan (CSEA Consulting Engineers, 2020), a project environmental management plan will be developed prior to works commencing. This document will ensure that storm water and wastewater runoff are managed and will not cause an off-site environmental impact. This document will be developed to include the following: • Silt control on the roads; • Discharge water from dewatering systems; • Diversion of clean water; • Treatment and disposal of wastewater from general clean-up of tools and equipment; • Spills control; • A buffer zone of at least 20m separating working machinery from watercourses; • A prohibition on machinery entering watercourses; • Refueling of machinery off-site or at a designated bunded refueling area; and • Silt trapping and oil interception (to be considered where surface water runoff may enter watercourses). The Outline Construction Management Plan (CSEA Consulting Engineers, 2020) specifies that the following general pollution prevention measures will be implemented: • It will not be permitted to discharge into any newly constructed storm water systems or watercourse without adhering to the conditions of the discharge licence; • Only approved storage system for oil/ diesel within the site will be permitted. The bunded area will accommodate the relevant oil/ diesel storage capacity in case of accidental spillage. Any accidental spillages will be dealt with immediately on site however minor by containment/ removal from site; • The washing out of concrete trucks on site will not be permitted as they are a potential source of high alkalinity in watercourses. Consequently, it is a requirement that all concrete truck washout takes place in the ready-mix depot; • The Site Management Team will maintain a record of all receipts for the removal of toilet or interceptor waste off site to ensure its disposal in a traceable manner; and • The cleaning of public roads in and around the subject site will be undertaken to reduce environmental impacts and care will be taken to prevent any pollution of watercourses The mitigation measures outlined in the Hydrology chapter (Chapter 8) of this EIAR will prevent pollution of the Baldonnel Stream and the receiving surface water network. These include measures which prevent contaminated surface water run-off entering the stream, measures to prevent spillage of fuels and chemicals, measures to deal with accidental releases and measures to prevent impacts arising from the management of soil removal and compaction.
Construction ***- Habitats and flora***	Invasive species on the site, butterfly-bush *Buddleia davidii,* will be appropriately controlled and eradicated using either physical or chemical control methods. The landscape strategy[1] associated with the Permitted Development consented under SDCC Planning Reg. Ref. SD20A/0121 will enhance the biodiversity value of the Proposed Development site and provide green infrastructure links to the surrounding area. The north-eastern treeline habitat along the Baldonnel Stream to be lost as part of construction works as part of the Permitted Development will be re-worked around the wayleaves and strengthened with native tree planting. This will create commuting and foraging corridors within the Proposed Development site for a range of fauna species. A woodland belt is permitted along the northern boundary of the site, along the route of the proposed 110kV transmission line to the Kilmahud-Corkagh circuit. Large, semi-mature tree planting has been permitted for this area and will provide an immediate ecological corridor within the site. Large areas of native wildflower meadow are also permitted along the Baldonnel Stream and to the east of the proposed substation and will provide foraging and resting habitat for a range of fauna, particularly pollinators and birds. Planting lists for woodlands have included pollinator friendly species as recommended by the All Ireland Pollinator Plan 2015-2020.

[1] Kevin Fitzpatrick Landscape Architecture (2020)

	Two of the three attenuation ponds permitted as part of the Permitted Development consented under SDCC Planning Reg. Ref. SD20A/0121 lie within the footprint of the Proposed Development site. These areas will enhance the biodiversity value of the Proposed Development site. The range of proposed habitats in this area will provide a refuge for flora and fauna species. The installation of bat and bird boxes in appropriate locations within the Proposed Development site were proposed as part of the Permitted Development consented under SDCC Planning Reg. Ref. SD20A/0121. Bird boxes have been selected to provide nesting habitat for birds of conservation concern that have been recorded on the site i.e. kingfisher, swallow and grey wagtail. Woodcrete bat boxes will be installed in areas with low light levels, in close proximity to suitable commuting and foraging features.
Construction - *Bats*	Construction phase lighting will be designed to be sensitive to the presence of bat commuting and foraging bats along the northern tree-line and southern boundary to the Castlebaggot substation and should adhere to the following guidance: • *Bats & Lighting: Guidance Notes for Planners, engineers, architects and developers* (Bat Conservation Trust, 2010); • *Guidance Notes for the Reduction of Obtrusive Light GN01 (Institute of Lighting Professionals, 2020); and* • *Bats and Lighting in the UK – Bats and the Built Environment Series (Bat Conservation Trust UK, January 2008).* The landscape strategy[2] under the Permitted Development consented under SDCC Planning Reg. Ref. SD20A/0121 allows for the planting of native treelines along the western and northern boundary of the Castlebaggot substation and native woodlands to be planted to the east and north of the proposed substation. This proposed tree planting will further mitigate the effects of light spill.
Construction phase - *Birds*	In order to avoid disturbance of breeding birds, their nests, eggs and/or their unfledged young, all works involving the demolition of buildings and/or removal of trees or hedgerows will be undertaken outside of the nesting season (1st March to 31st August inclusive). If vegetation removal must take place in the nesting season, then checks for breeding birds will be undertaken immediately prior to site clearance. Where active nests are found, works must cease until such a time that the nests are deemed inactive. As part of the Permitted Development consented under SDCC Planning Reg. Ref. SD20A/0121, alternative nesting habitat for birds of conservation concern are to be erected that were recorded on the Proposed Development site. It is proposed to install dipper/ wagtail boxes along the stream to provide suitable nesting habitat for grey wagtails. Kingfisher tunnels will be installed into the banks of the stream. These will be installed during the first phase of the development[3]. These mitigation measures have been permitted under the Permitted Development consented under SDCC Planning Reg. Ref. SD20A/0121.
Construction phase – *Common frog*	If works to clear any of the habitat features suitable to support common frog are to begin during the season where frogspawn or tadpoles may be present (February – mid-summer), a pre-construction survey will be undertaken to determine whether breeding common frogs are present. Any frog spawn, tadpoles, juvenile or adult frogs present will be captured and removed from the affected habitat by hand net and translocated to the nearest area of available suitable habitat, beyond the Zone of influence of the Proposed Development. Any capture and translocation works will be undertaken immediately in advance of site clearance/construction works commencing.
Operational – *Pollution prevention*	Pollution of the Baldonnel Stream as a result of surface water run-off during the operation phase of the development will be prevented as outlined in the *'Engineering Services Report'* (CS Consulting, 2020). In summary, all surface waters from hardstanding areas within the

[2] Kevin Fitzpatrick Landscape Architcture (2020)

[3] Guidelines on the installation of nest boxes: Chris Du Feu (2005). *Nestboxes. Extracts from British Trust for Ornithology Field Guide Number 23 with some additions and amendments.* British Trust for Ornithology, The Nunnery, Thetford, Norfolk. Available from: https://www.bto.org/sites/default/files/u15/downloads/publications/guides/nestbox.pdf

	Proposed Development site will pass through an oil interceptor and 'forebays' to remove detritus from the water. These waters will be retained onsite in one of the three attenuation areas prior to controlled release into the Baldonnel Stream.
Operational – *Operational lighting*	Operational phase lighting will be designed to be sensitive to the presence of bats commuting and foraging bats along the northern treeline and southern boundary to the Castlebaggot substation and should adhere to the following guidance: • *Bats & Lighting: Guidance Notes for Planners, engineers, architects and developers* (Bat Conservation Trust, 2010); • *Guidance Notes for the Reduction of Obtrusive Light GN01 (Institute of Lighting Professionals, 2020);* • *Bats and Lighting in the UK – Bats and the Built Environment Series (Bat Conservation Trust UK, January 2008).*
	Land, Soil and Geology
Construction - *CEMP*	An outline Construction Environmental Management Plan (CEMP) has been prepared by CSEA for the Proposed Development and is included with the planning documentation. In advance of work starting on site, the works Contractor will prepare a detailed Construction Environmental Management Plan (CEMP). The detailed CEMP will set out the overarching vision of how the construction of the Proposed Development will be managed in a safe and organised manner by the Contractor. The CEMP will be a live document and it will go through a number of iterations before works commence and during the works. It will set out requirements and standards which must be met during the construction stage and will include the relevant mitigation measures outlined in this EIA Report and any subsequent planning conditions relevant to the Proposed Development.
Construction – *Control of soil excavation*	Subsoil will be excavated to facilitate the construction of foundations and the installation of the ducting for the cable routes. The Proposed Development will incorporate the reduction, reuse and recycle approach in terms of soil excavations on site. The construction will be carefully planned to ensure only material required to be excavated will be excavated resulting in as much material left in situ as possible.
Construction – *Control of soil excavation*	It is unlikely given the findings of the site investigations - where no contamination was encountered, as outlined previously in this chapter - that any contaminated material will be encountered during construction of the Proposed Development. Nonetheless, any excavation works will be carefully monitored by a suitably qualified person to ensure any potentially contaminated soil is identified and segregated from clean/inert soil. In the unlikely event that any potentially contaminated soils are encountered, they should be tested and classified as hazardous or non-hazardous in accordance with the EPA *Waste Classification – List of Waste & Determining if Waste is Hazardous or Non-Hazardous* publication, HazWasteOnline tool or similar approved method. The material will then need to be classified as inert, non-hazardous, stable non-reactive hazardous or hazardous in accordance with *EC Decision 2003/33/EC*. It should then be removed from site by a suitably permitted waste contractor to an authorised waste facility.
Construction – *Control of soil excavation*	Stockpiles have the potential to cause negative impacts on air and water quality. The effects of soil stripping and stockpiling will be mitigated against through the implementation of an appropriate earthworks handling protocol (as detailed within the CEMP) during construction. It is anticipated that any stockpiles will be formed within the boundary of the site and there will be no direct link or pathway from this area to any surface water body
Construction – *Export of material from site*	It is envisioned that 24,300 m^3 of soil/stones will be excavated to facilitate the Proposed Development. Suitable soils and stones will be reused on site as backfill in the grassed areas, where possible. However, it is currently envisaged that majority of the excavated material will require removal offsite for reuse, recovery and/or disposal. Refer to Chapter 14 Waste Management for further detail.
Construction – *Export of material from site*	If any waste soil requires removal from site, it should be classified by an experienced and qualified environmental professional to ensure that the waste soil is correctly classified for transportation and recovery/disposal offsite. Refer to Chapter 14 Waste Management for further relevant information.
Construction – *Sources of fill and aggregates*	All fill and aggregate for the Proposed Development will be sourced from reputable suppliers. All suppliers will be vetted for:

	Aggregate compliance certificates/declarations of conformity for the classes of material specified for the Proposed Development; Environmental Management status; and Regulatory and Legal Compliance status of the Company.
Construction – *Fuel and chemical handling*	The following mitigation measures will be taken at the construction stage in order to prevent any spillages to ground of fuels and prevent any resulting soil and/or groundwater quality impacts: • Designation of a bunded refuelling areas on the site; • Provision of spill kit facilities across the site; and • Where mobile fuel bowsers are used the following measures will be taken: – Any flexible pipe, tap or valve will be fitted with a lock and will be secured when not in use; – The pump or valve will be fitted with a lock and will be secured when not in use; – All bowsers to carry a spill kit – Operatives must have spill response training; and – Drip trays used on any required mobile fuel units.
Construction – *Fuel and chemical handling*	In the case of drummed fuel or other potentially polluting substances which may be used during construction the following measures will be adopted: • Secure storage of all containers that contain potential polluting substances in a dedicated internally bunded chemical storage cabinet unit or inside a concrete bunded area; • Clear labelling of containers so that appropriate remedial measures can be taken in the event of a spillage; • All drums to be quality approved and manufactured to a recognised standard; • If drums are to be moved around the site, they will be secured and on spill pallets; and • Drums to be loaded and unloaded by competent and trained personnel using appropriate equipment.
Construction – *Control of water during construction*	No significant dewatering is required for the site development. However, run-off from excavations/earthworks cannot be prevented entirely and is largely a function of prevailing weather conditions. Earthwork operations will be carried out such that surfaces, as they are being raised, shall be designed with adequate drainage, falls and profile to control run-off and prevent ponding and flowing. These measures will ensure that there will be minimal inflow of shallow/perched groundwater into any excavation Care will be taken to ensure that exposed soil surfaces are stable to minimise erosion. All exposed soil surfaces will be within the main excavation site which limits the potential for any offsite impacts. All run-off will be prevented from directly entering into any water courses/ drainage ditches. Should any discharge of construction water be required during the construction phase, discharge will be to foul sewer. Pre-treatment and silt reduction measures on site will include a combination of silt fencing, settlement measures (silt traps, 20m buffer zone between machinery and watercourses, refuelling of machinery off site) and hydrocarbon interceptors.
Operational – *Environmental procedures*	As detailed in Section 2.92 in Chapter 2 ESB Networks implement an Environmental Safety and Health Management System at each of its facilities. Prior to operation of the Proposed Development, a comprehensive set of operational procedures will be established (based on those used at other similar facilities) which will include site-specific mitigation measures and emergency response measures.
Operational – *Fuel storage*	A small (less than 1 MW) generator will be located within the GIS substation building. The purpose of this generator is to provide power in the event of a power failure to the GIS building. Diesel fuel will be supplied to this generator via a 1,000 Litre diesel tank. The tank will be surrounded by a concrete bund. The primary potential impact of the operational phase relates to a failure or accidental spill of diesel fuel. The following mitigation measures will be undertaken at the operational stage in order to manage any leaks from vehicles resulting in soil and/or groundwater quality impacts: Provision of spill kit facilities and training of operatives in use of same.

Operational – *Increase in hard stand area*	A proportion of the Proposed Development area will be covered in hardstand (3,600sqm). This provides protection to the underlying aquifer but also reduces local recharge in this area of the aquifer. As the area of aquifer is large this reduction in local recharge will have no significant change in the natural hydrogeological regime.
	Hydrology
Construction - *CEMP*	An outline Construction Environmental Management Plan (CEMP) has been prepared by CSEA for the Proposed Development and is included with the planning documentation. A detailed CEMP will be prepared and maintained by the appointed contractors during the construction phase of the proposed project. The CEMP will cover all potentially polluting activities and include an emergency response procedure. All personnel working on the site will be trained in the implementation of the CEMP. At a minimum, the CEMP will be formulated in consideration of the standard best international practice including, but not limited, to: • CIRIA, (2001), *Control of Water Pollution from Construction Sites, Guidance for Consultants and Contractors, (C532)* Construction Industry Research and Information Association; • CIRIA (2002) *Control of water pollution from construction sites: guidance for consultants and contractors (SPI56)* Construction Industry Research and Information Association; • CIRIA (2005), *Environmental Good Practice on Site* (C650); Construction Industry Research and Information Association; • BPGCS005, *Oil Storage Guidelines*; • CIRIA 697 (2007), *The SuDS Manual*; and • *UK Pollution Prevention Guidelines,* (PPG) UK Environment Agency, 2004. All contractors will be required to implement the CEMP.
Construction - *Surface water run-off*	As there is potential for direct run-off to a watercourse present bounding the site, mitigation measures will be put in place to manage run-off during the construction phase. Run-off water containing silt will be contained on site via settlement tanks and treated to ensure adequate silt removal. Silt reduction measures on site will include a combination of silt fencing and settlement measures (silt traps, silt sacks and settlement tanks/ponds). The temporary storage of soil will be carefully managed. Stockpiles will be tightly compacted to reduce runoff and graded to aid in runoff collection. This will prevent any potential negative impact on the storm water drainage and the material will be stored away from any surface water drains. Movement of material will be minimised to reduce the degradation of soil structure and generation of dust. Excavations will remain open for as little time as possible before the placement of fill. This will help to minimise the potential for water ingress into excavations. Soil from works will be stored away from existing drainage features to remove any potential impact. Weather conditions will be considered when planning construction activities to minimise the risk of run-off from the site and the suitable distance of topsoil piles from surface water drains will be maintained.
Construction – *Fuel and chemical handling*	The following mitigation measures will be taken at the construction stage in order to prevent any spillages of fuels and prevent any resulting impacts to surface water systems. • Designation of a bunded refuelling areas on the site; • Provision of spill kit facilities across the site; • Where mobile fuel bowsers are used the following measures will be taken: - Any flexible pipe, tap or valve will be fitted with a lock and will be secured when not in use; - The pump or valve will be fitted with a lock and will be secured when not in use; - All bowsers will carry a spill kit and operatives must have spill response training; and - Portable generators or similar fuel containing equipment will be placed on suitable drip trays. In the case of drummed fuel or other potentially polluting substances which may be used during construction the following measures will be adopted: • Secure storage of all containers that contain potential polluting substances in a dedicated internally bunded chemical storage cabinet unit or inside a concrete bunded areas; • Clear labelling of containers so that appropriate remedial measures can be taken in the

	event of a spillage; • All drums to be quality approved and manufactured to a recognised standard; • If drums are to be moved around the site, they should be done so secured and on spill pallets; and • Drums to be loaded and unloaded by competent and trained personnel using appropriate equipment. All ready-mixed concrete will be brought to site by truck. A suitable risk assessment for wet concreting will be completed prior to works being carried out which will include measures to prevent discharge of alkaline waste waters or contaminated storm water to the underlying subsoil. Wash-down and washout of concrete transporting vehicles will take place at an appropriate facility offsite.
Construction – *Accidental release*	Emergency response procedures will be outlined in the detailed CEMP. All personnel working on the site will be suitably trained in the implementation of the procedures.
Construction – *Soil removal and compaction*	Temporary storage of soil will be carefully managed in such a way as to prevent any potential negative impact on the receiving environment. The material will be stored away from any surface water drains (see Surface Water Run-off section above). Movement of material will be minimised to reduce degradation of soil structure and generation of dust. All excavated materials will be visually assessed for signs of possible contamination such as staining or strong odours. Should any unusual staining or odour be noticed, samples of this soil will be analysed for the presence of potential contaminants to ensure that historical pollution of the soil has not occurred. Should it be determined that any of the soil excavated is contaminated, this will be segregated and appropriately disposed of by a suitably permitted/licensed waste disposal contractor. Site investigations carried out at the site in 2019 found no residual contamination on site. Nonetheless, all excavated materials will be visually assessed for signs of possible contamination such as staining or strong odours. Should any unusual staining or odour be noticed, samples of this soil will be analysed for the presence of potential contaminants to ensure that historical pollution of the soil has not occurred. Should it be determined that any of the soil excavated is contaminated, this will be segregated and appropriately disposed of by a suitably permitted/licensed waste disposal contractor.
Operational – *Environmental procedures*	ESB Networks implement an Environmental Safety and Health Management System at each of its facilities. Prior to operation of the Proposed Development, a set of operational procedures will be established (based on those used at other similar facilities) which will include site-specific mitigation measures and emergency response measures.
Operational – *Fuel and chemical handling*	The containment measures planned will minimise the risk of release of solid/ liquid material spillages to the water environment. Containment measures will include storage of fuels on site in bunded containers or compartments. The design of all bunds will conform to standard bunding specifications - BS EN 1992-3:2006, *Design of Concrete Structures – Part 3: Liquid retaining and containment measures.*
Operational – *Storm water & foul sewer drainage*	As stated previously the permitted drainage system formed part of the planning application for the permitted data storage facility on site and is intended to service that development (SDCC Reg. Ref. SD20A/0121) and the Proposed Development. As such, there will be capacity for the SuDs for the permitted development to accommodate runoff from the Proposed Development. Further information of surface and foul water drainage for the proposed development is included in the Engineering Planning Report *(Engineering Planning Report – Drainage & Water Services Clutterland – 110 kv GIS Substation DUB 69*) which is provided as a separate document to this application. The allowable discharge rate (QBAR) applicable to the Proposed Development is 2.01 l/s/ha.. To mitigate the impact of a spillage entering the surface water system from anywhere within the substation it is proposed that any spillage will be within the bunded area within the building and will therefore be cleaned up and taken off site to a suitable licensed facility. The proposed surface water attenuation system will be released via a hydrobrake to the Baldonnel Stream.

	Foul drainage for the Proposed Development will be in accordance with the relevant standards for design and construction as detailed in the *Engineering Planning Report,* prepared by CSEA Engineers.
Operational – *Water supply*	The proposed development will connect to a watermain permitted under SDCC Reg. Ref. SD20A/0121. The water system will be metered to facilitate detection of leakage and the prevention of water loss. Dual and low flush toilets, water economy outlets and water saving measures will also be proposed.
Operational – Crossing beneath Culverted Griffeen River	Use of Horizontal drilling beneath the culverted Griffeen River will ensure no impact on the existing river hydraulics.
	Noise and vibration
Construction – *Noise and vibration*	With regard to construction activities, reference has been made to BS5228 Parts 1 and 2, which offer detailed guidance on the control of noise and vibration from demolition and construction activities. Various mitigation measures will be considered and applied during the construction of the Proposed Development. As an example, the following measures will be implemented on site: • limiting the hours during which site activities likely to create high levels of noise or vibration are permitted; • establishing channels of communication between the contractor/developer, Local Authority and residents; • appointing a site representative responsible for matters relating to noise and vibration; • monitoring levels of noise and/or vibration during critical periods and at critical sensitive locations; and • all site access roads will be kept even so as to mitigate the potential for vibration from lorries. Furthermore, a variety of practicable noise control measures will be employed, such as: • selection of plant with low inherent potential for generation of noise and/ or vibration; • erection of barriers as necessary around items such as generators or high duty compressors; • situate any noisy plant as far away from sensitive properties as permitted by site constraints and the use of vibration isolated support structures where necessary. We would recommend that vibration from construction activities to off-site residences be limited to the values set out in Table 9.7 of the EIA Report. These limits are not absolute but provide guidance as to magnitudes of vibration that are very unlikely to cause cosmetic damage. Where there is existing building damage these limits may need to be reduced by up to 50%. Chapter 9 - Appendix 9.4 of the EIA Report presents an indicative construction noise and vibration management plan that will be implemented in terms of the day to day operation of the site. This will focus on opening up and maintaining lines of communication with the local community to address issues in relation to noise and/or vibration and to advise the community of periods where specific activities take place that have an increased potential in giving rise to issues off site (Note: no rock breaking is anticipated as part of the Proposed Development). It is required that the appointed contractor monitor levels of noise and vibration during the construction phase at nearby sensitive locations and/or development site boundaries.
Operational - *Building services noise / emergency site operation*	Once operational, there are no noise or vibration mitigation measures required. With due consideration as part of the detailed design process, this approach will result in the site operating well within the constraints of the best practice guidance noise limits that have been adopted as part of this detailed assessment.
Additional vehicular traffic on public roads	The noise impact assessment outlined previously has demonstrated that mitigation measures are not required.
Operational - *Cumulative*	The environmental noise survey takes account of noise emissions from existing developments. It was noted that the existing ambient noise levels in the area were dominated

assessment	primarily by road traffic on the surrounding road network. The noise criteria proposed for new building services plant items has been derived with consideration of existing site noise emissions levels to ensure that cumulative noise emissions do not exceed the relevant noise criteria. The potential cumulative noise emissions from the Permitted Development, Proposed Development and neighbouring Google Ireland Data Centre and Cyrus One Data Centre have been considered. Reference is made to Section 9 of the Google Ireland EIS (PM Group ref. IE0311190-22-RP-0001, Issue A) (Google EIS Table 9.12) and Section 10 of the Cyrus One EIAR which presents noise predictions to nearby shared residential receptors. The closest shared receptors to the two neighbouring sites are the receivers R2, R5 and R6. Table 9.17 presents the predicted cumulative noise levels to these two receivers and compares to the proposed noise criteria. Predicted cumulative plant noise emissions are therefore within the adopted criteria.
	Air quality and climate
Construction – *Dust control*	The objective of dust control at the site is to ensure that no significant nuisance occurs at nearby sensitive receptors. In order to develop a workable and transparent dust control strategy, the following management plan has been formulated by drawing on best practice guidance from Ireland, the UK and the USA based on the following publications: • 'Guidance on the Assessment of Dust from Demolition and Construction' (IAQM, 2014); • 'Planning Advice Note PAN50 Annex B: Controlling The Environmental Effects Of Surface Mineral Workings Annex B: The Control of Dust at Surface Mineral Workings' (The Scottish Office, 1996); • 'Controlling the Environmental Effects of Recycled and Secondary Aggregates Production Good Practice Guidance' (UK Office of Deputy Prime Minister, 2002); • 'Controlling Particles, Vapours & Noise Pollution From Construction Sites' (BRE, 2003); • 'Fugitive Dust Technical Information Document for the Best Available Control Measures' and the USA (USEPA, 1997). ; and • 'Compilation of Air Pollutant Emission Factors, AP-42, Fifth Edition' (periodically updated) (USEPA, 1986). In advance of work starting on site, the works contractor will prepare a detailed Construction Environmental Management Plan (CEMP). The CEMP will set out the overarching vision of how the construction of the Proposed Development will be managed in a safe and organised manner by the Contractor. The CEMP will be a live document. It will set out requirements and standards which must be met during the construction stage and will include the relevant mitigation measures outlined in the EIA Report and any subsequent planning conditions relevant to the Proposed Development.
Construction – *site management*	The aim is to ensure good site management by avoiding dust becoming airborne at source. This will be done through good design and effective control strategies. At the construction planning stage, the siting of activities and storage piles will take note of the location of sensitive receptors and prevailing wind directions in order to minimise the potential for significant dust nuisance (see Figure 10.1 for the wind rose for Casement Aerodrome). As the prevailing wind is predominantly westerly to south-westerly, locating construction compounds and storage piles downwind (to the east or north-east) of sensitive receptors will minimise the potential for dust nuisance to occur at sensitive receptors. Good site management will include the ability to respond to adverse weather conditions by either restricting operations on-site or quickly implementing effective control measures before the potential for nuisance occurs. When rainfall is greater than 0.2mm/day, dust generation is generally suppressed (UK Office of Deputy Prime Minister (2002), BRE (2003)). The potential for significant dust generation is also reliant on threshold wind speeds of greater than 10 m/s (19.4 knots) (at 7m above ground) to release loose material from storage piles and other exposed materials (USEPA, 1986). Particular care should be taken during periods of high winds (gales) as these are periods where the potential for significant dust emissions are highest. The prevailing meteorological conditions in the vicinity of the site are favourable in general for the suppression of dust for a significant period of the year. Nevertheless, there will be infrequent periods were care will be needed to ensure that dust nuisance does not occur.

	The following measures shall be taken in order to avoid dust nuisance occurring under unfavourable meteorological conditions: • The Principal Contractor or equivalent must monitor the contractors' performance to ensure that the proposed mitigation measures are implemented and that dust impacts and nuisance are minimised; • During working hours, dust control methods will be monitored as appropriate, depending on the prevailing meteorological conditions; • The name and contact details of a person to contact regarding air quality and dust issues shall be displayed on the site boundary, this notice board should also include head/regional office contact details; • It is recommended that community engagement be undertaken before works commence on site explaining the nature and duration of the works to local residents and businesses; • A complaints register will be kept on site detailing all telephone calls and letters of complaint received in connection with dust nuisance or air quality concerns, together with details of any remedial actions carried out; • It is the responsibility of the contractor at all times to demonstrate full compliance with the dust control conditions herein; • At all times, the procedures put in place will be strictly monitored and assessed. The dust minimisation measures shall be reviewed at regular intervals during the works to ensure the effectiveness of the procedures in place and to maintain the goal of minimisation of dust, through the use of best practice and procedures. In the event of dust nuisance occurring outside the site boundary, site activities will be reviewed, and satisfactory procedures implemented, to rectify the problem. Specific dust control measures, to be employed, are described below.
Construction – *site roads / haulage routes*	Movement of construction trucks along site roads (particularly unpaved roads) can be a significant source of fugitive dust if control measures are not in place. The most effective means of suppressing dust emissions from unpaved roads is to apply speed restrictions. Studies show that these measures can have a control efficiency ranging from 25 to 80% (UK Office of Deputy Prime Minister, 2002). • A speed restriction of 20 km/hr will be applied as an effective control measure for dust for on-site vehicles using unpaved site roads; • Access gates to the site will be located at least 10m from sensitive receptors where possible; • Bowsers or suitable watering equipment will be available during periods of dry weather throughout the construction period. Research has found that watering can reduce dust emissions by 50% (USEPA, 1997). Watering will be conducted during sustained dry periods to ensure that unpaved areas are kept moist. The required application frequency will vary according to soil type, weather conditions and vehicular use; and • Any hard surface roads will be swept to remove mud and aggregate materials from their surface while any unsurfaced roads shall be restricted to essential site traffic only.
Construction – *Land clearing / earth moving*	Land clearing / earth-moving works during periods of high winds and dry weather conditions can be a significant source of dust. • During dry and windy periods, and when there is a likelihood of dust nuisance, watering will be conducted to ensure moisture content of materials being moved is high enough to increase the stability of the soil and thus suppress dust; and • During periods of very high winds (gales), activities likely to generate significant dust emissions will be postponed until the gale has subsided.
Construction – *storage piles*	The location and moisture content of storage piles are important factors, which determine their potential for dust emissions. • Overburden material will be protected from exposure to wind by storing the material in sheltered regions of the site. Where possible storage piles will be located downwind of sensitive receptors; • Regular watering will take place to ensure the moisture content is high enough to increase the stability of the soil and thus suppress dust. The regular watering of stockpiles has been found to have an 80% control efficiency (UK Office of Deputy Prime Minister, 2002); and • Where feasible, hoarding will be erected around site boundaries to reduce visual impact.

	This will also have an added benefit of preventing larger particles from impacting on nearby sensitive receptors.
Construction – *Site traffic on public roads*	Spillage and blow-off of debris, aggregates and fine material onto public roads will be reduced to a minimum by employing the following measures: • Vehicles delivering or collecting material with potential for dust emissions shall be enclosed or covered with tarpaulin at all times to restrict the escape of dust; and • At the main site traffic exits, a wheel wash facility will be installed. All trucks leaving the site must pass through the wheel wash. In addition, public roads outside the site shall be regularly inspected for cleanliness, as a minimum on a daily basis, and cleaned as necessary.
Construction – *Dust mitigation*	The pro-active control of fugitive dust will ensure that the prevention of significant emissions, rather than an inefficient attempt to control them once they have been released, will contribute towards the satisfactory performance of the contractor. The key features with respect to control of dust will be: • The specification of a site policy on dust and the identification of the site management responsibilities for dust issues; • The development of a documented system for managing site practices with regard to dust control; • The development of a means by which the performance of the dust minimisation plan can be regularly monitored and assessed; and • The specification of effective measures to deal with any complaints received.
Operational	There are no predicted impacts for the operational phase of the Proposed Development and therefore, no additional mitigation measures are proposed.
	Landscape and visual assessment
Operational – *visual impact*	The Proposed Development is situated on suitably zoned lands in a landscape where a number of large developments have been recently constructed or have recently acquired planning permission. The Permitted Data Centre Development (described in detail in chapter 2 of this EIAR) will precede the construction of the Proposed Development and the built development and the significant landscape scheme permitted as part of the Permitted Development will provide substantial mitigation of the proposed development. • earth modelling and large tree planting, reinforced with woodland whip planting in belts is proposed to provide a high level of visual screening of the most sensitive views of the development; and • the colour palette chosen for the building aims to further reduce any visual impact of the building. The mitigation of potential negative landscape and visual impacts of the Proposed Development was considered in the application made for the Permitted Development under SDCC Planning Reg. Ref. SD20A/0121 (refer to the Permitted Landscape Mitigation Drawing, Kevin Fitzpatrick Landscape Architecture included in Chapter 11 – Appendix 11.1 of this EIA Report). No additional landscape mitigation measures are therefore proposed as part of the Proposed Development beyond minor changes to the positioning of the berms permitted to the north of the permitted Buildings B and C under the Permitted Development. As a result of the mitigations measures, the following landscape design mitigation measures will be implemented: • earth modelling and large tree planting, reinforced with woodland whip planting in belts is proposed to provide a high level of visual screening of the most sensitive views of the development; and • set back of built development form the perimeter of the lands to accommodate significant landscape buffer zones; and • incorporation of the stormwater attenuation systems as above ground wetlands and ponds to improve the amenity, visual and biodiversity value of the landscape.
	Traffic and transportation
Construction – *traffic and*	The following measures will be put in place during the construction works to ensure the effective traffic management during this period:

transportation	• The contractor will be required to provide wheel cleaning facilities, and regular cleaning of the main access road; • Temporary car parking facilities for the construction workforce will be provided within the site and the surface of the car park will be prepared and finished to a standard sufficient to avoid mud spillage onto adjoining roads; • Monitoring and control of construction traffic will be ongoing during construction works. Construction traffic will minimise movements during peak hours; and • Construction traffic routes shall be use strategically by construction vehicles to minimise traffic impact to surrounding properties.
Operational – *traffic and transportation*	The potential traffic impact associated with the operational phase of the Proposed Development will be ***long-term, neutral*** and ***imperceptible***. The traffic impact assessment for the operational phase are significantly below the thresholds stated in the TII Guidelines for Traffic and Transport Assessments, 2014 for junction analysis. Therefore, no mitigation measures in the form of junction modifications are proposed on the public road to facilitate the Proposed Development.
	Cultural heritage
Construction - *Archaeology*	It is recommended that archaeological monitoring of topsoil stripping associated with the construction of the Proposed Development be carried out in all areas outside the footprint of the previously excavated areas. If any features of archaeological potential are discovered during the course of the works further archaeological mitigation may be required, such as preservation *in-situ* or by record. Any further mitigation will require approval from the National Monuments Service of the DoCHG.
Construction – *Architecture*	As there are no potential impacts on the architectural resource, no mitigation is deemed necessary.
Construction – *Cultural heritage*	As there are no potential impacts on the cultural heritage resource, no mitigation is deemed necessary.
Operational phase – *cultural heritage*	As there are no potential impacts on cultural heritage, no mitigation is deemed necessary.
	Waste management
Construction – *C&D WMP*	A project specific outline C&D WMP has been prepared in line with the requirements of the *Best Practice Guidelines for the Preparation of Waste Management Plans for Construction and Demolition Projects* guidance document issued by the Department of Environment, Heritage and Local Government (DoEHLG). Adherence to the high-level strategy presented in this C&D WMP will ensure effective waste management and minimisation, reuse, recycling, recovery and disposal of waste material generated during the construction phase of the Proposed Development. Prior to commencement of construction, the contractor(s) will be required to refine/update this document to detail specific measures to minimise waste generation and resource consumption and provide details of the proposed waste contractors and destinations of each waste stream.
Construction – *C&D WMP*	The project engineers, CSEA, have estimated that 24,300m^3 of excavated material will be generated. Suitable soils and stones will be reused on site as backfill in the grassed areas, where possible. However, it is currently envisaged that majority of this material will require removal offsite. It will be reused offsite where practical and where it cannot be reused, it will be recycled/recovered.
Construction – *C&D WMP*	In addition, the following mitigation measures will be implemented: • On-site segregation of waste materials will be carried out to increase opportunities for off-site reuse, recycling and recovery – it is anticipated that the following waste types, at a minimum, will be segregated: - Made ground - Soils and stones - Trees/shrubbery - In addition, the following wastes will be segregated at the site compound: - Organic (food) waste - Packaging (paper/card/plastic) - Mixed dry recyclables - Mixed non-recyclable waste • All excavations will be carefully monitored by a suitably qualified person to ensure that potentially contaminated soil is identified and segregated, if encountered. In the event that

	any potentially contaminated material is encountered, it will be segregated from clean/inert material, tested and classified as either non-hazardous or hazardous and further classified as clean, inert, non-hazardous or hazardous in accordance with the EC Council Decision 2003/33/EC, which establishes the criteria for the acceptance of waste at landfills. • Waste materials generated at the site compound will be stored in suitable receptacles in designated areas of the site compound; • Any hazardous wastes generated (such as chemicals, solvents, glues, fuels, oils) will also be segregated and will be stored in appropriate receptacles (in suitably bunded areas, where required); • A waste manager will be appointed by the main contractor to ensure effective management of waste during the excavation and construction works; • All construction staff will be provided with training regarding the waste management procedures; • All waste leaving site will be reused, recycled or recovered where possible to avoid material designated for disposal; • All waste leaving the site will be transported by suitable permitted contractors and taken to suitably registered, permitted or licenced facilities; and • All waste leaving the site will be recorded and copies of relevant documentation maintained.
Construction – *C&D WMP*	As surplus soils and stones will require removal from site, any nearby sites requiring clean fill material will be contacted to investigate reuse opportunities for clean and inert material, which requires removal off-site. If any of the material is to be reused on another site as by-product (and not as a waste), this will be done in accordance with Article 27 of the *EC (Waste Directive) Regulations (2011)* as previously referred to in this chapter, and detailed in the C&D WMP (Chapter 14 - Appendix 14.1). These mitigation measures will ensure that the waste arising from the construction phase of the development is dealt with in compliance with the provisions of the *Waste Management Act 1996*, as amended, associated Regulations, the *Litter Pollution Act 1997 to 2009* and the *EMR Waste Management Plan (2015 - 2021)*. It will also ensure optimum levels of waste reduction, reuse, recycling and recovery are achieved and will encourage sustainable consumption of resources.
Operational - *Waste*	Small volumes of waste will be generated at the proposed GIS substation. No waste will be generated from the operation of the proposed 220kV transmission line, 49kVA cable installation and new cable bays. Any waste materials will be segregated into appropriate categories and will be temporarily stored in appropriate bins or other suitable receptacles in a designated, easily accessible areas of the substation. In addition, the following mitigation measures will be implemented: • On-site segregation of all waste materials into appropriate categories including (but not limited to): - Dry Mixed Recyclables; - Organic food/green waste; - Mixed Non-Recyclable Waste; - Batteries (non-hazardous and hazardous); - Waste electrical and electronic equipment (WEEE) including computers, printers and other ICT equipment; and - Cleaning chemicals (solvents, pesticides, paints, adhesives, resins, detergents, etc.). • All waste materials will be stored in colour coded bins or other suitable receptacles in designated, easily accessible locations. Bins will be clearly labelled with the approved waste type to ensure there is no cross contamination of waste materials; • All waste collected from the development will be reused, recycled or recovered where possible, with the exception of those waste streams where appropriate facilities are currently not available; • All waste leaving the site will be transported by suitable permitted contractors and taken to suitably registered, permitted or licensed facilities; and • All waste leaving the site will be recorded and copies of relevant documentation maintained. These mitigation measures will ensure the waste arising from the development is dealt with in

	compliance with the provisions of the *Waste Management Act 1996*, as amended, associated Regulations, the *Litter Pollution Act 1997* and the *EMR Waste Management Plan (2015 - 2021)*. It will also ensure optimum levels of waste reduction, reuse, recycling and recovery are achieved.
	Material assets
Construction – *Service providers*	Construction of the proposed GIS substation will require connections to power, telecommunications, drainage infrastructure and water supply but will not require any connections outside the Permitted Development site and Proposed Development site boundaries. Construction of the 110kV transmission lines, 49kVA cable installation and new cable bays will not require any power, telecommunications, drainage infrastructure and water supply from existing services. Surveys completed have identified where short term diversion of any services will be required. Ongoing consultation with EirGrid, ESB Networks, SDCC, Irish Water and other relevant utility providers within the locality and compliance with any requirements or guidelines they may have will ensure a smooth construction schedule without disruption to the local and business community. Such diversions are common practice.
Construction – *Power and Electricity supply*	The power demand for the construction phase will be relatively minor and the temporary connection works are entirely within the Permitted and Proposed Development site, and there will therefore be no offsite impact. The excavation of trenches within the vicinity of existing electrical services will be carried out in consultation with ESB Networks to ensure there is no impact on existing users. Once the construction of the Proposed Development is completed, ESB Networks will be mobilised to complete the commissioning in accordance with the ESB Network requirements. As stated in Chapter 2, there is no requirement for chemicals usage and minimal access to the route by personnel and there is no likely environmental effect as a result of commissioning.
Construction - *Telecommunications*	No remedial or mitigation measures are required in relation to telecommunications.
Construction - *Surface water and foul water infrastructure*	Welfare facilities (canteens, toilets etc.) will be available within the construction compound of the Permitted Development during the construction of Building A and it is proposed that this will be in place for the construction of the Proposed Development. No remedial or mitigation measures are required in relation to surface water and foul drainage infrastructure and water supply.
Operational – *Power and electricity supply*	The Proposed Development has been designed in accordance with ESB Networks requirements. Eirgrid has confirmed that there is sufficient power available from the existing area network for the Proposed Development. No remedial or mitigation measures are required in relation to power and electricity supply.
Operational - *Telecommunications*	As there are no potential effects on telecommunications during the operational phase of the Proposed Development, no remedial or mitigation measures are required.
Operational - *surface water and foul water infrastructure*	There are no potential effects associated with surface water and foul drainage infrastructure or water supply for the Proposed Development for the operational phase and as such no remedial or mitigation measures deemed necessary required.

CHAPTER 4 - CONSIDERATION OF ALTERNATIVES

Appendix 4.1 Evaluation of Alternative Routes to Kilmahud-Corkagh 110kV circuit – 110kV Route Options Matrix (CSEA Consulting Engineers) taking into consideration environmental and other matters

	Colour Legend	0 = Not Feasible / Not Assessed		2 = Less Preferred		4 = Neutral		6 = More Preferred	
		ROUTE OPTIONS							
	Criteria	Option 1	Score	Option 2	Score	Option 3	Score	Option 4	Score
1	Route Length	Circa 1.5 km	4	Circa 1.5 km	4	Circa 1.1 km	6	Circa 1.1 km	6
2	Ground Conditions/Stability	No SI available at this time	4	No SI available at this time	4	No SI available at this time	4	No SI available at this time	4
3	Road Closures/Traffic Management	Route involves significant works on the Baldonnell road and junction between Baldonnell road and New Nangor road.	0	Route commencement involves minor works on the Baldonnell road but is off road therafter	6	Route commencement involves minor works on the Baldonnell road but is off road therafter	6	Route involves significant works on the New Nangor road.	2
4	Water Crossings	No impact impact expected due to existing services crossing over existing culverts	6	No impact due to HDD crossing under culvert however works required adjacent to watercourse	4	No impact due to HDD crossing under culvert however works required adjacent to watercourse	4	Minimal due to crossing under culvert however works required adjacent to watercourse	4
5	Impact on Roads	Works along Baldonnell road and junction of Baldonnell road and New Nangor road.	2	No impact on roads due to requirement for directional drilling underneath the existing 220kv twin circuits within the road bed of the New Nangor road	4	No impact on roads due to requirement for directional drilling underneath the existing 220kv twin circuits within the road bed of the New Nangor road	4	Significant disruption to traffic due to on road works for the proposed underground circuit.	0
6	Environmental Impact	Potential impact in terms of noise and dust due to working on road in the vicinty of existing local businesses/industry	2	Potential impact in terms of works in parallel with watercourse.	4	Potential impact in terms of works in parallel with watercourse.	4	Potential impact in terms of noise and dust due to working on road in the vicinty of existing local businesses/industry	2
7	Impact on Residents and Commercial Premises	Potential access and traffic impact on all residents within Grange Castle Business Park due to the nature of the works being within the road bed	2	Minor impacts in terms of construction related traffic however 90% of the works are off road activities.	4	Minor impacts in terms of construction related traffic however 90% of the works are off road activities.	4	Potential access and traffic impact on New Nangor road and grange castle business park due to the nature of the works being within the road bed	2
8	Private Wayleaves/Easements Required/Access issues	Access to existing SDCC wayleave required for circa 160m	4	Access to existing SDCC wayleave required for circa 640m	4	Access to existing SDCC wayleave required for circa 405m and access to 105m of new wayleave	2	Access to existing SDCC for 405m and Irish Water wayleave for 20m.	2
9	Constructability and Access for Construction	Construction of route along Baldonnell road and junction of Baldonnell road and New Nangor are considered proplematic due to existing services crossing / parrallel of existing services.Logistics of construction associated with joint bays being located within centre of trafficked carriageway.	0	Construction works are considered to be manageable in terms of traffic management, logistic and crossing / parrallel of existing services. Works would involve construction in parrallel with existing watercourses, directional drill beneath New Nangor Road.	4	Construction works are considered to be manageable in terms of traffic management, logistic and crossing / parrallel of existing services. Works would involve construction in parrallel with existing watercourses, directional drill beneath New Nangor Road.	6	Construction of route along New Nangor road are considered proplematic due to existing services crossing / parrallel of existing services, existing 220kv line.Logistics of construction associated with joint bays being located within centre of trafficked carriageway.	0
10	Existing Services	Route involves significant works on the Baldonnell road which is heavily congested with existing services and invloves crossing 2 No. 220kv lines	0	Directional drilling beneath 220kv lines on New Nangor road	4	Directional drilling beneath 220kv lines on New Nangor road	4	Route involves significant works on the New Nangor road in parrallel and crossings of the existing 2 No. 220kv circuits.	0
11	Cable Pulling	Longer route for cable pullling however geometry is suitable	4	Less perferred option to Option 3 due to extra length.	4	More preferred route for cable pullling due to distances and geometry.	6	Less perferred to option 3 due to geometry.	2
12	Cable Ratings	Circuit will be in parrallel with existing and future 110kv circuits due to be built later this year and de-rating of circuits will have to be considered.	2	Circuit will be in parrallel with existing and future 110kv circuits due to be built later this year and de-rating of circuits will have to be considered.	2	Least impacted due to minimal interfacing with existing underground HV circuits	6	Least preferred option as circuit is in parrallel with existing 220kv and de-rating of circuits will have to be considered.	0
13	Future Maintenance Considerations at Joint Bay locations.	Route will involve both on and off road joint bays, C2 chambers and link boxes	2	All joint bays will be off the carriageway as will the C2 Chambers and link boxes.	4	All joint bays will be off the carriageway as will the C2 Chambers and link boxes.	4	Route will involve both on and off road joint bays, C2 chambers and link boxes	2
14	Potential impact on 3rd Party Landowners excluding state bodies	No Impact	4	No Impact	4	No Impact	4	No Impact	4
15	Potential impact on AWS DC Development	Significant impact on lanscaping and mounding proposals of current planning application for AWS DC development	2	Significant impact on lanscaping and mounding proposals of current planning application for AWS DC development	2	Impact on lanscaping and mounding proposals of current planning application for AWS DC development	4	Minimal impact on lanscaping and mounding proposals of current planning application for AWS DC development	4
	Total Score		**38**		**58**		**68**		**34**

Most Preferred Route:	**Option 3**
Second Most Preferred Route (s):	**Option 2**

CHAPTER 6 - BIODIVERSITY

Appendix 6.1 – Legislation, policy and Guidelines

National and International Legislation

- Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora; hereafter, referred to as the 'Habitats Directive'. The Habitats Directive is the legislation under which the Natura 2000 network4 was established and special areas of conservation (SACs) are designated for the protection of natural habitat types listed in Annex I, and habitats of the species listed in Annex II, of that directive.
- Directive 2009/147/EEC; hereafter, referred to as the 'Birds Directive'. The Birds Directive is the legislation under which special protection areas are designated for the protection of endangered species of wild birds listed in Annex I of that directive.
- Wildlife Acts 1976 to 2019; hereafter collectively referred to as the 'Wildlife Acts'. The Wildlife Acts are the principal pieces of legislation at national level for the protection of wildlife and for the control of activities that may harm wildlife. All bird species, 22 other animal species or groups of species, and 86 species of flora are protected under this legislation.
- Planning and Development Acts 2000 to 2019; hereafter collectively referred to as the 'Planning and Development Acts'. This piece of legislation is the basis for Irish planning. Under the legislation, development plans (usually implemented at local authority level) must include mandatory objectives for the conservation of natural heritage and for the conservation of European sites. It also sets out the requirements in relation to environmental assessment with respect to planning matters, including transposition of the Habitats and Birds Directive into Irish law.
- European Communities (EC) (Birds and Natural Habitats) Regulations 2011 to 2015; hereafter the 'Birds and Habitats Regulations'. This legislation transposes the Habitats and Birds Directives into Irish law. It also contains regulations (49 and 50) that deal with invasive species (those included within the Third Schedule of the regulations).
- Flora (Protection) Order, 2015. This lists species of plant protected under Section 21 of the Wildlife Acts.

Relevant Policies and Plans

- *National Biodiversity Action Plan 2017 – 2021;*
- *South Dublin County Development Plan 2016 – 2022;*
- *South Dublin County Heritage Plan 2010 – 2015.*

Relevant Guidelines

- *Advice Notes on Current Practice (in preparation of Environmental Impact Statements)* (EPA, 2003 and Draft update 2015);
- *Guidelines on the Information to be contained in Environmental Impact Statements* (EPA, 2002 and Draft update 2015);
- *Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal, and Marine. Chartered Institute of Ecology and Environmental Management, Winchester*. (CIEEM (2018);
- *Guidelines for Assessment of Ecological Impacts of National Roads Schemes. National Roads Authority, Dublin*. (National Roads Authority, 2009);
- *Best Practice Guidance for Habitat Survey and Mapping* (Heritage Council, 2011); and
- *A Guide to Habitats in Ireland* (Fossitt, 2000).

[4] The Natura 2000 network is a European network of important ecological sites, as defined under Article 3 of the Habitats Directive 92/43/EEC, which comprises both special areas of conservation and special protection areas. Special conservation areas are sites hosting the natural habitat types listed in Annex I, and habitats of the species listed in Annex II, of the Habitats Directive, and are established under the Habitats Directive itself. Special protection areas are established under Article 4 of the Birds Directive 2009/147/EC for the protection of endangered species of wild birds. The aim of the network is to aid the long-term survival of Europe's most valuable and threatened species and habitats.
In Ireland these sites are designed as *European sites* - defined under the Planning Acts and/or the Birds and Habitats Regulations as (a) a candidate site of Community importance, (b) a site of Community importance, (c) a candidate special area of conservation, (d) a special area of conservation, (e) a candidate special protection area, or (f) a special protection area. They are commonly referred to in Ireland as Special Areas of Conservation (SACs) and Special Protection Areas (SPAs).

Appendix 6.2 Criteria for ecological evaluation

International Importance:

- 'European Site' including Special Area of Conservation (SAC), Site of Community Importance (SCI), Special Protection Area (SPA) or proposed Special Area of Conservation.
- Proposed Special Protection Area (pSPA).
- Site that fulfils the criteria for designation as a 'European Site' (see Annex III of the Habitats Directive, as amended).
- Features essential to maintaining the coherence of the Natura 2000 Network.[5]
- Site containing 'best examples' of the habitat types listed in Annex I of the Habitats Directive.
- Resident or regularly occurring populations (assessed to be important at the national level)[6] of the following:
  - Species of bird, listed in Annex I and/or referred to in Article 4(2) of the Birds Directive; and/or
  - Species of animal and plants listed in Annex II and/or IV of the Habitats Directive.
- Ramsar Site (Convention on Wetlands of International Importance Especially Waterfowl Habitat 1971).
- World Heritage Site (Convention for the Protection of World Cultural & Natural Heritage, 1972).
- Biosphere Reserve (UNESCO Man & The Biosphere Programme).
- Site hosting significant species populations under the Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animals, 1979).
- Site hosting significant populations under the Berne Convention (Convention on the Conservation of European Wildlife and Natural Habitats, 1979).
- Biogenetic Reserve under the Council of Europe.
- European Diploma Site under the Council of Europe.
- Salmonid water designated pursuant to the European Communities (Quality of Salmonid Waters) Regulations, 1988, (S.I. No. 1988).[7]

National Importance:

- Site designated or proposed as a Natural Heritage Area (NHA).
- Statutory Nature Reserve.
- Refuge for Fauna and Flora protected under the Wildlife Acts.
- National Park.
- Undesignated site fulfilling the criteria for designation as a Natural Heritage Area (NHA); Statutory Nature Reserve; Refuge for Fauna and Flora protected under the Wildlife Act; and/or a National Park.
- Resident or regularly occurring populations (assessed to be important at the national level)[8] of the following:
  - Species protected under the Wildlife Acts; and/or
  - Species listed on the relevant Red Data list.
- Site containing 'viable areas'[9] of the habitat types listed in Annex I of the Habitats Directive

County Importance:

- Area of Special Amenity.[10]
- Area subject to a Tree Preservation Order.
- Area of High Amenity, or equivalent, designated under the County Development Plan.
- Resident or regularly occurring populations (assessed to be important at the County level)[11] of the following:
  - Species of bird, listed in Annex I and/or referred to in Article 4(2) of the Birds Directive;
  - Species of animal and plants listed in Annex II and/or IV of the Habitats Directive;
  - Species protected under the Wildlife Acts; and/or
  - Species listed on the relevant Red Data list.
- Site containing area or areas of the habitat types listed in Annex I of the Habitats Directive that do not fulfil the

[5] See Articles 3 and 10 of the Habitats Directive

[6] It is suggested that, in general, 1% of the national population of such species qualifies as an internationally important population. However, a smaller population may qualify as internationally important where the population forms a critical part of a wider population or the species is at a critical phase of its life cycle.

[7] Note that such waters are designated based on these waters' capabilities of supporting salmon (Salmo salar), trout (Salmo trutta), char (Salvelinus) and whitefish (Coregonus)

[8] It is suggested that, in general, 1% of the national population of such species qualifies as a nationally important population. However, a smaller population may qualify as nationally important where the population forms a critical part of a wider population or the species is at a critical phase of its life cycle.

[9] A 'viable area' is defined as an area of a habitat that, given the particular characteristics of that habitat, was of a sufficient size and shape, such that its integrity (in terms of species composition, and ecological processes and function) would be maintained in the face of stochastic change (for example, as a result of climatic variation).

[10] It should be noted that whilst areas such as Areas of Special Amenity, areas subject to a Tree Preservation Order and Areas of High Amenity are often designated on the basis of their ecological value, they may also be designated for other reasons, such as their amenity or recreational value. Therefore, it should not be automatically assumed that such sites are of County importance from an ecological perspective.

[11] It is suggested that, in general, 1% of the County population of such species qualifies as a County important population. However, a smaller population may qualify as County important where the population forms a critical part of a wider population or the species is at a critical phase of its life cycle.

criteria for valuation as of International or National importance.
- County important populations of species, or viable areas of semi-natural habitats or natural heritage features identified in the National or Local Biodiversity Action Plan, if this has been prepared.
- Sites containing semi-natural habitat types with high biodiversity in a county context and a high degree of naturalness, or populations of species that are uncommon within the county.
- Sites containing habitats and species that are rare or are undergoing a decline in quality or extent at a national level.

Local Importance (higher value):
- Locally important populations of priority species or habitats or natural heritage features identified in the Local BAP, if this has been prepared;
- Resident or regularly occurring populations (assessed to be important at the Local level)[12] of the following:
  - Species of bird, listed in Annex I and/or referred to in Article 4(2) of the Birds Directive;
  - Species of animal and plants listed in Annex II and/or IV of the Habitats Directive;
  - Species protected under the Wildlife Acts; and/or
  - Species listed on the relevant Red Data list.
- Sites containing semi-natural habitat types with high biodiversity in a local context and a high degree of naturalness, or populations of species that are uncommon in the locality;
- Sites or features containing common or lower value habitats, including naturalised species that are nevertheless essential in maintaining links and ecological corridors between features of higher ecological value.

Local Importance (lower value):
- Sites containing small areas of semi-natural habitat that are of some local importance for wildlife;
- Sites or features containing non-native species that are of some importance in maintaining habitat links.

[12] It is suggested that, in general, 1% of the local population of such species qualifies as a locally important population. However, a smaller population may qualify as locally important where the population forms a critical part of a wider population or the species is at a critical phase of its life cycle.

Appendix 6.3 Flora species list

Improved agricultural grassland (GA1)

Common Name	Scientific Name
Yorkshire Fog	*Holcus lanatus*
Perennial Rye	*Lolium perenne*
Red Fescue	*Festuca rubra*
Ragwort	*Jacobaea vulgaris*
White clover	*Trifolium repens*
Red Clover	*Trifolium pratense*
Creeping Thistle	*Cirsium arvense*
Curled Dock	*Rumex crispus*
Meadow Buttercup	*Ranunculus acris*

Recolonising bare ground (ED3)

Common Name	Scientific Name
Perennial Rye	*Lolium perenne*
Ragwort	*Jacobaea vulgaris*
White clover	*Trifolium repens*
Red Clover	*Trifolium pratense*
Scarlet Pimpernel	*Anagallis arvensis*
Black Medic	*Medicago lupulina*
Broad Leaved Dock	*Rumex obtusifolius*
Meadow Buttercup	*Ranunculus acris*
Nettles	*Urtica dioica*

Treeline (WL2)

Common Name	Scientific Name
Cedar species	*Cedrus sp.*
Sycamore	*Acer pseudoplatanus*
Ash *Fraxinus excelsior*	*Fraxinus excelsior*
Hawthorn	*Crataegus monogyna*
Blackthorn	*Prunus spinosa*
Bramble	*Rubus fruticosus agg*
Beech	*Fagus sylvatica*
Ivy	*Hedera helix*
Cleavers	*Galium aparine*
Nettles	*Urtica dioica*
Herb-Robert	*Geranium robertanium*
Common hogweed	*Heracleum sphondylium*

Depositing lowland river (FW2)

Common Name	Scientific Name
Hart's Tongue	*Asplenium scolopendrium*
Meadowsweet	*Filipendula ulmaria*
Ivy	*Hedera helix*
Celery-Leaved Buttercup	*Ranunculus scleratus*
Hawthorn	*Crataegus monogyna*
Elder	*Sambucus nigra*
Sycamore	*Acer pseudoplatanus*
Butterfly-Bush	butterfly-bush *Buddleja davidii*
Yellow Iris	*Iris pseudacorus*
Water Cress	*Nasturtium officinale*
Rush Species	*Juncus sp.*
Creeping Thistle	*Cirsium arvense*

Sowthistle Species	*Sonchus sp.*
Nettles	*Urtica dioica*

Improved amenity grassland (GA2)

Common Name	Scientific Name
Perennial Rye	*Lolium perenne*
Ribwort plantain	*Plantago lanceolata*
Creeping Buttercup	*Ranunculus reopens*
White clover	*Trifolium repens*
Lime species	*Tilia sp.*
Oak species	*Quercus sp*

Scrub (WS1)

Common Name	Scientific Name
Blackthorn	*Prunus spinosa*
Bramble	*Rubus fruticosus agg*
Common Sorrell	*Rumex acetose*
Ragwort	*Senecio jacobaea*
Creeping Thistle	*Cirsium arvense*
Ivy	*Hedera helix*
Nettles	*Urtica dioica*
Herb-Robert	*Geranium robertanium*
Common hogweed	*Heracleum sphondylium*
Butterfly-Bush	*Buddleia davidii*
Rose Bay Willowherb	*Epilobium angustifolium*

Appendix 6.4 Records of Protected, Red-Listed or Notable Fauna from the desktop study in the vicinity of the Study Area

Common Name	Scientific Name	Protection[13]	Red-Listing Status[14]
Plants			
Ribbonwort	*Pallavicinia lyellii*	FPO	Endangered
Many-seasoned Thread-moss	*Bryum intermedium*	FPO	Endangered
Amphibians			
Common Frog	*Rana temporaria*	HD V, WA	Least Concern
Smooth Newt	*Lissotriton vulgaris*	WA	Least Concern
Mammals			
Red Deer	*Cervus elaphus*	WA	Least Concern
Badger	*Meles meles*	HD II IV, WA	Least Concern
Otter	*Lutra lutra*	HD II IV, WA	Near Threatened
Brown Long-eared Bat	*Plecotus auritus*	HD IV, WA	Least Concern
Daubenton's Bat	*Myotis daubentonii*	HD IV, WA	Least Concern
Leisler's Bat	*Nyctalus leisleri*	HD IV, WA	Near Threatened
Pipistrelle	*Pipistrellus pipistrellus sensu lato*	HD IV, WA	Least Concern
Soprano Pipistrelle	*Pipistrellus pygmaeus*	HD IV, WA	Least Concern
Pygmy Shrew	*Sorex minutus*	WA	Least Concern
Hedgehog	*Erinaceus europaeus*	WA	Least Concern
Pine marten	*Martes martes*	HD V, WA	Least Concern
Red squirrel	*Sciurus vulgaris*	WA	Least Concern
Birds			
Barn Owl	*Tyto alba*	WA	Red Listed
Black-Headed Gull	*Larus ridibundus*	WA	Red Listed
Corn Crake	*Crex crex*	BD I, WA	Red Listed
Curlew	*Numenius arquata*	BD II (II), WA	Red Listed
Golden Plover	*Pluvialis apricaria*	BD I II (II), III (III), WA	Red Listed
Grey Partridge	*Perdix perdix*	BD II III, WA	Red Listed
Herring Gull	*Larus argentatus*	WA	Red Listed
Lapwing	*Vanellus vanellus*	BD II (II), WA	Red Listed
Pintail	*Anas acuta*	BD II (I) III (II), WA	Red Listed
Red Grouse	*Lagopus lagopus*	BD II (I) III (I), WA	Red Listed
Redshank	*Tringa totanus*	WA	Red Listed
Yellowhammer	*Emberiza citrinella*	WA	Red Listed
Coot	*Fulica atra*	BD II (I), WA	Amber Listed
Cormorant	*Phalacrocorax carbo*	WA	Amber Listed
Eurasian Teal	*Anas crecca*	BD II (I), WA	Amber Listed
Gadwall	*Anas strepera*	BD II (I), WA	Amber Listed
Goldeneye	*Bucephala clangula*	BD II (II), WA	Amber Listed
Goosander	*Mergus merganser*	BD II (II), WA	Amber Listed
Grasshopper Warbler	*Locustella naevia*	WA	Amber Listed
Great Crested Grebe	*Podiceps cristatus*	WA	Amber Listed
Great-Black Backed Gull	*Larus marinus*	WA	Amber Listed
Greylag Goose	*Anser anser*	BD III (II), WA, Regulation S.I. 477 (Ireland)	Amber Listed
Hen Harrier	*Circus cyaneus*	BD I, WA	Amber Listed
House Martin	*Delichon urbicum*	WA	Amber Listed
House Sparrow	*Passer domesticus*	WA	Amber Listed
Kestrel	*Falco tinnunculus*	WA	Amber Listed
Kingfisher	*Alcedo atthis*	BD I, WA	Amber Listed
Lesser Black-Backed Gull	*Larus fuscus*	WA	Amber Listed
Linnet	linnet *Carduelis cannabina*	WA	Amber Listed
Little Grebe	*Tachybaptus ruficollis*	WA	Amber Listed
Merlin	*Falco columbarius*	BD I, WA	Amber Listed

[13] HDII/IV/V = Habitats Directive Annexes II/IV/V; FPO = Flora Protection Order; WA = Wildlife Acts; BD I = Birds Directive Annex I.
[14] Mammal Red-list from Marnell et al., Birds from Birds of Conservation Concern in Ireland (Colhoun & Cummings 2013); Vascular Flora from the Irish Red Data Book 1
Vascular Plants (Curtis & McGough 2005); Fish and Amphibians from King et al., 2011; Non-Marine Molluscs from Byrne et.al, 2009.

Mew Gull	*Larus canus*	WA	Amber Listed
Mute Swan	*Cygnus olor*	WA	Amber Listed
Northern Wheatear	*Oenanthe oenanthe*	WA	Amber Listed
Oystercatcher	*Haematopus ostralegus*	WA	Amber Listed
Pochard	*Aythya ferina*	BD II (I), WA	Amber Listed
Ringed Plover	*Charadrius hiaticula*	WA	Amber Listed
Sand Martin	*Riparia riparia*	WA	Amber Listed
Sandpiper	sandpiper *Actitis hypoleucos*	WA	Amber Listed
Sky Lark	*Alauda arvensis*	WA	Amber Listed
Snipe	snipe *Gallinago gallinago*	BD II (I), WA	Amber Listed
Spotted Flycatcher	*Muscicapa striata*	WA	Amber Listed
Starling Sturnus Vulgaris	starling *Sturnus vulgaris*	WA	Amber Listed
Stock Pigeon	*Columba oenas*	WA	Amber Listed
Swallow	*Hirundo rustica*	WA	Amber Listed
Swift	*Apus apus*	WA	Amber Listed
Tree Sparrow	*Passer montanus*	WA	Amber Listed
Waterrail	*Rallus aquaticus*	WA	Amber Listed
Whinchat	*Saxicola rubetra*	WA	Amber Listed
Whooper Swan	*Cygnus cygnus*	BD I, WA	Amber Listed
Wigeon	*Anas Penelope*	BD II (I), WA	Amber Listed
Woodcock	*Scolopax rusticola*	BD II (I), WA	Amber Listed
Little Egret	*Egretta garzetta*	BD I, WA	Green Listed
Peregrine Falcon	*Falco peregrinus*	BD I, WA	Green Listed
Invertebrates			
Marsh fritillary butterfly	*Euphydryas aurinia*	HD II	Vulnerable
Small Blue	*Cupido minimus*		Endangered
Wall butterfly	*Lasiommata megera*		Endangered
Andrena (Melandrena) nigroaenea	*Andrena (Melandrena) nigroaenea*		Vulnerable
Andrena (Micrandrena) semilaevis	*Andrena (Micrandrena) semilaevis*		Vulnerable
Great Yellow Bumble Bee	*Bombus (Subterraneobombus) distinguendus*		Endangered
Red-tailed Carder Bee	*Bombus (Thoracombus) ruderarius*		Vulnerable
Sphecodes hyalinatus	*Sphecodes hyalinatus*		Vulnerable
Trimmer's Mining Bee	*Andrena (Hoplandrena) trimmerana*		Critically endangered

CHAPTER 7 - LAND, SOIL, GEOLOGY AND HYDROGEOLOGY

Appendix 7.1 Criteria for Rating Site Attributes – Estimation of Importance of Hydrogeological Attributes (National Roads Authority (NRA, 2009))

Table 1 Criteria for rating site importance of Geological Features (NRA)

Importance	Criteria	Typical Example
Very High	Attribute has a high quality, significance or value on a regional or national scale Degree or extent of soil contamination is significant on a national or regional scale Volume of peat and/or soft organic soil underlying route is significant on a national or regional scale.	Geological feature rare on a regional or national scale (NHA) Large existing quarry or pit Proven economically extractable mineral resource
High	Attribute has a high quality, significance or value on a local scale. Degree or extent of soil contamination is significant on a local scale. Volume of peat and/or soft organic soil underlying route is significant on a local scale.	Contaminated soil on site with previous heavy industrial usage Large recent landfill site for mixed wastes Geological feature of high value on a local scale (County Geological Site) Well drained and/or high fertility soils Moderately sized existing quarry or pit Marginally economic extractable mineral resource
Medium	Attribute has a medium quality, significance or value on a local scale Degree or extent of soil contamination is moderate on a local scale Volume of peat and/or soft organic soil underlying route is moderate on a local scale	Contaminated soil on site with previous light industrial usage Small recent landfill site for mixed wastes Moderately drained and/or moderate fertility soils Small existing quarry or pit Sub-economic extractable mineral resource
Low	Attribute has a low quality, significance or value on a local scale Degree or extent of soil contamination is minor on a local scale. Volume of peat and/or soft organic soil underlying route is small on a local scale	Large historical and/or recent site for construction and demolition wastes. Small historical and/or recent landfill site for construction and demolition wastes. Poorly drained and/or low fertility soils. Uneconomically extractable mineral resource.

Table 2 Criteria for rating impact magnitude at EIS stage – Estimation of magnitude of impact on soil / geology attribute (NRA)

Magnitude of Impact	Criteria	Typical Examples
Large Adverse	Results in loss of attribute	Loss of high proportion of future quarry or pit reserves
Moderate Adverse	Results in impact on integrity of attribute or loss of part of attribute	Loss of moderate proportion of future quarry or pit reserves
Small Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	Loss of small proportion of future quarry or pit reserves
Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	No measurable changes in attributes
Minor Beneficial	Results in minor improvement of attribute quality	Minor enhancement of geological heritage feature
Moderate Beneficial	Results in moderate improvement of attribute quality	Moderate enhancement of geological heritage feature
Major Beneficial	Results in major improvement of attribute quality	Major enhancement of geological heritage feature

The NRA criteria for estimation of the importance of hydrogeological attributes at the site during the EIA stage are summarised in Table 4 below.

Table 3 Criteria for rating Site Attributes - Estimation of Importance of Hydrogeology Attributes (NRA)

Magnitude of Impact	Criteria	Typical Examples
Extremely High	Attribute has a high quality or value on an international scale	Groundwater supports river, wetland or surface water body ecosystem protected by EU legislation e.g. SAC or SPA status
Very High	Attribute has a high quality or value on a regional or national scale	Regionally Important Aquifer with multiple well fields Groundwater supports river, wetland or surface water body ecosystem protected by national legislation – NHA status Regionally important potable water source supplying >2500 homes Inner source protection area for regionally important water source
	Attribute has a high quality or value on a local scale	Regionally Important Aquifer Groundwater provides large proportion of baseflow to local rivers Locally important potable water source supplying >1000 homes Outer source protection area for regionally important water source Inner source protection area for locally important water source
Medium	Attribute has a medium quality or value on a local scale	Locally Important Aquifer Potable water source supplying >50 homes Outer source protection area for locally important water source
Low	Attribute has a low quality or value on a local scale	Poor Bedrock Aquifer Potable water source supplying <50 homes

Table 4 Criteria for Rating Impact Significance at EIS Stage – Estimation of Magnitude of Impact on Hydrogeology Attribute (NRA)

Magnitude of Impact	Criteria	Typical Examples
Large Adverse	Results in loss of attribute and /or quality and integrity of attribute	Removal of large proportion of aquifer. Changes to aquifer or unsaturated zone resulting in extensive change to existing water supply springs and wells, river baseflow or ecosystems. Potential high risk of pollution to groundwater from routine run-off. Calculated risk of serious pollution incident >2% annually.
Moderate Adverse	Results in impact on integrity of attribute or loss of part of attribute	Removal of moderate proportion of aquifer. Changes to aquifer or unsaturated zone resulting in moderate change to existing water supply springs and wells, river baseflow or ecosystems. Potential medium risk of pollution to groundwater from routine run-off. Calculated risk of serious pollution incident >1% annually.
Small Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	Removal of small proportion of aquifer. Changes to aquifer or unsaturated zone resulting in minor change to water supply springs and wells, river baseflow or ecosystems. Potential low risk of pollution to groundwater from routine run-off. Calculated risk of serious pollution incident >0.5% annually.
Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	Calculated risk of serious pollution incident <0.5% annually.

Table 5: Rating of Significant Environmental Impacts at EIS Stage (NRA)

Importance of Attribute	Magnitude of Importance			
	Neglible	**Small Adverse**	**Moderate Adverse**	**Large Adverse**
Extremely High	Imperceptible	Significant	Profound	Profound
Very High	Imperceptible	Significant/moderate	Profound/Significant	Profound
High	Imperceptible	Moderate/Slight	Significant/moderate	Profound/Significant
Medium	Imperceptible	Slight	Moderate	Significant
Low	Imperceptible	Imperceptible	Slight	Slight/Moderate

Appendix 7.2 Environmental Site Assessment and Generic Quantitative Risk Assessment

Environmental Site Assessment and Generic Quantitative Risk Assessment

DUB002: Grange Castle, Dublin

for

Amazon Web Services (AWS)

OCSC
O'CONNOR | SUTTON | CRONIN
Multidisciplinary Consulting Engineers

OCSC Job No.:	Project Code	Originator	Zone Volume	Level	File Type	Role Type	Number	Status / Suitability Code	Revision
A588	A588	OCSC	XX	XX	RP	ENV	0001	S0	P0

Rev.	Status	Authors	Checked	Authorised	Issue Date
0	FINAL	EB	EB	TH	06.06.19

NOTICE

This document represents the findings from an Environmental Site Assessment (ESA) and Generic Quantitative Risk Assessment (GQRA) conducted at the above referenced site. Best practice was followed at all times and within the limitations stated. This document has been produced by O'Connor Sutton Cronin & Associates for its client Amazon Web Services. It may not be used for any purpose other than that specified by any other person without the written permission of the authors.

TABLE OF CONTENTS

TABLES

APPENDICES

EXECUTIVE SUMMARY

The site for assessment is located in Grange Castle Business Park South (GCBPS), in the west of Dublin some 13 kilometres from the City Centre. It is proposed that the site will be developed for data centre purposes.

The site currently comprises agricultural lands is bounded to the north by the realigned Nangor Road, to the west by Baldonnel Road and to the south by a GCBPS access road. Part of the old R134 Nangor Road cuts diagonally through the northwest corner of the site separating a 2.65 hectare portion of the site from the main 16.26 hectare section.

The proposed site development includes the construction of 3 no. data centres comprising 2no. 2 storey 12 pod buildings, measuring 190m*160m in plan along with 1no. 2 storey 8 pod building measuring 150m*60m in plan. The overall development, including ancillary substation, sprinkler house and fuel storage facilities will be of the order of 40,000 m^2.

The site is a greenfield site and aerial images of the site from 1995, 2000 and 2005 show the site layout as it is today. The Premium Aerial photograph from Ordnance Survey Ireland illustrate the realigned Nangor Road.

The nearest surface water feature is the Baldonnel Stream which runs roughly east to west through the northern part of the site until it discharges to the Griffeen River.

The National Monuments Service (NMS) maps show that there are 2No. concentric enclosures within the site boundary identified to be included within the next RMP. These are not indicated on any OS map and consist of large concentric enclosures visible as a crop-mark on an aerial photo (DU021-108---- & DU021-109----).

Site investigations were undertaken by IGSL and investigations showed the site's proven geology to be Topsoil/Made Ground over a layer of glacial till, underlain by possible weathered bedrock. The site investigation works carried out included the collection of a number of soil and groundwater samples.

The conceptual site model identified the receptors as future commercial receptors on-site and offsite human health and environmental receptors. A GQRA was undertaken using commercial GACs to assess the risk to future commercial users. None of the soil sample contained concentrations in excess of the GAC Commercial landuse values.

Two parameters, barium and zinc, showed mildly elevated concentrations in groundwater samples however it is not considered that these present a risk to future users nor that they represent a significant plume of contamination. No LNAPL (floating hydrocarbon) or DNAPL (settled/sinking hydrocarbon) layer was observed and/or sampled.

Based on the conservative assessment undertaken no remedial measures are required.

A waste soil assessment was undertaken on five (5No.) samples collected and submitted for a suite of analysis appropriate for completing a Waste Soil Classification. All of the samples were classified as Inert, as expected given the greenfield nature of the site.

In summary it is considered that the site is consistent with a greenfield site with no evidence of contamination that could present a risk to human health or the environment.

1. INTRODUCTION

1.1. Project Contractual Basis & Parties Involved

This report has been prepared by O'Connor Sutton Cronin & Associates Ltd. (OCSC) at the request of their Client Amazon Web Services (AWS). The project brief and terms were set out in OCSC proposal to AWS.

The site is located in Grange Castle Business Park South (GCBPS), in the west of Dublin some 13 kilometres from the City Centre. It is proposed that the site will be develop for data centre purposes. The Regulating Authority for the site is South Dublin County Council (SDCC).

The report was completed by Eleanor Burke who is the OCSC Environmental Division Manager. The Project Director is Tony Horan CEng, FIEI, Chartered Engineer and Managing Director of OCSC.

Other documents relevant to this report are:

- IGSL - Desktop Study and Technical Memorandum Site at Grangecastle (Report No. 21713) – May 2019

1.2. Background Information

The site for assessment is located in Grange Castle Business Park South (GCBPS), and is bounded to the north by the realigned Nangor Road, to the west by Baldonnel Road and to the south by a GCBPS access road. Refer to Figure 1.1. below.

The site currently comprises agricultural lands. Part of the old R134 Nangor Road cuts diagonally through the northwest corner of the site separating a 2.65 hectare portion of the site from the main 16.26 hectare section – Figure 1.1.

Figure 1.1: Site Location and approximate site boundary (Source: GoogleMaps)

1.3. Proposed Development

The development of the site is to accommodate 3 no. data centres comprising 2no. 2 storey 12 pod buildings, measuring 190m*160m in plan along with 1no. 2 storey 8 pod building measuring 150m*60m in plan. The overall development, including ancillary substation, sprinkler house and fuel storage facilities will be of the order of 40,000 m^2.

Test Fits were developed for the site as part of a Conceptual Masterplanning exercise. The preferred layout is shown in Figure 1.2 below.

Figure 1.2: Preferred Test Fit Layout

The 2 no. 12 pod buildings are located on an almost true north-south alignment (4° clockwise of true north), with the 8 pod building perpendicular to and west of same at the eastern edge of the site, just south of the watercourse, but with access roadways oversailing the foul sewer wayleave and the Baldonnel Stream.

Access is from the south with the on-site substation in the northeastern corner of the site. Provision is made for sprinkler house, security and fuel storage with a 15 m boundary security offset. The layout can be accommodated in an overall site area of 14.88 hA if necessary, thus potentially avoiding an EIAR. The layout avoids the old Nangor Road and the T50 network. No part of the 2.65 hA parcel is required albeit the security fence skirts the southern edge of the road. However, critically no access will be required to the site for future maintenance of the T50 network. The layout will require the northwards realignment of both the Baldonnel Stream and the existing foul sewer.

1.4. Previous Reports

- There were no previous reports available for the site.

1.5. Project Objectives

The overall project objectives include:

- Provide environmental information on the site focusing on its environmental setting and past site activities including a review of all up to date mapping;
- Assess any obvious environmental liabilities;
- Assess current soil and groundwater quality at the project site in terms of contamination and to inform the Client of any risk posed by contamination if present in the context of the proposed future use – Commercial Landuse;
- Formulate initial Conceptual Site model;
- Undertake a generic quantitative risk assessment (GQRA) using up to date Generic Assessment Criteria (GAC); and
- Make recommendations for any further assessments/site investigations, if required.

1.6. Methodology and Approach

The methodology and approach for the proposed work will follow:

- BS 10175.2011+A2.2017 Investigation of potentially contaminated sites, Code of Practice;
- EPA, 2015, Waste Classification, List of Waste & Determining if Waste is Hazardous or Non-hazardous;
- EPA 2013, Guidance on the Management of Contaminated Land and Groundwater at EPA Licensed Sites;
- EPA 2007, Code of Practice, Environmental Risk Assessment for Unregulated Waste Disposal Sites;
- EA, 2015, Guidance on the classification and assessment of waste, Technical Guidance WM3;
- EA, 2004, Model Procedures for the Management of Land Contamination (CLR11);
- The LQM/CIEH S4ULs for Human Health Risk Assessment (2015);
- SP1010 – Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination CL:AIRE (2014);
- EIC/AGS/CL:AIRE Soil Generic Assessment Criteria for Human Health Risk Assessment (2010);
- 2010 European Communities Environmental Objectives (Groundwater) Regulations (Statutory Instrument No. 9 of 2010);
- 2016 European Communities Environmental Objectives (Groundwater) (Amendment) Regulations (Statutory Instrument No. 366 of 2016);
- EPA (2003) Towards Setting Guideline Values for the Protection of Groundwater in Ireland (2003);
- Environmental Liability Regulations (S.I. 547 of 2008);
- Environment Agency (2000) Guidance on the Assessment and Monitoring of Natural Attenuation of Contaminants in Groundwater;
- Environment Agency (2004) Model Procedures for the Management of Land Contamination. Contaminated Land Report 11;
- FRTR (2009) Remediation Technologies Screening Matrix and Reference Guide Version 4.0; and
- US EPA (2004) How to Evaluate Alternative Cleanup Technologies for Underground Storage Tank Sites: A Guide for Corrective Action Plan Reviewers, EPA 510-R-04-002.
- List of Waste & Determining if Waste is Hazardous or Non-Hazardous (EPA, 2015) and European Waste Catalogue (Commission Decision 2014/955/EU);
- European Waste Framework Directive (2008/98/EC);
- Guidance on the classification and assessment of waste, Technical Guidance WM3 v1.1 (EA et al, 2018);
- S.I. 233 of 2015 EU (Properties of Waste which Render it Hazardous) Regulation;
- Landfill Directive 1999/31/EC (2003/33/EC);
- Waste Management Act 1996 (as amended);

- S.I. 126/2011 – European Community (Waste Directive) Regulations;
- Classification, Labelling & Packaging Regulations EC/1272/2008;

The proposed end-use defines the level of risk assessment required and in this instance, the development will consist of the development of the site to provide data centres. Therefore, as an initial assessment a conservative assessment of commercial use will be undertaken.

1.7. Scope of Works

To meet the project objectives the following scope of works were completed:

- Undertake and present a historical site and area review, primarily referring to old Ordnance Survey Maps but utilising other sources as appropriate and readily available including previous site investigations and data available;
- Review third party interpretative report and identify if any gap(s) exists;
- Present a discussion of the current site status and key environmental influences around the site;
- Present a discussion of the general soil and groundwater conditions within the topographical and area context;
- Evaluate the results spatially to determine whether any subsurface pathways exists at the site and evaluate the distribution of contamination encountered, if any;
- Evaluate the results against Generic Quantitative Risk Assessment (GQRA) criteria as a first screen to evaluate if the concentrations on site present a risk to future site users (human health) or the environment; and
- Based on the results of the above assessment the requirement for further detailed site investigation or more site specific Detailed Quantitative Risk Assessment (DQRA) will be discussed.

1.8. Limitations

This Environmental Site Assessment (ESA) and Generic Quantitative Risk Assessment Report (GQRA) has been prepared for the sole use of Amazon Web Services (AWS) ("the Client"). No other warranty, expressed or implied, is made as to the professional advice included in this report or any other services provided by OCSC. This Report is confidential and may not be disclosed by the Client nor relied upon by any other party without the prior and express written agreement of OCSC.

This assessment is based on a review of available historical information, environmental records, consultations, relevant information and reports from third parties in addition to result from Site Investigations and laboratory analysis. All information received has been taken in good faith as being true and representative.

This report has been prepared in line with best industry standards. The methodology adopted and the sources of information used by OCSC in providing its services are outlined in this Report. A small area was not accessible due to the presence of archaeology. The scope of this Report and the services are accordingly factually limited by these circumstances.

OCSC disclaim any undertaking or obligation to advise any person of any change in any matter affecting the Report, which may come or be brought to OCSC's attention after the date of the Report.

The conclusions presented in this report represent OCSC's best professional judgement based on review of the relevant information available at the time of writing. The opinions and conclusions presented are valid only to the extent that the information provided was accurate and complete.

2. ENVIRONMENTAL SITE SETTING

2.1. Site Location

The site for assessment is located in Grange Castle Business Park South (GCBPS), and is bounded to the north by the realigned Nangor Road, to the west by Baldonnel Road and to the south by a GCBPS access road. The site and surrounding area is historically agricultural and has been recently developed by a number of companies including Google.

The regional site location is illustrated on Figure 2.1.

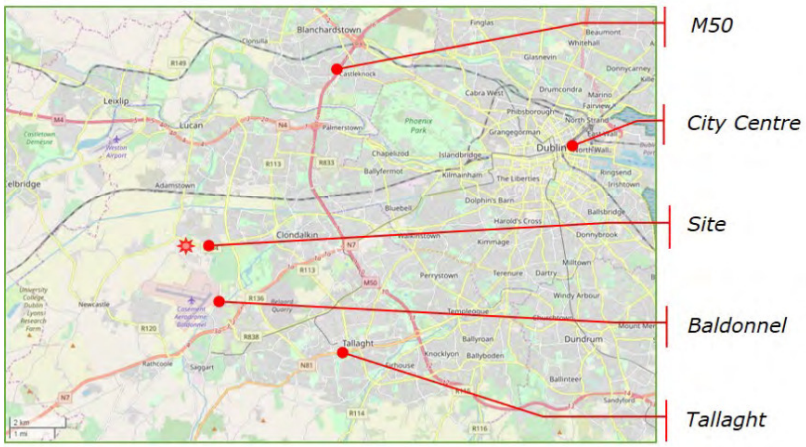


Figure 2.1: Regional Site Location (Source: GoogleMaps)

The site is greenfield in nature and appears to fall gently from south to north towards the Baldonnel Stream a tributary of the Griffeen River. The Ordnance Survey of Ireland (OSI) Easting Northing Coordinates for the site are 704003, 731201.

Another portion of the site to the northwest is separated from the main body of the overall holding, by the old Nangor Road which joins the realigned Nangor Road to the Baldonnel Road.

2.2. Surrounding Land Use

The site's surrounding area is a mix between industrial/commercial and agricultural in nature. An Eirgrid substation abuts the southeastern corner of the site and a new development by Google lies immediately southeast of the site. There is a 3 Mobile mast in the extreme southeast corner of the site east of the substation.

The Griffeen River runs immediately northwest of the site. Newly constructed roads lie to the north (Nangor Road), south (GCBPS Access Road) and west (Baldonnel Road) of the site with a Motor Sales Business (Boland's Grangecastle) forming the entire of the eastern boundary. A portion of the site in the southeast has been carved out to accommodate the substation.

Refer to Figure 2.2 for an aerial photograph of the site and surrounding area.

Figure 2.2: Aerial Photograph of the Site and surrounding area

The adjacent land uses are listed in Table 2.1.

Table 2.1 – Adjacent Land Uses

BOUNDARY	LAND USE
North	Griffeen River, Nangor Road, Arytza Food. There is a residential property to the north of the site beyond the Nangor Road– detached dwelling; however this is vacant and in poor repair. There are three EPA licenced facilities to the north of the site including from west to east (Refer to Figure 2.3): • Takeda • Grange BackUp Power Limited • Pfizer
South	Google development to south, GCBPS Access Road. There are a number of residential properties to the south of the site off the Baldonnel Road – detached dwellings. Further south there is a wood drying kiln facility. This is not an EPA licenced facility and therefore no specific EPA limits.
East	Motor Sales Business (Boland's Grangecastle)
West	Baldonnel Road, agricultural land. There are a number of residential properties to the west of the site on the R120 – detached dwellings. The one located within the site boundary will be demolished as part of the works.

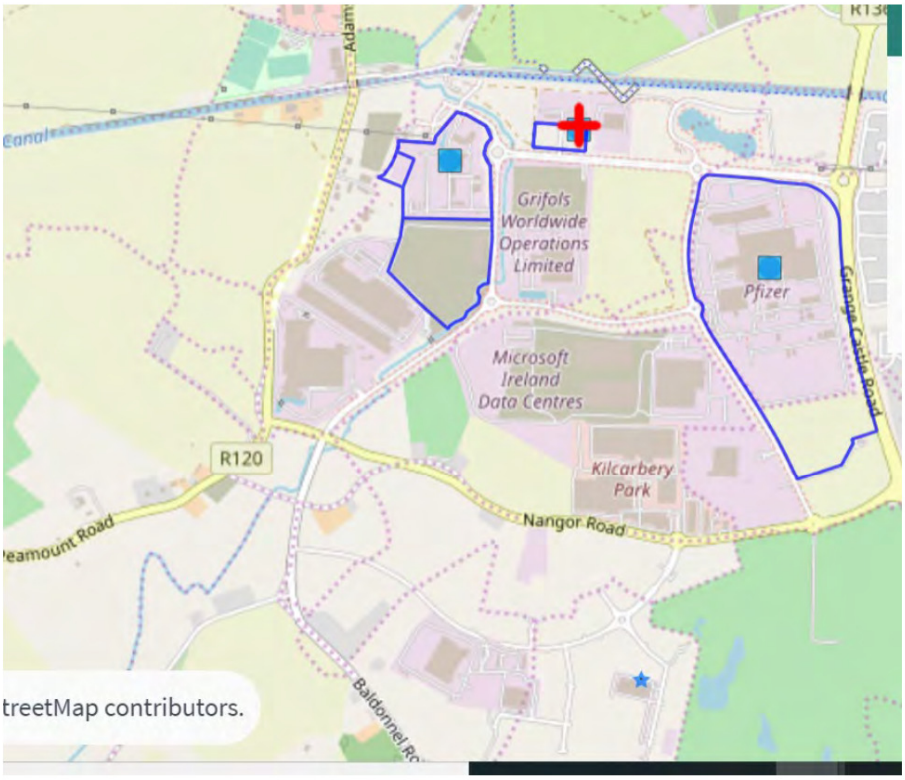


Figure 2.3: EPA Licensed Facilities (EPA, 2019)

2.3. Site History

An understanding of the site history was gained by undertaking a review of the following primary sources including:

- a review of available extracts of historical Ordnance Survey of Ireland (OSI) maps;
- National Monuments Service (NMS) viewer;
- a review of information held by the Environmental Protection Agency (EPA) EnVision online Mapping;
- aerial images available of the site (OSI, Google and Bing);
- the Geological Survey of Ireland (GSI) online map tool; and
- the National Parks and Wildlife Service online map tool.

2.4. Site Development

Aerial images of the site from 1995, 2000 and 2005 show the site layout as it is today. The Premium Aerial photograph from Ordnance Survey Ireland illustrate the realigned Nangor Road. All historical maps show the site as occupied by agricultural lands/pastures including:

- 6" historical map (1837-1842)
- 25'' OSI maps 1888-1913
- 6" Cassini

Figure 2.4. Approximate Location of the proposed development on 1888-1913 25 Inch OS Map (Source: Ordnance Survey Ireland)

2.5. Site Physical Setting

Information regarding the site topography, hydrology, geology, hydrogeology and ecology of the area has been obtained from records held by the Geological Survey of Ireland (GSI), Environmental Protection Agency (EPA) Envision online mapping tool, Ordnance Survey of Ireland (OSI), Water Framework Directive Maps and National Parks and Wildlife Service (NPWS) databases.

2.5.1. Topography

The site is greenfield in nature and appears to fall gently from south to north towards the Baldonnel Stream a tributary of the Griffeen River.

2.5.2. Area of Geological Interest

The Geological Survey of Ireland (GSI) online mapping service was consulted regarding areas of geological interest in the area of the site. There two areas of geological heritage approximately 3km south west and south east of the site, Belgard Quarry and Newcastle Buried Channel, respectively.

Belgard Quarry (Site Code SD002) is a large working quarry and the feature of importance is the fact that it represents the 'biggest exposure of the usually poorly exposed Calp Limestone which underlies Dublin'. It is designated as a County Geological Site (CGS). Given the distance to the site and its nature it is considered to be outside of the zone of influence of the proposed development.

Newcastle Buried Channel (Site Code SD010) is a deep buried channel in the carboniferous limestone bedrock, not seen at surface with the feature of importance being 'Limestone bedrock, but the channel sediments and cave infill are presumed to be Tertiary in age'. It is designated as a County Geological Site (CGS). Given the distance to the site and its nature it is considered to be outside of the zone of influence of the proposed development.

2.5.3. Unconsolidated Geology

Teagasc Topsoils and Subsoils

The topsoil and subsoil beneath the site has been classified into two categories deep well drained mineral and deep poorly drained mineral (Till derived from limestones). Refer to Figure 2.5 from the GSI online mapping for further information.

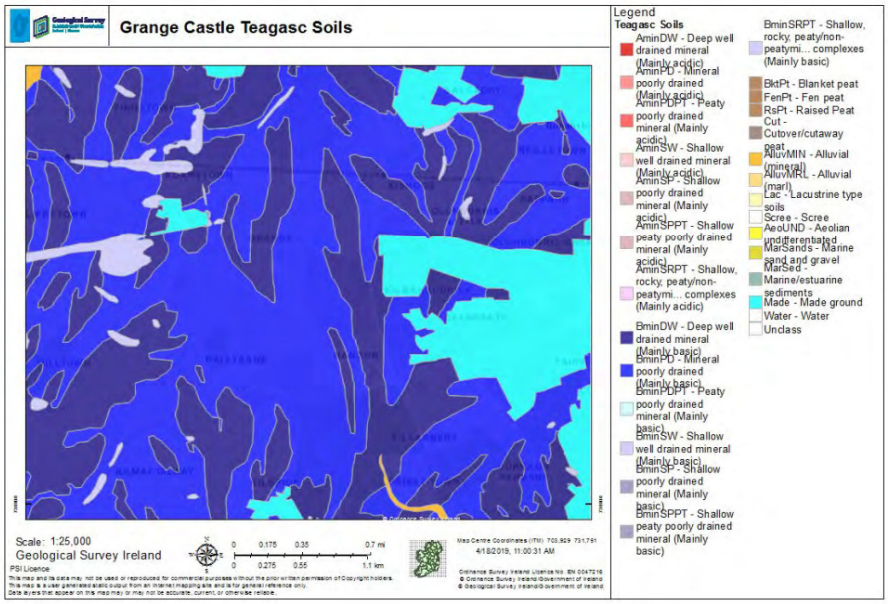


Figure 2.5 Teagasc Topsoils and Subsoils

2.5.4. Geology

The bedrock beneath the site and the greater surrounding area consists of the Lucan Formation, colloquially known as Calp Limestone and is known to contain areas of mudstone and occasionally pyrites. The formation comprises dark-grey to black, fine-grained, occasionally cherty, micritic limestones that weather paler, usually to pale grey. There are rare dark coarser grained calcarenitic limestones, sometimes graded, and interbedded dark-grey calcarThe local geology mapped by the GSI is illustrated on Figure 2.6.

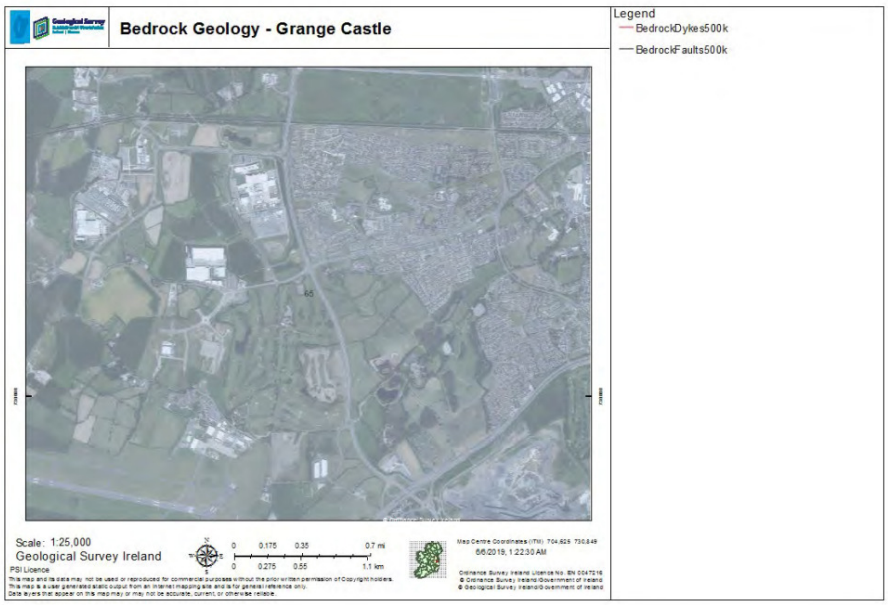


Figure 2.6 Geology

Note: *Coloured classification – grey. Legend missing on GSI.*

2.5.5.Aquifers

The GSI provides a methodology for aquifer classification based on resource value (Regionally Important, Locally Important and Poor) and vulnerability (Extreme, High, Moderate or Low). Resource value refers to the scale and production potential of the aquifer whilst vulnerability refers to the ease with which groundwater may be contaminated by human activities (vulnerability classification primarily based on the permeability and thickness of subsoils).

The aquifer beneath the site is a bedrock aquifer which is described as a Locally Important aquifer (LI) which is moderately productive in local zones only (Refer to Figure 2.7). The aquifer covers an area of 1309km^2 and covers the City of Dublin and surrounding area.

The limestone is part of the Dublin Urban Ground Water Body (GWB) which is described as poorly productive. The GWB covers an area of 837km^2 over the Dublin area and towards Kildare. The GSI Summary Characteristics of the Dublin GWB identify that the permeability of these rock units are likely to be low (1-10m^2/d).

There is no evidence of gravel aquifers within the area.

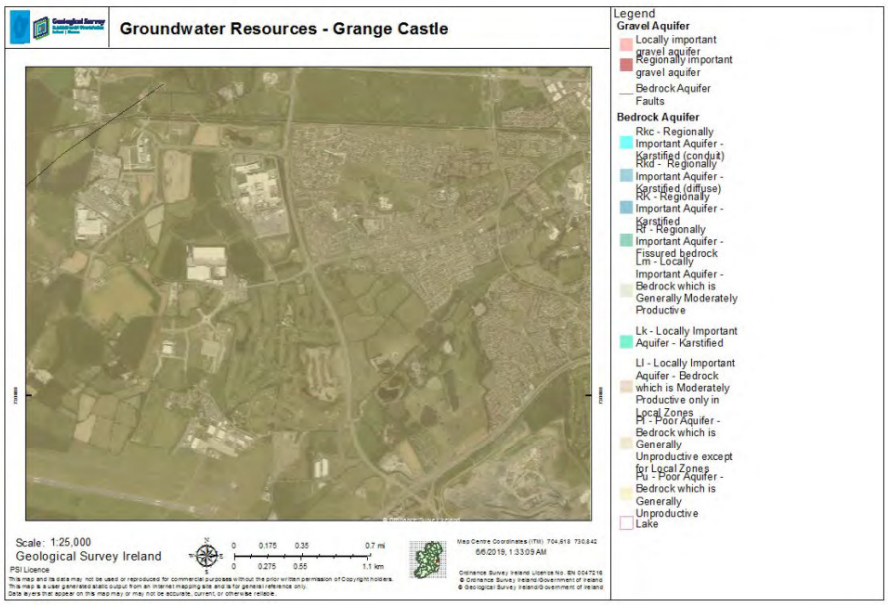


Figure 2.7 Aquifers

2.5.6. Aquifer Vulnerability

The groundwater vulnerability beneath the proposed site is High on the eastern portion and Extreme on the western portion; refer to Figure 2.8 (GSI, 2019). There are pockets of extreme vulnerability at varying locations outside of the site boundary. Vulnerability ratings are related to a function of overburden thickness and permeability which might offer a degree of protection and/or attenuation to the underlying aquifer from surface activities and pollution.

Rotary coring was carried out in 8 locations and confirmed the presence of limestone bedrock at depths that were typically in the range 2.0 to 2.8 m BGL. The exception to this occurred at RC07 (north of the site), where bedrock was encountered at a depth of 3.6 m BGL.

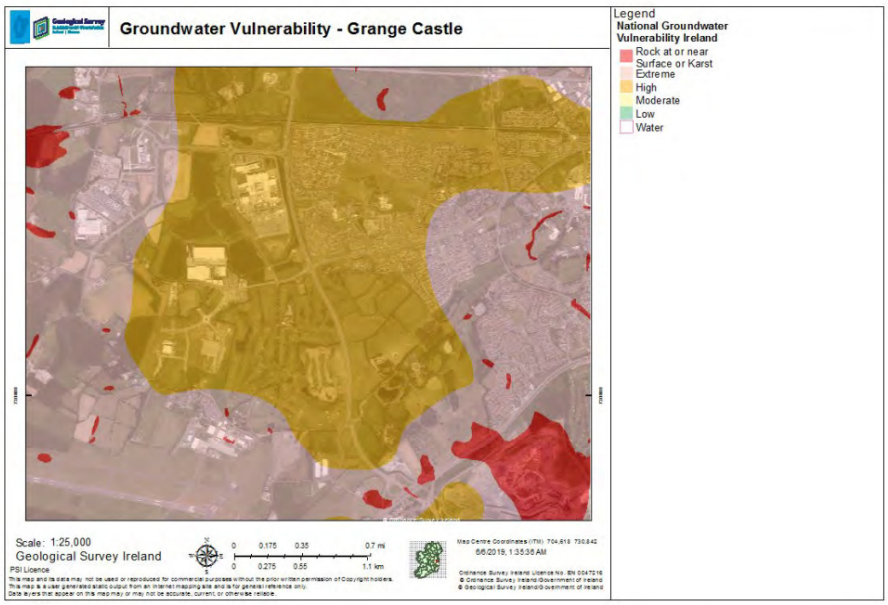


Figure 2.8 Aquifer Vulnerability

There were no karst features identified adjacent to the site.

2.5.7. Groundwater Status

An assessment carried out under the Water Framework Directive 2010-2015 groundwater body (EPA, 2019) has concluded that the groundwater within the bedrock aquifer is presently of "Good status". The objective is to protect the "Good status" by recognizing that the quality of the groundwater is at risk due to point and diffuse sources of pollution.

Figure 2.9 WFD Status 2010-2015

The Groundwater Bodies risk status is 'Not At Risk' assigned to the Dublin bedrock aquifer.

2.5.8. Groundwater Recharge

Diffuse recharge generally occurs via rainfall percolating through the subsoil being higher in areas where subsoil is thinner and/or more permeable. The proportion of the effective rainfall that recharges the aquifer is largely determined by the thickness and permeability of the soil and subsoil, and by the slope.

Currently a large percentage of recharge will occur due to the agricultural nature of the site. In future development, only a small percentage of recharge will occur due to a significant percentage of hardstanding and building coverage on site.

The GSI's groundwater recharge model parameters for the site are summarised in Table 2.2. There are two different model parameters as seen in Table 2.2. Figure 2.10 contains a drawing from the GSI indicating the recharge zone.

Groundwater Recharge Parameters		
	Model Parameter (1)	Model Parameter (2)
Average Recharge (mm/yr)	200	77
Hydrogeological Setting	1.iv	1.v
Hydrogeological Setting Description	Till overlain by well drained soil	Till overlain by poorly drained gley soil
Recharge Coefficient (%)	60.00	22.50
Effective Rainfall	344	344
Recharge Cap Apply	Y	Y
Maximum Recharge Capacity (mm/yr)	200	200
Recharge (pre cap) mm/yr	206	77
rech_mm/yr_*PRE-CAP	206	77
SOIL DRAINAGE	DRY	WET
Subsoil Type	TLs	TLs
Subsoil Description	Till derived chiefly from limestone	Till derived chiefly from limestone
Peat	NOT PEAT	NOT PEAT
SAND/GRAVEL SUBSOIL	NOT SG_SUBSOIL	NOT SG_SUBSOIL

Table 2.2 GSI Groundwater Recharge Parameters

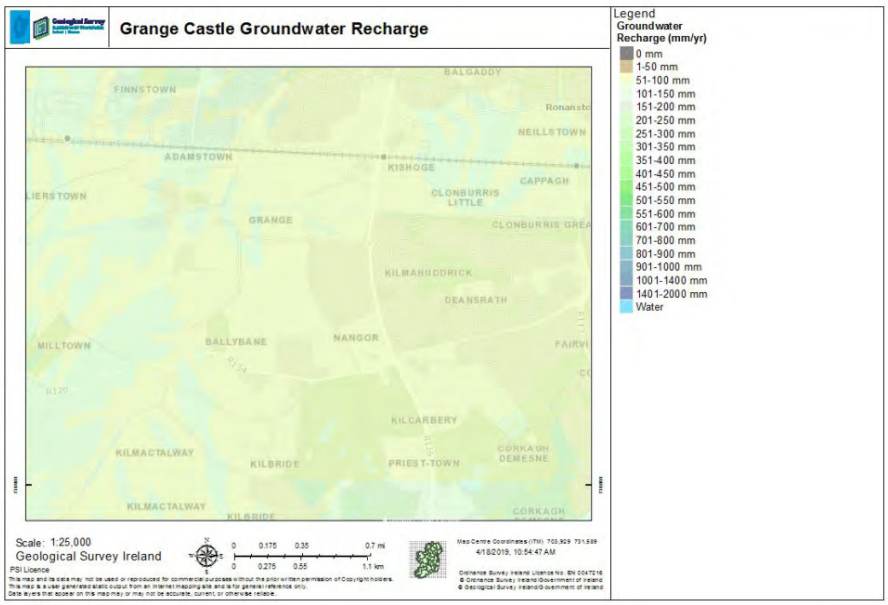


Figure 2.10 Groundwater Recharge

2.5.9.Wells & Springs

A search of the GSI groundwater well database was conducted to identify registered wells in the surrounding area.

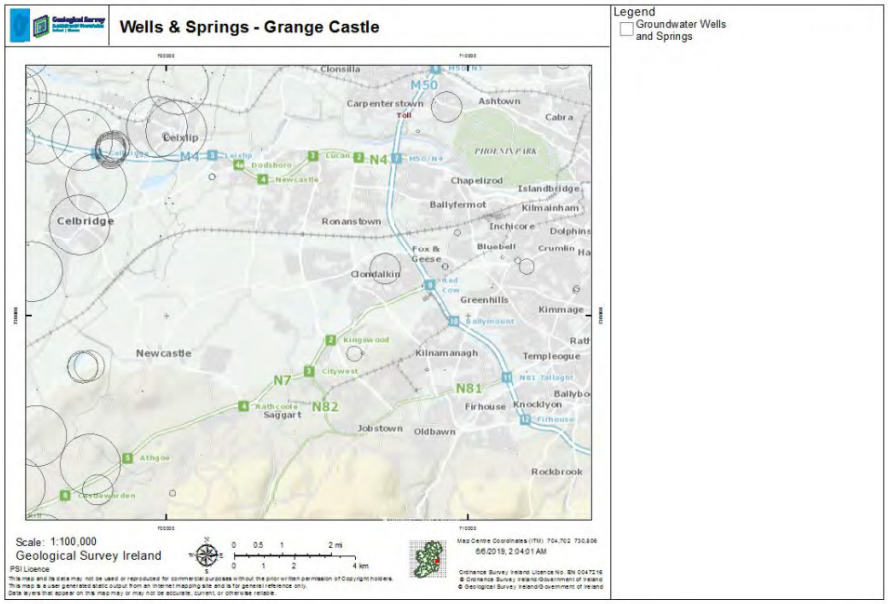


Figure 2.11 Wells and Springs

The nearest well is located at approximately 5km to the east of the site in Clondalkin (2923SEW006) located at E307320, N231530 with an accuracy of 1km. Depth of the well drilled in 1899 is reportedly 53.3km with a depth to rock of 3m. It also states that the well was used for industrial use. Mapped wells and springs in the general vicinity of the site identified by the GSI are illustrated on Figure 2.11.

The GSI (1999) also provides a framework for the protection of groundwater source zones (e.g. areas of contribution to water supply bores). There are no reported Groundwater Drinking Water Protected Areas (including either Public Supply Source Protection Areas or Group Scheme Preliminary Source Protection Areas within a 4km radius of the proposed site.

Based on a review of available information local groundwater flow is expected to the north.

2.5.10. Hydrology

The Baldonnel Stream runs roughly east to west through the northern part of the site. The river is in three distinct forms. The eastern reach is in its natural condition and runs at surface, for approximately 200 m, from the boundary with Boland's Grangecastle behind a vacant bungalow in an open ditch. The central 280 m reach has been realigned and runs again on the surface in a newly formed channel parallel to the Nangor Road. The final, western reach is in a 200 m culvert and continues westwards to outfall to the Griffeen River at a point southeast of the junction of the New Nangor and Baldonnel roads. The three individual reaches are shown in Figure 2.12.

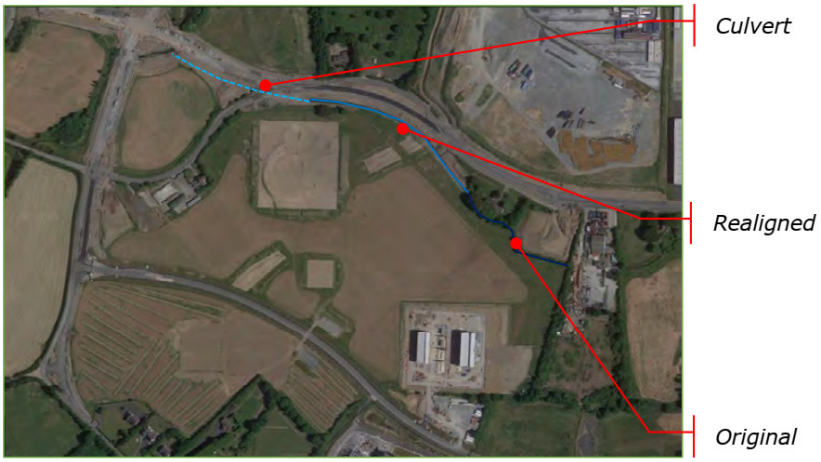


Figure 2.12 Baldonnel Stream Location

The points at which the Baldonnel Stream enters and exits the culvert link to the Griffeen River are shown in Plates 1 & 2 below.

Plates 1 & 2: Baldonnel Stream

Based on the most recent water quality information 2010-2015 (EPA, 2019) the stream has been designated as 'Good' chemical and fish status with Moderate status overall (refer to Figure 2.12).

Figure 2.13 Surface Water Quality

Under the Water Framework Directive the River Liffey has been designated as 'at Risk'.

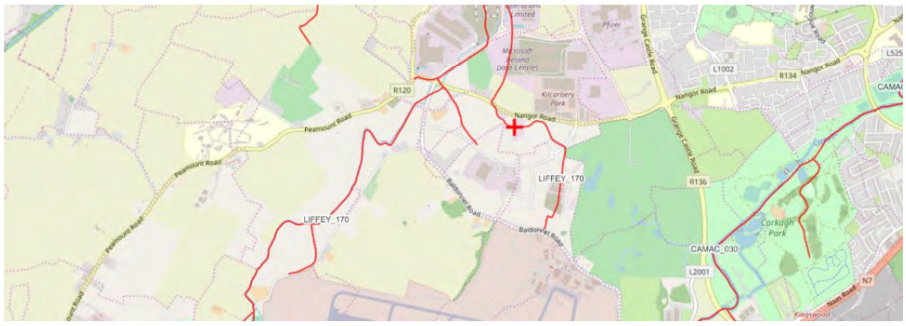


Figure 2.14 WFD Risk (EPA, 2018)

2.5.11. Radon

According to the EPA (now incorporating the Radiological Protection Institute of Ireland) between five and ten per cent of the homes in this 10km grid square are estimated to be above

the Reference Level of 200 Bq/m^3. The Building Regulations in Ireland only require radon protection to be installed in areas of high radon risk (10% to 30% of homes exceed reference level). Refer to Figure 2.15.

Figure 2.15 Radon Map (EPA, 2019)

2.5.12. Designated Area of Conservation

The nearest designated area of conservation is the South Dublin Bay and River Tolka Special Area of Conservation (SAC) Site Code 000210 and Special Protection Area (SPA) Site code 004024 located approximately 16km east of the site (NPWS, 2019).

There nearest proposed Natural Heritage Area (pNHA) is the Grand Canal pNHA located 1.5km north of the site, Site Code 002104.

Figure 2.16 NPWS Designated Area (Source: NPWS MapViewer)

2.5.13. Nearby Site Investigations

The site is located in a relatively well investigated area on the outskirts of Dublin of which the Geological Survey of Ireland (GSI) have compiled a database from site investigations previously carried out in Ireland. Figure 2.17 identifies the site investigation locations with the vicinity of the site.

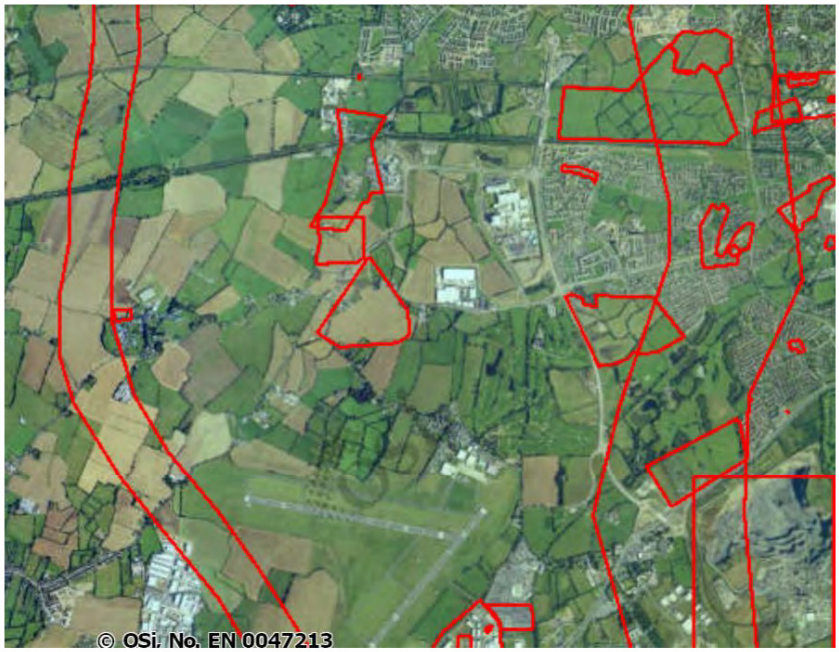


Figure 2.17 Nearby Site Investigations (Source: GSI Geotechnical Viewer)

2.5.14. Summary of the Physical Site Setting

Summary of the site physical setting are outlined in Table 2.3.

Table 2.3 Summary Site Setting

FEATURE	DETAILS & COMMENTS
Topography	Mix of commercial and agricultural with one-off residential properties.
Geology	**Topsoil and Subsoil:** Limestone Till
	Solid Geology: According to GSI data, the bedrock geology beneath the site is 'Calp' Limestone.
Hydrogeology	**Aquifer Classification:** The bedrock aquifer underlying the site is classified as a Locally Important Aquifer (Ll) which is moderately productive in local zones only.
	Vulnerability & Recharge: The vulnerability has been classified as Moderate to High The average recharge has been modelled at 77 - 200mm/year.
	Groundwater Flow: The regional groundwater flow direction can be expected to be to the north.
	Well Search: There were no Source Protection Areas identified (for either Public Drinking Water Supplies or Group Water Schemes) and therefore the assumption is that there are no public supply wells within a 2km zone.
Hydrology	**Surface Water Courses:** The Baldonnel Stream runs roughly east to west through the northern part of the site.
Designated sites	The nearest designated site is the South Dublin Bay and Tolka River SAC (Site Code 000210) and SPA (Site Code 004024) located approximately 16km east of the site. The nearest pNHA is the Grand Canal.

2.6. Protected structures

National Monuments Service (NMS) maps show that there are 2No. concentric enclosures within the site boundary identified to be included within the next RMP. These are not indicated on any OS map and consist of large concentric enclosures visible as a crop-mark on an aerial photo (DU021-108---- & DU021-109----).

Figure 2.18 National Monuments Service (Source: GSI Geotechnical Viewer)

2.7. Air Quality

Air quality was reviewed in the context of available air quality information from publicly available resources such as the Environmental Protection Agency. The site is located within Air Zone A: Dublin Conurbation (Figure 2.19) which is also within the coal restricted zone (Figure 2.20).

Air monitoring locations have been identified in Figure 2.21.

The Air Quality Index for Health (AQIH) is comprised of 6 regions as follows: Dublin, Cork, Large Towns, Small Towns, Rural East and Rural West. The AQIH is calculated on an hourly basis using representative sampling from each region. The site is within Dublin and has a 'Good' Air Quality Index for Health.

Figure 2.19 Dublin Conurbation

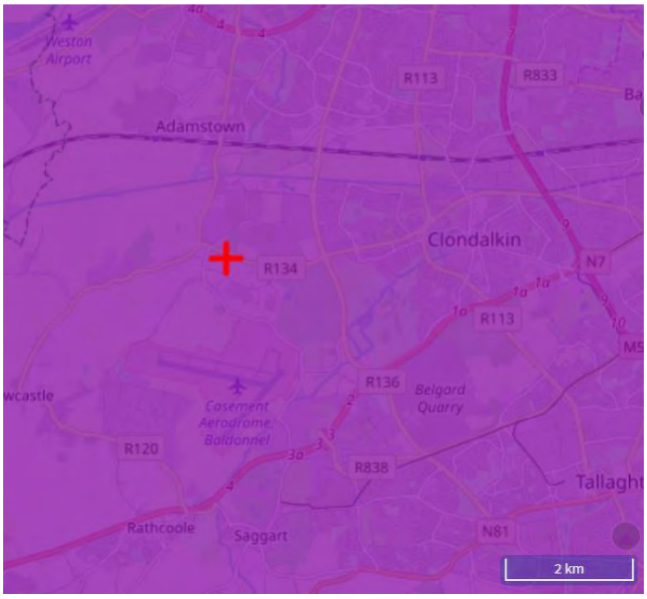


Figure 2.20 Dublin Coal Restricted Area

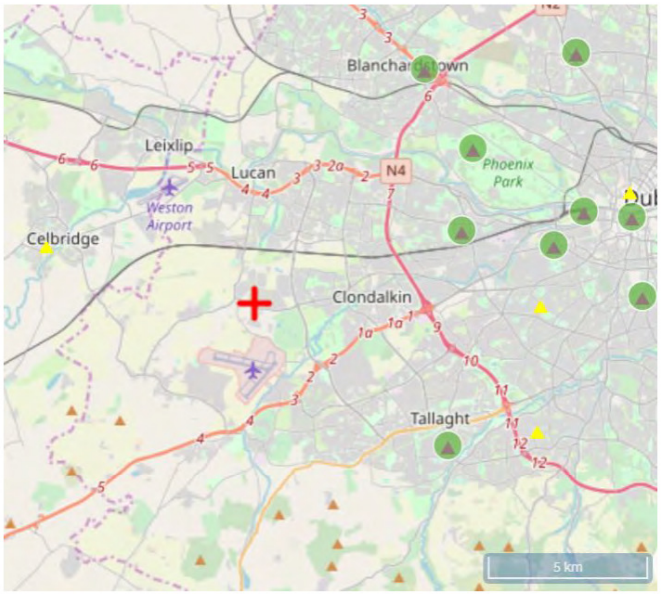


Figure 2.21 Air Monitoring Sites

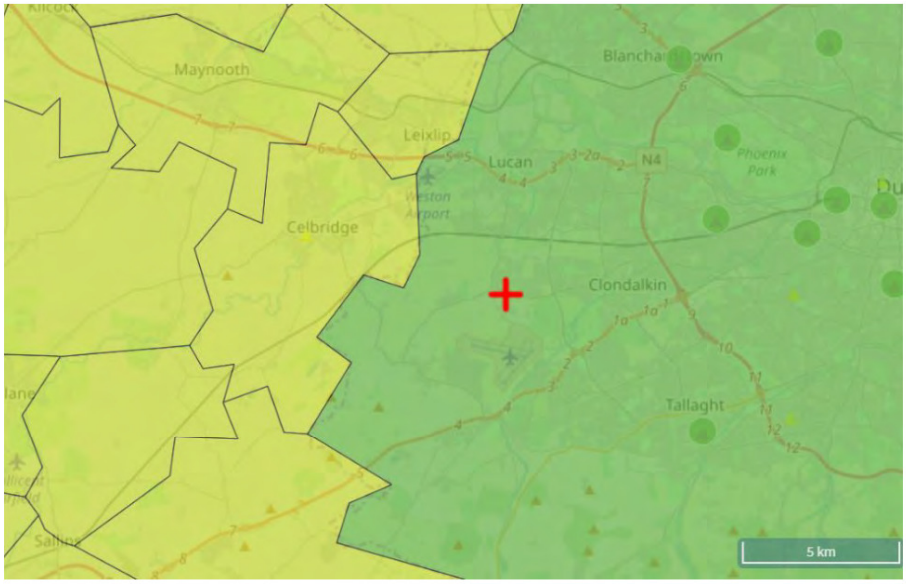


Figure 2.22 Air Quality

2.8. Site Walkover

A site walkover was undertaken by an OCSC Environmental Consultant prior to the commencement of intrusive site works. The site is agricultural in nature with no evidence of fuel storage or asbestos containing materials.

3. PRELIMINARY CONCEPTUAL SITE MODEL

3.1. Risk Assessment Methodology

Currently there is no specific legislation addressing contaminated land in Ireland and therefore this report has been prepared considering the most relevant guidance published by the Irish Environmental Protection Agency (EPA) and the UK Environment Agency (EA) guidance as referenced in Section 1.6. Both authorities advocate a risk-based assessment when dealing with contaminated land and groundwater issues and this is considered best practice as well as being a requirement under the Environmental Liability Regulations (S.I. 547 of 2008).

A critical element of the risk assessment process is the establishment of a Conceptual Site Model (CSM) for the site. A CSM describes the potential sources of contamination at a site, the migration pathways it may follow and the receptors it could impact. If a complete source-pathway-receptor scenario exists then there is a potential pollutant linkage that needs to be characterised and assessed (via formal risk assessment). All three elements need to be present for a viable risk to exist (e.g. if a source and receptor exist but no pathway is present then there is no pollutant linkage and hence no risk). The CSM is updated and refined as more information becomes available.

3.2. Contamination Sources

Following the Phase I review the areas of concern which are considered as potential pollutant sources are summarised in Table 3.1:

Table 3.1 Potential Areas of Concern

AREA/ ASPECT	DETAILS & COMMENTS	SIZE/ MAGNITUDE	POTENTIAL FUTURE RISK
Made Ground	Confirmation required that no fill material placed on site.	Unknown	Low
Previous site use – agricultural	Any contaminants within the material associated with the past site use.	Small	Low
Offsite contaminant sources	Activities associated with offsite sources,	Medium-large	Low

3.3. Outline Conceptual Site Model

Based on the preliminary assessment, several possible pollution linkages were identified for the site (Refer Table 3.2).

Table 3.2 Preliminary Conceptual Site Model

SOURCE	PATHWAY	RECEPTOR	POTENTIAL POLLUTANT LINKAGE Y/N
Environmental			
Migration of contamination from adjacent properties.	Migration of contaminants from made ground and soils	Groundwater in the Gravel and/or bedrock aquifer	Y
Previous site use.			Y
Potential if Made Ground present.			Y
Potential contamination within groundwater	Migration of contaminants in the subsoil & bedrock aquifer	Potential surface watercourses (Baldonnel stream) via groundwater baseflow	Y
Human Health			
Migration of contamination from adjacent properties. Previous site use. Potential if Made Ground present.	Vapour migration to indoor and outdoor air	Onsite Commercial Future Users.	Y
Migration of contamination from adjacent properties. Previous site use. Potential if Made Ground present.	Inhalation/ dermal contact/ ingestion of soils/ dusts	Onsite Commercial Future Users.	Y
Potential contamination within groundwater	Migration of contaminants in the bedrock aquifer	Groundwater users.	Y

Note: Generic risk assessments do not assess risks to construction workers who are managed under the Safety and Welfare at Work Regulations.

4. SITE INVESTIGATION - METHODOLOGY

4.1. OCSC – Site Investigation (2019)

OCSC undertook a preliminary site investigation of the Grange Castle site between April and May 2019. All of the intrusive investigation works were carried out by IGSL Ltd and are documented in report Desktop Study and Technical Memorandum Report No. 21713 May 2019 which is contained in Appendix A. The intrusive investigation completed included the following:

- Excavation of 6No. Trial Pits and 2No. soakaway pit:
    - TP01-TP06, SA01-SA02;
- 5No. Plate Bearing tests;
- Drilling of 16No. cable percussion boreholes: BH01-BH16;
- Drilling of 8No. Rotary Core boreholes: RC01, RC05, RC06, RC09, RC07, RC10, RC13 and RC14;
- BH02, BH08,BH11 and BH16 was converted into a groundwater monitoring well with slots across the overburden;
- RC01, RC07 and RC14 were converted into a groundwater monitoring wells with slots across the bedrock;
- Sampling and analysis of soil samples collected from the trial pits, soakaway pit, window samples and boreholes.
- Sampling of 3No. groundwater wells.

An OCSC Environmental Engineer was onsite during the trial pitting stage of the site investigations. Works were logged to assess potential contamination, to identify any contamination material, to classify any waste material and to obtain environmental samples.

Site Investigation locations are presented in Figure 4.1 below:

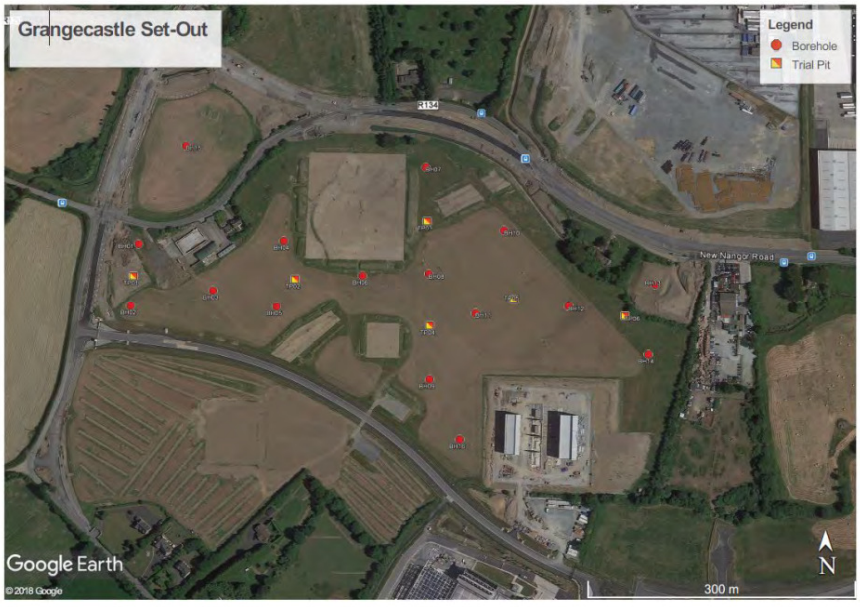


Figure 4.1 Site Investigation Locations (IGSL, 2019)

4.2. Sampling & Analysis

Best practice environmental sampling techniques were adopted to minimize the risk of cross contamination between sampling locations. OCSC's field engineer wore single-use disposable gloves, which were changed following the collection of each sample. Samples were placed into laboratory supplied sample jars. OCSC's Engineer on site was present on site to retrieve samples from the trial pits and also to note any contamination encountered, OCSC's Engineer also visually screened the Made Ground layer for any evidence of Asbestos sheeting and/or fragments, none of which were found.

Groundwater samples were collected following the development and subsequent purging of the wells. Dedicated sampling was used to ensure that cross contamination did not occur. Field parameters were also collected and specific samples containers used as provided by the laboratory for certain parameters.

Samples were stored in a chilled cool box and dispatched to Exova Jones Environmental laboratory in Deeside, UK accompanied by an appropriate chain of custody form and scheduled for analysis.

4.3. Laboratory Analysis – Soil

Ten (10No.) soil samples were collected and submitted to Exova Jones Environmental Laboratory, a UKAS and MCERTS accredited laboratory, for a suite of analysis including:

- Petroleum Hydrocarbons C10-C50
- Polycyclic Aromatic Hydrocarbons
- VOCs & SVOCs
- Metal elements
- Pesticides
- PCBs
- Asbestos

Five (5No.) samples were analysed for a suite of analysis appropriate to assess and classify the material in terms of hazardous, non-hazardous and inert material.

Laboratory certificates are attached in Appendix B.

4.4. Laboratory Analysis – Water

Three (3No.) groundwater samples were collected and submitted to Exova Jones Environmental Laboratory, a UKAS and MCERTS accredited laboratory, for a suite of analysis including:

- Petroleum Hydrocarbons C10-C50
- Polycyclic Aromatic Hydrocarbons
- VOCs & SVOCs
- Metal elements
- Pesticides
- PCBs
- Asbestos

Laboratory certificates are attached in Appendix C.

5. SITE INVESTIGATION – FINDINGS

5.1. Conditions Encountered – Geology

The geology of the site from the intrusive investigation can be summarised to be as follows:

- Topsoil / Made Ground
- Firm brown sandy gravelly CLAY
- Stiff brown sandy gravelly CLAY
- Very stiff dark brown / grey sandy gravelly CLAY
- Possible weathered LIMESTONE

5.1.1.Topsoil/Made Ground

The exploratory holes encountered Topsoil with a thickness of up to 0.4 m. At boreholes BH01 and BH04, a thin covering of Made Ground comprising granular fill and gravelly clay respectively were present from ground level.

5.1.1. Firm brown sandy gravelly CLAY

Firm brown sandy gravelly clay underlay the Topsoil / Made Ground within the eastern portion of the site (Boreholes BH09, 11, 12, 13 and 14). These upper clays were present to depths of between 1.1 and 2.2 m BGL and were characterised by SPT "N" values in the range 13 to 16, indicating undrained shear strengths of the order of 60 to 80 kPa.

5.1.2.Stiff brown sandy gravelly CLAY

Towards the north of the site (Boreholes BH01, 04, 06, 07 and 10), stiff deposits of brown sandy gravelly clay were present within the upper metre. SPT "N" values within this material were in the range 20 to 24, indicating undrained shear strengths of the order of 100 to 125 kPa. The stiff deposits extended to depths of between 0.9 and 1.9 m BGL in these boreholes.

5.1.3.Very stiff dark brown / grey sandy gravelly CLAY

Very stiff deposits of sandy gravelly clay were encountered in all boreholes, and underlay the upper firm or stiff gravelly clay soils, where present. Towards the north of the site (BH01, 04, 06, 07 and 10), these deposits were encountered at depths of between 1.7 and 1.9 m BGL. Further south (BH02, 05, 08 and 16), very stiff gravelly clay soils were typically present within the upper metre. Shallow deposits were also encountered in BH15, within the north-western corner of the site. SPT "N" values for the very stiff deposits were generally in excess of 30, indicating minimum undrained shear strengths of the order of 150 kPa.

5.2. Groundwater Monitoring

No LNAPL or DNAPL was detected in any of the sampling locations during the monitoring period.

6. GENERIC QUANTITATIVE RISK ASSESSMENT

6.1. Generic Assessment Criteria

A risk-based approach has been adopted for the assessment of data. In order to assess the human health and environmental risks posed by potential contaminants within the underlying soils and groundwater, a comparison of the laboratory analytical results for soil and groundwater samples using Generic Assessment Criteria (GAC) was carried out.

Constituent concentrations in soil and groundwater at the site were deemed 'potentially significant' where they exceeded the generic values. These generic values are used for initial assessment of contaminant concentrations for the purpose of providing an initial indication of impacts at a site. Comparison with GACs is a means of evaluating the compounds that could proceed to a more detailed assessment. It should be noted that generic exceedances are not an indication of the requirement for remediation and instead are indicative of the need for further assessment or Detailed Quantitative Risk Assessment (DQRA).

Additionally, where further risk assessment is considered necessary, use of more site-specific information in the assessment can often lead to the conclusion that the observed concentrations are present at levels which represent an acceptable level of risk, considering the actual or proposed end use of a site (although each site assessment has to be considered on an individual basis).

The risk to construction workers is not considered under the CLEA methodology. It is assumed that health and safety guidelines will be adhered to and appropriate health and safety planning/assessments will be undertaken in advance of any on-site works.

6.2. Soil Screening Criteria

The soil analytical data was compared with a set of standard GAC for Commercial/Industrial Landuse – The LQM/CIEH S4ULs for Human Health Risk Assessment (2015) in addition to the SP1010 – Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination CL:AIRE (2014) and the EIC/AGS/CL:AIRE Soil Generic Assessment Criteria for Human Health Risk Assessment (2010). As an initial generic assessment this will allow the screening out of significant contaminants of concern.

In general GACs are conservative screening criteria protective of human health. If the concentrations are below the GAC, then the risks to human health are considered negligible. If the concentrations are above the GAC, a potential risk to human health is identified and further assessment is required. The GACs are consistent with the principles of human health protection in Irish EPA, UK DEFRA and UK Environment Agency guidance.

The active exposure pathways considered under the commercial/industrial scenario are:

- Ingestion of soil and dust;
- Dermal contact with soils and dust;
- Inhalation of dusts; and
- Inhalation of vapours (indoor and outdoor air).

6.3. Groundwater Screening Criteria

In terms of protected waters (i.e. the underlying groundwater and nearby surface waters), there is the potential for contaminated soils (if present) to impact these via leaching. However, estimated soil GACs using a partitioning equation result in theoretical values are likely to be very conservative. Greater reliance is therefore placed on measured groundwater contaminant results to assess the potential risks to waters (surface and ground) in the vicinity of the site.

Groundwater data has been compared with the overall threshold value range identified in the 2016 European Communities Environmental Objectives (Groundwater) Regulations (Statutory Instrument No 366 of 2016). In the event that there is no overall threshold value range identified for a parameter and where one is available as an Interim Guideline Values (IGV) published by the Environmental Protection Agency in the Guidance Document titled 'Towards Setting Guideline Values for the Protection of Groundwater in Ireland' (2003) an IGV has been provided instead.

It is noted that the comparison of groundwater analytical results with the Groundwater Regulations is not representative of actual risk and is used as a guide to the potential risks posed. Contaminant concentrations below the GACs are considered not to warrant further risk assessment. However, concentrations above the generic screening criteria may require further consideration through either qualitative or quantitative assessment.

To determine the vapour risk from groundwater, the newly published Society of Brownfield Risk Assessment – Development of Generic Assessment Criteria for Assessing Vapour Risks to Human Health from Volatile Contaminants in Groundwater February 2017 were used to assess potential risks from volatile compounds in on site groundwater.

6.4. Soil Assessment

The soil analytical results compared to the relevant Commercial GACs are presented in Tables 1 & 2. None of the samples contained concentrations in excess of the Commercial GACs.

6.5. Groundwater Assessment

The groundwater analytical results compared the relevant GACs are presented in Table 3. With the exception of Barium and Zinc concentrations none of the other parameter contained concentrations in excess of the GACs. Concentrations of both barium and zinc were less that twice the GAC for the dissolved phase metals. It is likely that these concentrations represent naturally occurring fluctuations. There were no other elevated concentrations that would indicate that there is a significant contaminant plume beneath the site.

In terms of the Society of Brownfield Risk Assessment (SoBRA) which was set up to develop a methodology for assessing chronic risk to human health via inhalation of groundwater-derived vapours and also to derive generic assessment criteria (GAC) for selected contaminants. From the analytical results, none of the samples exceeded the GACs.

6.5.1. LNAPL & DNAPL Samples

No visual, olfactory, or chemical evidence of the presence of LNAPL or DNAPL during the investigation and/or sampling.

7. REFINED CONCEPTUAL SITE MODEL (CSM)

Based on the findings of the soil and groundwater assessment i.e. the results of the GQRA, potential contamination source areas have been identified for the site. The CSM can now be refined using site specific information and the potential risk to human health can be assessed taking into account the proposed redevelopment of the site as outlined in Section 1.3.

7.1. Source – Made Ground

Made ground represents a thin layer in a small area of the site.

No exceedances of GACs observed in any of the soil samples.

Outcome: No further assessment required

7.2. Source – Vapour Risk.

No evidence of concentrations that could present vapour risk.

Outcome: No further assessment required

7.3. Source – Offsite Sources/Groundwater

There would appear to be minimal risk from migration of contamination from adjacent properties with the only exceedances considered including elevated zinc and barium concentrations. It is not considered that these concentrations present a significant risk.

Outcome: No further assessment required

7.4. Refined CSM

Table 7.1 Summary Revised Conceptual Site Model

SOURCE	PATHWAY	RECEPTOR	POTENTIAL POLLUTANT LINKAGE Y/N
Environmental			
Migration of contamination from adjacent properties.	Migration of contaminants from made ground and soils	Groundwater in the Gravel and/or bedrock aquifer	N
Previous site use.			N
Potential if Made Ground present.			N
Potential contamination within groundwater	Migration of contaminants in the subsoil & bedrock aquifer	Potential surface watercourses (Baldonnel stream) via groundwater baseflow	Yes however acceptable Risk
Human Health			
Migration of contamination from adjacent properties. Previous site use. Potential if Made Ground present.	Vapour migration to indoor and outdoor air	Onsite Commercial Future Users.	N

Migration of contamination from adjacent properties. Previous site use. Potential if Made Ground present.	Inhalation/ dermal contact/ ingestion of soils/ dusts	Onsite Commercial Future Users.	N
Potential contamination within groundwater	Migration of contaminants in the bedrock aquifer	Groundwater users.	N No evidence of drinking water supplies

Note: Generic risk assessments do not assess risks to construction workers who are managed under the Safety and Welfare at Work Regulations.

8 WASTE SOIL CLASSIFICATION

Five (5No.) soil samples were submitted for a suite of analysis to facilitate the assessment of material in terms of waste soil classification.

8.1 Hazardous Waste Assessment

To comply with the European Waste Framework Directive (2008/98/EC), S.I. 233 of 2015 and S.I. 126 of 2011; a hazardous waste assessment was carried out utilising HazWasteOnline software using classification engine WM3.v1.1 (2018). The software enables the user to review the total pollutant content analysis in terms of any Hazardous Properties (as defined in the Regulations) the material may have. The material is assessed against an array of hazardous property thresholds as prescribed in the relevant Regulations and Guidance (Section 1.6).

Of the analyses of the 5No. samples all of the samples were assessed as being non-hazardous (hazardous v non-hazardous). This is as expected given the greenfield nature of the site. HWOL outputs included in Appendix D.

8.2 Waste Acceptance Criteria Assessment

The same 5No. samples were subjected to a leaching test. The leaching results and a selection of total pollutant content results have been compared with the thresholds for acceptance of waste at inert, non-hazardous and hazardous facilities as prescribed in the Landfill Directive. An additional category was included which is based on the integrated Material Solutions Hollywood waste acceptance criteria which are the same as the inert criteria with the exception of total PAHs (100mg/l). The classification categories are outlined in Table 8.1

Table 8.1 Classification Categories

WASTE CATEGORY	TITLE	CLASSIFICATION CATEGORY	POTENTIAL OUTLET
Category A	Inert Waste Criteria	Reported concentrations less than inert waste guidelines, which are based on waste acceptance criteria set out by the adopted EU Council Decision 2003/33/EC establishing criteria and procedures for the acceptance of waste at landfills pursuant to Article 16 and Annex II of Directive 1999/31/EC (2002). Results found to be non-hazardous using the HazWasteOnline application.	Reuse or recovery subject to Planning and/or Waste Permissions. Inert Landfills e.g. Murphy Gormanston, Roadstone Huntstown. If material constitutes MADE ground acceptance needs to be confirmed in advance with landfill.
Category B	Inert (IMS Acceptance Criteria)	MEHL Acceptance Criteria as laid out in their Waste Licence W0129-02. Reported concentrations less than inert waste guidelines, which are based on waste acceptance criteria set out by the adopted EU Council Decision 2003/33/EC establishing criteria and procedures for the acceptance of waste at landfills pursuant to Article 16 and Annex II of Directive 1999/31/EC (2002) **with the exception of PAHs (Total 17 <100mg/kg)**. Results found to be non-hazardous using the HazWasteOnline application.	Disposal at Integrated Materials Solutions Naul Facility.
Category C1	Non-Haz Criteria	Analytical results greater than Category A criteria but less than non-hazardous waste guidelines, which are based on waste acceptance criteria set out by the adopted EU Council Decision 2003/33/EC establishing criteria and procedures for the acceptance of waste at landfills pursuant to Article 16 and Annex II of Directive 1999/31/EC (2002) **no limit for TOC**. Results found to be non-hazardous using the HazWasteOnline application.	Disposal/Recovery at licensed Landfill (Ballynagran, Knockharley, Drehid). Material can be sent for recovery as engineering material rather than disposed of (no landfill tax).
Category C2	Non-Haz Criteria but with trace asbestos	Results as per C1 but with trace asbestos	Material will need to be disposed of at a licensed landfill if trace asbestos confirmed. If asbestos level is quantifiable then it may have to be disposed in N. Ireland.
Category D	Hazardous	Analytical results found to be hazardous using the HazWasteOnline application.	None in Ireland (export).

NOTE: HazWasteOnline accessed through http://www.hazwasteonline.com. Application developed by One Touch Data Limited based on Regulation (EC) No. 1272/2008: the classification, labelling and packaging of substances and mixtures (CLP) and the latest UK Environment Agency guidance, WM3 v1.1 (2018). The EPA have stated that the HazWasteOnline tool is acceptable for the classification of wastes in Ireland and they have a licence for the application to review results if required.
NOTE: Where material is sent for RECOVERY it does not incur the landfill tax (currently €75/tonne)
NOTE: While waste soil is classified based on the EU Council Decision 2003/33/EC, waste acceptance criteria may vary at each potential Waste Receiver site and further assessment and consultation may be required with the proposed Waste Receiver to confirm suitability for disposal. In terms of permitted sites, further assessment in terms of potential impact to the environment may be required or inert waste comprising made ground may not be acceptable. The Regulations also allow Waste Receivers to agree increased specific limits (e.g. TOC, sulphates) following Risk Assessment, agreement with the EPA and notification of the EC.

The assessment for each sample is contained in the Waste Classification Table which is attached in Table 4 at the end of this report.

While OCSC provide an opinion on which potential Waste Receivers may accept any particular type of material, it is up to the individual Waste Receivers whether they can accept the material (based on results, site acceptance criteria, void space, percentage of non-natural materials within made ground etc).

8.3 Waste Codes

The code for soil and stone material as per the List of Waste is:

- 17 05 04 soil and stone other than those mentioned in 17 05 03

For made ground there is often a portion of the material which is not soil and stone (e.g. brick fragments, concrete, clinker, timber etc). There is no guidance available on what proportion of other materials is acceptable when classifying a single waste stream although a standard industry guideline of 5% maximum visible contamination with other waste types is often employed. Some facilities have specific limits in their licence (e.g. for non-greenfield sites soil and stone to have <2% contamination with non-natural materials). Therefore it is required to confirm the acceptable levels of contamination of non-natural materials with the Waste Receiver in advance of exporting material to site.

8.4 Summary of Waste Classification to Date

Table 8.2 summarises the waste assessment carried out on site investigation samples (i.e. from boreholes and window samples).

Table 8.2 Waste Classification Results

	A Inert	B Inert (IMS)	C1 Non-Haz	C2 Non-Haz w/ trace asbestos	D Hazardous
No. of samples	5	0	0	0	0

8.5 Asbestos

All samples were subjected to asbestos screening and none of the samples contained detectable asbestos fibres.

8.6 Dig Plans

It should be noted that the Dig Plans indicate waste soil classifications to enable excavations and assume that the analytical sample results for the key components from that cell are representative for the entire volume of the cell. This is an accepted industry practice and the Contractor will also be informed of the Watching Brief and Discovery Strategy (contained in the

Construction Demolition Waste Management Plan (CDWMP) in the event of any unexpected visual or olfactory contamination hot-spots being encountered. However, given the nature of the site no hotspots are considered likely.

8.7 Contractor Requirements regarding Waste Soil & Groundwater Management

The management of waste soils, hazardous materials and groundwater during construction must comply with all relevant environmental and waste regulations (see Section 1.6 for a non-exhaustive list).

A Soil and Groundwater Management Plan should submitted with the planning applications for the site. This report outlines requirements and recommendations regarding the management of Soil and Groundwater during the construction phase. The designated Contractors will be required to adopt and amend these plans in advance of works starting on site.

The following section outlines requirements and recommendations which the Contractor is required to implement regarding the management of waste soil throughout the project.

8.7.1 Watching Brief

Should the contractor encounter any ground conditions which differ from those outlined in this report and/or the ground investigation reports they should suspend works in that area and notify the Client or their representative.

8.7.2 Hazardous Cells

There are no hazardous cells identified by the site investigations. Should however it become evident for any reason that contamination is or suspected to be present in the soil then the contractor should suspend works in that area, notify the Client or their representative, and request that the dig plans be revised including if appropriate further site investigation.

8.7.3 Export from Site

All excavated soil and wastes requiring export from the site, for recovery or disposal offsite, shall require waste classification. Waste classification shall be carried out by a suitability qualified and experienced person via sampling and analysis following best industry practice and relevant legislation including:

- List of Waste & Determining if Waste is Hazardous or Non-Hazardous (EPA, 2015);
- European Waste Framework Directive (2008/98/EC);
- Guidance on the classification and assessment of waste, Technical Guidance WM3 (EA et al, 2015);
- EU Council Decision 2003/33/EC and 1999/31/EC (2002);
- European Union (Properties of Waste which render it Hazardous) Regulations 2015 – S.I. 233 of 2015; and
- EC Classification, Labelling & Packaging Regulations (No. 1272/2008).

Written confirmation shall be obtained from the proposed Receiver (either under an Article 27 Declaration or Waste Permission) in advance of materials being removed from site. All Waste Receivers and Waste Hauliers shall hold valid and appropriate permissions and shall be preapproved by the Client or their Representative.

Where material is to be exported out of the State it shall be carried out with the agreement of the TFS office in DCC and in accordance with all relevant legislation including:

- Waste Management (Movement of Hazardous Waste) Regulations, 1998 (S.I. No. 147 of 1998);

- The European Communities (Transfrontier Shipment of Hazardous Waste) Regulations, 1988 (S.I. No. 248 of 1988);
- The Basel Convention; and
- European Communities (Shipments of Hazardous Waste exclusively within Ireland) Regulations 2011 (S.I. No. 324 of 2011).

Where material is awaiting classification and/or acceptance by a Waste Receiver it shall either be; left in-situ or; excavated and stockpiled in an appropriate manner, which means, as a minimum, that:

- A temporary storage area shall be designated;
- All stockpiles to be assigned an identifier number;
- Excavation and stockpile formation shall be carried out in a controlled manner to ensure cross-contamination is avoided;
- Non-hazardous and hazardous soil shall be stockpiled only on hard-standing or high-grade plastic to prevent leaching and cross contamination of underlying soils; and
- Stockpiles shall be covered with high-grade plastic sheeting to avoid leachate and dust generation. The plastic sheeting must be adequately weighted on tied down to prevent being blown off by the wind.

Stockpile sampling shall be carried out by a competent person following a documented sampling procedure or recognised standard[1]. Once a stockpile has been sampled it is considered complete and no more material shall be added to it.

An excavation/stockpile register shall be maintained showing as a minimum the following information:

- Stockpile number;
- Origin;
- Approximate volume of material;
- Date of creation;
- Date of sampling;
- Description of material;
- Classification;
- Removal date and destination; and
- Photograph.

8.7.4 Monitoring Requirements

The Contractor shall ensure that all waste materials associated with the project are appropriately classified and documented and shall include in the CDWMP appropriate measures such as:

- Arrange for soil samples to be collected either prior to excavation (in situ) and/or from the stockpiles of material before disposal;

[1] eg. ISO 10381-8:2006 Soil quality – Sampling- Part 8: Guidance on sampling of stockpiles or WM3 Guidance

- Arrange for samples to be analysed at an accredited laboratory for an appropriate and approved suite of parameters;
- Assess the results against the appropriate criteria to classify the waste; and
- Maintain copies of all sample details, results, assessments and provide copies of same to the Client or its Representatives.

8.7.5 Documentation

Waste disposal shall be documented within a Waste Documentation System which shall be developed by the Contractor within the overall document management system for the works and shall be included in the Construction Management Plan (CMP). The documentation to be maintained in relation to wastes shall include the following:

- Details of all parties involved in the transport of material (including. Hauliers, Agents, Shipping details etc.);
- Details of the Waste Receivers including any intermediary facilities;
- Written confirmation of the acceptance and recovery/disposal of any hazardous waste consignments;
- The tonnages and Waste Code for all waste materials;
- Details of each individual consignment of waste including:
    - Docket number of consignment
    - Date and time;
    - Name of Haulier, vehicle registration and Driver;
    - Volume/weight of consignment;
    - Description of material and origin (stockpile or cell number);
    - Name of receiving facility;
    - Date and time of arrival at receiving facility; and
    - Docket/weighbridge ticket number from receiving facility;
- All Waste Transfer Forms for hazardous waste;

The Contractor shall maintain an electronic register with the aforementioned details, as well as copies of all dockets from hauliers, and receivers. The Contractor shall provide regular reports to the Client or its representative including copies of the register and dockets if required.

9 SUMMARY & CONCLUSIONS

The site is located in Grange Castle Business Park South (GCBPS), in the west of Dublin some 13 kilometres from the City Centre. It is proposed that the site will be develop for data centre purposes. An outline of what is proposed is outlined in section 1.3. A summary of the Environmental Site Assessment (ESA) and Generic Quantitative Risk Assessment (GQRA) findings are detailed below:

- The site currently comprises agricultural lands and is bounded to the north by the realigned Nangor Road, to the west by Baldonnel Road and to the south by a GCBPS access road. Part of the old R134 Nangor Road cuts diagonally through the northwest corner of the site separating a 2.65 hectare portion of the site from the main 16.26 hectare section.
- The development of the site is to accommodate 3 no. data centres comprising 2no. 2 storey 12 pod buildings, measuring 190m*160m in plan along with 1no. 2 storey 8 pod building measuring 150m*60m in plan. The overall development, including ancillary substation, sprinkler house and fuel storage facilities will be of the order of 40,000 m^2.
- Aerial images of the site from 1995, 2000 and 2005 show the site layout as it is today. The Premium Aerial photograph from Ordnance Survey Ireland illustrate the realigned Nangor Road.
- The Baldonnel Stream runs roughly east to west through the northern part of the site.
- National Monuments Service (NMS) maps show that there are 2No. concentric enclosures within the site boundary identified to be included within the next RMP. These are not indicated on any OS map and consist of large concentric enclosures visible as a crop-mark on an aerial photo (DU021-108---- & DU021-109----).
- Investigations showed the site's proven geology to be Topsoil/Made Ground over a layer of glacial till, underlain by possible weathered bedrock.
- The conceptual site model identified the receptors as future commercial receptors on-site and offsite human health and environmental receptors.
- The site investigation works carried out included the collection of a number of soil and groundwater samples.
- A GQRA was undertaken using commercial GACs to assess the risk to future commercial users. None of the soil sample contained concentrations in excess of the GAC Commercial landuse values.
- Two parameters, barium and zinc, showed mildly elevated concentrations in groundwater samples however it is not considered that these present a risk to future users nor that they represent a significant plume of contamination.
- No LNAPL (floating hydrocarbon) or DNAPL (settled/sinking hydrocarbon) layer was observed and/or sampled.
- Based on the conservative assessment undertaken no remedial measures are required.
- A waste soil assessment was undertaken on five (5No.) samples collected and submitted for a suite of analysis appropriate for completing a Waste Soil Classification. All of the samples were classified as Inert, as expected given the greenfield nature of the site.

- In summary it is considered that the site is consistent with a greenfield site with no evidence of contamination that could present a risk to human health or the environment.

Respectfully submitted

on behalf of OCSC Multidisciplinary Consulting Engineers

ELEANOR BURKE
MSc MIEnvSc
TECHNICAL PRINCIPAL &
DIVISION MANAGER

CHAPTER 8 - HYDROLOGY

Appendix 8.1 Criteria for rating Site Attributes - Estimation of Importance of Hydrology Attributes (NRA)

Importance	Criteria	Typical Examples
Extremely High	Attribute has a high quality or value on an international scale	River, wetland or surface water body ecosystem protected by EU legislation e.g. 'European sites' designated under the Habitats Regulations or 'Salmonid waters' designated pursuant to the European Communities (Quality of Salmonid Waters) Regulations, 1988.
Very High	Attribute has a high quality or value on a regional or national scale	River, wetland or surface water body ecosystem protected by national legislation – NHA status Regionally important potable water source supplying >2500 homes Quality Class A (Biotic Index Q4, Q5) Flood plain protecting more than 50 residential or commercial properties from flooding Nationally important amenity site for wide range of leisure activities
High	Attribute has a high quality or value on a local scale	Salmon fishery Locally important potable water source supplying >1000 homes Quality Class B (Biotic Index Q3-4) Flood plain protecting between 5 and 50 residential or commercial properties from flooding Locally important amenity site for wide range of leisure activities
Medium	Attribute has a medium quality or value on a local scale	Coarse fishery Local potable water source supplying >50 homes Quality Class C (Biotic Index Q3, Q2- 3) Flood plain protecting between 1 and 5 residential or commercial properties from flooding
Low	Attribute has a low quality or value on a local scale	Locally important amenity site for small range of leisure activities Local potable water source supplying <50 homes Quality Class D (Biotic Index Q2, Q1) Flood plain protecting 1 residential or commercial property from flooding Amenity site used by small numbers of local people

Appendix 8.2 Stage 2 Flood Risk Assessment (AWN Consulting Ltd. (2020))

FLOOD RISK ASSESSMENT FOR PROPOSED GIS SUBSTATION & 2 NO. TRANSMISSION LINES

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Title	Environmental Consultant	Director
Date	10 September 2020	10 September 2020

EXECUTIVE SUMMARY

AWN Consulting Ltd (AWN) has been appointed to undertake a Flood Risk Assessment (FRA) for a new 110 kV Gas Insulated Switchgear (GIS) Substation (known as Clutterland), 4 no. transformer bays, Client Control Building, 49 kVa rural supply, associated compounds and site infrastructure to be located on lands at Grange Castle South Business Park, Baldonnel, Dublin 22, an underground single circuit 110 kV transmission line from the proposed Clutterland Substation to the existing 220 kV / 110 kV Castlebaggot Substation to the immediate south and an underground single circuit 110 kV transmission line from the proposed Clutterland Substation connecting to the existing 110 kV underground Kilmahud Corkagh circuit c. 900 m to the north-west. The site was previously used for agriculture. There are a number of other industrial facilities located throughout the Grange Castle Business Park site

This assessment is undertaken in accordance with the guidelines produced by the Department of the Environment, Heritage and Local Government, *The Planning System and Flood Risk Management - Guidelines for Planning Authorities* (2009), hereafter referred to as the FRM Guidelines.

As outlined in the FRM Guidelines, an FRA aims to quantify the risk posed to the development and the surrounding environment by this development.

No historic flooding of the site has been identified from the OPW flood maps or local planning applications. Soil cover mapping was researched and indicated that the site was not underlain by alluvium soils but mainly glacial clay till. Alluvium soils, which could be indicative of flooding, were not identified.

Part of the development resides within Flood Zone B and is not at risk of flooding from a 10%.AEP event. As drainage is designed to adhere to the Local Authority requirements, the Greater Dublin Strategic Drainage Study and has incorporated SuDS measures for the permitted data centre development SDCC Reg. 20A/0121, it is not expected that the proposed development would adversely impact on flood risk for other neighbouring properties. Furthermore, the transmission line installation will be reinstated to current. Under the sequential approach and within section 3.5 under the FRM guidelines (2009) any building that is used for "*Essential Infrastructure such as....utilities distribution, including electricity generating power stations and substations*" is deemed "Highly Vulnerable Development". Part of the Proposed Development resides in **Flood Zone B** therefore (based OPW Eastern CFRAM Mapping). Therefore, a justification test was required. Based on the assessment the proposed scheme satisfies the Justification Test criteria for Development Management.

CONTENTS

1.0 INTRODUCTION

AWN Consulting Ltd. (AWN) has been appointed to undertake a Flood Risk Assessment (FRA) to support a planning application on a new 110 kV Gas Insulated Switchgear (GIS) Substation (known as Clutterland), 4 no. transformer bays, Client Control Building, 49 kVa rural supply, associated compounds and site infrastructure to be located on lands at Grange Castle South Business Park, Baldonnel, Dublin 22, an underground single circuit 110 kV transmission line from the proposed Clutterland Substation to the existing 220 kV / 110 kV Castlebaggot Substation to the immediate south and an underground single circuit 110 kV transmission line from the proposed Clutterland Substation connecting to the existing 110 kV underground Kilmahud Corkagh circuit c. 900 m to the north-west. The site was previously used for agriculture. There are a number of other industrial facilities located throughout the Grange Castle Business Park site

The site of the substation is currently greenfield with some domestic dwellings. The route of the transmission lines will be within current road wayleaves and will be returned to the current condition following the proposed development. The Grange Castle Business park has a number of industrial buildings located in the area including a number of data storage facilities.

There is a fall of approximately 10 m from the southeastern boundary of the proposed development to north-west boundary towards the Griffeen River.

1.1 Scope

A Flood Risk Assessment (FRA) is undertaken over several stages with the need for progression to a more detailed stage dependent on the outcomes of the former stage.

This hierarchy of assessment is necessary to ensure that flood risk is considered at all levels of the planning process and that the appropriate level of detail is also considered, avoiding the need for detailed and costly assessments prior to making strategic decisions.

The assessment has been undertaken in accordance with the guidelines produced by the Department of the Environment, Heritage and Local Government (DoEHLG) - The Planning System and Flood Risk Management Guidelines for Planning Authorities, November 20091, hereafter referred to as the FRM Guidelines.

In terms of the Flood Risk Assessment and Management Study the scope of works incorporates three stages:

Stage 1: Flood Risk Identification - to identify whether there may be any flooding or surface water management issues related to a plan area or proposed development site that may warrant further investigation.

Stage 2: Initial Flood Risk Assessment - to confirm sources of flooding that may affect a plan area or proposed development site, to appraise the adequacy of existing information and to determine what surveys and modelling approach is appropriate to match the spatial resolution required and complexity of the flood risk issues. The extent of the risk of flooding should be assessed which may involve preparing indicative flood zone maps. Where existing river or coastal models exist, these should be used broadly to assess the extent of the risk of flooding and potential

impact of a development on flooding elsewhere and of the scope of possible mitigation measures; and

Stage 3: Detailed Flood Risk Assessment - to assess flood risk issues in sufficient detail and to provide a quantitative appraisal of potential flood risk to a proposed or existing development, of its potential impact on flood risk elsewhere and of the effectiveness of any proposed mitigation measures. This will typically involve use of an existing or construction of a hydraulic model of the river or coastal cell across a wide enough area to appreciate the catchment-wide impacts and hydrological processes involved.

As described in the FRM guidelines flood risk is a combination of the likelihood of flooding occurring and the potential consequences which may arise, and is normally expressed in terms of the following relationship:

Flood risk = Probability of flooding x Consequences of flooding

Likelihood of flooding is normally expressed as the percentage probability based on the average frequency measured or extrapolated from records over a large number of years. A 1% probability indicates the flood level that is expected to be reached on average once in 100 years, i.e. it has a 1% chance of occurring in any one year. Therefore:

100-year flood = 1% Annual Exceedance Probability (AEP).
1000-year flood = 0.1% AEP.

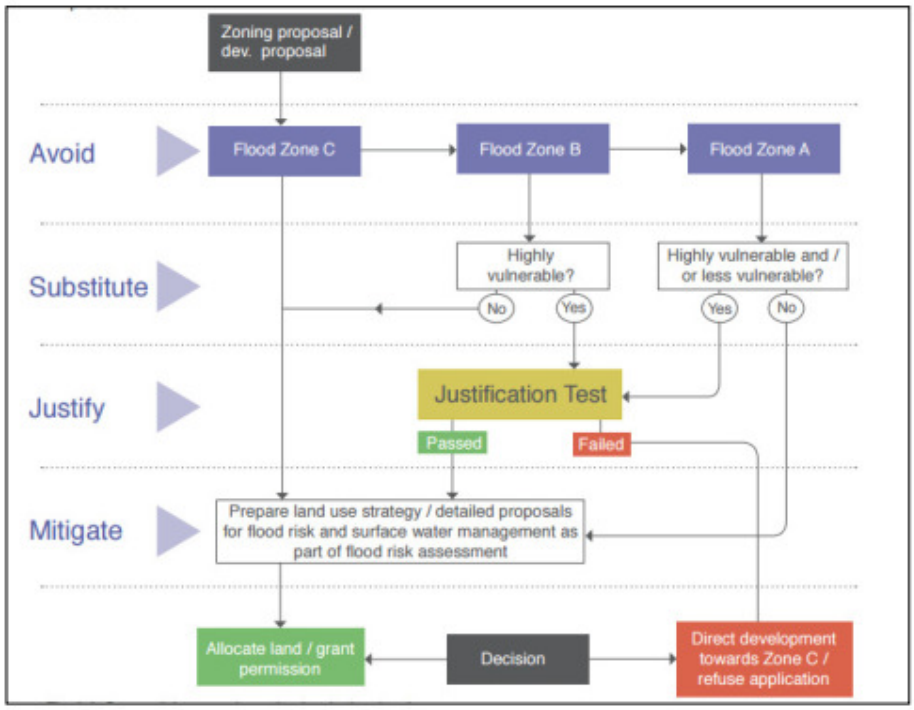
In the FRM Guidelines, the likelihood of a flood occurring is established through the identification of Flood Zones which indicate a high, moderate or low risk of flooding from fluvial or tidal sources, as defined as follows:

Flood Zone A - Where the probability of flooding is highest (greater than 1% AEP or 1 in 100 for river flooding and 0.5% AEP or 1 in 200 for coastal flooding) and where a wide range of receptors would be vulnerable.

Flood Zone B - Where the probability of flooding is moderate (between 0.1% AEP or 1 in 1000 and 1% AEP or 1 in 100 for river flooding and between 0.1% AEP or 1 in 1000 year and 0.5% AEP or 1 in 200 for coastal flooding); and

Flood Zone C - Where the probability of flooding is low (less than 0.1% AEP or 1 in 1000 year for both river and coastal flooding).

Potential impacts of the proposed development were considered within the study area. This is defined as the area within the proposed development site boundary (i.e. the proposed development site), and the wider hydrological setting of the area. A sequential approach was undertaken for this risk assessment under guidance from the local planning authorities (2009). Specifically, a sequential approach is first and foremost directed towards land that is at low risk of flooding. The underpinning philosophy of the sequential approach is highlighted in the illustration below. Based on the OPW Eastern CFRAM Maps and SDCC Development Plan 2016-2022 Strategic Flood Risk Assessment maps, the parts of the proposed development (substation and proposed transmission line routes) resides within Flood Zone B. This report contains the second tier of the flood risk assessment



Insert 1 Sequential approach mechanism in the planning process

1.2 Methodology

This assessment follows the FRM Guidelines; the methodology involves researching the following data sources:

- Base maps – Ordnance Survey of Ireland[1]
- Flood Hazard Maps and flooding information for Ireland, www.floodmaps.ie Office of Public Works (OPW)[5]
- Geological Survey of Ireland (GSI) maps on superficial deposits[6]
- EPA hydrology maps[3]
- Eastern Catchment Flood Risk Assessment & Management Study[4]
- The National Planning Framework (Project Ireland 2040)[7]

Under the sequential approach and within section 3.5 under the FRM guidelines (2009) any building that is used for "*Essential Infrastructure such as….utilities distribution, including electricity generating power stations and substations*" is deemed a "Highly Vulnerable Development" (see Table 1.1 below). Part of the Proposed Development resides in **Flood Zone B** and is classed as a "Highly Vulnerable" development, therefore, a Justification Test is required (see Table 1.2) (based on OPW Eastern CFRAM Mapping).

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

Table 1.1 Classification of the vulnerability of different types of developments.

	Flood Zone A	Flood Zone B	Flood Zone C
Highly vulnerable development (including essential infrastructure)	Justification Test	Justification Test	Appropriate
Less vulnerable development	Justification Test	Appropriate	Appropriate
Water-compatible development	Appropriate	Appropriate	Appropriate

Table 1.2 Matrix of vulnerability versus flood zone to illustrate appropriate development and that required to meet the Justification Test.

2.0 EXISTING HYDROLOGICAL ENVIRONMENT

2.1 Site Location

The site is in Grange Castle Business Park in Dublin 22. Figure 2.1 below illustrates the site location. The area consists mostly of agricultural, industrial and commercial premises. The immediate surroundings of the site are summarised as follows:

- The proposed 110 kV GIS substation is located on lands that are bounded by the realigned Baldonnel Road to the west; by the old and new Nangor Road to the north; by agricultural fields and the Grange Castle Motor Company to the east; and by the Grange Castle South Access Road
- The lands to the west of the Proposed Development are currently undeveloped and are subject to the recent decision of South Dublin County Council to issue a Notification of a Decision to Grant Permission for 3 no. two storey data centres and ancillary elements with a total gross floor area of 80,269 m^2 applied for under Reg. Ref. SD20A/0121. The lands that were included within the red line of this application included the Proposed Development site of the Substation and parts of the transmission lines being proposed under the current application.
- The route of the underground 110kV transmission line to the Castlebaggot Substation passes around its northern and part of the western boundary before passing into the Substation approximately halfway along its western boundary with the Proposed Development site.
- The route of the underground 110 kV transmission line to the Kilmahud Corkagh circuit passes to the north of Building C and Building A as proposed under Reg. Ref. SD20A/0121. It then passes over the former Nangor Road (now cut off at either end) before passing across the SDCC owned land before crossing the realigned Nangor Road and passing along the wayleave on the east/south of the Grange Castle internal Business Park Road before looping around to connect to the Kilmahud Corkagh circuit.
- The route of the proposed 49 kVA cable installation is shown in Figure 2.2. It will link from existing infrastructure within the wayleave along the Grange Castle South Business Park Road from where it will extend up within the wayleave to the west of the Castlebaggot Substation before connecting into the proposed Clutterland 110 kV GIS Substation

Figure 2.1 Site Location and Context

2.2 Hydrology

The site falls generally from south to north, with topographical levels ranging from c. 75 mAOD in the south-east to c. 65 mAOD in the north-west of proposed development boundary.

The Proposed Development is within the River Liffey catchment, which encompasses an area of approximately 1,369 km^2. The river extends from the mountains of Kippure and Tonduff in County Wicklow to the sea at Dublin Bay. The main channel covers approximately 120 km and numerous tributaries enter along its course. The Proposed Development site is within the sub-catchment of the Griffeen River and Baldonnell Stream which are tributaries of the River Liffey.

Figure 2.2 Local Hydrological Environment

The Griffeen River (stream) is located to the northwest. The Griffeen River rises in the townland of Greenoge, approximately 3.5 km south of the Proposed Development. It flows in a northerly direction where it is culverted beneath the Grand Canal and from there it flows north through Lucan. The Griffeen River enters the River Liffey just north of Lucan town. A section of the Griffeen was realigned during the construction of the Business Park and associated access roads and it now runs alongside the now realigned Nangor Road in a northerly direction

The Baldonnell Stream runs roughly east to west along the north-eastern boundary of the centre section of the proposed development boundary. The river is in three distinct forms. The eastern section, which runs over the central northeast corner, is in its natural condition and runs at the surface for approximately 200 m from the boundary with Boland's Grangecastle, behind a vacant bungalow in an open ditch. The central 280 m reach has been realigned and borders the central northern boundary of the proposed development. This section of the river runs on the surface in a newly formed channel parallel to the Nangor Road. The final, western reach is in a 200 m culvert and borders the north-west boundary of the site. This section of the stream continues north-westwards (along the Grange Castle Business Park internal access road) to outfall to the Griffeen River at a point southeast of the junction of the New Nangor and Baldonnell roads.

Other notable hydrological features near the Proposed Development are the Camac river and the stream called 'Miltown 09' by the EPA. The River Camac runs from the south to the northeast, approximately 2.5 km south-west of the Proposed Development site. The River Camac catchment from immediately downstream of Baldonnell Business Park has an estimated catchment area of 13.6 km^2 and is steep to moderately sloping (1% to 10%). The catchment area consists largely of greenfield, a section of the residential areas on the outskirts of Saggart, Baldonnell Business Park and one-off residential/ commercial

developments. The Miltown 09 is a small stream running off the Griffeen River and runs through the site from north-west to south-east. The local hydrological environment is shown in Figure 2.2.

2.3 Existing Flood Records

The potential risk of flooding on the site was assessed. This included a review of the Office of Public Works (OPW) Catchment Flood Risk Assessment and Management Study (CFRAM) Maps.

The OPW on-line database floodmaps.ie was reviewed regarding incidences of historical regional and local flooding relevant to the area. While there are flood events recorded in the regional area there is no apparent historical risk of flooding in the immediate vicinity of the site. The nearest flood point recorded is approximately 200 m to the west of the western section of the proposed development boundary at the R134 R120 junction. This location was recorded by Fingal County Council as prone to flooding in the year 2000. The OPW flood map for this area is included in Figure 2.3.

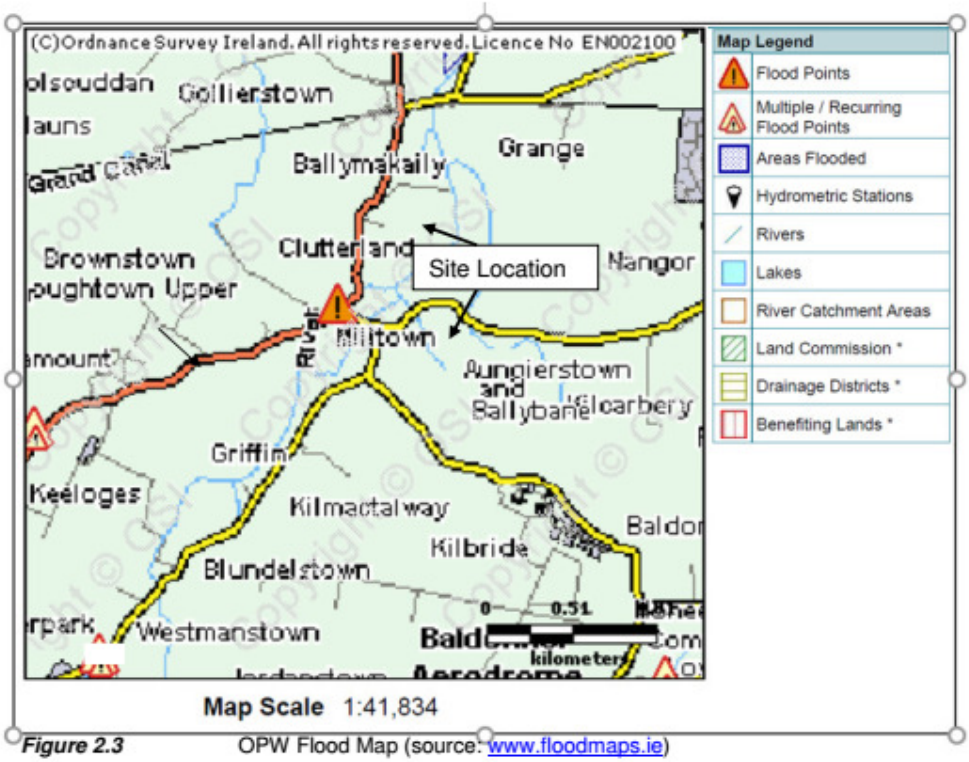


Figure 2.3 OPW Flood Map (source: www.floodmaps.ie)

Based on a review of floodmaps.ie there was no evidence which would indicate a risk of flooding to the site and neighbouring properties.

Eastern CFRAM Study & OPW Flood Risk Maps

The EU Floods Directive (2007/60/EC) required Member States to undertake a national preliminary flood risk assessment by 2011 to identify areas where significant flood risk exists or might be considered likely to occur. Members States were also

required to prepare catchment-based Flood Risk Management Plans by 2015 that would set out flood risk management objectives, actions and measures. The OPW, in co-operation with various Local Authorities, have produced a large number of CFRAMs. These CFRAMs aim to map out current and possible future flood risk areas and develop risk assessment plans. They will also identify possible structural and non-structural measures to improve the flood risk of the area. As part of the CFRAM programme provisional flood risk assessment maps (PFRA) were produced by the OPW with cooperation with the local authorities.

According to the Eastern CFRAM study, HA09 Hydraulic Report (Baldonnel Model) as carried out by RPS Group (see figure 2.4 below) the southern section of the proposed development boundary is not at risk of flooding at the site (Appendix A). However, ~75m to the west part of the site is shown to be an area that is affected by the 0.1% AEP Flood Event (1 in 1000 year)). This is based on local modelling.

It should be noted that there is an inconsistency with the CFRAM mapping (E09BAL-EXFCD-F0-09 & E09CAM-DPFCD001-F0-15) which shows the western section of the site is located within the extents of a possible 0.1% AEP Flood Event. However, the above report is considered to be more accurate as both the modelled flows and hydrology flow has estimation has been compared.

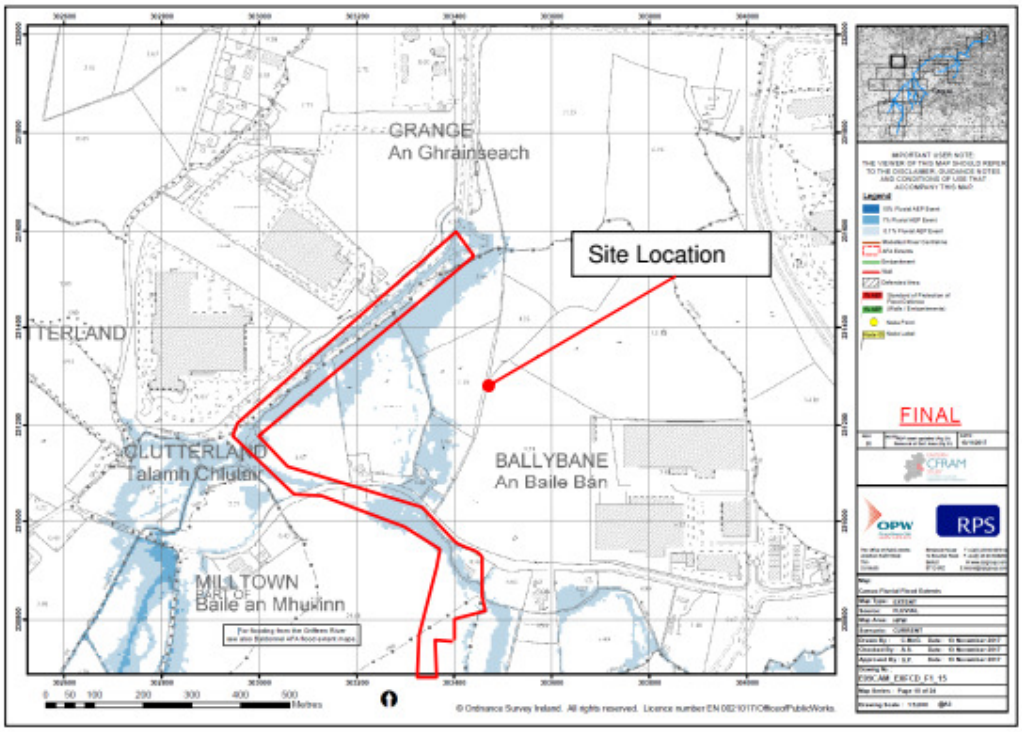


Figure 2.4 Flood extents map from CFRAM Study HA09 with site location indicated (OPW, 2017)

2.4 Existing Drainage

The proposed works are situated at a greenfield site and existing road wayleave within the larger Grange Castle business park. Stormwater drainage from Grange

Castle South Access Road currently discharges the existing SDCC stormwater system and subsequently into the Griffeen River.

The existing surface water drainage systems are laid out as required by the Greater Dublin Strategic Drainage Study (GDSGS) and associated Technical Guidance Document on Sustainable Drainage Systems (SuDS). Further detail of the existing surface drainage system is provided in the *Engineering Planning Report – Drainage and Water Services*, prepared by CSEA, which accompanies the planning application for the proposed development.

2.5 Existing Site Geology and Hydrogeology

The bedrock aquifer, according to the GSI: (www.gsi.ie/mapping) National Draft Bedrock Aquifer Map, is classified as a Locally Important Aquifer (Ll) i.e. *Bedrock which is Moderately Productive only in Local Zones*. According to the GSI, the aquifer is not considered to have any primary porosity and flow will be primarily fracture controlled.

The site is underlain by the Dublin Groundwater Body (EU code: IE_EA_G_008). This groundwater body (GWB) has been investigated by the GSI and is described as having a groundwater flow regime of PP i.e. poorly productive bedrock aquifer. The vulnerability status of this GWB, as with subsoil thickness, is highly variable at all scales according to the GSI. Presently, the GSI classifies the groundwater vulnerability at the site as Extreme. Based on the local site geology and clay subsoil thicknesses observed (<2 metres Clay) this appears to be appropriate.

3.0 DEVELOPMENT CHARACTERISTICS

The Proposed Development comprises new 110 kV Gas Insulated Switchgear (GIS) Substation (known as Clutterland), 4 no. transformer bays, Client Control Building, 49 kVa rural supply, associated compounds and site infrastructure to be located on lands at Grange Castle South Business Park, Baldonnel, Dublin 22, an underground single circuit 110 kV transmission line from the proposed Clutterland Substation to the existing 220 kV / 110 kV Castlebaggot Substation to the immediate south and an underground single circuit 110 kV transmission line from the proposed Clutterland Substation connecting to the existing 110 kV underground Kilmahud Corkagh circuit c. 900 m to the north-west.

The proposed development will be required to adhere to the Local Authority requirements as well as the requirements of the GDSGS and the SuDS Technical Guidance document.

New developments must ensure that a comprehensive sustainable urban drainage system, SuDS, is incorporated into the development. SuDS requires that post-development run-off rates be maintained at equivalent, or lower, levels than pre-development levels. Thus, the development must be able to retain, within its boundaries, surface water volumes from extreme rainfall events up to a 1 in 100-year rainfall event, more commonly expressed as a 1.0% AEP. Any new development must have the physical capacity to retain surface water volumes as directed under the GDSGS and, if necessary, release these attenuated surface water volumes to an outfall at a controlled flow rate. These requirements have been incorporated into the design of the development as set out in Section 3.1.

3.1 Specific SuDS Measures Proposed

In accordance with the Greater Dublin Strategic Drainage Study Regional Drainage Policy Volume 2 - New Development (GDSDS-RDP Volume 2), a sustainable urban drainage system has been incorporated into the design of the development. Specific design requirements for SuDS components are established by the Construction Industry Research and Information Association's publication CIRIA C697-SuDS Manual (C697).

The permitted drainage system formed part of the planning application for the permitted data storage facility on-site and is intended to service that development (SDCC Reg 20A/0121) and the Proposed Development. This SuDs was initially designed to accommodate surface water drainage from the Proposed Development. As such, there will be capacity for the SuDs for the permitted development to accommodate runoff from the Proposed Development. Further information of the surface and foul water drainage for the proposed development is included in the Engineering Planning Report (Engineering Planning Report – Drainage & Water Services Clutterland – 110 kV GIS Substation DUB 69) which is provided as a separate document to this application. The allowable discharge rate (QBAR) according to project Engineers. The allowable discharge rate (QBAR) applicable to the Proposed Development is 2.01 l/s.

4.0 FLOOD RISK IDENTIFICATION

4.1 Fluvial Flooding

A thorough review of historical records such as the OPW Flood maps and the GSI Subsoil maps was undertaken as part of this FRA process. The nearest potential source of fluvial flooding is the Griffeen River. However, the OPW flood maps do not indicate any historic flooding at the site or immediate vicinity of site that would indicate it is at risk of flooding.

The GSI Subsoil maps do not indicate the presence of alluvium near the proposed development. Alluvium could be indicative of historic flooding. The primary subsoil within the site is identified as glacial clays.

OPW CFRAM study HA09 indicates sections of the site are within Flood Zone B meaning there is between a 0.1% AEP or 1 in 1000 and 1% AEP or 1 in 100 chance of flooding in the area in any one year.

As part of the awarded application SD20A/0121 for the wider data centre site, RPS Engineers completed a flood study for the area. The results of the flood study indicated that the proposed development site is within 1% AEP floodplains. As a mitigation measure, it was recommended to incorporate compensatory flood storage within the proposed development site with a safe discharge route to the unnamed stream located along the northern boundary (RPS, 2019).

Further hydraulic modelling was carried out to including compensatory flood storage upstream of the proposed development site. A storage volume of approximately 2,680 m^3 over an area of 5,500 m^2 storage resulted in a maximum decrease of 4 mm in peak 0.1% AEP water levels within the Baldonnell Stream downstream of the proposed flood compensatory storage area. The potential for further reduction was severely limited by the surcharging condition of the New Nangor Road Culverts. Therefore, additional compensatory flood storage was provided in the design of the wider data centre site within which the substation is located (RPS, 2020). Sections of the proposed transmission line route running to the north are within Flood Zone B

outside the permitted data centre site area. Due to this, a justification test has been included in section 4.5 as per the FRM Guidelines.

4.2 Pluvial Flooding

Pluvial flooding is usually caused by intense rainfall that may only last a few hours. The resulting water follows natural valley lines, creating flow paths along roads and through and around developments and ponding in low spots, which often coincide with fluvial floodplains in low lying areas. Any areas at risk from fluvial flooding will almost certainly be at risk from pluvial flooding.

The OPW CFRAM maps do not indicate pluvial flooding at or near the site. Localised events are highlighted in the surrounding areas. The proposed development is to be constructed with suitable drainage infrastructure and therefore in the event of pluvial flooding in this area, it would not have any significant adverse impact on the site.

4.3 Groundwater Flooding

Groundwater flooding can be due to high water tables and increased recharge following extended periods of wet weather. Groundwater flooding typically occurs in areas underlain by karst limestone and where underlying geology is highly permeable with high capacity to receive and store rainfall. Groundwater flooding is more common in the west of Ireland.

CFRAM maps do not indicate the occurrence of groundwater flooding at or near the site.

4.4 Overview of Flood Risk Identification

Historic flood maps do not indicate a history of flooding of the site from the Griffeen River. This is confirmed by the OPW CFRAM Study HA09 which indicate that the site is located within Flood Zone B.

Pluvial flood maps produced as part of the OPW CFRAM flood maps indicate that the site is not at risk from pluvial flooding. No pluvial flood zones are identified at the site; however, areas of localised pluvial flooding have been identified in the surrounding area. Though due to existing drainage infrastructure in place, it is not anticipated that pluvial flooding would have a significant impact on the site.

The groundwater underneath the site is located within a *Locally Important Aquifer (LI) –Bedrock which is Generally Moderately Productive only in Local Zones*. The vulnerability of the aquifer is extreme. However, based on a review of available records there is no evidence of groundwater flooding at or near the site.

4.5 Justification Test

The OPW Guidelines acknowledges that there is a need for a justification test for development with established urban centres, which will continue to be at risk of flooding. In order to rigorously assess the appropriateness of such developments, Section 5 of the OPW Guidelines outlines the criteria for justification tests for development management in areas at high or moderate risk of flooding that include types of development that are vulnerable to flooding.

As noted in Section 4.1, a portion of the proposed scheme is located within Flood Zone B specifically the transmission line route to the north. As noted in Section 1.2

the scheme is classified as highly vulnerable (*Essential Infrastructure such as….utilities distribution, including electricity-generating power stations and substations*). Accordingly, the Justification Test for Development Management has been carried out and the assessment is outlined in Table 4.1.

Table 4.1 Justification Test Criteria Assessment

Ref	Criteria	Assessment
1	The subject lands have been zoned or otherwise designated for the particular use or form of development in an operative development plan, which has been adopted or varied taking account of these Guidelines.	As per the South Dublin County Council Development Plan, the site area is zoned as EE – To provide for enterprise and employment-related uses
2	The proposal has been subject to an appropriate flood risk assessment that demonstrates:	
2 (i)	The development proposed will not increase flood risk elsewhere and, if practicable, will reduce overall flood risk.	The proposed scheme will not increase flood risk elsewhere. The excavations for the gridlines to the north will be withing current wayleaves and will be reinstated to current following development. There will be no additional hardstand as part of the trenching and installation of ducting Surface water discharge from the substation site will be limited to Qbar or 2.01 l/s/ha whichever is greatest as requested by South Dublin County Council. Planning permission has been granted for the data centre development (SDCC Reg. 20A/0121) which showed through significant hydraulic modelling by RPS Engineers that due to compensatory storage being provided onsite the risk of flooding elsewhere is negligible.
2 (ii)	The development proposal includes measures to minimise flood risk to people, property, the economy and the environment as far as reasonably possible	SuDs measures will be employed onsite to control and reduce outflow to surface water drainage including the measured in permitted development SDCC Reg. 20A/0121. Rainwater runoff from the substation roof and yard will be collected in stormwater drainage channels and diverted to a large stormwater attenuation basin (sized for a 1 in 100-year rainfall event As the transmission lines to the north will be reinstated to present levels and will not include additional hardstanding.
2 (iii)	The development proposed includes measures to ensure that residual risks to the area and/or development can be managed to an acceptable level as regards the adequacy of existing flood protection measures or the design, implementation and funding of any future flood risk management measures and provisions for emergency services access	There have been no recorded incidences of flooding on the proposed site. As stated, a post-development flood model has shown that the river flows will not increase downstream (RPS, 2020) There will be no impacts from the proposed development to adjacent lands due to best design practice. In an emergency scenario access for workers, visitors and

		emergency vehicles would be from the east (the R134 onto the New Nangor Road) which as per OPW CFRAM mapping is not at risk from flooding and is also protected via compensatory storage as part of the permitted development SDCC Reg. 20A/0121.
2 (iv)	The development proposed addresses the above in a manner that is also compatible with the achievement of wider planning objectives in relation to development of good urban design and vibrant and active streetscapes.	The proposed development has been designed using best practice techniques and will be similar to other such developments in the area.

Based on the above assessment the proposed scheme satisfies the Justification Test criteria for Development Management.

5.0 CONCLUSIONS

This report sets out the Flood Risk Assessment Stage 2 desktop assessment of the application site, in accordance with the FRM Guidelines. The assessment is based on the best data available in the public domain at the time of writing.

The sequential approach, as outlined in the FRM Guidelines, was followed. As the proposed development is located in an area at risk from flooding (0.1% - 1% AEP Event) and adhering to the first stage of the sequential approach, a Stage 2 assessment was undertaken with a requirement for a justification test.

Part of the proposed development resides within Flood Zone B and is not at risk of flooding from a 10% event. As drainage is designed to adhere to the Local Authority requirements, the Greater Dublin Strategic Drainage Study and has incorporated SuDS measures, it is not expected that the proposed development would adversely impact on flood risk for other neighbouring properties. Under the sequential approach and within section 3.5 under the FRM guidelines (2009) any building that is used for "*Essential Infrastructure such as….utilities distribution, including electricity generating power stations and substations*" is deemed "Highly Vulnerable Development" (see Table 1.1). Part of the Proposed Development resides in **Flood Zone B** (based OPW Eastern CFRAM Mapping). Therefore, a justification test was required. Based on the assessment the proposed scheme satisfies the Justification Test criteria for Development Management.

REFERENCES

1. Base maps – Ordnance Survey of Ireland
2. CS Consulting Group (2020) Site Specific Flood Risk Assessment Proposed Data Centres Grange Castle Business park South, Baldonnel, Dublin 22. Job No A093 May 2020
3. Department of the Environment, Heritage and Local Government, *The Planning System and Flood Risk Management - Guidelines for Planning Authorities* (2009)
4. EPA, Hydrology Data, www.epa.ie
5. Eastern (Catchment Flood Risk Assessment & Management Study
6. Flood Hazard Maps and flooding information for Ireland, www.floodmaps.ie Office of Public Works (OPW)
7. GSI, Online mapping, www.gsi.ie
8. Project Ireland 2040 The National Planning Framework (2018); Department of Housing Planning and Local Government
9. RPS (2020) Grangecastle Flood Study Additional Hydraulic Modelling Report – MDW0856 Grange castle Flood Study Additional Modelling A01 07th February 2020

APPENDIX A

Eastern CFAM Study HA09 Hydraulics Report

Baldonnel Model

Eastern CFRAM Study

HA09 Hydraulics Report

Baldonnel Model

DOCUMENT CONTROL SHEET

Client	OPW
Project Title	Eastern CFRAM Study
Document Title	IBE0600Rp0027_HA09 Hydraulics Report
Model Name	Baldonnel

Rev.	Status	Author(s)	Modeller	Reviewed by	Approved By	Office of Origin	Issue Date
D01	Draft	K. Smart	D. Irwin	S. Patterson	M. Brian	Belfast	08/01/2014
D02	Draft	T. Carberry	D. Irwin	S. Patterson	G. Glasgow	Belfast	26/06/2014
F01	Draft Final	T. Carberry	D. Irwin	S. Patterson	G. Glasgow	Belfast	21/01/2015
F02	Draft Final	T. Carberry	D. Irwin	S. Patterson	G. Glasgow	Belfast	13/08/2015
F03	Draft Final	T. Carberry	D. Irwin	S. Patterson	G. Glasgow	Belfast	05/08/2016

Table of Reference Reports

Report	Issue Date	Report Reference	Relevant Section
Eastern CFRAM Study Flood Risk Review	December 2011	IBE0600Rp0001_Flood Risk Review_F02	3.9.2, 3.9.5
Eastern CFRAM Study Inception Report UoM09	August 2012	IBE0600Rp0008_HA09 Inception Report_F02	4.3.2
Eastern CFRAM Study Hydrology Report UoM09	September 2013	IBE0600Rp0016_HA09_Hydrology Report_F01	4.13
Eastern CFRAM Study HA09 Liffey Survey Contract Report	November 2012	2001s4884- SC2 Survey Report v1	1.2
Eastern CFRAM Study Overarching Report on the October 2011 Flood Event	May 2013	IBE0600Rp0014_F02	2.2, 4.2

4 HYDRAULIC MODEL DETAILS

4.1 BALDONNEL MODEL

4.1.1 General Hydraulic Model Information

(1) Introduction:

The Eastern CFRAM Flood Risk Review (IBE0600 Rp0001_Flood Risk Review_F02) highlighted Baldonnel as an Area for Further Assessment for fluvial flooding based on a review of historic flooding and the extents of flood risk determined during the PFRA.

The Baldonnel model represents the upper and middle reaches of the Griffeen River, a tributary of the River Liffey, including all the smaller tributaries of the Griffeen which affect the Baldonnel AFA including the Carrigeen and the Baldonnel watercourses which neighbour the Camac catchment to the east. The Griffeen joins the Liffey approximately 8km to the north of Baldonnel. The catchment of the model is relatively small (30 km^2) and is partially urbanised (16%).

Although there are no gauging stations on the Griffeen River within the Baldonnel model extents, the Lucan gauging station (09002 – EPA) is just downstream on the lower reaches of the Griffeen at a location just upstream of the confluence with the main Liffey channel. This gauging station represents a contributing catchment area of approximately 36 km^2. The station was given a classification of A1 under FSU and as such there can be considered to be a high degree of confidence in the flow at Q_{med}. The gauging station also has over 20 years of continuous flow data. As this station is not within the model extents it was not suitable for model calibration, however data from this gauge was used when calculating design flows and estimating return periods of historical flood events.

All of the watercourses within this model have been designated as HPW, and have been modelled as 1D-2D using the MIKE suite of software. Channel markers have been located at the right and left banks of all cross sections. Flow within these markers is calculated by the 1D model component; however when the water level rises sufficiently to meet the bank markers flow can enter the 2D domain which represents the floodplain.

(2) Model Reference:	HA09_BALD2A
(3) AFAs included in the model:	Baldonnel

(4) Primary Watercourses / Water Bodies (including local names):

Reach ID	**Name**
09GRIF	GRIFFEEN RIVER
09CARK	CORNERPARK
09BALD	BALDONNEL WATERCOURSE
09CARR	CARRIGEEN

(5) Software Type (and version):		
(a) 1D Domain: MIKE 11 (2011)	**(b) 2D Domain:** MIKE 21 - Rectangular Mesh (2011)	**(c) Other model elements:** MIKE FLOOD (2011)

4.1.2 Hydraulic Model Schematisation

(1) Map of Model Extents:

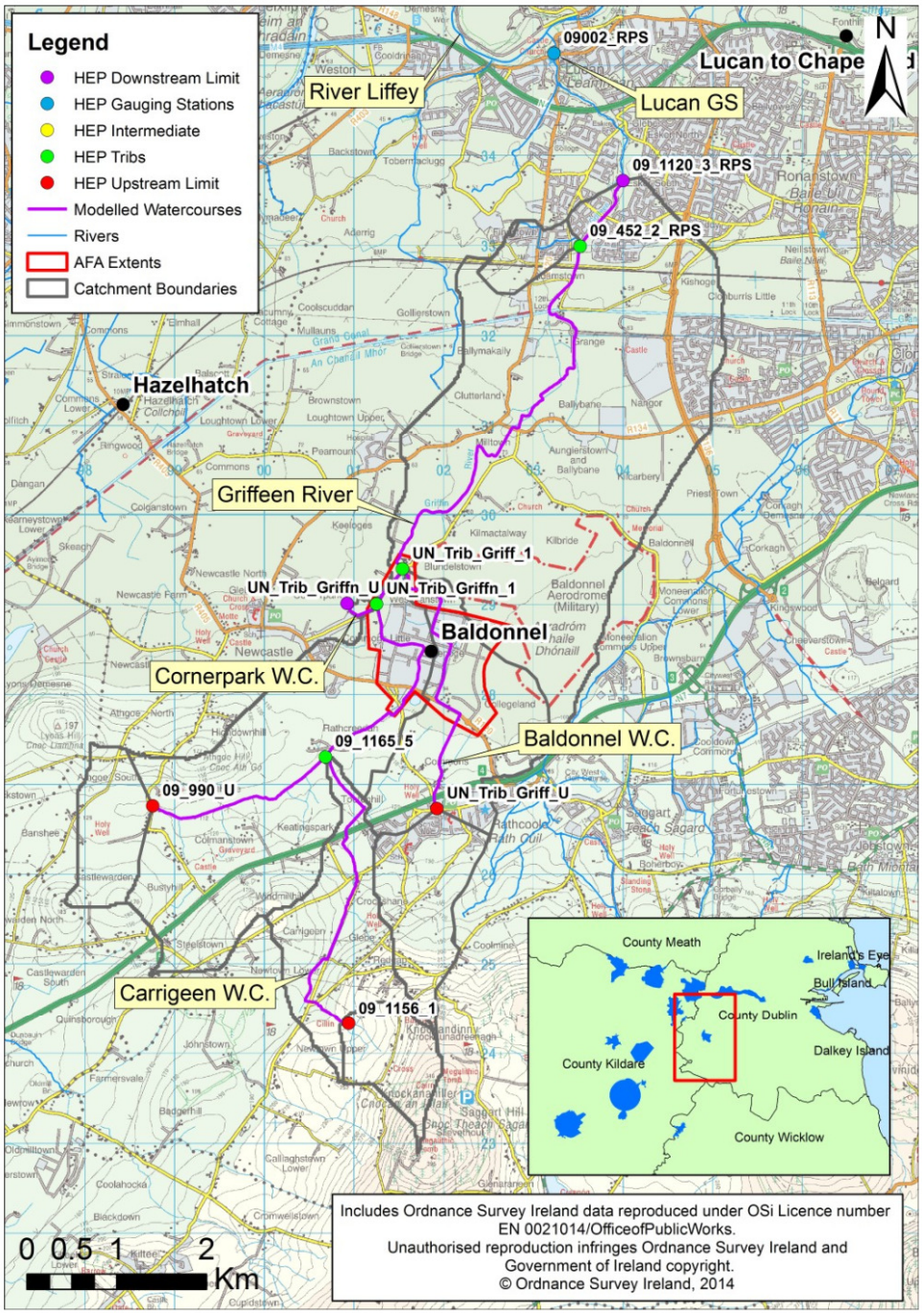


Figure 4.1.1: Baldonnel Model Overview

Figure 4.1.2: Baldonnel AFA Extent

Figure 4.1.1 and Figure 4.1.2 illustrate the extent of the modelled catchment, river centre line, HEP locations and AFA extents as applicable. The catchment contains 3 Upstream Limit HEPs, 2 Downstream Limit HEPs and 4 Trib HEPs. The catchment does not contain any Gauging Station or Intermediate HEPs.

(2) x-y Coordinates of River (Upstream extent):

Table 4.1.1: x-y Coordinates of River

River Name		x	y
09GRIF	GRIFFEEN RIVER	298753	226761
09CARK	CORNERPARK	301248	229006.5
09BALD	BALDONNEL WATERCOURSE	301919	226730
09CARR	CARRIGEEN	300939.5	224332.5

(3) Total Modelled Watercourse Length:		19.2 km (approx.)	
(4) 1D Domain only Watercourse Length:	0 km	**(5) 1D-2D Domain Watercourse Length:**	19.2 km (approx.)
(6) 2D Domain Mesh Type / Resolution / Area:		Rectangular / 5 metres / 67 km^2	
(7) 2D Domain Model Extent:			

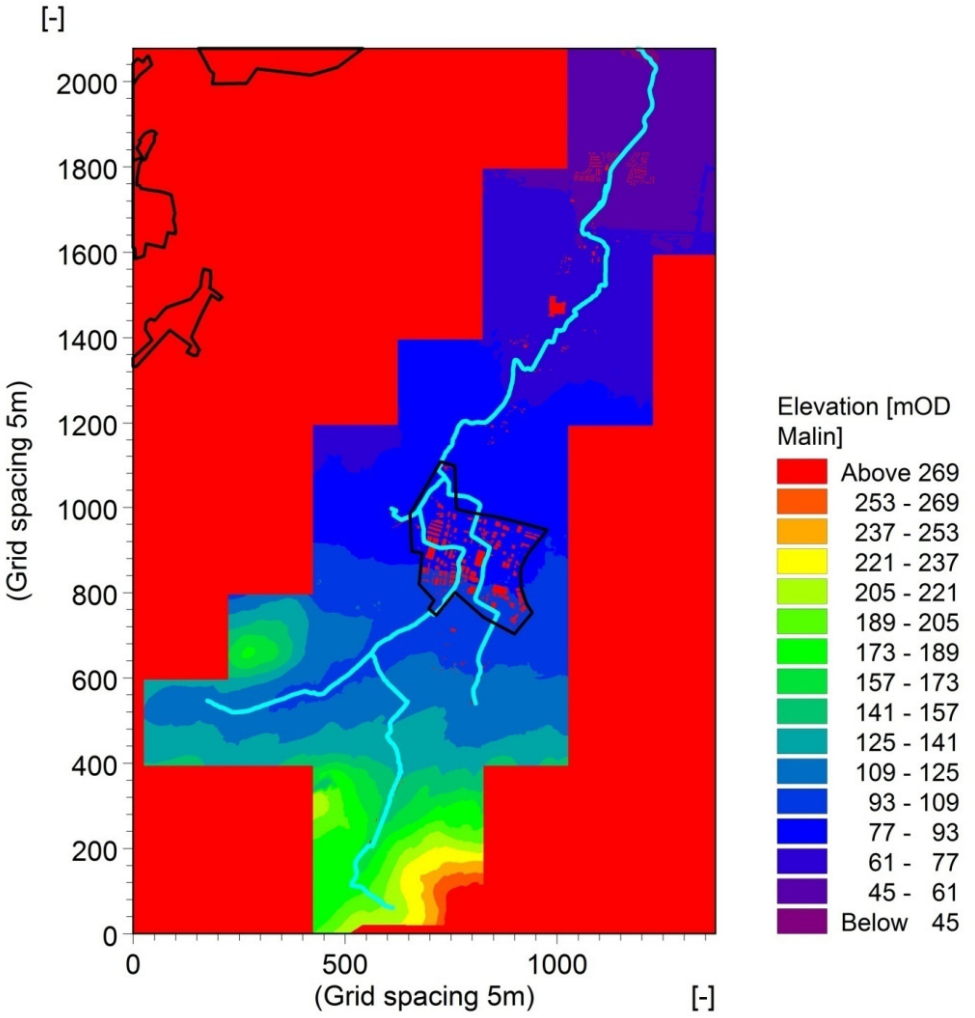


Figure 4.1.3: 2D Domain Overview

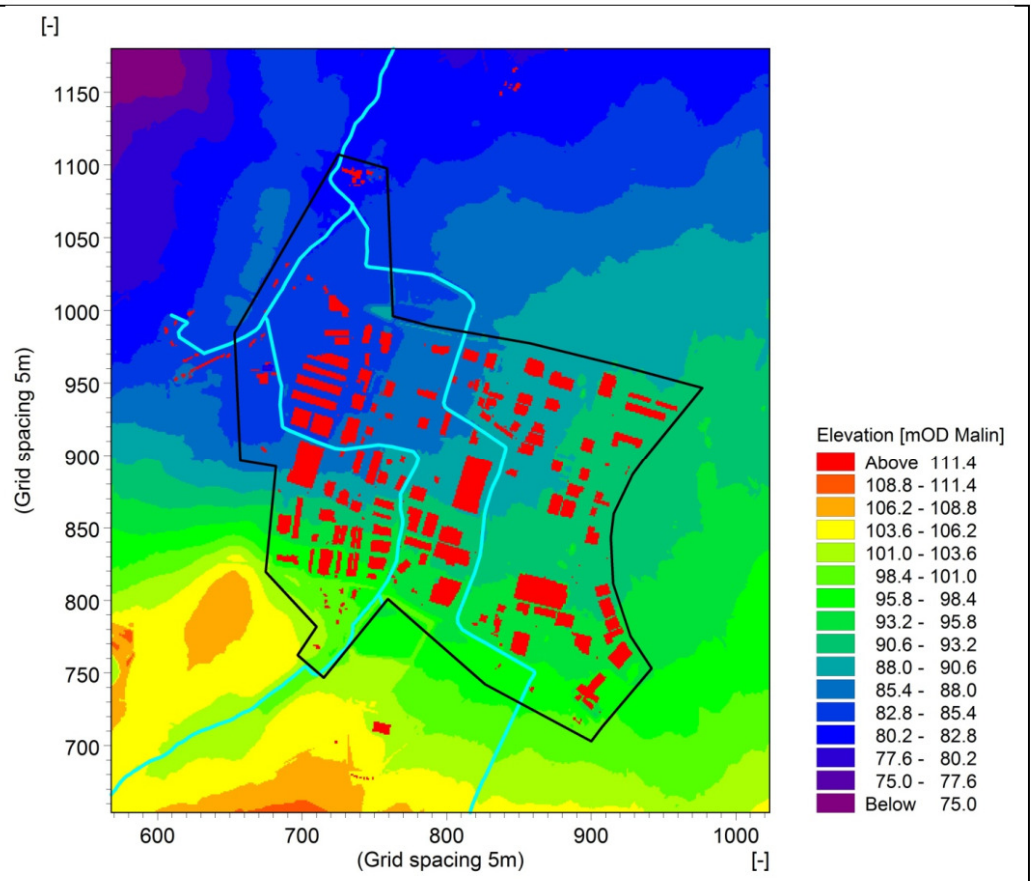


Figure 4.1.4: 2D Domain AFA Extent

Figure 4.1.3 and Figure 4.1.4 illustrate the modelled extents and the general topography of the catchment. The spatial extent of the AFA boundaries is outlined in black. The reach centre-lines are presented in light-blue which also represents the 1D modelled extent that is within the 2D area. Buildings are excluded from the mesh and therefore represented as red. Refer to Chapter 3 for details on representation of buildings in the model.

Figure 4.1.5 shows an overview drawing of the model schematisation. Figure 4.1.6 to Figure 4.1.9 show detailed views. The overview diagram covers the model extents, showing the surveyed cross-section locations, AFA boundary and river centre line. It also shows the area covered by the 2D model domain. The detailed areas are provided where there is the most significant risk of flooding. These diagrams include the surveyed cross-section locations, AFA boundary and river centre. They also show the location of the critical structures as discussed in Section 4.1.3(1), along with the location and extent of the links between the 1D and 2D models. For clarity in viewing cross-section locations, the detailed diagram shows the full extent of the surveyed cross-sections. Note that the 1D model considers only the cross-section between the 1D-2D links.

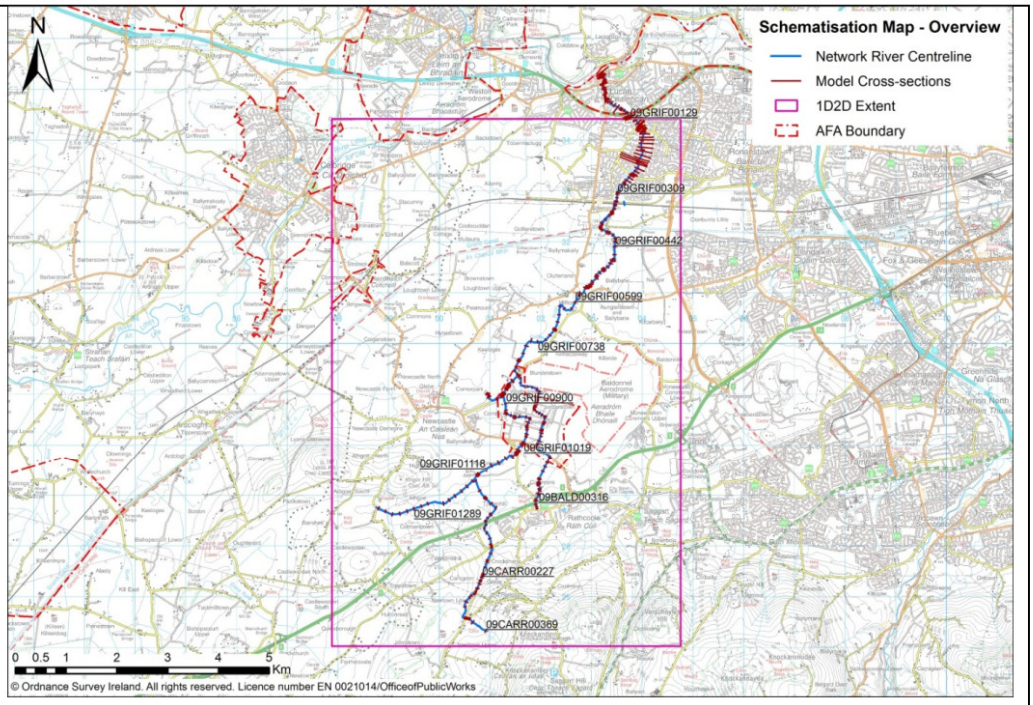


Figure 4.1.5: Model Schematisation Overview

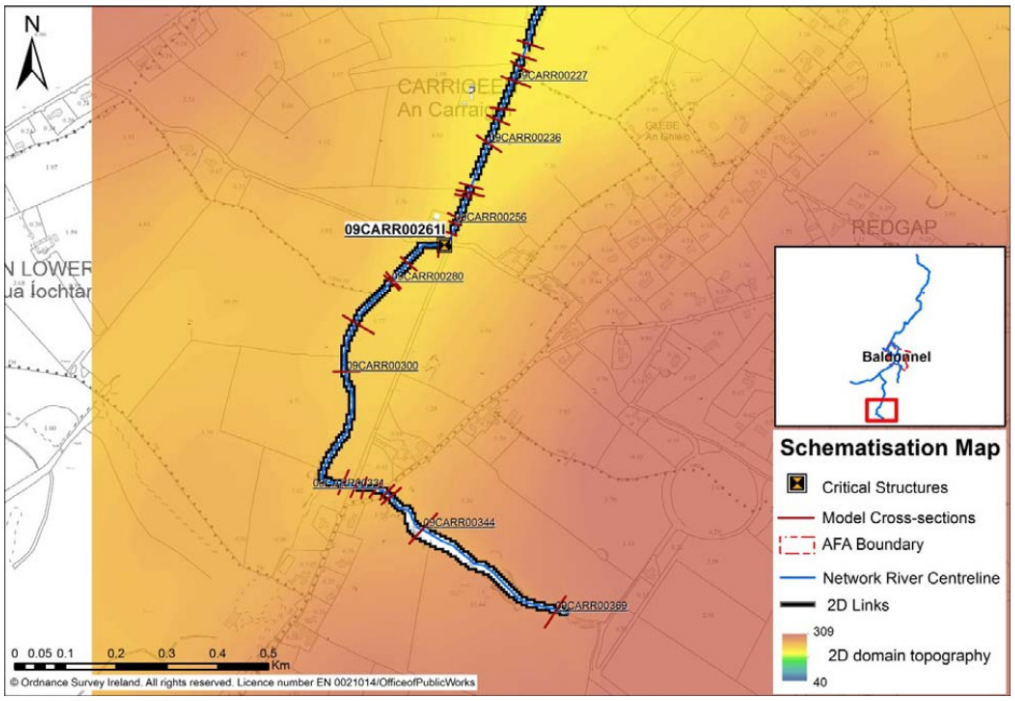


Figure 4.1.6: Detailed Area of Model Schematisation showing Critical Structures

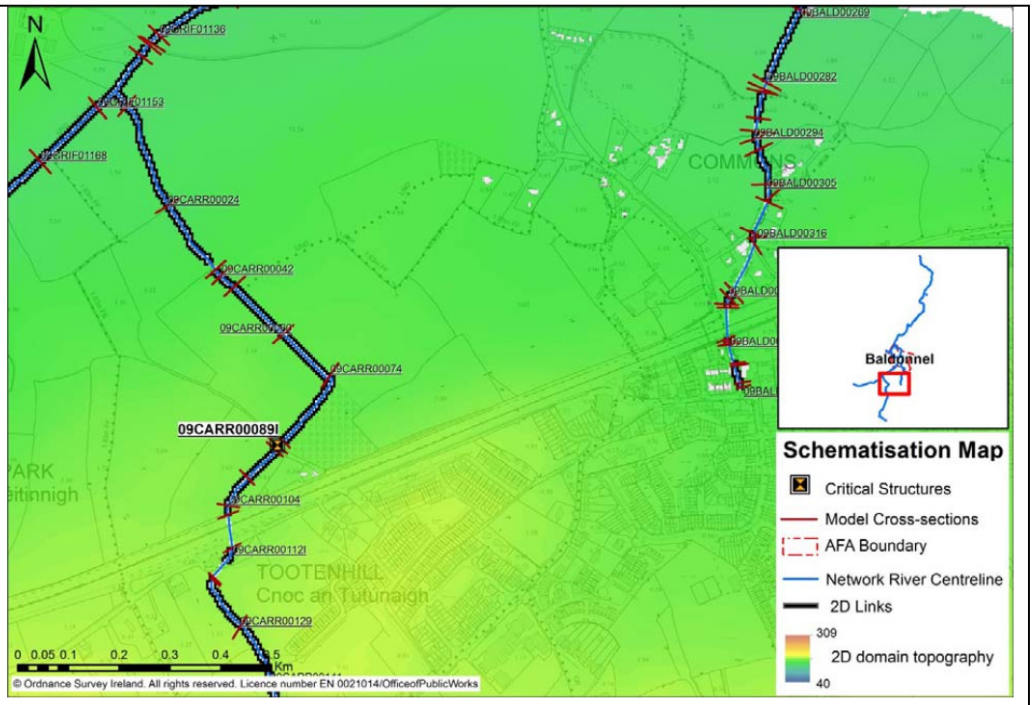


Figure 4.1.7: Detailed Area of Model Schematisation showing Critical Structures

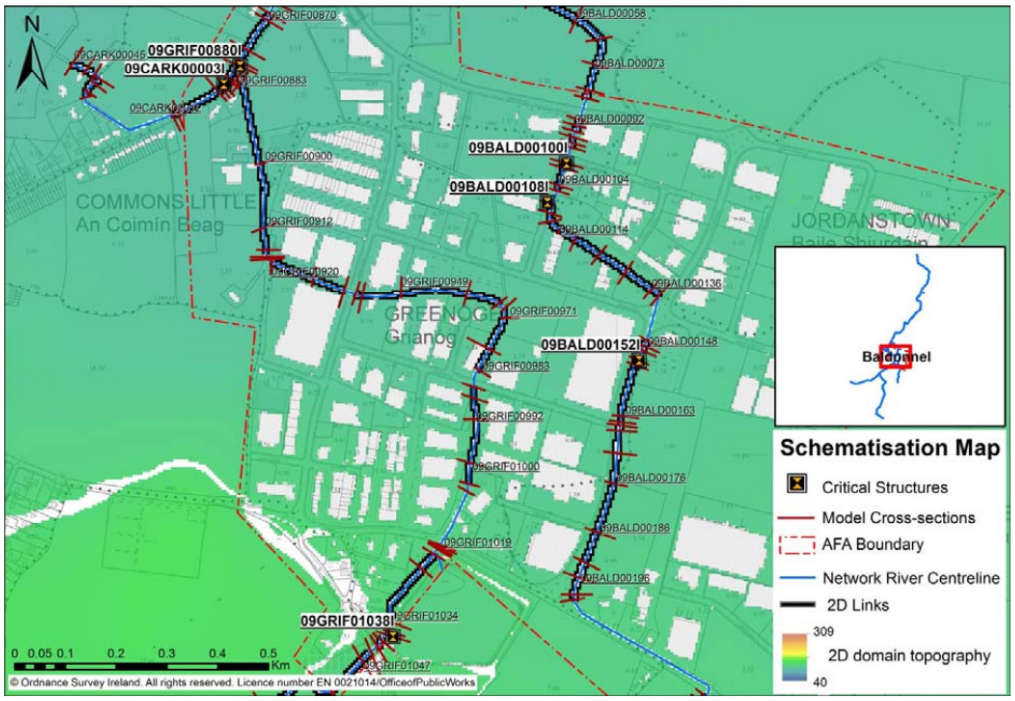


Figure 4.1.8: Detailed Area of Model Schematisation showing Critical Structures

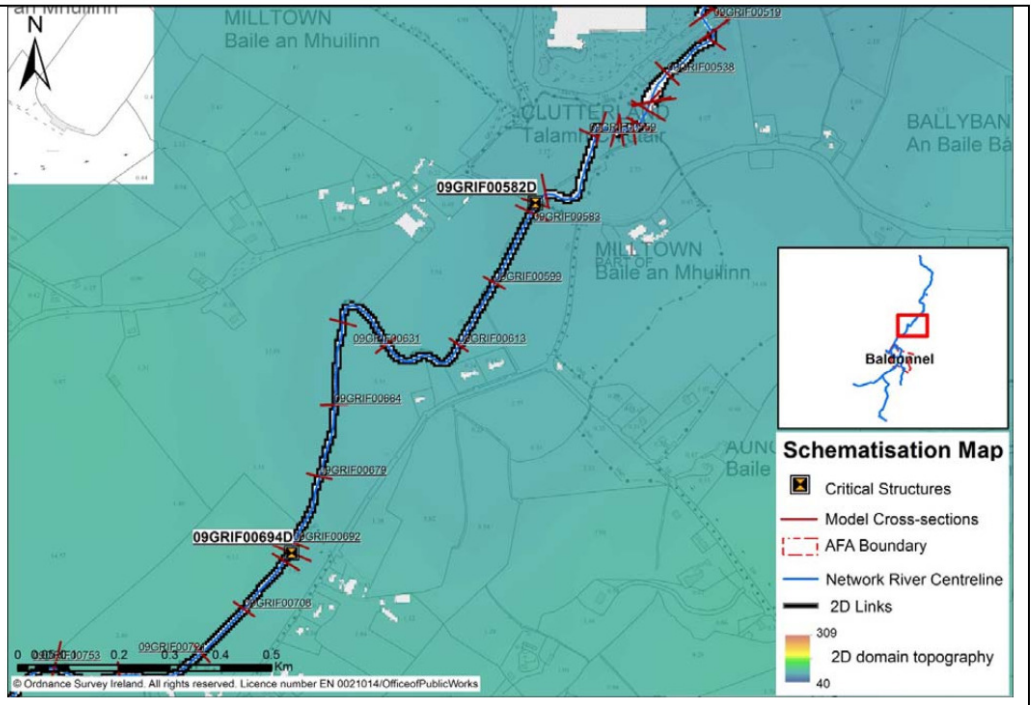


Figure 4.1.9: Detailed Area of Model Schematisation showing Critical Structures

(8) Survey Information

(a) Survey Folder Structure:

First Level Folder	Second Level Folder	Third Level Folder
Murphy_E09_M02A_WP5_120830_09GRIF_E Where: Murphy - Surveyor Name E09 - Eastern CFRAM Study Area, Hydrometric Area 09 M02A - Model Number 02A WP5 - Work Package 5 120830 - Date issued (30 August 2012) 1028M - River Reference	GIS and Floodplain Photos	Flood Defence Register
		Floodplain Photos and Shapefiles
		Structure Register
		Surveyed Cross Section Lines
	Videos	
	Ascii	
	Photos *(Naming convention is in the format of Cross-Section ID and orientation - upstream, downstream, left bank or right bank)*	

(b) Survey Folder References:

Reach ID	Name	File Ref.
09GRIF	GRIFFEEN RIVER	Murphy_E09_WP1_M02B_130516_09GRIF_A Murphy_E09_M02A_WP5_120801_09GRIF_B Murphy_E09_M02A_WP5_120801_09GRIF_C Murphy_E09_M02A_WP5_120801_09GRIF_D Murphy_E09_M02A_WP5_130502_09GRIF_E
09CARK	CORNERPARK	Murphy_E09_M02A_WP5_120801_09CARK
09BALD	BALDONNEL WATERCOURSE	Murphy_E09_M02A_WP5_120801_09BALD
09CARR	CARRIGEEN	Murphy_E09_M02A_WP5_120801_09CARR
09FINN	FINNSTOWN	Murphy_E09_M02A_WP5_120801_09FINN
	Additional information	Baldonnell_culverts_QUERY_130813

(9) Survey Issues:

The Griffeen River splits into two parallel channels in between surveyed sections 09GRIF00383 and 09GRIF00316 (chainage 9848 - 10514). There are two structures on the Griffeen River on this section of watercourse, 09GRIF00349D at chainage 10194 and 09GRIF00330I at chainage 10404, as shown in Figure 4.1.10. Only the structure detail for the right-hand channel was surveyed originally, so a survey query was requested to capture the detail of these structures at the left-hand channel. This information was received on 13/08/2013 and included in the hydraulic model. Upon delivery of this updated data it became apparent that there are actually 3 openings at structure 09GRIF00349D, all of which were included.

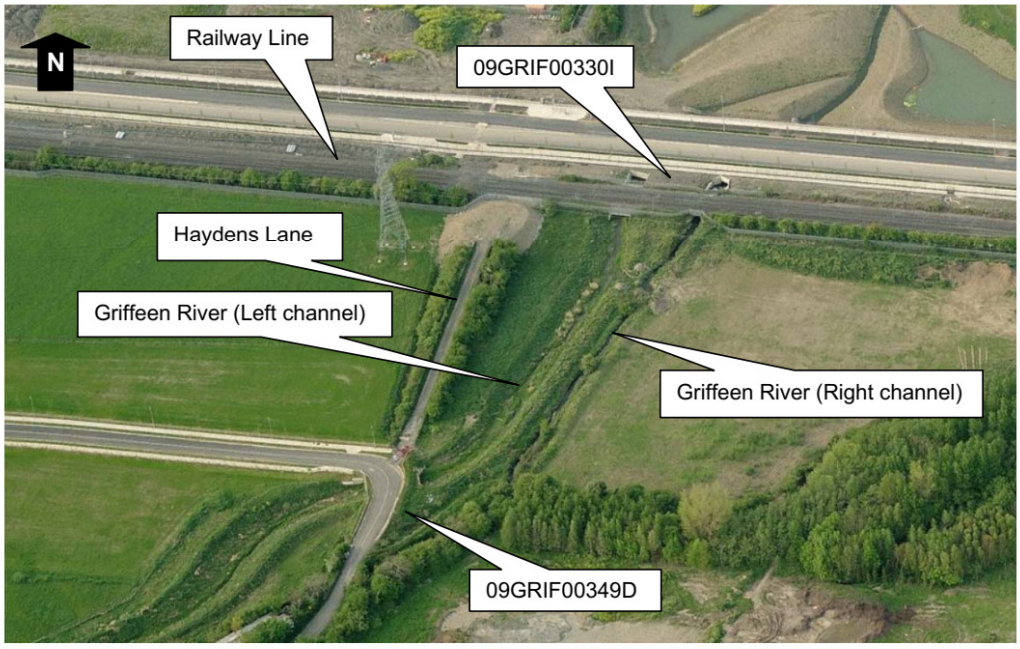


Figure 4.1.10: Culverts which required additional survey

It also became apparent that there is one additional culvert structure under the railway line close to Haydens Lane, approximately 180m East of the Griffeen channel. Historical reports also suggested an underpass existed directly beside Haydens Lane. A survey query was therefore requested to obtain details of any culverts which may enable floodplain flow to pass under the railway, and to check if the underpass beside Haydens Lane still exists. Survey data for the culvert approximately 180m East of the Griffeen channel was received on 13/08/2013 and included in the model. Confirmation was also received that no other culverts or bypasses under the railway line are present.

An error was present in the original survey deliverables for section 09GRIF00259W as the levels shown in the cross-section drawing did not correspond with the levels in the weir long section detail. A survey query was submitted requesting this section to be re-surveyed. Updated data for this structure was received on 16/05/2013 and included in the model.

The 2D domain was derived using 5m resolution LiDAR data as described in section 2.2.2. The topographic data for the Northern corner of the attenuation pond was lowered based on drawings received from SDCC as it was assumed the LiDAR picked up water as opposed to the bed. Levels at the entrance and exit of culverts modelled in the 2D domain were also edited to equal the invert levels received in additional survey data of these structures. No other post-processing of the LiDAR data was carried out.

4.1.3 Hydraulic Model Construction

(1) 1D Structures (in-channel along modelled watercourses):	See Appendix A.1 Number of Bridges and Culverts: 82 Number of Weirs: 21

The survey information recorded includes a photograph of each structure, which has been used to determine the Manning's n value. Further details are included in Chapter 3.5.1. A discussion on the way structures have been modelled is included in Chapter 3.3.4.

There is a sluice gate immediately upstream of culvert 09GRIF01038I (Figure 4.1.11) on the Griffeen River adjacent to the attenuation pond. This structure restricts flow on the Griffeen River, causing flow to enter the attenuation pond by backing up and spilling over the right bank of the Griffeen River immediately upstream of the culvert. Please refer to Section 4.1.5(2) for an update to the model following informal public consultation and formal S.I. public consultation periods in 2015. Refer to Section 4.1.6(1) for modelling assumptions regarding this sluice gate and the attenuation pond.

Figure 4.1.11: Culvert 09GRIF01038I

Flooding occurs at the confluence of the Griffeen River with the Cornerpark watercourse during design runs of 1% AEP or greater due to insufficient capacity in culverts 09GRIF00880I and 09CARK00003I (Figure 4.1.12). Flooding at this confluence was found to affect up to approximately 10 properties and the Aylmer Road.

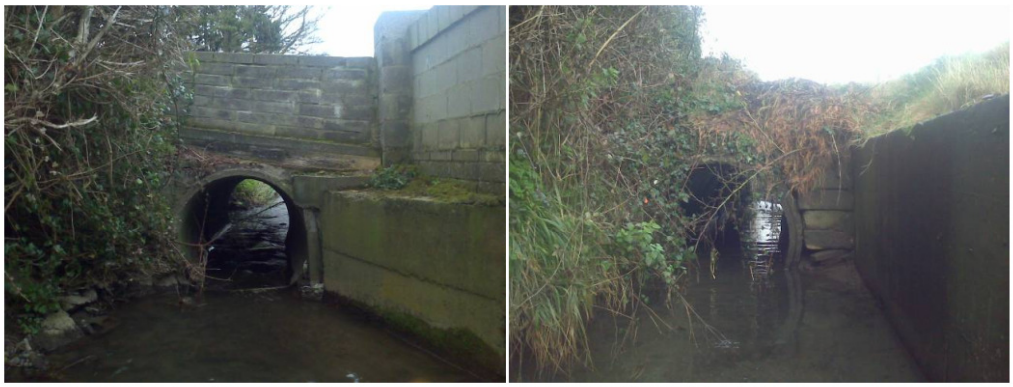


Figure 4.1.12: Culvert 09GRIF00880I (left) and culvert 09CARK00003I (right)

Flooding was found to occur of the Griffeen River during design runs of 10% AEP or greater due to insufficient capacity in bridge 09GRIF00694D and design runs of 1% AEP or greater due to bridge 09GRIF00582D (Figure 4.1.13). Two roads including the R134 New Nangor Road, up to approximately 5 properties and agricultural land was found to be affected by this flooding.

Figure 4.1.13: Bridge 09GRIF00694D (left) and bridge 09GRIF00582D (right)

Culvert 09CARR00261I (Figure 4.1.14) on the Carrigeen watercourse was found to restrict flow and cause flooding during design runs of 10% AEP or greater. Flooding from this culvert was found to affect local roads, up to 2 properties and agricultural land.

Figure 4.1.14: Culvert 09CARR00261I

Culvert 09CARR00089I (Figure 4.1.15) on the Carrigeen watercourse was found to restrict flow during design runs of 10% AEP or greater. Out-of-bank flooding occurs from the left bank during design runs of 10% AEP, and from both banks during design runs of 1% AEP or greater. Flooding from the right bank was found to affect 3 roads including the R120, up to approximately 3 properties and agricultural land before flowing into the Baldonnel Watercourse.

Figure 4.1.15: Culvert 09CARR00089I

Culverts 09BALD00152I, 09BALD00108I and 09BALD00100I (Figure 4.1.16) on the Baldonnel watercourse restrict flow during design runs of 1% AEP or greater, resulting in widespread flooding of Greenogue Business Park. Up to approximately 30 properties, numerous roads and a sports ground were found to be affected by flooding due to these culverts.

Figure 4.1.16: Culvert 09BALD00152I (top left), culvert 09BALD00108I (top right) and culvert 09BALD00100I (bottom)

(2) 1D Structures in the 2D domain (beyond the modelled watercourses):	3 culverts in the 2D domain were modelled as 1D structures. These were included as additional branches in the MIKE 11 Network file: 'Culvert 1' represents the central opening of bridge 09GRIF00349D under Haydens Lane, as shown in Figure 4.1.17. The downstream end of this culvert connects back to the main Griffeen River. 'Culvert 2' represents the off-line culvert under the road and railway near Adamstown, as shown in Figure 4.1.17. 'Pond Outlet' represents the outlet pipe linking the attenuation pond upstream of Greenogue Business Park back into the Griffeen River, as shown in Figure 4.1.18.

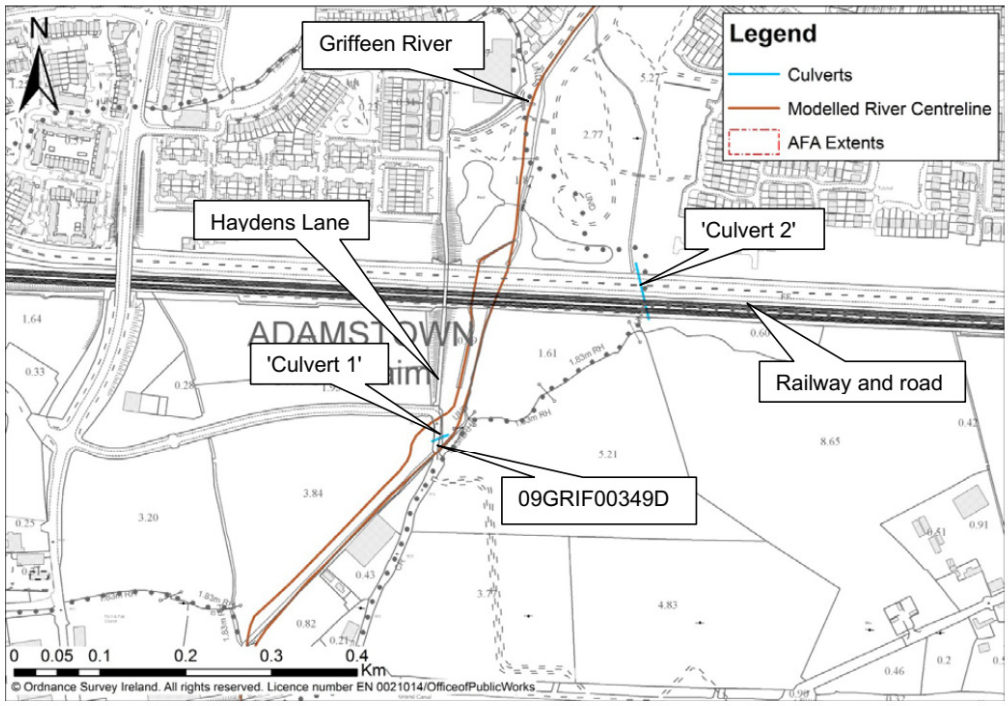


Figure 4.1.17: Location of 'Culvert 1' and 'Culvert 2'

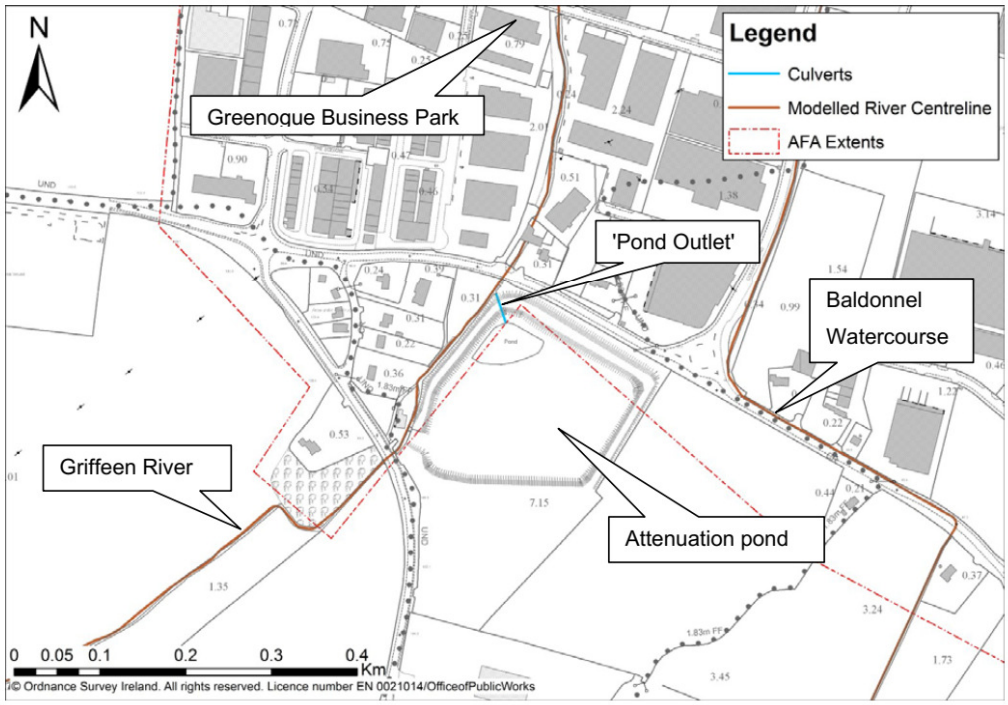


Figure 4.1.18: Location of 'Pond Outlet'

(3) 2D Model structures:	The attenuation pond upstream of Greenogue Business park, as shown in Figure 4.1.18, is modelled within the 2D domain. Flow from the Griffeen River spills into the attenuation pond upstream of culvert 09GRIF01038I over a low right bank. Flow exits the attenuation pond and rejoins the Griffeen River through a 225mm diameter outlet pipe at the North of the pond. The ground elevation of the pond was determined using 5m resolution LiDAR data, enabling this structure to be included in the 2D model grid. The typical ground elevation of the pond varies between approximately 95.5 - 96.5mOD Malin, and the typical embankment elevation around the pond is approximately 100mOD Malin. The area of the pond is approximately 40000m^2. Bed elevations in the North corner were adjusted as detailed in Section 4.1.2(9) due to the LiDAR data containing details of water rather than true bed levels. It was assumed that the pond was empty at the start of all model design runs, as discussed in Section 4.1.6(1).
(4) Defences:	
No formal defences	
(5) Model Boundaries - Inflows:	
Full details of the flow estimates are provided in the Hydrology Report (IBE0600Rp0016_HA09 Hydrology Report_F01 - Section 4.13 and Appendix D). The boundary conditions implemented in the model are shown below:	

Table 4.1.2: Model Boundary Conditions for 0.1% AEP design run

	Boundary Description	Boundary Type	Branch Name	Chainage	Chainage	Gate ID	Boundary ID
1	Open	Inflow	GRIFFEEN RIVER	0	0		09_990_U
2	Open	Inflow	CARRIGEEN	0	0		09_1156_1
3	Open	Inflow	BALDONNEL WATERCOURSE	0	0		UN_Trib_Griff_U
4	Open	Q-h	CORNERPARK	477.719	0		UN_Trib_Griffn_U
5	Open	Q-h	GRIFFEEN RIVER	13625.05	0		09002_RPS
6	Distributed Source	Inflow	CARRIGEEN	0	3821		Top-up between 09_1156_1 & 09_1165_5
7	Distributed Source	Inflow	BALDONNEL WATERCOURSE	0	3342		Top-up between 09_Trib_Griff_U & 09_Trib_Griff_1
8	Distributed Source	Inflow	GRIFFEEN RIVER	0	5858.998		Top-up between 09_990_U & 09_1120_3_RPS_SPLIT_A
9	Point Source	Inflow	GRIFFEEN RIVER	10622.052	0		09_452_2_RPS
10	Open	Water Level	Pond Outlet	0	0		Dummy WL
11	Open	Water Level	Culvert 1	0	0		Dummy WL
12	Open	Water Level	Culvert 2	0	0		Dummy WL
13	Open	Water Level	Culvert 2	66.7	0		Dummy WL
14	Distributed Source	Inflow	GRIFFEEN RIVER	5858.998	11523		Top-up between 09_990_U & 09_1120_3_RPS_SPLIT_B
15	Point Source	Inflow	BALDONNEL WATERCOURSE	2078.052	0		Camac cross-catchment Baldonnel watercourse
16	Distributed Source	Inflow	GRIFFEEN RIVER	6300.136	7543.696		Camac cross-catchment Griffeen_1
17	Distributed Source	Inflow	GRIFFEEN RIVER	7684.621	8410.913		Camac cross-catchment Griffeen_2
18	Distributed Source	Inflow	GRIFFEEN RIVER	8491.81	8917.31		Camac cross-catchment Griffeen_3

Upon completion of the rating review at Lucan gauging station (09002), it became apparent that urbanisation in the catchment post 2004 had resulted in an increase in the value of Q_{med}. As a result, the design flows used for the Baldonnel model were updated in line with this adjustment to Q_{med}, which generally resulted in an overall increase in model inflows. For full details of the rating review, refer to IBE0600Rp0016_HA09 Hydrology Report_F01. Full details of the final flow estimates used in the model are also given in IBE0600Rp0016_HA09 Hydrology Report_F01 - Section 4.13 and Appendix D.

In order to model the effect of cross-catchment flow from the River Camac, flow outputs from the Eastern CFRAM Camac AFA model were extracted and input into the Baldonnel AFA model. Upon review of the Camac AFA model results, it was found that cross-catchment flow only enters the modelled watercourses of the Baldonnel AFA model during the 0.1% AEP design run. Flow was found to enter the Baldonnel Watercourse at one location and the Griffeen River at three locations. The extracted hydrographs which were input into the Baldonnel AFA model during the 0.1% AEP design run are shown in Figure 4.1.19, and the type of input used to represent these inflows along with their model chainage is given in Table 4.1.2.

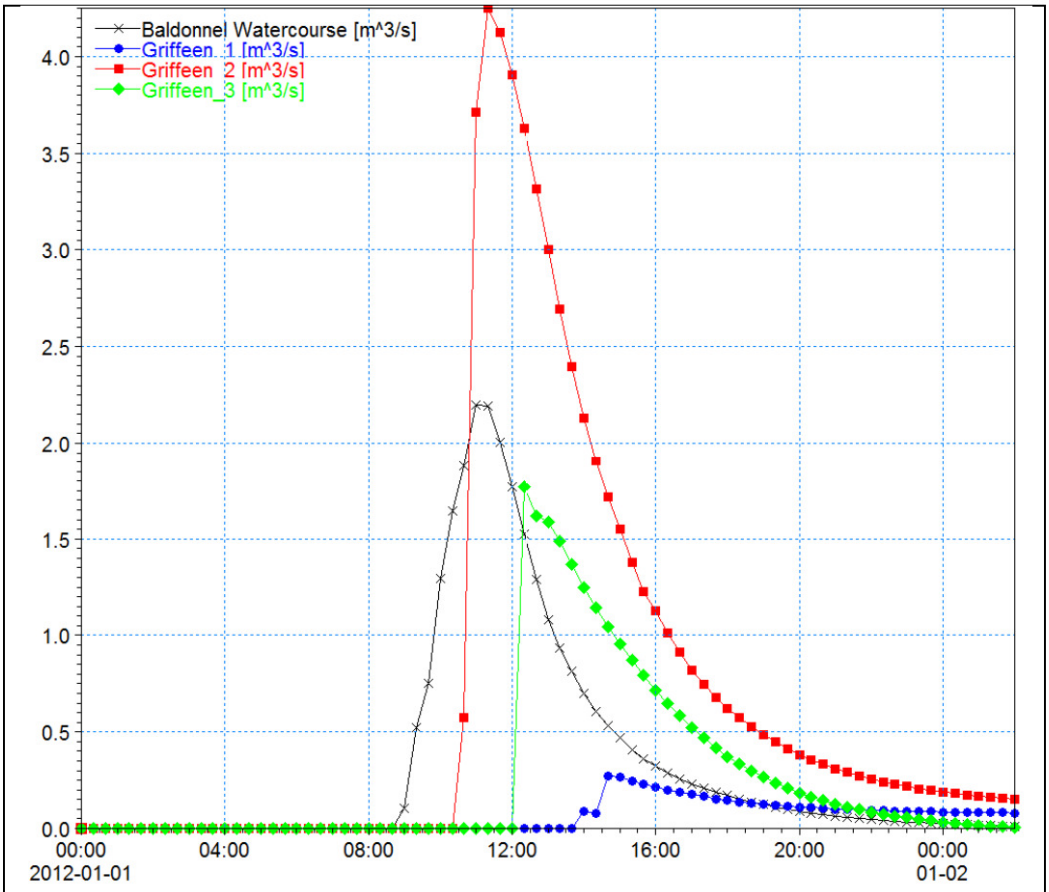


Figure 4.1.19: Camac cross-catchment inflows

In order to improve the representation of the lateral inflow being applied to the Griffeen River, the lateral inflow between HEPs 09_990_U and 09_1120_3_RPS was split into two separate hydrographs. The point selected to split the inputs was cross-section 09GRIF00782 at chainage 5858 on the Griffeen River, which is located approximately 500m downstream of the confluence point between the Griffeen River and the Baldonnel watercourse. The contributing catchment area upstream and downstream of this point was measured, and it was determined that approximately one-third of the lateral catchment is located upstream of this point and two-thirds downstream. The overall lateral inflow hydrograph for the Griffeen River was therefore scaled according to this calculated area ratio to produce two separate lateral inflow hydrographs i.e. one-third of the total lateral inflow was applied upstream of chainage 5858 and two-thirds was applied downstream of this point.

The timing of the input hydrographs for the Griffeen River and Carrigeen were adjusted in order to improve anchoring of model flows to hydrological estimates. It was required to delay the inputs on both the Griffeen River and Carrigeen in order to achieve the most representative model results. Refer to Appendix A.3 for

full flow tables comparing modelled and estimated flows.

Hydrology estimates for the Cornerpark watercourse were produced based on this watercourse flowing into the Griffeen River. It was reported during the channel and structure survey that this watercourse actually flows away from the Griffeen. Flow therefore splits at the confluence of the Griffeen River and the Cornerpark, and this is predominantly governed by hydraulic factors. As a result, HEP UN_Trib_Griffn_U was used as a downstream limit point, however it was not possible to produce a hydrological flow estimate for the downstream extent of Cornerpark. Flow from the Cornerpark drains to the Shinkeen Stream, so estimates of flow at the downstream end of the Cornerpark were extracted and incorporated into the Celbridge & Hazelhatch AFA model. This is discussed further in Appendix A.3.

After consultation with the Project Manager on 19/02/2013, The Finnstown tributary was omitted from the model due to access issues as discussed in section 4.1.6(1). This watercourse was therefore treated as an un-modelled tributary, with the estimated flow at the downstream extent of the watercourse included as a point inflow on the Griffeen River. Finnstown was assessed as part of the FRR and it was recommended that it should not be considered as an AFA (IBE0600Rp0001_Flood Risk Review_F02, Section 3.9.2). As a result, it was not considered that significant flood risk in this area was not going to be modelled in detail.

Figure 4.1.20 provides an example of the associated upstream hydrographs on the Griffeen River, Carrigeen Watercourse and Baldonnel Watercourse at HEPs 09_990_U, 09_1156_1 and UN_Trib_Griff_U respectively during a 1% AEP design run.

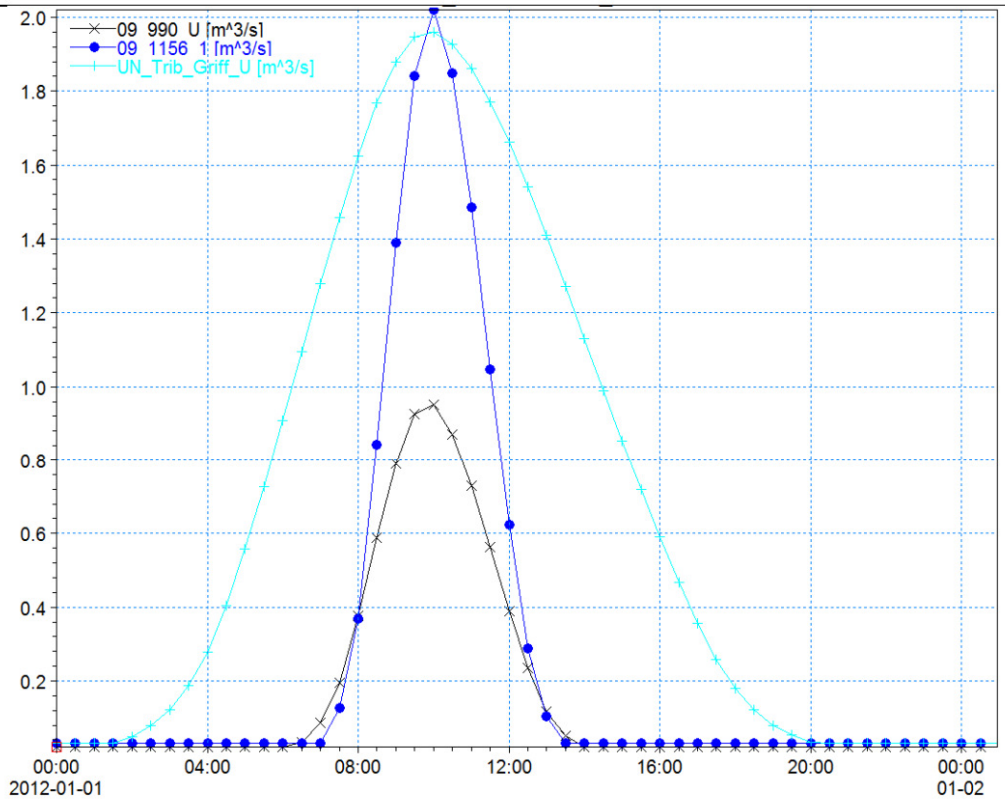


Figure 4.1.20: Inflow hydrograph at HEPs 09_990_U, 09_1156_1 and UN_Trib_Griff_U during 1% AEP design run

(6) Model Boundaries – Downstream Conditions:	Q-h relationship boundaries have been defined at the downstream model extent of the Griffeen River (chainage 13625) and Cornerpark (chainage 477). These relationships are based on critical flow conditions and are plotted in Figure 4.1.21 and Figure 4.1.22. It should be noted that the downstream limit of the Baldonnel AFA model used for producing flood mapping is section 09GRIF00276 at chainage 10917 on the Griffeen River. As there is approximately 2700m of data beyond this point before the downstream model extent of the Griffeen River, the boundary conditions at this location are not considered to have a significant impact upon model results. A number of dummy water level boundaries were also included at the upstream and downstream extents of the 1D structures 'Pond Outlet', 'Culvert 1' and 'Culvert 2'. The purpose of these boundaries is to enable flow to transfer between the 1D and 2D model domains. In order to achieve this, a water level boundary with a constant level slightly higher than the bed level of the structure is assigned at each location where flow

	is to transfer between the 1D and 2D domain e.g. at a culvert inlet or outlet. The constant level which is assigned to the boundary is ignored once the simulation starts and the water level at the boundary is defined by dynamic calculations based on flow upstream and downstream.

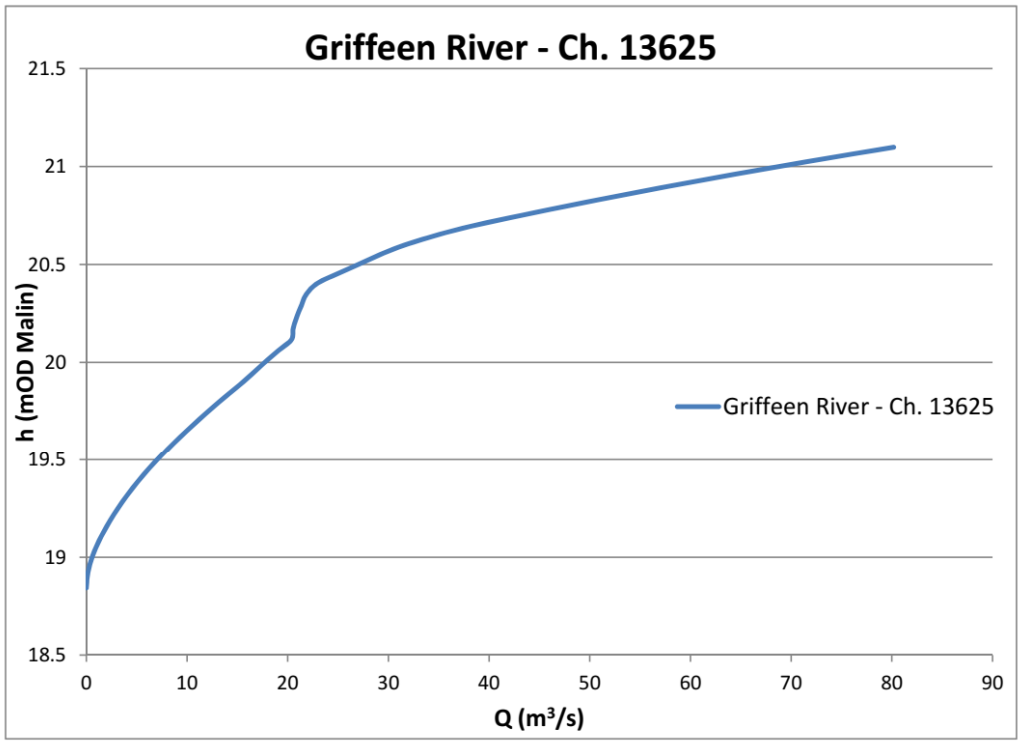


Figure 4.1.21: Griffeen River Q-h relationship boundary

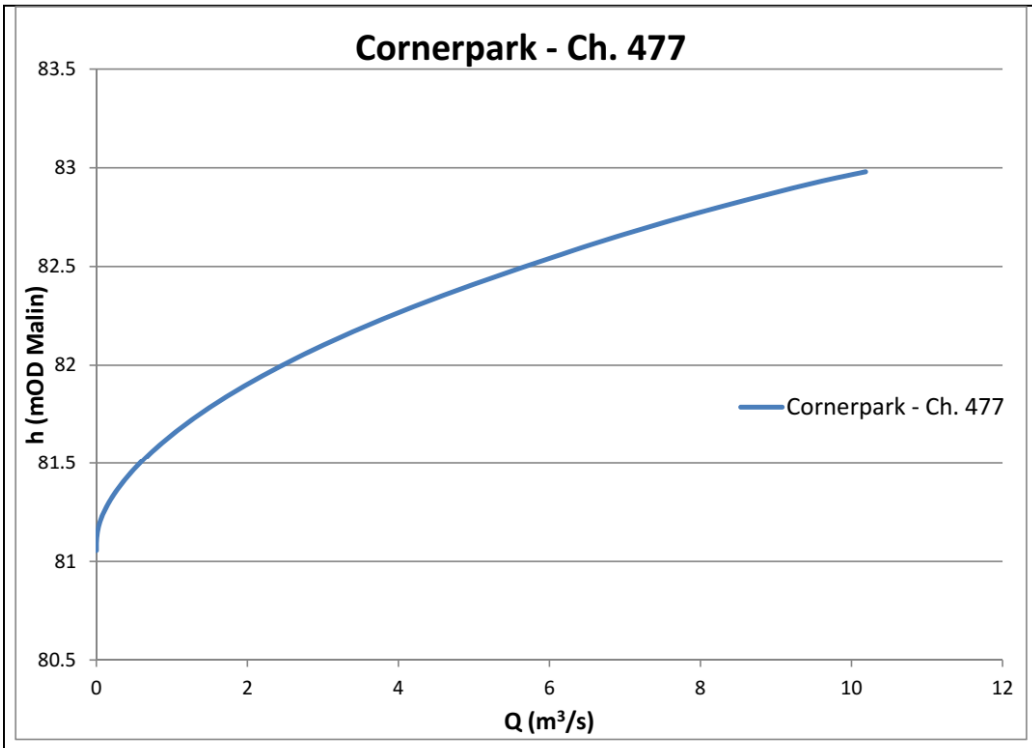
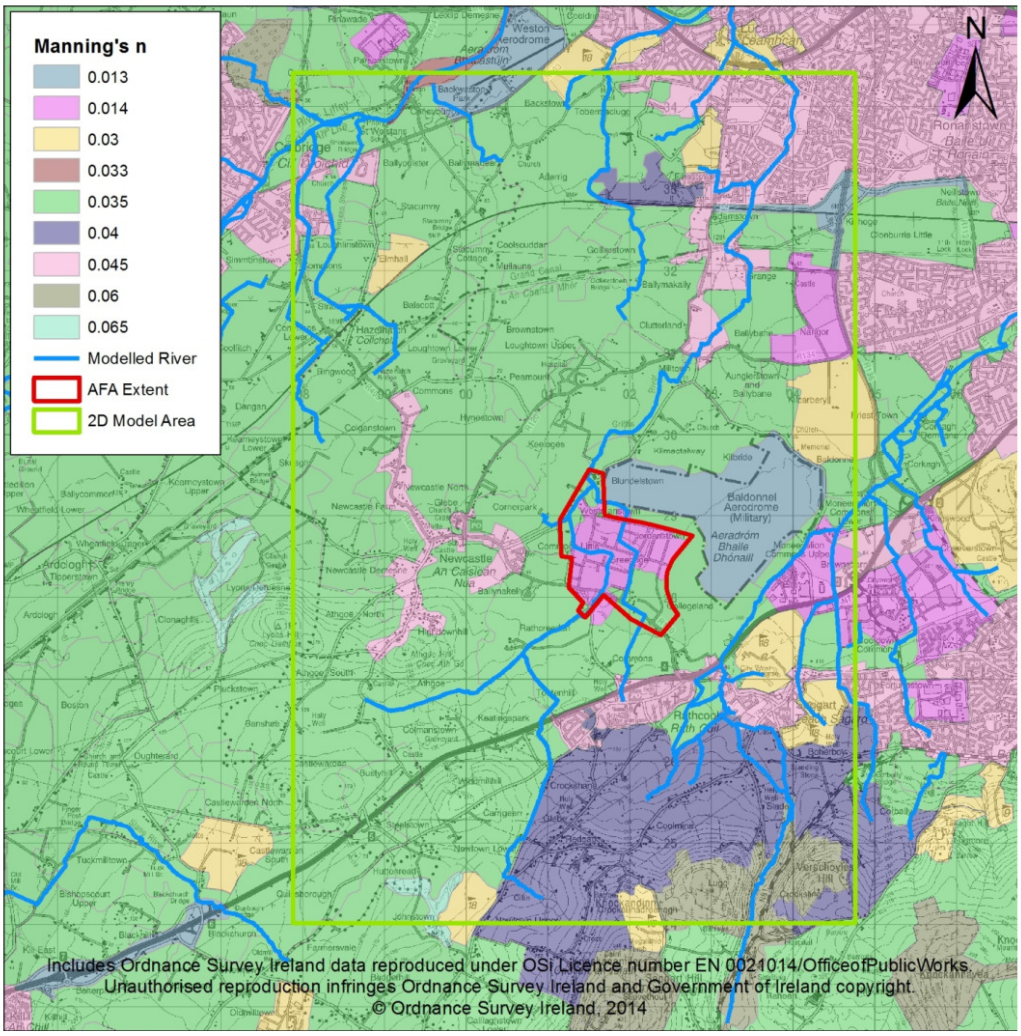


Figure 4.1.22: Cornerpark Q-h relationship boundary

(7) Model Roughness: (see Section 3.5.1 'Roughness Coefficients')		
(a) In-Bank (1D Domain)	Minimum 'n' value: 0.020	Maximum 'n' value: 0.100
(b) MPW Out-of-Bank (1D)	Minimum 'n' value: N/A	Maximum 'n' value: N/A
(c) MPW/HPW Out-of-Bank (2D)	Minimum 'n' value: 0.013 (Inverse of Manning's 'M')	Maximum 'n' value: 0.067 (Inverse of Manning's 'M')



Map of 2D Roughness (Manning's n)

This map illustrates the roughness values applied within the 2D domain of the model. Roughness in the 2D domain was applied based on land type areas defined in the Corine Land Cover Map with representative roughness values associated with each of the land cover classes in the dataset. Null Manning's M values on inland water bodies including Leixlip Reservoir were corrected to Manning's n of 0.033.

(d) Examples of In-Bank Roughness Coefficients

Griffeen River - 09GRIF01213_d	*Griffeen River - 09GRIF00299_up*

 Manning's n = 0.045 River with shallows and meanders and noticeable aquatic growth.	 Manning's n = 0.035 Standard natural stream or river in stable condition.
Carrigeen - 09CARR00331us  Manning's n = 0.05 Clean, winding natural stream with noticeable weeds and stones.	*Baldonnel watercourse - 09BALD00028_UP*  Manning's n = 0.035 Standard natural stream or river in stable condition.

4.1.4 Sensitivity Analysis

To be completed.

4.1.5 Hydraulic Model Calibration and Verification

(1) Key Historical Floods (from IBE0600Rp0008_HA09 Inception Report_F02 unless otherwise specified):	
(a) **Oct 2011**	It was reported that up to 90mm of rain fell during six hours on the evening of 24 October, which is more than four times the level associated with the country's heaviest rainfall. It is not known where this quoted rainfall total relates to however.

	Data at Casement hourly rainfall station shows that 78.9mm of rain fell in a 8 hour period from 11.00am to 7.00pm on 24th October 2011. This equates to a 1.4% AEP rainfall event using the FSU Depth Duration Frequency model (FSU WP 1.2 'Estimation of Point Rainfall Frequencies'). A single site frequency analysis was undertaken at Lucan gauging station for the report IBE0600Rp0014_F02, and this estimates the frequency of the October 2011 flood event as approximately 4-8% AEP. The report "Flooding at Greenogue Business Park, Rathcoole, Co. Dublin on 24th Oct 2011" shows flood extents around a commercial property in Greenogue Business Park, as shown in Figure 4.1.23, and this states the typical flood depth was 0.3m with a maximum depth of 0.6m. Design flows for the Baldonnel model were increased upon completion of the rating review at Lucan gauging station (09002), as discussed in Section 4.1.3(5). This adjustment to the design flows allowed for good model calibration to the extents and depths quoted in the report from October 2011 during model design runs of 1% AEP, as shown in Figure 4.1.24. The maximum depth calculated adjacent to this property during this design run is equal to approximately 0.53m, with typical depths between 0.3-0.4m. Model results therefore show good agreement with the recorded data for this flood event. Flooding of this property in the model is due to overflow from the left bank of the Baldonnel Watercourse, upstream of culvert 09BALD00100I. It should be noted that the report "Flooding at Greenogue Business Park, Rathcoole, Co. Dublin on 24th Oct 2011" suggests that the source of flooding was the Griffeen River, and as indicated by the arrows on Figure 4.1.23 that the flow path was along Grants Road. The model was reviewed but the suggested flood mechanism could not be recreated during any design run under normal conditions. The flow regime of the Griffeen River is highly sensitive to the attenuation pond immediately upstream of the business park and a number of culverts along the watercourse. It is not known if the attenuation pond was operating correctly or if culvert blockage occurred during this event. The suggested flow path along Grants Road was also reviewed, and the LiDAR data suggests that there is a high point at the junction between Grants Road and Grants Place as shown in Figure 4.1.24, so even if flooding from the Griffeen River was to be recreated by the model it is not considered likely that floodwater would travel in the direction suggested by the flood report without significant alterations to the LiDAR dataset. Considering that the suggested flowpath does not appear to be viable from the available topographical survey, and as good model calibration to this flood event was achieved when the Baldonnel Watercourse was considered as the source of flooding, it is possible that the suggested flooding source in the report from October 2011 is incorrect.

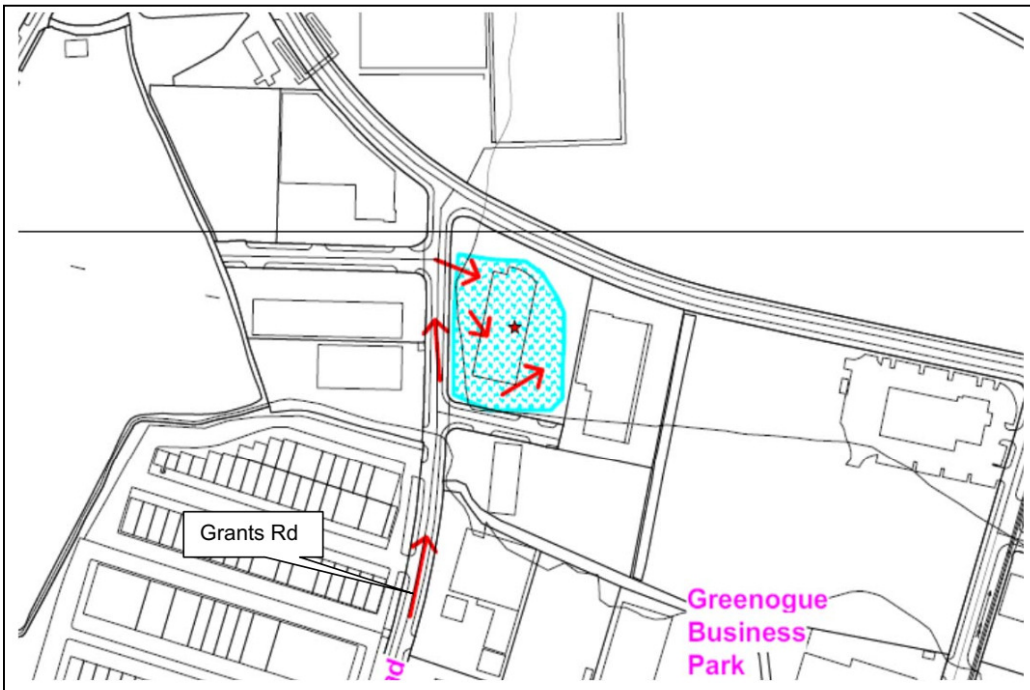


Figure 4.1.23: Flood extents from report "Flooding at Greenogue Business Park, Rathcoole, Co. Dublin on 24th Oct 2011"

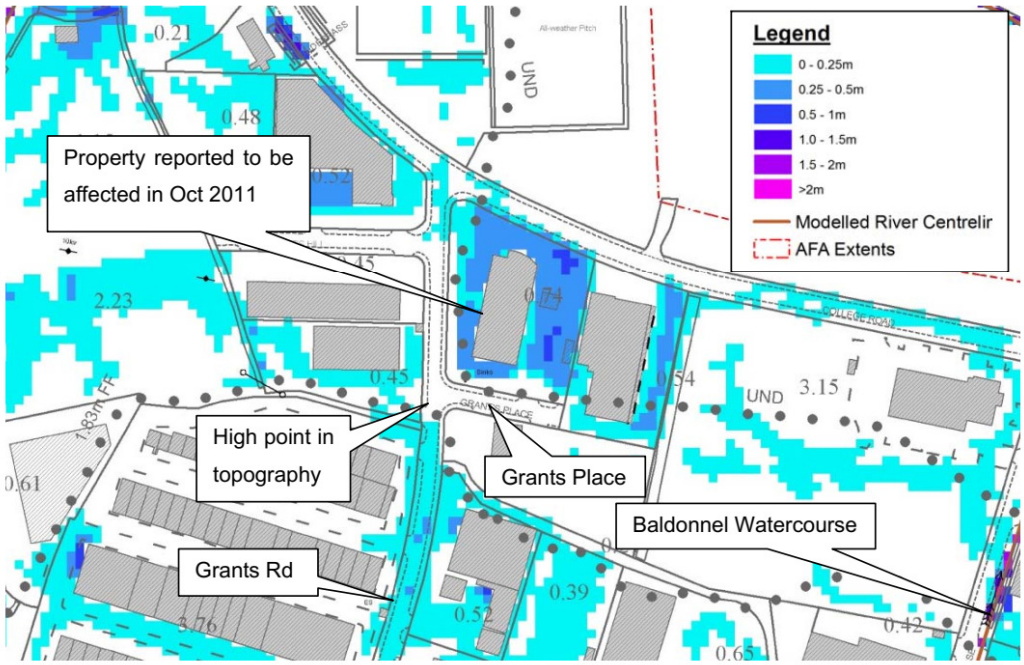


Figure 4.1.24: Flood depths from 1% AEP design run

(b) **Nov 2000**	95.3mm of rainfall was measured at Casement Aerodrome, Baldonnel over a period of 40 hours beginning at 8.00am on 5 November 2000. The rainfall recorded at Casement Aerodrome for this event equates to a 3-4% AEP rainfall event using the FSU Depth Duration Frequency model. Using the single site frequency analysis at station 09002, the estimated frequency of the flood event in November 2000 is approximately 1.5-3% AEP. "Report on Flood Event 5/6th November 2000 in the River Griffeen Catchment" describes this flood event in detail, and includes photos and maps showing flood outlines. The report focuses mainly on the lower reaches of the Griffeen River, especially the area where the Griffeen passes under the railway line near Haydens Lane. Additional information is also available in the report "South Dublin County Report on Flooding 5th & 6th November 2000". Flooding was found to occur only in this area during the 0.1% AEP design run, and it became apparent during calibration that this area has changed substantially since this flood event occurred. Flooding in November 2000 was caused by a lack of capacity in the culvert under Haydens Lane, causing flooding left of the River Griffeen. This floodwater then flowed North through a railway underpass, and onto Haydens Lane as shown in Figure 4.1.25.

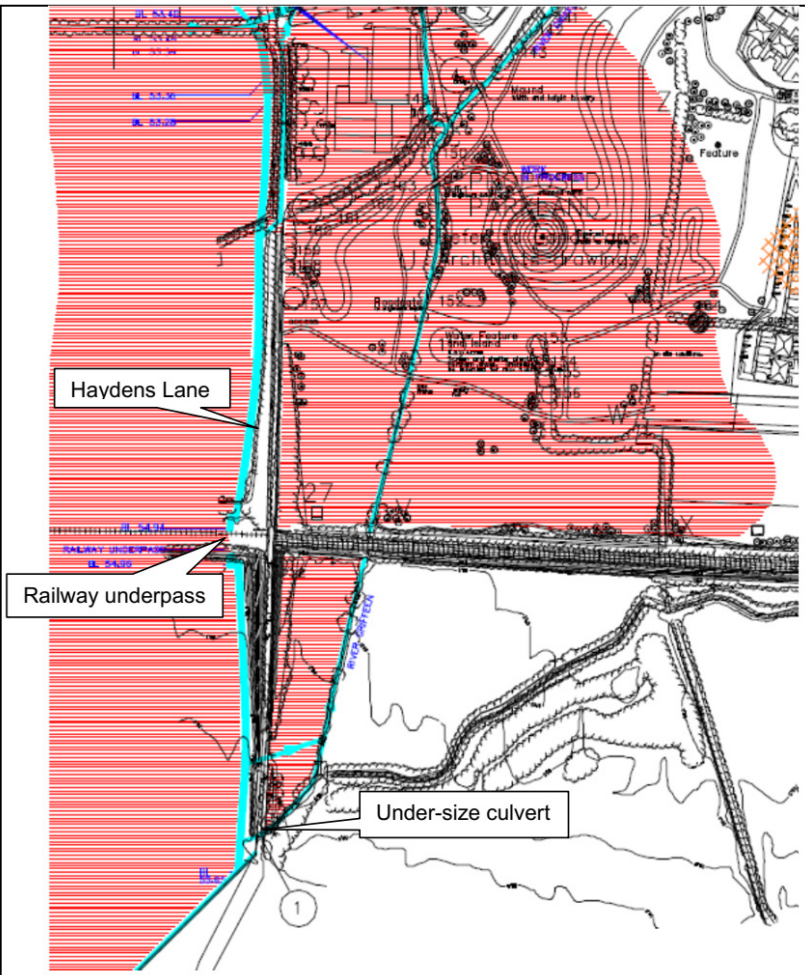


Figure 4.1.25: Flooding in November 2000

Since the flood event of November 2000, channel capacity has been improved, a second culvert has been constructed under Haydens Lane and the Railway underpass which acted as a flow path for floodwater has been closed off. A new road has been constructed parallel to the railway line, but a second culvert to convey flow on the Griffeen River under the road and railway has been constructed. Overall these remedial measures were found to be effective, but this flood event could not be used for model calibration due to the significant changes to the flow regime in this area.

(c) **June 1993**	Roads and houses were flooded in Rathcoole and Saggart due to the River Camac overflowing. An ESBi report "River Liffey Flood of June 1993" estimates that the 12-hour rainfall had an AEP of approximately 1% at Casement Station while the 24 hour rainfall total (108.6mm) had an AEP of approximately 0.4%. The 24 hour rainfall total of 108.6mm recorded at Casement Aerodrome for this event

	was analysed using the FSU Depth Duration Frequency model, and the rainfall event frequency was estimated at approximately 1% AEP. Using the single site frequency analysis at station 09002, the estimated frequency of the flood event in November 2000 is approximately 4-5% AEP. The River Camac is not included within this model as it is subject to a separate hydraulic model under the Eastern CFRAM Study. Cross-catchment flow from the River Camac is simulated in the Baldonnel AFA model as discussed in Section 4.1.3(5), however as the River Camac is not included within this model this flood event is not suitable for model calibration.

Summary of Calibration

There are no gauging stations within the extents of the Baldonnel AFA model, however the Lucan gauging station (09002) is just downstream on the lower reaches of the Griffeen, so a single site frequency analysis at this station was used to provide an estimate of the flood frequency of historical events.

Data from Casement daily rainfall station (located approximately 2km East of the AFA extent) was also used for each historical event in order to provide an estimate of the rainfall AEP.

Model flows were checked against the estimated flows at HEP check points where possible to ensure they were within an acceptable range. For example at HEP 09_1165_5, the estimated flow during the 1% AEP event was 5.15m^3/s and the modelled flow was 5.46m^3/s. Full flow tables can be found in Appendix A.3.

A mass balance check has been carried out on the model to make sure that the total volume of water entering and leaving the model at the upstream and downstream boundaries balances the quantity of water remaining in the model domain at the end of a simulation. Refer to Chapter 3.11 for details of acceptable limits. The mass error in the 1% AEP design run was found to be -2.85%. Further analysis was undertaken to determine the source of this mass error. After reviewing the model it was concluded that this mass error is the accumulation of a number of minor instabilities which generally occur at low flow. Each of these minor instabilities was reviewed (discussed in Section 4.1.6(2)). None of these individual instabilities were found to have a significant impact upon model results, so this mass error was found to be acceptable.

Model calibration was carried out using data from the flood event in October 2011. Data from this event included extents, maximum depths and typical depths at a commercial property in Greenogue Business Park. Initial model results did not show flooding of the area for the calculated AEP of this flood event. The rating review at Lucan gauging station suggested that the index flood flow for this catchment has increased due to urbanisation in recent years, so inflows for the Baldonnel AFA model were increased as part of the calibration process. This adjustment resulted in good agreement between 1% AEP design run model results and observed data for the October 2011 flood event.

Apart from October 2011, very little detailed information relating to historical flooding within the Baldonnel AFA is available, and often it was found that historical reports referred to areas which have changed significantly in the last number of years. Model calibration could therefore only be carried out using the flood event in October 2011. Despite the limited calibration and verification data, the model is considered to be performing satisfactorily for design event simulation.

(2) Post Public Consultation Updates:

At a draft flooding mapping workshop held on 24/10/2013, Local Authorities suggested that flooding in the Greenogue Business Park area was being underestimated as the draft maps displayed flooding in this area only during the 0.1% AEP design run. It was suggested that flooding here may be sensitive to culvert blockage or operation of the attenuation pond upstream on the Griffeen River. The model inputs were adjusted after this workshop following the completion of the Rating Review at Lucan gauging station (09002). As a result of this adjustment, flooding was found to occur in the Greenogue Business Park area during design runs of 1% AEP or greater, which is consistent with the comments received from Local Authorities.

Details were also received of a gap in the wall along the left bank of the Baldonnel Watercourse, upstream of the N7 at St. Bridget's. Due to the presence of this gap, and as this wall was not built as a flood defence, it was deemed appropriate to exclude it from the hydraulic model. It should be noted that no flooding was found to occur from the left bank of this section of the Baldonnel Watercourse during any design run when this wall was removed from the model due to the nature of the ground topography. This is shown in Figure 4.1.36.

All other flood extents within the model were considered to be reasonable. It was noted that severe flooding has occurred in the Haydens Lane area in the past, but remedial works have been undertaken in recent years to mitigate this risk. No flooding has been reported in this area since these works have been carried out, so the modelled flood extents were considered to be reasonable.

Following informal public consultation and formal S.I. public consultation periods in 2015, it was identified that the sluice gate immediately upstream of culvert 09GRIF01038I remains in a fixed position, with the culvert approximately half closed. The model was updated to reflect this. This resulted in reduced flooding from the Griffeen River at Greenogue Business park, especially at its confluence with the Cornerpark watercourse – see Figure 4.1.26. The model was updated and check flows recalculated with a revised set of flood hazard and risk mapping issued as Final to reflect this change.

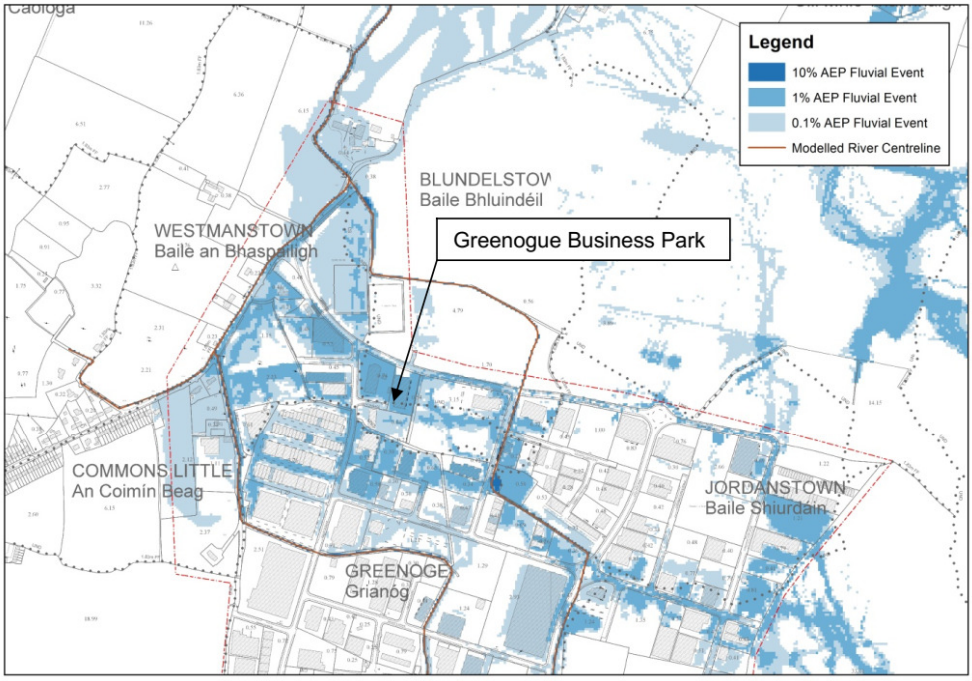


Figure 4.1.26 Modelled Fluvial Event at Greenogue Business Park

Flood hazard and risk mapping issued for informal public consultation in early 2015 and for the formal S.I. public consultation, represents both the Baldonnel and Camac model outputs, the illustrations in this report represent the Baldonnel model hazard outputs.

(3) Standard of Protection of Existing Formal Defences:

None

(4) Gauging Stations:

There are no gauging stations located within the Baldonnel AFA model extents. The Lucan gauging station (09002) is located downstream on the Griffeen River (beyond the model extents) and a rating review was carried out on this station. Full details of the rating review can be found in IBE0600Rp0016_HA09_Hydrology Report_F01, however as the gauge was not within the model extent, it was not suitable for model calibration.

A comparison of the modelled hydrograph at the downstream extent of the Baldonnel AFA model (HEP 09_1120_3_RPS) from the 1% AEP design run and the recorded flow hydrographs at the Lucan Gauging station (09002) for the flood events of October 2011, November 2000 and June 1993 was carried out in order to verify the modelled hydrograph in terms of shape and timing. For comparison purposes, a dimensionless term of flow divided by peak flow for each flood event has been used, and the peak of each hydrograph has been aligned. This allows a direct comparison of hydrograph shape and timing to be made

and is necessary as the true peak flow values are not comparable. This is plotted in Figure 4.1.27.

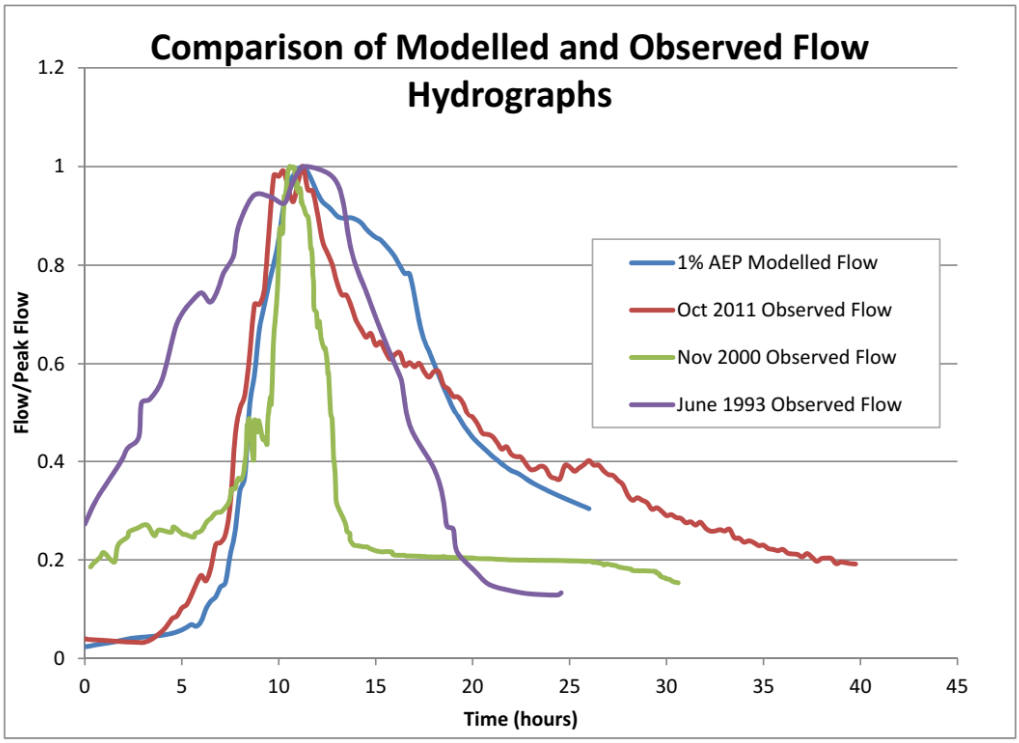


Figure 4.1.27: Comparison of Modelled and Observed Flow Hydrographs

It can be seen from Figure 4.1.27 that there is a considerable range of hydrograph shapes from the observed data at Lucan gauging station (09002). The modelled hydrograph was found to correlate well with the observed data, especially the flood event of October 2011, providing good verification of the model results.

(5) Other Information:

(a) *South Dublin CC Drainage Meeting - Minutes (2005)* - Meeting with SDCC Drainage Engineers identifying areas which are prone to flooding.

'Newcastle Greenogue Recurring' - This note refers to flooding at Greenogue Business Park, however no further details are available relating to the source or frequency of flooding. Flooding was found to occur in this area during design runs of 1% AEP or greater (as shown in Figure 4.1.28), however this location may be prone to culvert blockage. It is also noted that this information is taken from minutes of a meeting with drainage engineers, so the source of flooding at this location may be pluvial, especially as there are numerous drainage ditches in the vicinity of Greenogue Business Park.

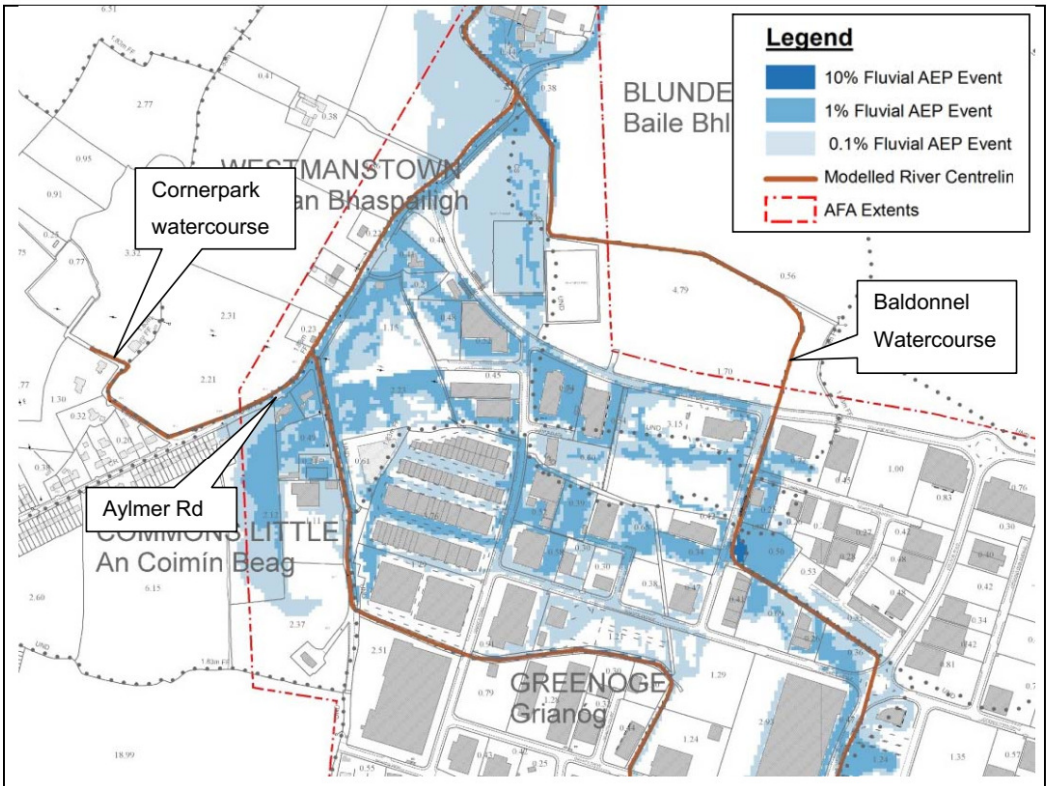


Figure 4.1.28: Model flood extents at Greenogue Business Park

'Aylmer Road Newcastle. Location to be confirmed' - No further details are available relating to the source or frequency of flooding. Flooding was found to occur at the confluence between the Griffeen River and Cornerpark watercourse during design runs of 1% AEP or greater, and this may affect the Aylmer Road (as shown in Figure 4.1.28). It is unclear however if this is the location referred to in the meeting minutes.

4.1.6 Hydraulic Model Assumptions, Limitations and Handover Notes

(1) Hydraulic Model Assumptions:

(a) Following consultation with the Project Manager, the Finnstown watercourse was omitted from the model and was instead represented by adding a point source at the location where it joins the Griffeen River. This assumption was made because there was insufficient survey data available to fully model the Finnstown watercourse due to access issues.

(b) Various assumptions had to be made regarding the attenuation pond and how it is operated during a flood event. There is a sluice gate immediately upstream of culvert 09GRIF01038I on the main channel of the Griffeen adjacent to the pond. Please refer to Section 4.1.5(2) for an update to the model following informal public consultation and formal S.I. public consultation periods in 2015.

(c) Design drawings indicate there are two outlet pipes from the attenuation pond, one of 900mm diameter and the other 225mm. The larger 900mm diameter pipe is designed to ensure the pond can be rapidly drained once a storm event has passed and should therefore be closed during a flood event. As a result, only the 225mm diameter pipe has been included in the model as it is permanently open. It is assumed that the design and as-built drawings of the attenuation pond received from SDCC accurately represent the outlet arrangement.

(d) Due to the presence of the two outlet pipes, it can be assumed that the attenuation pond is designed to remain empty except for when there is a flood event. This assumption is supported by two separate aerial images of the site (Google and Bing) and survey photographs which all show the attenuation pond as empty except for the Northern corner. The Northern corner remains permanently wet as the bed level here is slightly lower than the inlet level of the outlet pipe. As it is assumed that the attenuation pond is designed to remain empty, this condition was replicated in all model design runs. It should be noted that sensitivity analysis for this model still has to be undertaken, and it is recommended that this analysis includes the initial water level within the attenuation pond.

(e) The topographic data for the Northern corner of the attenuation pond was edited as it was assumed the LiDAR had picked up water as opposed to the bed. The levels were lowered based on drawings received from SDCC.

(f) A number of footbridges on the Griffeen River (09GRIF00307D, 09GRIF00283D, 09GRIF00229D, 09GRIF00164D and 09GRIF00125D) were not included in the model. This assumption was made after running the model with a 0.1% AEP HEFS design flow to ensure the water level did not reach the sides or soffit of the bridges. They were therefore not considered hydraulically significant and greater model stability could be achieved by omitting them.

(g) There is a large pipe crossing the Griffeen River at bed level at section 09GRIF00228 (chainage 11396). This was modelled by increasing the bed resistance at this cross section to a Manning's n value of 0.06.

(h) For culvert 09GRIF00262I on the Griffeen River, only the left-hand opening has been included along the main Griffeen channel. The right hand opening was modelled by inserting a second branch running parallel to the main channel. This was done in order to accurately model weir 09GRIF00258W downstream of the culvert, which only acts on the left-hand opening.

(i) The Griffeen River splits into two parallel channels in between surveyed sections 09GRIF00383 and 09GRIF00316 (chainage 9848 - 10514). This section of the Griffeen River was therefore modelled as two branches running in parallel in the 1D model component. Additional survey data of structures 09GRIF00349D and 09GRIF00330I at chainage 10194 and 10404 respectively was required in order to model this area as discussed in Section 4.1.2(9). No additional open cross-sections were required.

(j) Three culverts in the 2D domain were modelled using 1D branches, 'Pond Outlet', 'Culvert 1' and 'Culvert 2'. To improve stability of 'Culvert 1' and 'Culvert 2', the bathymetry at the entrance and exit of these culverts was edited to equal the invert levels received in additional survey data.

(k) The timing of the input hydrographs for the Griffeen River and Carrigeen was adjusted in order to improve anchoring of model flows to hydrological estimates. This is discussed further in Section 4.1.3(5).

(2) Hydraulic Model Limitations and Parameters:

(a) A grid resolution of 5 metres has been selected. This resolution was selected as it allows the area of interest to be modelled in sufficient detail whilst also maintaining good computational performance of the model.

(b) There is a minor instability at bridge 09GRIF01138D at chainage 2308 on the Griffeen River. It was not possible to eradicate this instability completely, so its significance and impact on model results was reviewed. This instability causes fluctuations of up to approximately ±0.7m^3/s in the discharge profile at this structure at low flow as shown in Figure 4.1.29. This results in fluctuations of up to approximately ±10mm in the calculated water level at this location. As this instability doesn't affect the peak discharge or water level, and no erroneous out-of-bank flooding is caused, it does not have any significant impact on model results.

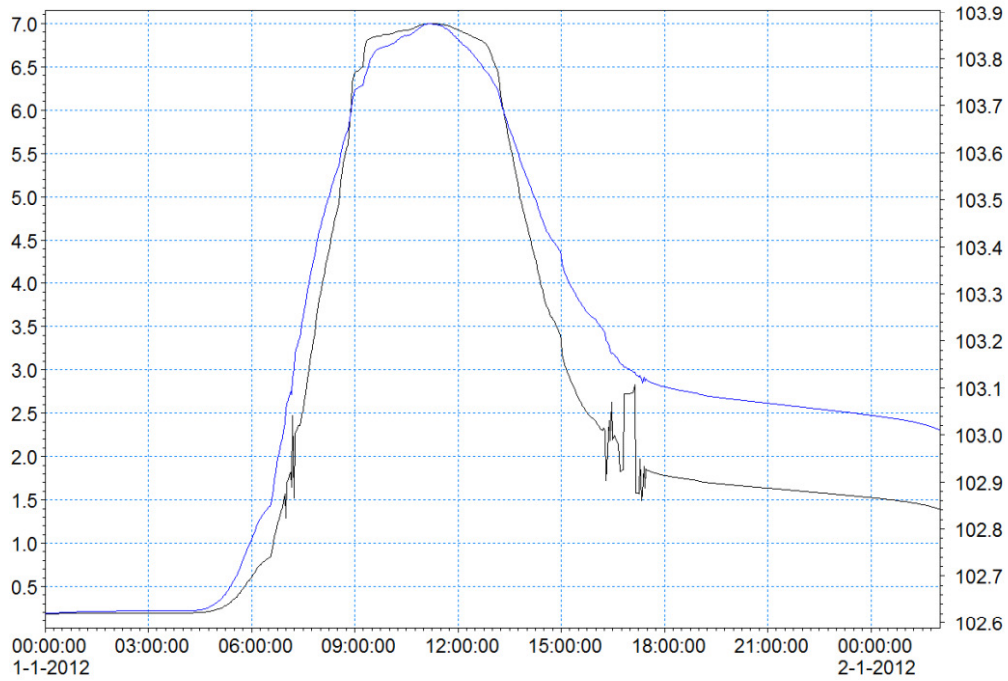


Figure 4.1.29: Water level and discharge profiles for 0.1% AEP design run at bridge 09GRIF01138D

(c) There is a minor instability just upstream of culvert 09GRIF01038I at chainage 3279 on the Griffeen River. As it was not possible to eradicate this instability completely, its significance and impact on model results was reviewed. This instability causes fluctuations of up to approximately ±0.6m^3/s in the discharge profile at this section at low flow as shown in Figure 4.1.30. This causes fluctuations in the water level profile of up to approximately ±20mm. As this instability doesn't affect the peak discharge or water level, and no erroneous out-of-bank flooding is caused, it does not have any significant impact on model results.

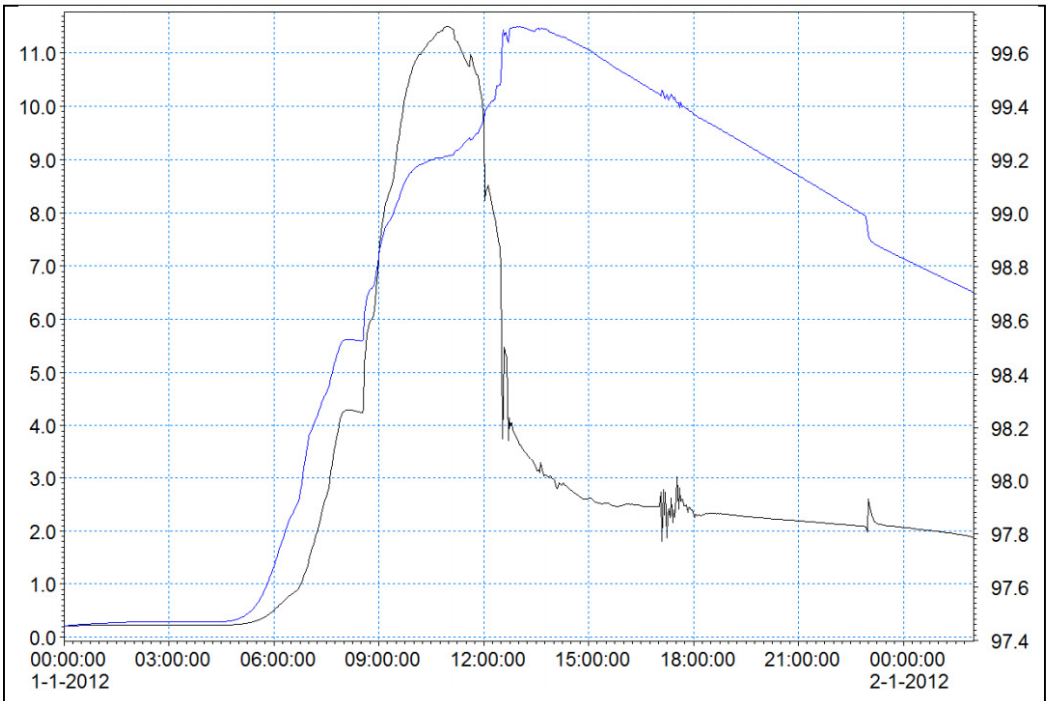


Figure 4.1.30: Water level and discharge profiles for 0.1% AEP design run upstream of culvert 09GRIF01038I

(d) There is a minor instability at culvert 09GRIF00548I at chainage 8201 on the Griffeen River. As it was not possible to eradicate this instability completely, its significance and impact on model results was reviewed. This instability causes fluctuations of up to approximately ±0.6m^3/s in the discharge profile at this section at low flow as shown in Figure 4.1.31. This causes fluctuations in the water level profile of up to approximately ±90mm. As this instability does not affect the peak discharge or water level, and no erroneous out-of-bank flooding is caused, it does not have any significant impact on model results.

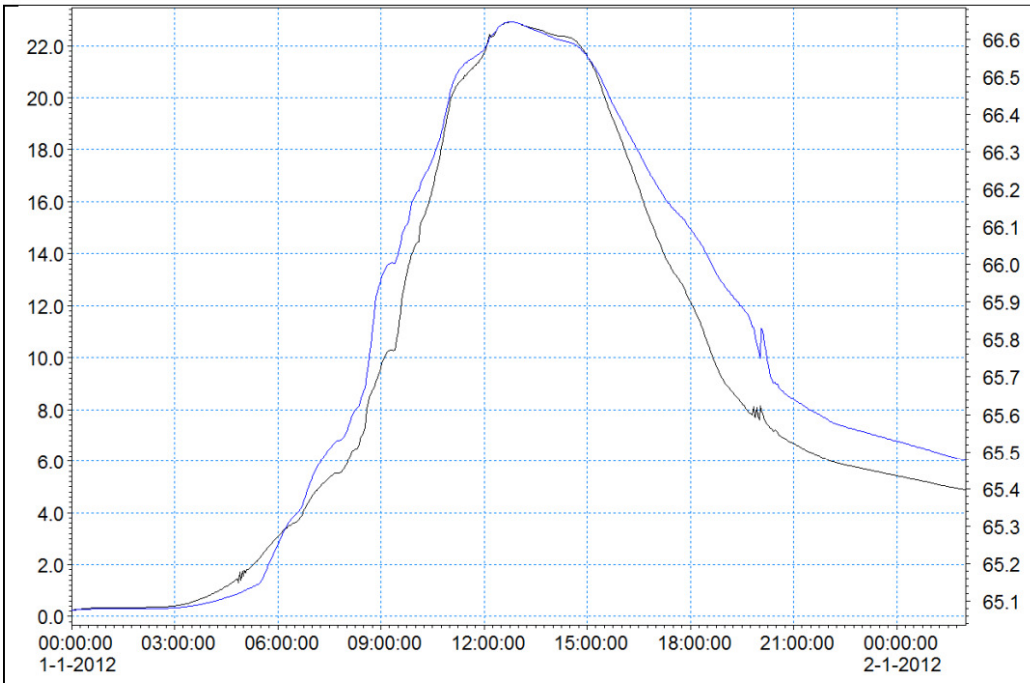


Figure 4.1.31: Water level and discharge profiles for 0.1% AEP design run at bridge 09GRIF00548I

(e) The downstream limit of the Baldonnel AFA model used for flood mapping is section 09GRIF00276 at chainage 10917 on the Griffeen River. The Lucan to Chapelizod AFA model created as part of the Eastern CFRAM Study is used to generate flood mapping of the Griffeen River downstream of this location. The Baldonnel AFA model includes survey information of the Griffeen River up to chainage 13625 in order to improve model accuracy at the downstream limit of the Baldonnel AFA mapping. There are several minor instabilities on the Griffeen River branch beyond section 09GRIF00276, however as this is only used as a 'cool-down' area and results from this part of the model are not used for flood mapping, these instabilities are not considered to be significant. The locations of these instabilities are at section 09GRIF00228 at chainage 11396 (Figure 4.1.32) and weir 09GRIF00153W at chainage 12149 (Figure 4.1.33).

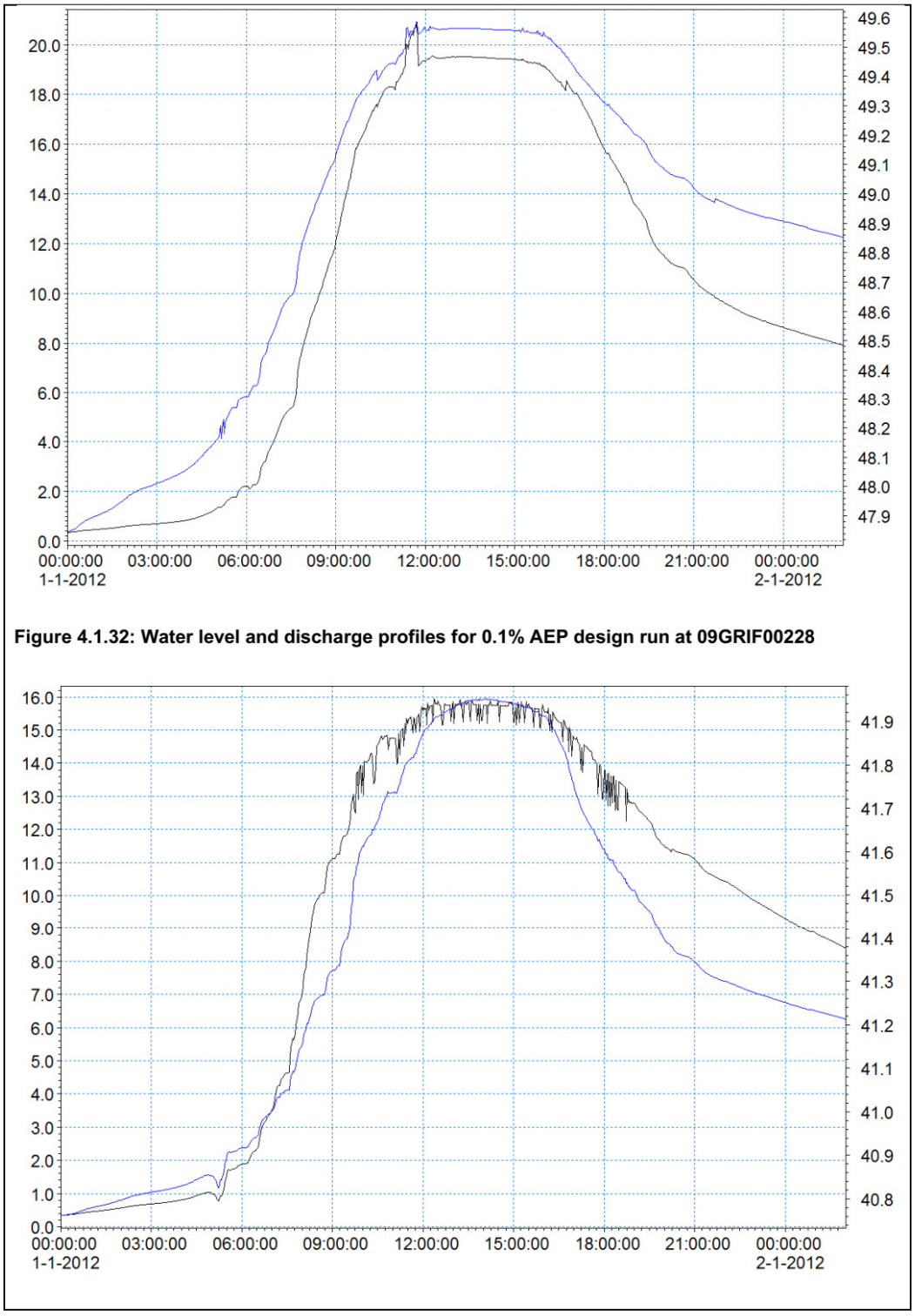


Figure 4.1.32: Water level and discharge profiles for 0.1% AEP design run at 09GRIF00228

Figure 4.1.33: Water level and discharge profiles for 0.1% AEP design run at weir 09GRIF00153W	
Hydraulic Model Parameters:	
MIKE 11	
Timestep (seconds)	2
Wave Approximation	High Order Fully Dynamic
Delta	0.8
MIKE 21	
Timestep (seconds)	2
Drying / Flooding depths (metres)	0.02 / 0.03
Eddy Viscosity (and type)	0.25 (Flux Based)
MIKE FLOOD	
Link Exponential Smoothing Factor (where non-default value used)	Griffeen River, Ch 8228 - Ch 8428: 0.8 Griffeen River, Ch 9406 - Ch 9603: 0.8 Griffeen River, Ch 10203 - Ch 10377: 0.8
Lateral Length Depth Tolerance (m) (where non-default value used)	Griffeen River, Ch 8228 - Ch 8428: 0.2 Griffeen River, Ch 10203 - Ch 10377: 0.2
(3) Design Event Runs & Hydraulic Model Handover Notes:	
(a) The Cross-section and Network files are identical for all design run simulations. The parameters within the HD parameter file are also identical. (b) Hotstart initial conditions have been used in the 1D model component during all design runs. The hotstart file represents baseflow conditions in all reaches. (c) Global surface elevation initial conditions of 0mOD Malin in the 2D domain have been used during all design runs. As the minimum topographical level in the 2D domain is greater than 40mOD Malin, these initial conditions mean the 2D domain is fully dry at the start of the simulation. (d) The water level exceedance factor was increased to 15 in the Mike11.ini configuration file in order to achieve model completion. Checks were carried out to ensure previous abnormal completions were not due to instabilities. (e) Culvert 09CARR00261I on the upper reaches of Carrigeen restricts flow, leading to localised out-of-bank flooding during design runs of 10% AEP or greater as shown in Figure 4.1.34. This flooding was found to affect local roads, up to 2 properties and agricultural land. Bridge 09CARR00326D was also found to restrict flow during design runs of 0.1% AEP or greater, resulting in localised flooding of a local road as shown in Figure 4.1.34.	

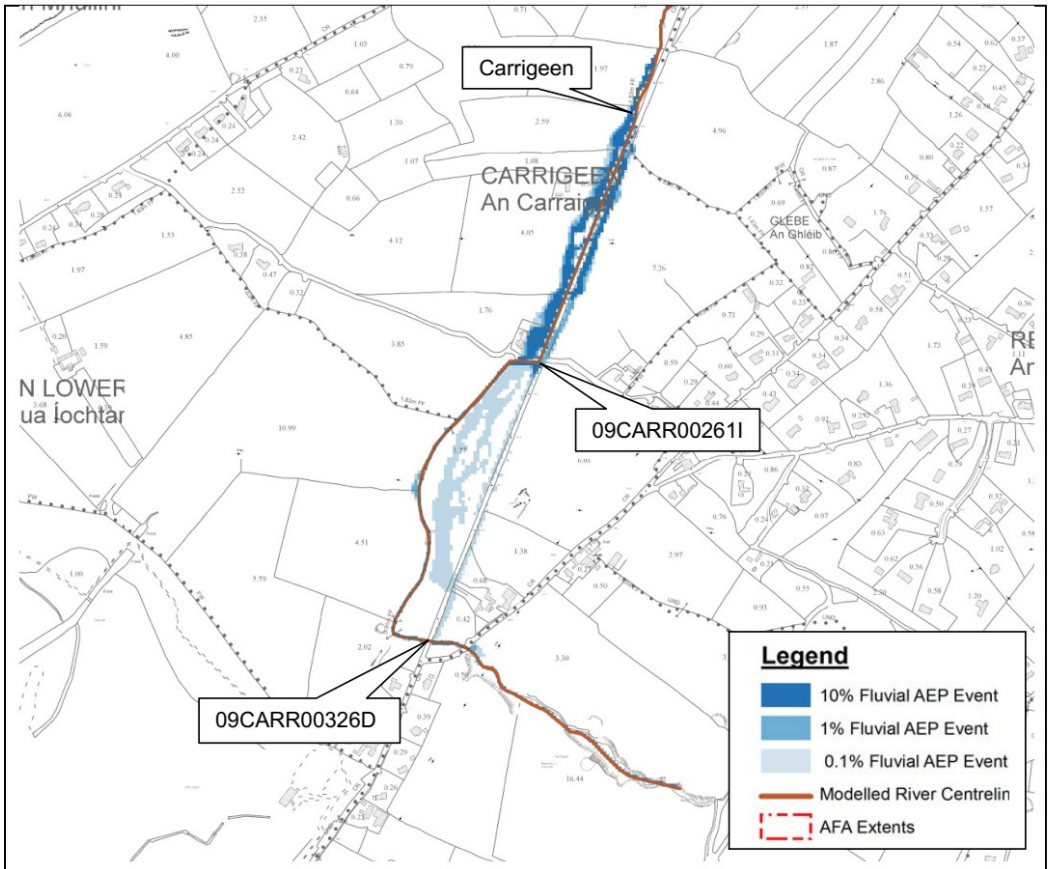


Figure 4.1.34: Flood extents on the upper reaches of the Carrigeen watercourse

(f) On the lower reaches of Carrigeen out-of-bank flooding was found to occur during design runs of 10% AEP or greater due to insufficient capacity of culvert 09CARR00089I, as shown in Figure 4.1.35. Flooding was only found to occur from the left bank during design runs of 10% AEP, affecting agricultural land before rejoining the Carrigeen approximately 200-300m downstream. During design runs of 1% AEP or greater, flooding occurs from both banks, with the flood water from the right bank flowing North-East to eventually join the Baldonnel Watercourse. This flooding was found to affect agricultural land, approximately 3 properties and 2 local roads including the R120. The capacity of culvert 09CARR00041I was also found to be insufficient, resulting in flooding of agricultural land at the confluence between Carrigeen and the Griffeen River during design runs of 10% AEP or greater. Flooding was only found to occur from the right bank of the Carrigeen during design runs of 10% AEP, and from both banks during design runs of 1% AEP or greater. Floodwater from the right bank of the Carrigeen was found to flow along the right bank of the Griffeen River, further affecting agricultural land and flooding an access road.

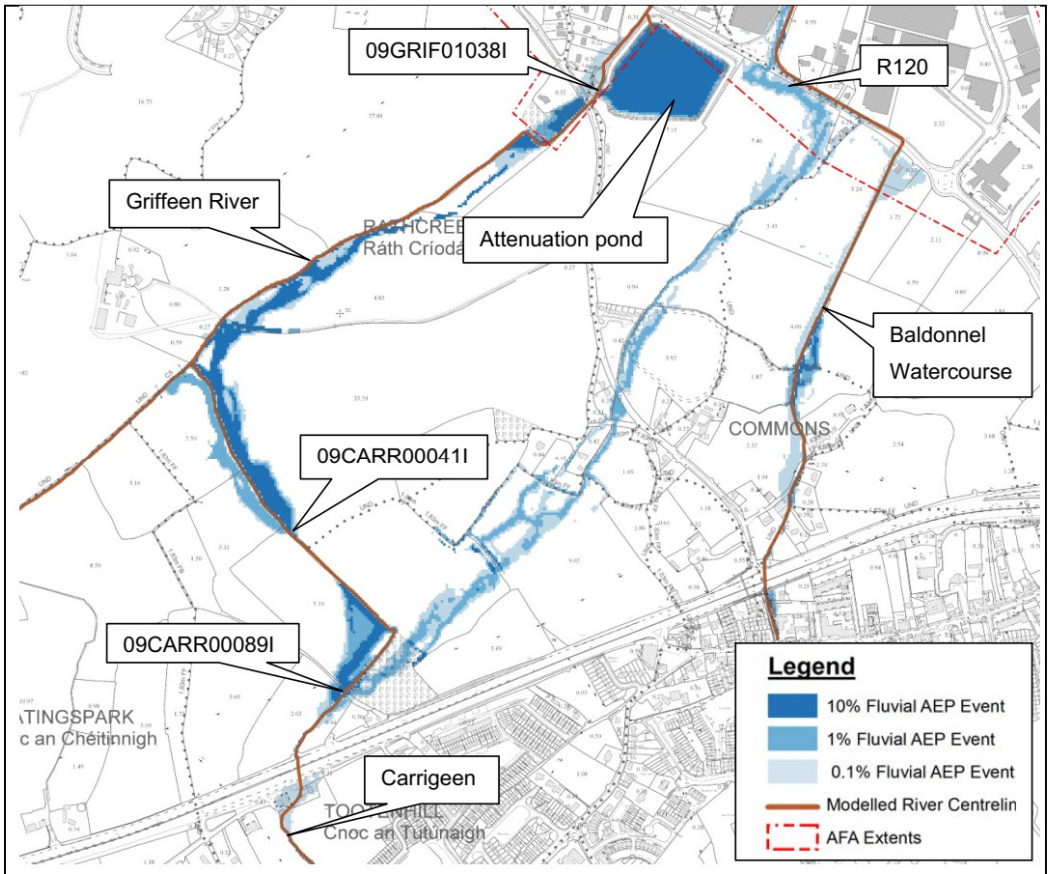


Figure 4.1.35: Flood extents on the lower reaches of the Carrigeen

(g) On the Baldonnel Watercourse, localised flooding was found to occur immediately upstream of the N7 during design runs of 1% AEP or greater as shown in Figure 4.1.36. This is due to insufficient capacity of culvert 09BALD00341I. One property was found to be affected by this flooding during the 0.1% AEP design run. It should be noted that there is a wall along the left bank of the Baldonnel Watercourse upstream of the N7, however comments received during a draft Flood Mapping Workshop on 24/10/2013 indicated that there is a gap in this wall. Details of this wall were therefore removed from the hydraulic model. Tay Lane was not found to flood even when this wall was removed due to the topography of the area.

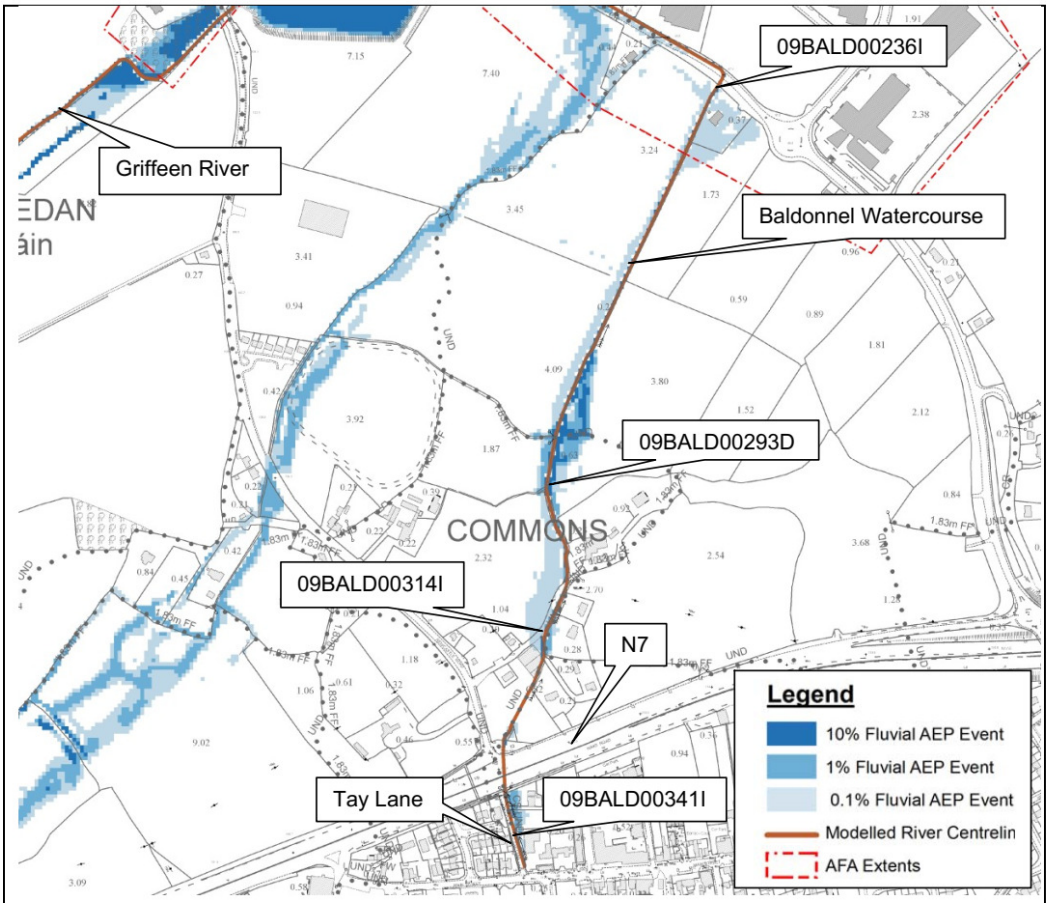


Figure 4.1.36: Flood extents on the upper reaches of the Baldonnel Watercourse

(h) Flooding of agricultural land was found to occur on the Baldonnel Watercourse during design runs of 10% AEP or greater due to insufficient capacity of bridge 09BALD00293D as shown in Figure 4.1.36. Further flooding of one property and an access road was also found to occur during design runs of 0.1% AEP due to insufficient capacity of culverts 09BALD00236I and 09BALD00314I.

(i) The section of the Baldonnel Watercourse which runs through Greenogue Business Park is heavily culverted, and flooding from this reach was found to occur during design runs of 1% AEP or greater as shown in Figure 4.1.37. Culverts 09BALD00152I, 09BALD00108I and 09BALD00100I were all found to have insufficient capacity. Flooding occurs from both banks upstream of culvert 09BALD00152I, affecting College Road, Grants Avenue, Plaza Roundabout and up to approximately 5 properties. Flooding also occurs from both banks upstream of both 09BALD00108I and 09BALD00100I. This is mainly due to insufficient culvert capacity but a low right bank immediately upstream of culvert 09BALD00108I also contributes. This flooding mainly flows West across Greenogue Business Park, affecting up to approximately 25 properties and numerous roads including Grants Rise, Grants Road and College Road. This flooding was found to flow North and affect the sports grounds before rejoining the Baldonnel Watercourse at its confluence with the Griffeen River.

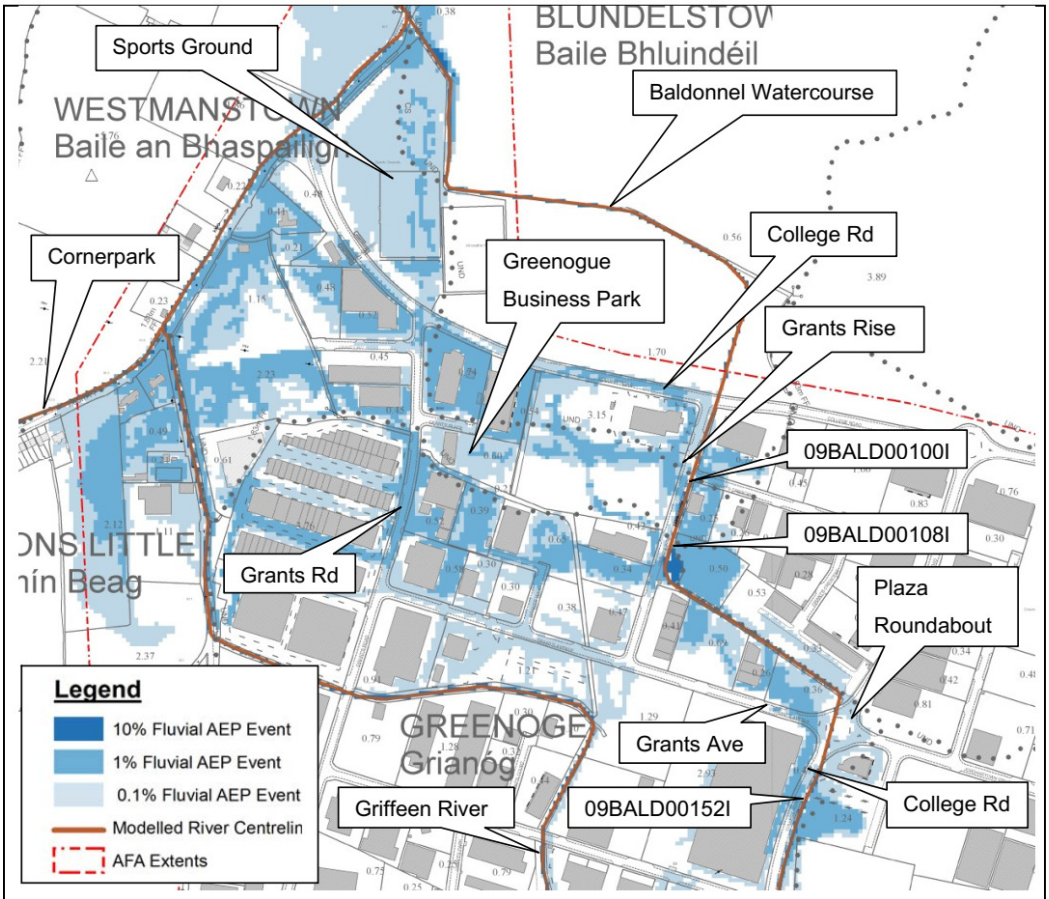


Figure 4.1.37: Flood extents at Greenogue Business Park

(j) Culvert 09GRIF01038I restricts flow on the Griffeen River and causes flow to back up and spill over the right bank immediately upstream into the attenuation pond as shown in Figure 4.1.35. Please refer to Section 4.1.5(2) for an update to the model following informal public consultation and formal S.I. public consultation periods in 2015. Aerial and survey photos were also analysed and it was determined that the pond is designed to remain empty except for during flood events. All model design runs were therefore carried out using initial conditions where the pond is empty at the start of the simulation. It should be noted that sensitivity analysis for this model still has to be undertaken, and it is recommended that this analysis includes the level of the sluice gate and the initial water level within the attenuation pond.

(k) The capacity of the Griffeen River immediately downstream of the attenuation pond was found to be sufficient to convey flows up to 1% AEP. Localised flooding was found to occur during design runs of 0.1% AEP from the Griffeen river downstream of the outlet of culvert 09GRIF01019I. This is due to insufficient channel capacity resulting in flow spilling over a low right bank. Bridge 09GRIF00969D was also found to become surcharged during design runs of 0.1% AEP, resulting in flooding from the right bank affecting Grant's Avenue and approximately 5 properties at Greenogue Business Park. This floodwater then combines with floodwater from the Baldonnel Watercourse.

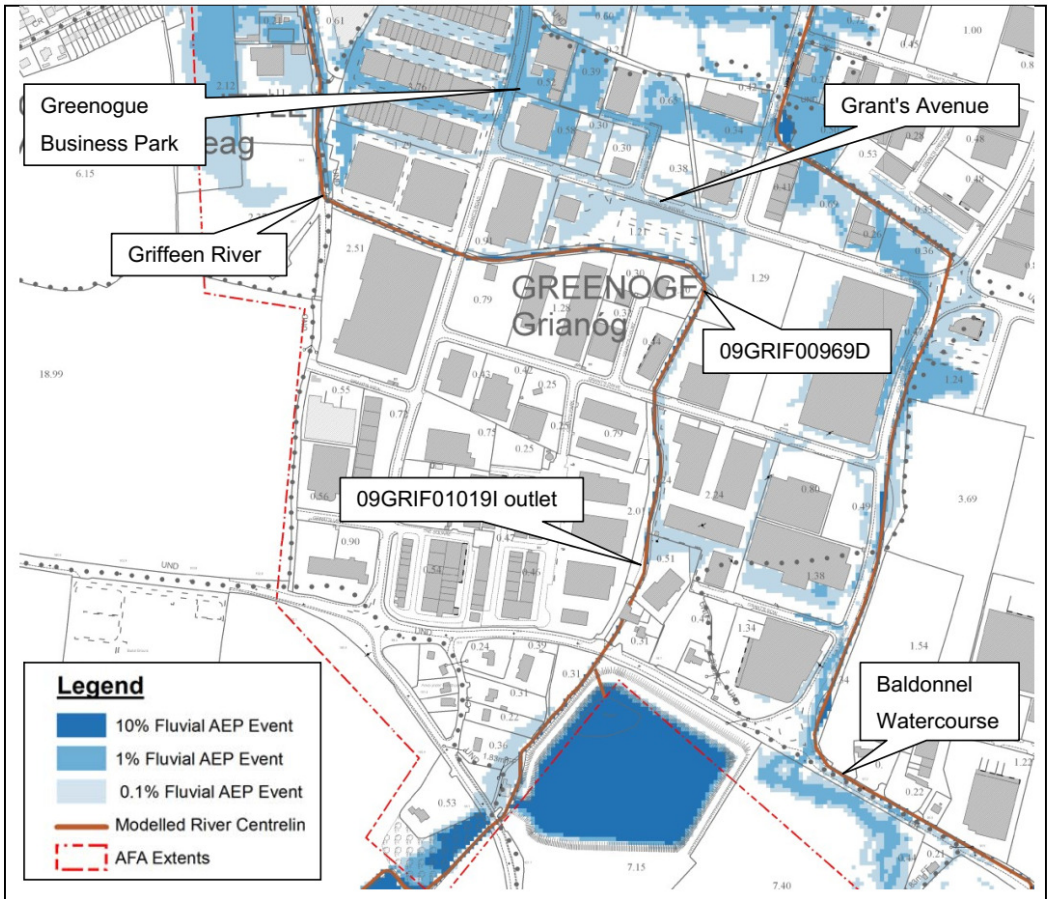


Figure 4.1.38: Flood extents immediately downstream of attenuation pond

(l) The Cornerpark watercourse is relatively flat, and when the survey specification was drawn up it was thought that this river flowed into the Griffeen River. However when the reach was surveyed it was found to flow away from Griffeen instead. Out-of-bank flooding was found to occur at the confluence of the Griffeen River and Cornerpark during design runs of 1% AEP or greater due to the influence of culverts 09GRIF00881D, 09GRIF00880I and 09CARK00003I at this junction, as shown in Figure 4.1.39. This flooding affects up to approximately 10 properties and the Aylmer Road. Culvert 09CARK00013I also restricts flow on the Cornerpark and is one of the main hydraulic factors governing how flow is split between the Griffeen River and the Cornerpark at this confluence.

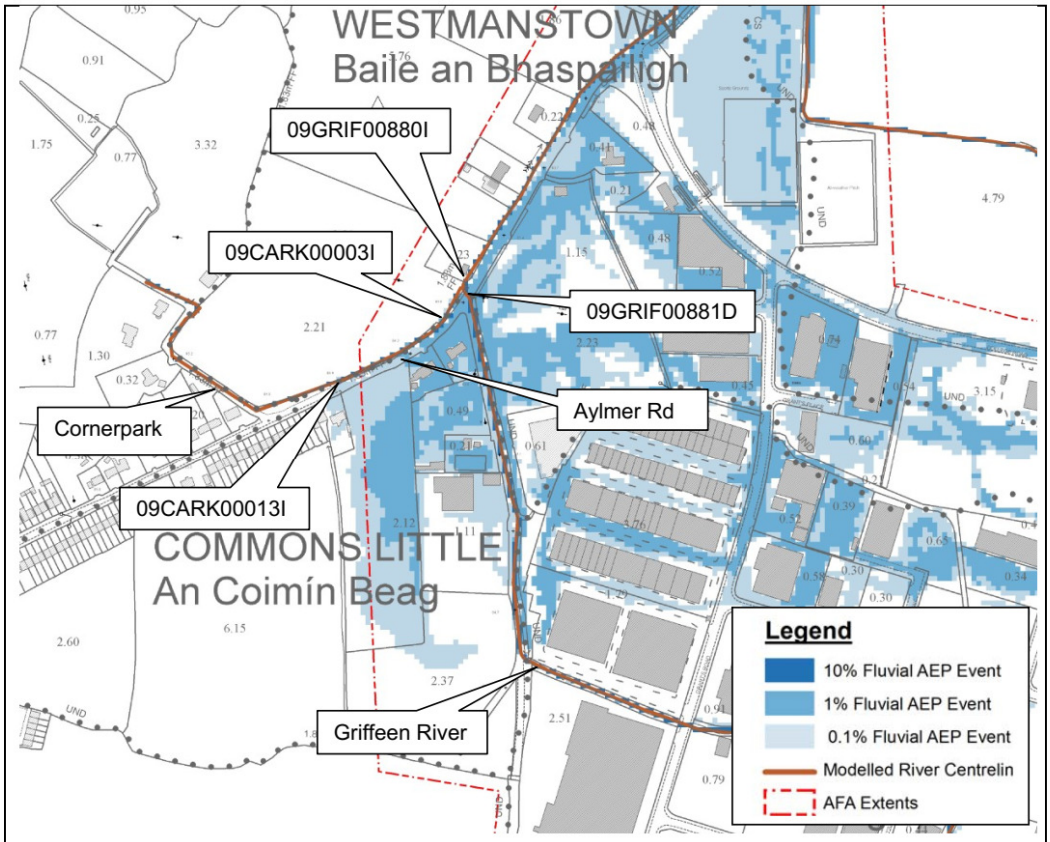


Figure 4.1.39: Flooding at confluence of Griffeen River and Cornerpark watercourse

(m) Out-of-bank flooding was found to occur immediately downstream of the confluence between the Griffeen River and the Baldonnel watercourse during design runs of 1% AEP or greater, as shown in Figure 4.1.40. This is due to inadequate channel capacity, leading to out-of-bank flooding from both banks. Up to approximately 5 properties, a local road and an area of agricultural land are affected by this flooding. Flooding was also found to occur during design runs of 10% AEP or greater due to insufficient capacity of bridge 09GRIF00694D. Flooding from this bridge was found to spill over the right bank and flow parallel to the Griffeen before rejoining the Griffeen River immediately downstream of the R134 New Nangor Road. In addition to the R134, up to approximately 5 properties, a local road and agricultural land were found to be affected by this flooding. Bridge 09GRIF00582D at the R134 New Nangor Road was also found to lack capacity, resulting in flooding from the left bank of the Griffeen River upstream of the bridge during design runs of 1% AEP or greater. This results in further flooding of the R134 and agricultural land immediately North of the road.

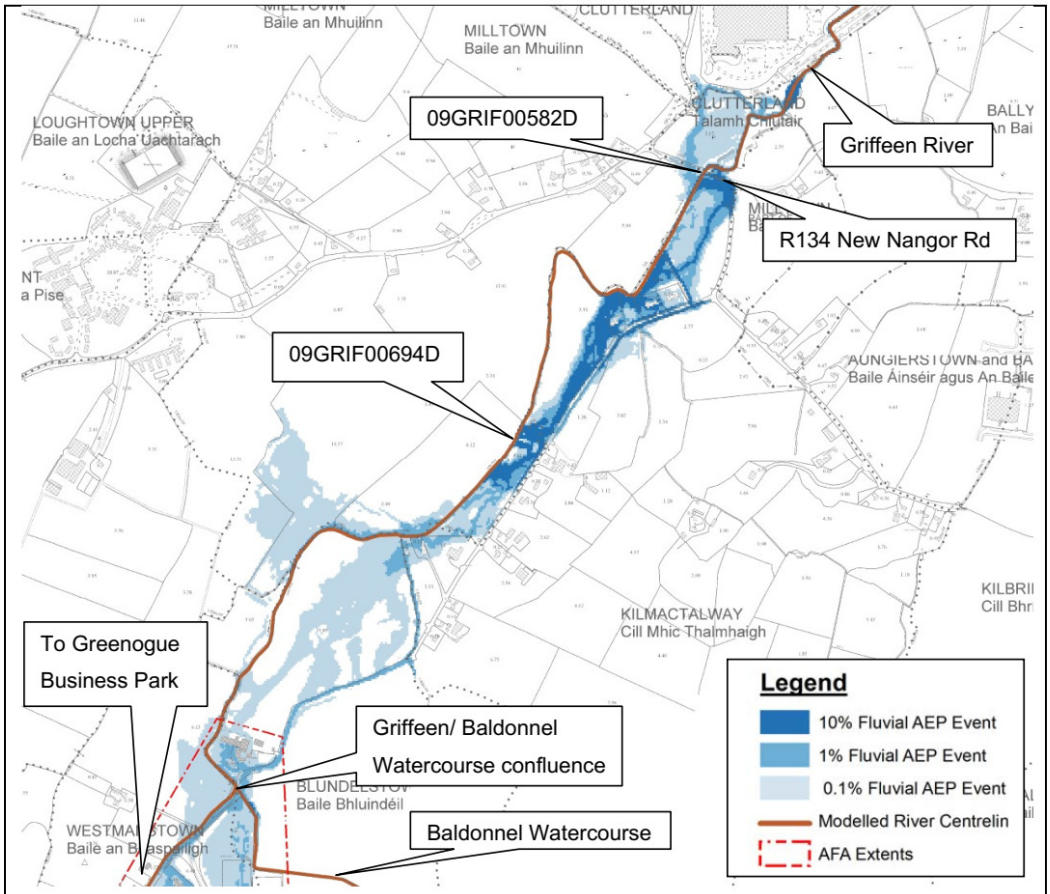


Figure 4.1.40: Flood extents on the Griffeen River downstream of Greenogue Business Park

(n) Flooding was found to occur on the Griffeen River during design runs of 0.1% AEP due to insufficient capacity of culvert 09GRIF00474I, as shown in Figure 4.1.41. This flooding was found to affect an area of agricultural land and a local road. Localised flooding was also found to occur immediately upstream of the inlet to bridge 09GRIF00389D which passes under the Grand Canal. This flooding occurs during design runs of 1% AEP or greater due to the restrictive effect of this bridge, and was found to affect a localised area of agricultural land.

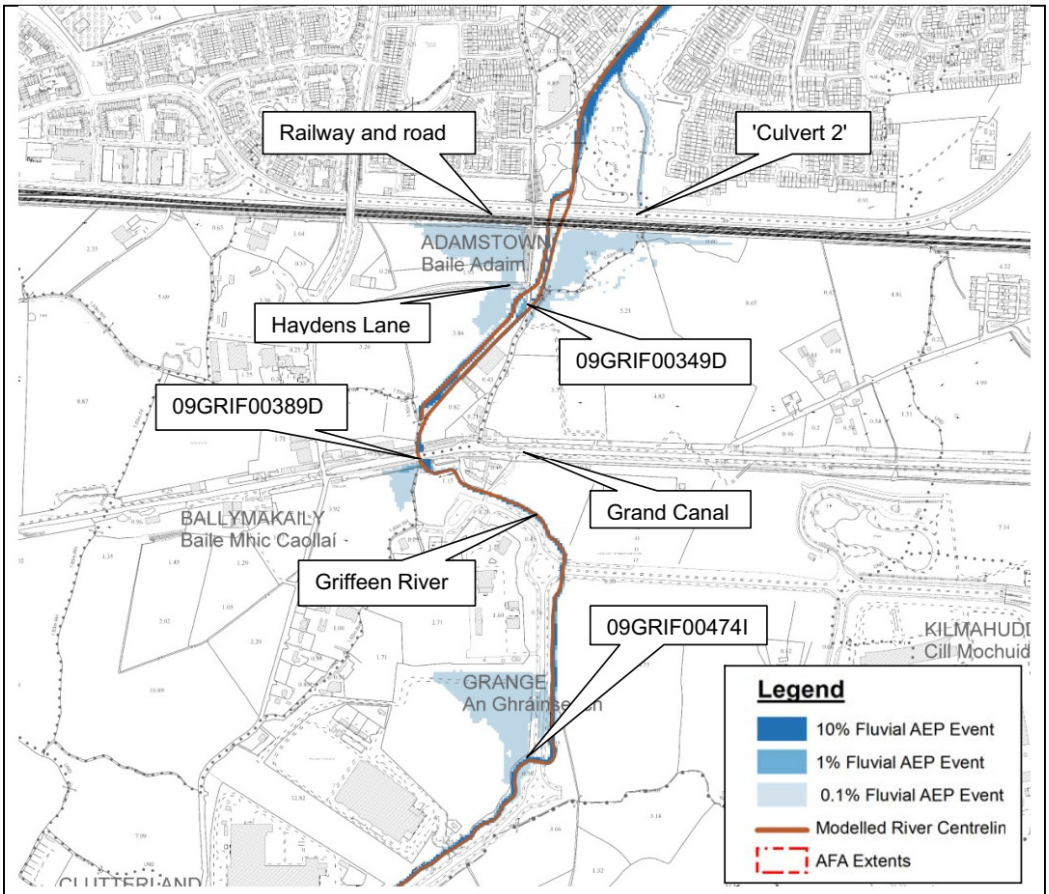


Figure 4.1.41: Flood extents on the lower Griffeen River

(o) Flooding was found to occur from the right bank of the Griffeen River immediately downstream of the outlet of the bridge 09GRIF00349D during design runs of 0.1% AEP, as shown in Figure 4.1.41. Flooding is due to insufficient channel capacity. Floodwater affects agricultural land and ponds against the edge of the railway before flowing into a bypass culvert ('Culvert 2' within the model) under the railway and road. This is the culvert located approximately 180m East of the Griffeen River, as discussed in Section 4.1.2(9). After passing through this culvert, water flows along a minor channel before rejoining the Griffeen River approximately 300m downstream of the culvert. Flooding was also found to occur from the left bank of the left channel of the Griffeen River upstream of bridge 09GRIF00349D. This is due to the capacity of the left-hand channel becoming exceeded, resulting in flooding which affects Haydens Lane and agricultural land.

(4) Hydraulic Model Deliverables:

Please see Appendix A.4 for a list of all model files provided with this report.

(5) Quality Assurance:	
Model Constructed by:	David Irwin
Model Reviewed by:	Stephen Patterson
Model Approved by:	Malcolm Brian

APPENDIX A.1

Structure Details – Bridges and Culverts

RIVER BRANCH	CHAINAGE	ID	LENGTH (m)	OPENING SHAPE	HEIGHT (m)	WIDTH (m)	SPRING HEIGHT FROM INVERT (m)	MANNING'S N
GRIFFEEN RIVER	191.242	09GRIF01349D	11.65	Irregular x2	1.09, 1.24	0.65, 0.91	N/A	0.025
GRIFFEEN RIVER	382.223	09GRIF01330I	4	Circular	0.90	N/A	N/A	0.013
GRIFFEEN RIVER	925.49	09GRIF01275I	4	Circular	0.75	N/A	N/A	0.013
GRIFFEEN RIVER	1042.911	09GRIF01262I	4.2	Circular	0.75	N/A	N/A	0.013
GRIFFEEN RIVER*	1179.996	09GRIF01250I	126.39	Circular	0.75	N/A	N/A	0.013
GRIFFEEN RIVER	1340.598	09GRIF01235I	40.68	Circular	0.75	N/A	N/A	0.015
GRIFFEEN RIVER	2308.273	09GRIF01138D	5.6	Irregular	1.05	1.78	N/A	0.013
GRIFFEEN RIVER	3239.234	09GRIF01045D	16.43	Irregular	1.70	2.85	N/A	0.02
GRIFFEEN RIVER	3279.859	09GRIF01038I	7.86	Irregular	0.64	1.00	N/A	0.013
GRIFFEEN RIVER*	3479.692	09GRIF01019I	128.04	Irregular	1.15	2.30	N/A	0.02
GRIFFEEN RIVER	3823.418	09GRIF00986D	13.8	Irregular	1.29	3.95	N/A	0.02
GRIFFEEN RIVER	3986.162	09GRIF00969D	1.98	Irregular	1.05	2.94	N/A	0.02
GRIFFEEN RIVER	4295.4	09GRIF00938D	14	Irregular	1.02	3.02	N/A	0.02
GRIFFEEN RIVER	4477.893	09GRIF00918I	5.46	Irregular	1.17	2.12	N/A	0.02
GRIFFEEN RIVER	4853.563	09GRIF00881D	12.06	Irregular	1.22	3.92	N/A	0.02
GRIFFEEN RIVER	4871.815	09GRIF00880I	9.1	Circular	1.00	N/A	N/A	0.02
GRIFFEEN RIVER	4990.822	09GRIF00868D	6.68	Arch	1.41	1.15	0.87	0.02
GRIFFEEN RIVER	5061.978	09GRIF00860I	4.5	Circular x2	0.90 (x2)	N/A	N/A	0.013
GRIFFEEN RIVER	5075.014	09GRIF00859	1	Arch	1.29	1.21	0.93	0.025

Structure Details – Bridges and Culverts

RIVER BRANCH	CHAINAGE	ID	LENGTH (m)	OPENING SHAPE	HEIGHT (m)	WIDTH (m)	SPRING HEIGHT FROM INVERT (m)	MANNING'S N
GRIFFEEN RIVER	5088.927	09GRIF00858	1	Arch	1.50	1.17	1.08	0.025
GRIFFEEN RIVER	5279.446	09GRIF00847I	167.74	Circular	1.10	N/A	N/A	0.013
GRIFFEEN RIVER	5693.901	09GRIF00799D	4.91	Irregular	1.75	1.60	N/A	0.02
GRIFFEEN RIVER	6745.056	09GRIF00694D	4.14	Irregular	1.31	1.93	N/A	0.02
GRIFFEEN RIVER	7865.284	09GRIF00582D	6.82	Arch	1.56	1.73	1.13	0.02
GRIFFEEN RIVER	8119.588	09GRIF00557I	28.256	Irregular	2.20	5.93	N/A	0.02
GRIFFEEN RIVER	8201.71	09GRIF00548I	31.69	Irregular	2.38	5.97	N/A	0.02
GRIFFEEN RIVER	8446.489	09GRIF00526I	35.1	Irregular	1.87	5.99	N/A	0.02
GRIFFEEN RIVER	8668.595	09GRIF00502D	12.888	Irregular	2.10	14.55	N/A	0.035
GRIFFEEN RIVER	8956.04	09GRIF00474I	35.12	Irregular	2.40	6.00	N/A	0.02
GRIFFEEN RIVER	9384.137	09GRIF00431I	43.85	Arch	3.46	4.84	0.84	0.02
GRIFFEEN RIVER	9622.29	09GRIF00407I	38.254	Irregular	1.90	4.51	N/A	0.02
GRIFFEEN RIVER	9807.765	09GRIF00389D	25.898	Arch x2, Irregular	2.00, 2.01, 1.78	1.57, 1.52, 4.50	1.17, 2.01, N/A	0.023
GRIFFEEN RIVER	9905.062	09GRIF00377I	6.63	Irregular	1.04	1.34	N/A	0.02
GRIFFEEN RIVER	10194.08	09GRIF00349D	10.8	Arch	1.45	2.37	0.99	0.033
GRIFFEEN RIVER	10404.28	09GRIF00330I	53.244	Arch	2.00	2.30	1.18	0.023
GRIFFEEN RIVER	11069.9	09GRIF00262I	21.01	Irregular	1.50	3.74	N/A	0.02
GRIFFEEN RIVER	11833.24	09GRIF00185D	2	Irregular	1.53	8.48	N/A	0.025
GRIFFEEN RIVER	12134.03	09GRIF00154 wall	1	Arch	2.14	2.78	1.37	0.025

Structure Details – Bridges and Culverts

RIVER BRANCH	CHAINAGE	ID	LENGTH (m)	OPENING SHAPE	HEIGHT (m)	WIDTH (m)	SPRING HEIGHT FROM INVERT (m)	MANNING'S N
GRIFFEEN RIVER	12176.35	09GRIF00150D	12.134	Multi-span x3	1.75, 1.52, 1.45	3.27, 3.56, 2.89	N/A	0.02
GRIFFEEN RIVER	12505.56	09GRIF00119I	53.96	Arch	2.13	3.55	0.87	0.024
GRIFFEEN RIVER	12686.07	09GRIF00099D	4.16	Arch	2.20	3.72	1.32	0.02
CARRIGEEN	450.785	09CARR00333D	7.636	Arch	1.57	1.80	0.71	0.025
CARRIGEEN	515.152	09CARR00326D	8.274	Irregular x2	1.00, 1.05	0.78, 0.72	N/A	0.03
CARRIGEEN	1024.566	09CARR00280I	4.418	Circular	0.75	N/A	N/A	0.013
CARRIGEEN	1173.407	09CARR00261I	22.766	Circular	0.75	N/A	N/A	0.013
CARRIGEEN	1223.846	09CARR00255I	6.74	Circular	0.90	N/A	N/A	0.013
CARRIGEEN	1294.05	09CARR00246I	11.646	Circular	0.60	N/A	N/A	0.013
CARRIGEEN	1458.195	09CARR00230I	8.746	Circular	0.75	N/A	N/A	0.013
CARRIGEEN	1567.837	09CARR00219I	6.46	Circular	0.60	N/A	N/A	0.013
CARRIGEEN	1853.12	09CARR00191I	9.94	Circular	0.60	N/A	N/A	0.013
CARRIGEEN	2189.345	09CARR00160D	7.19	Irregular x2	0.97, 1.00	0.75, 0.84	N/A	0.025
CARRIGEEN	2220.968	09CARR00156I1	5.358	Circular	0.60	N/A	N/A	0.013
CARRIGEEN	2220.968	09CARR00156I2	5.358	Circular	0.53	N/A	N/A	0.013
CARRIGEEN	2625.821	09CARR00118I	36.08	Circular	1.50	N/A	N/A	0.019
CARRIGEEN	2710.914	09CARR00112I	65.86	Circular	1.65	N/A	N/A	0.019
CARRIGEEN	2923.983	09CARR00089I	5.17	Circular x2	0.45	N/A	N/A	0.013

Structure Details – Bridges and Culverts

RIVER BRANCH	CHAINAGE	ID	LENGTH (m)	OPENING SHAPE	HEIGHT (m)	WIDTH (m)	SPRING HEIGHT FROM INVERT (m)	MANNING'S N
CARRIGEEN	3415.915	09CARR00041I	6.73	Circular	0.45	N/A	N/A	0.013
BALDONNEL WATERCOURSE	69.883	09BALD00341I	38.3	Circular	0.75	N/A	N/A	0.013
BALDONNEL WATERCOURSE	131.101	09BALD00336I	60.88	Irregular	1.21	1.77	N/A	0.025
BALDONNEL WATERCOURSE*	197.412	09BALD00327I	104.92	Circular	1.20	N/A	N/A	0.013
BALDONNEL WATERCOURSE	354.437	09BALD00314I	67.38	Circular	1.20	N/A	N/A	0.013
BALDONNEL WATERCOURSE	396.558	09BALD00306D	3.58	Irregular	1.08	2.56	N/A	0.02
BALDONNEL WATERCOURSE	535.377	09BALD00293D	4.5	Arch	0.56	0.66	0.36	0.013
BALDONNEL WATERCOURSE	619.971	09BALD00284I	4.5	Circular	0.60	N/A	N/A	0.013
BALDONNEL WATERCOURSE*	1110.647	09BALD00236I	341.74	Irregular	1.04	1.78	N/A	0.02
BALDONNEL WATERCOURSE	1813.616	09BALD00165I	7.15	Irregular	1.13	1.79	N/A	0.02
BALDONNEL WATERCOURSE	1954.989	09BALD00152I	21.18	Irregular	1.00	1.67	N/A	0.02
BALDONNEL WATERCOURSE	2032.846	09BALD00147I	90.41	Irregular	0.97	1.77	N/A	0.02
BALDONNEL WATERCOURSE	2388.15	09BALD00108I	28.04	Irregular	0.99	1.63	N/A	0.02

Structure Details – Bridges and Culverts								
RIVER BRANCH	**CHAINAGE**	**ID**	**LENGTH (m)**	**OPENING SHAPE**	**HEIGHT (m)**	**WIDTH (m)**	**SPRING HEIGHT FROM INVERT (m)**	**MANNING'S N**
BALDONNEL WATERCOURSE	2475.584	09BALD00100I	32.7	Irregular	0.97	1.66	N/A	0.02
BALDONNEL WATERCOURSE	2518.657	09BALD00094I	11.95	Irregular	0.96	1.82	N/A	0.02
BALDONNEL WATERCOURSE	2571.631	09BALD00091D	44.6	Irregular	0.98	1.82	N/A	0.02
BALDONNEL WATERCOURSE	3329.613	09BALD00003I	25.772	Irregular	1.01	1.81	N/A	0.02
CORNERPARK	46.482	09CARK00003I	7.9	Circular	1.20	N/A	N/A	0.013
CORNERPARK*	161.522	09CARK00013I	202.14	Circular	1.00	N/A	N/A	0.013
CORNERPARK	420.595	09CARK00041D	14.77	Irregular	0.85	1.68	N/A	0.025
CULVERT 262I	50.326	09GRIF00262Ir	21.01	Irregular	1.46	5.88	N/A	0.02
FLOOD CHANNEL	354.75	09GRIF00349D FC	15.5	Irregular	1.35	5.49	N/A	0.035
FLOOD CHANNEL	522.25	09GRIF00330I FC	54.5	Irregular	1.55	5.80	N/A	0.034
POND OUTLET*	0	09POND	35	Circular	0.23	N/A	N/A	0.013
CULVERT 1*	0	09CULV1	10.5	Irregular	1.14	2.93	N/A	0.025
CULVERT 2*	0	09CULV2	66.7	Irregular	1.19	2.90	N/A	0.025

Structure Details - Weirs				
RIVER BRANCH	**CHAINAGE**	**ID**	**MANNING'S N**	**TYPE**
GRIFFEEN RIVER	8233.923	09GRIF00541W	0.015	Broad Crested Weir
GRIFFEEN RIVER	9414.452	09GRIF00425W	0.015	Broad Crested Weir
GRIFFEEN RIVER	9652.994	09GRIF00402W	0.013	Broad Crested Weir
GRIFFEEN RIVER	10434.22	09GRIF00324W	0.013	Broad Crested Weir
GRIFFEEN RIVER	11083.51	09GRIF00258W	0.015	Broad Crested Weir
GRIFFEEN RIVER	11360.59	09GRIF00232W	0.025	Broad Crested Weir
GRIFFEEN RIVER	11639.02	09GRIF00204W	0.025	Broad Crested Weir
GRIFFEEN RIVER	12006.52	09GRIF00169W	0.013	Broad Crested Weir
GRIFFEEN RIVER	12026.05	09GRIF00165W	0.025	Broad Crested Weir
GRIFFEEN RIVER	12048.56	09GRIF00162W	0.015	Broad Crested Weir
GRIFFEEN RIVER	12149.86	09GRIF00153W	0.025	Broad Crested Weir
GRIFFEEN RIVER	12410.93	09GRIF00127W	0.025	Broad Crested Weir
GRIFFEEN RIVER	12438.2	09GRIF00124W	0.025	Broad Crested Weir
GRIFFEEN RIVER	12552.5	09GRIF00111W	0.013	Broad Crested Weir
GRIFFEEN RIVER	12663.75	09GRIF00101W	0.015	Broad Crested Weir
GRIFFEEN RIVER	12912.9	09GRIF00077W	0.04	Broad Crested Weir
GRIFFEEN RIVER	13054.52	09GRIF00062W	0.04	Broad Crested Weir
GRIFFEEN RIVER	13147.21	09GRIF00052W	0.04	Broad Crested Weir
GRIFFEEN RIVER	13150.27	09GRIF00051W	0.04	Broad Crested Weir
GRIFFEEN RIVER	13343.73	09GRIF00032W	0.04	Broad Crested Weir
GRIFFEEN RIVER	13471.63	09GRIF00020W	0.04	Broad Crested Weir

* Denotes structures incorporated as closed cross-sections only (and are therefore not included in the Network file).

** Structure ID Key:

D - Bridge Upstream Face
E - Bridge Downstream Face
I - Culvert Upstream Face
J - Culvert Downstream Face
W - Weir Crest

NB: All other weirs in the Network file are overtopping weirs which form part of a composite structure with the culvert/bridge at the corresponding chainage.

APPENDIX A.2

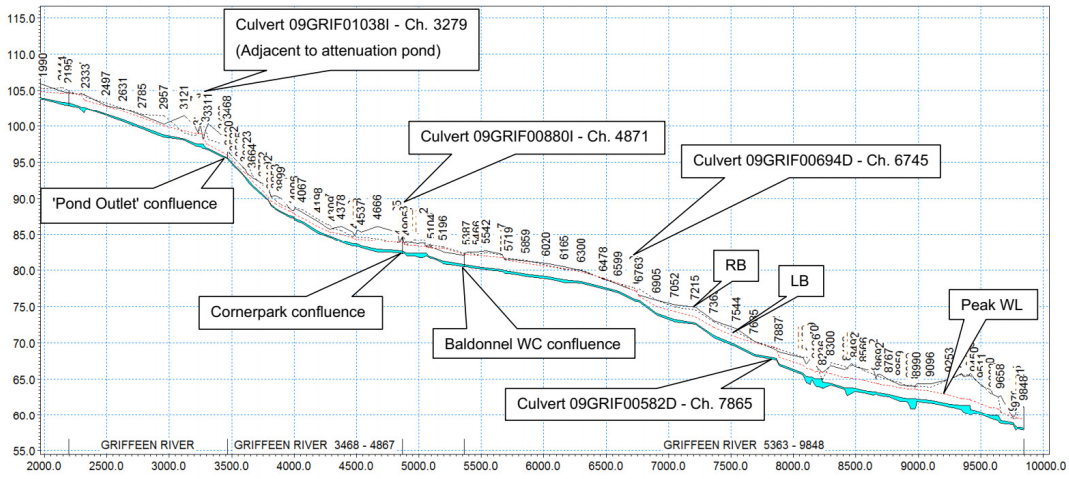


Figure 4.1.42: Griffeen River 1% AEP design run

APPENDIX A.3

IBE0600 EASTERN CFRAM STUDY **RPS**
PEAK WATER FLOWS

AFA Name	BALDONNEL
Model Code	HA09_BALD2A

	Peak Water Flows			
River Name & Chainage	**AEP**	**Check Flow (m3/s)**	**Model Flow (m3/s)**	**Diff (%)**
CARRIGEEN 3803.65	10%	2.79	2.97	6.24
09_1165_5	1%	5.15	5.27	2.41
	0.1%	9.18	7.61	-17.10
BALDONNEL WATERCOURSE 3282.24	10%	2.97	3.05	2.76
UN_Trib_Griff_1	1%	5.49	4.43	-19.38
	0.1%	9.8	6.55	-33.14
CORNERPARK 464.359	10%	N/A	1.30	N/A
UN_Trib_Griffn_U	1%	N/A	1.52	N/A
	0.1%	N/A	1.86	N/A
GRIFFEEN RIVER 11565.9	10%	10.56	9.74	-7.78
09_1120_3_RPS	1%	18.09	15.97	-11.74
	0.1%	29.68	37.28	25.60
GRIFFEEN RIVER 11565.9 & CORNERPARK 464.359 (Combined)	10%	10.56	11.03	4.48
09_1120_3_RPS & UN_Trib_Griffn_U	1%	18.09	17.49	-3.32
	0.1%	29.68	39.14	31.88

The table above provides details of the flow in the model at every HEP intermediate check point, modelled tributary and gauging station. These flows have been compared with the hydrology flow estimation and a percentage difference provided. Note that a percentage difference for HEP UN_Trib_Griffn_U has not been provided. The reason for this is discussed in detail later in this section.

The estimated and modelled flows at the downstream end of the Carrigeen watercourse (HEP 09_1165_5) correlate well during the 10% AEP and 1% AEP design runs. During the 0.1% AEP design run the modelled flow is approximately 17% lower than the hydrological estimate. This is due to the effect of culvert 09CARR00089I which lacks capacity and causes flow to flood out-of-bank during design runs of 10% AEP or greater, as shown in Figure 4.1.35. During the 10% AEP and 1% AEP design runs, the majority of the overland flow from this flooding is able to re-enter the Carrigeen further downstream, however during the 0.1% AEP design run a considerable proportion of flooding from the

right bank flows overland towards the Baldonnel Watercourse, therefore reducing the modelled flow in the Carrigeen.

The estimated and modelled flows at the downstream end of the Baldonnel Watercourse (HEP UN_Trib_Griff_1) were found to correlate well during the 10% AEP. The modelled flow was found to be approximately 19% and 33% lower than the hydrological estimate during the 1% AEP and 0.1% AEP design runs respectively. This is due to insufficient capacity of culverts 09BALD00152I, 09BALD00108I and 09BALD00100I which cause considerable out-of-bank flooding during design runs of 1% AEP or greater, as shown in Figure 4.1.37. This flooding attenuates the flow in the Baldonnel Watercourse during design runs of 1% AEP or greater, which is not accounted for in the hydrological estimation. These differences were therefore considered to be acceptable as hydraulic modelling can accurately account for the effect of culverts on a watercourse.

The modelled flow at the downstream extent of the model (HEP 09_1120_3_RPS) was found to be approximately 8% lower than the hydrological estimate during design runs of 10% AEP and 12% lower during design runs of 1% AEP. This is because the hydrological estimates at HEP 09_1120_3_RPS are based on all the flow in the catchment flowing to this point. It was discovered during the survey (refer to Section 4.1.2(9)) that the Cornerpark watercourse flows out of the Griffeen catchment and drains to the Shinkeen stream, so the total flow in the catchment is actually shared between the lower Griffeen River and the Cornerpark. The nature of how flow is split between the two watercourses is dependent on hydraulic parameters and cannot be estimated using hydrological methods, so the hydrological estimates of flow were not updated based on this information. A check of the combined modelled flow at the downstream extents of the Griffeen River and the Cornerpark compared to the hydrological estimate of flow at HEP 09_1120_3_RPS was carried out however. When the combined flow is considered, the modelled flow was found to be approximately 5% higher than the hydrological estimate in the 10% AEP design run and approximately 3% lower during the 1% AEP design run. This provides good support for the conclusion that the difference between modelled and hydrological estimates of flow at the downstream extent of the Griffeen River is predominantly because of flow leaving the catchment via the Cornerpark.

The modelled flow at the downstream extent of the Griffeen River was found to be approximately 26% higher than the hydrological estimate during design runs of 0.1% AEP. The same hydrological and hydraulic factors regarding the Griffeen and Cornerpark watercourses apply during the 0.1% AEP design run as have been discussed previously with the 10% AEP and 1% AEP design runs. The reason that the modelled flow is notably higher than the hydrological estimate during the 0.1% AEP design run by contrast is due to cross-catchment flow from the River Camac which is not accounted for in the hydrological estimates of flow. The total additional inflow from the River Camac equates to approximately 9m^3/s. In order to check that the difference is due to this cross-catchment flow, 9m^3/s was taken away from the combined modelled flow at HEP 09_1120_3_RPS on the Griffeen River and

the downstream extent of the Cornerpark, and this total was compared to the hydrological estimate of flow at HEP 09_1120_3_RPS. The combined modelled flow less 9m^3/s cross-catchment flow was found to be approximately 30.14m^3/s which is 2% higher than the hydrological estimate, which provides good support for this conclusion.

Values of flow at the downstream extent of the Cornerpark (HEP UN_Trib_Griffn_U) are given in the table above. Flow splits at the confluence of the Griffeen River and the Cornerpark, and as the catchment in this area is relatively flat the amount of flow on the Cornerpark is mainly governed by culvert 09CARK00013I. Hydrological estimates of flow cannot be derived for this location, so a percentage difference is not provided. A reality check of the maximum flow values for each design run was carried out using the CIRIA Culvert Design and Operation Guide (2010). The discharge values calculated using the CIRIA Culvert Design and Operation Guide were found to be in the same order of magnitude to the maximum modelled flow at the downstream extent of the Cornerpark, so the modelled values were considered to be reasonable.

APPENDIX A.4

Fluvial Model Files		
MIKE FLOOD	**MIKE 21**	**MIKE 21 RESULTS**
HA09_ BALD2A _MF_DES_14_Q10	HA09_BALD2A_M21_DES_14_Q10	HA09_BALD2A_M21_DES_14_Q10
HA09_ BALD2A _MF_DES_14_Q100	HA09_BALD2A_M21_DES_14_Q100	HA09_BALD2A_M21_DES_14_Q100
HA09_ BALD2A _MF_DES_14_Q1000	HA09_BALD2A_M21_DES_14_Q1000 HA09_BALD2A_DFS2_MESH_14 HA09_BALD2A_DFS2_MESH_14_FPR	HA09_BALD2A_M21_DES_14_Q1000

MIKE 11 - SIM FILE & RESULTS FILE	**MIKE 11 - NETWORK FILE**	**MIKE 11 - CROSS-SECTION FILE**	**MIKE 11 - BOUNDARY FILE**
HA09_BALD2A_M11_DES_14_Q10 HA09_BALD2A_M11_DES_14_Q100 HA09_BALD2A_M11_DES_14_Q1000	HA09_BALD2A_NWK_DES_14	HA09_BALD2A_XNS_DES_14	HA09_BALD2A_BND_DES_14_Q10 HA09_BALD2A_BND_DES_14_Q100 HA09_BALD2A_BND_DES_14_Q1000
MIKE 11 - DFS0 FILE		**MIKE 11 - HD FILE & RESULTS FILE**	
HA09_BALD2A_DFS0_Q10 HA09_BALD2A_DFS0_Q100 HA09_BALD2A_DFS0_Q1000 HA09_BALD2A_DFS0_Q1000_Camac		HA09_BALD2A_HD_DES_14_Q10 HA09_BALD2A_HD_DES_14_Q100 HA09_BALD2A_HD_DES_14_Q1000	

GIS Deliverables - Hazard

Flood Extent Files (Shapefiles)	**Flood Depth Files (Raster)**	**Water Level and Flows (Shapefiles)**
Fluvial E05EXFCD100F0 E05EXFCD010F0 E05EXFCD001F0	Fluvial E05DPFCD100F0 E05DPFCD010F0 E05DPFCD001F0	Fluvial E05NFCDF0
Flood Zone Files (Shapefiles)	**Flood Velocity Files (Raster)**	**Flood Defence Files (Shapefiles)**
E05ZNA_FCDF0 E05ZNB_FCDF0	E05VLFCD100F0 E05VLFCD010F0	N/A
	E05VLFCD001F0	

GIS Deliverables - Risk

Specific Risk - Inhabitants (Raster)	**General Risk - Economic (Shapefiles)**	**General Risk-Environmental (Shapefiles)**
Fluvial E05RIFCD100F0 E05RIFCD010F0 E05RIFCD001F0		

Appendix 8.3 Grange Castle Flood Study – Additional Hydraulic Modelling Report

GRANGECASTLE FLOOD STUDY

Additional Hydraulic Modelling Report

MDW0856 Grangecastle
Flood Study
Additional Modelling
A02
24 February 2020

rpsgroup.com

REPORT

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REPORT

Contents

Tables

Figures

Appendices

ADDITIONAL HYDRAULIC MODELLING REPORT

1 INTRODUCTION

RPS was commissioned by Cronin & Sutton Consulting Engineers and completed a Flood Study Report for a proposed development site in Grangecastle, Co. Dublin. That Report contained recommended mitigation measures necessary to alleviate flooding within the site without increasing flood risk elsewhere. RPS was again requested to undertake additional hydraulic modelling to:

- establish whether the proposed solutions to alleviate out-of-bank flooding from the south within the proposed development site was adequate,
- assess whether the proposed development within the site increases the flood risk to the Baldonnell Stream,
- assess Flood Compensatory Storage for the Baldonnell Stream to reduce peak water levels within the Baldonnell Stream adjacent to the proposed development site.

2 PROPOSED FLOOD ALLEVIATION MEASURES

The proposed measures to alleviate flooding within the development site consisted of a 450mm diameter pipe (total length – approximately 315m) to intercept out-of-bank flooding from the south and discharge directly to the Baldonnell Stream. The ground within the inlet, to the proposed 450mm diameter pipe, is to be profiled to intercept and contain the out-of-bank flooding for discharge to the Baldonnell Stream. The layout of the proposed 450mm diameter pipe is shown in **Figure 1** (in red).

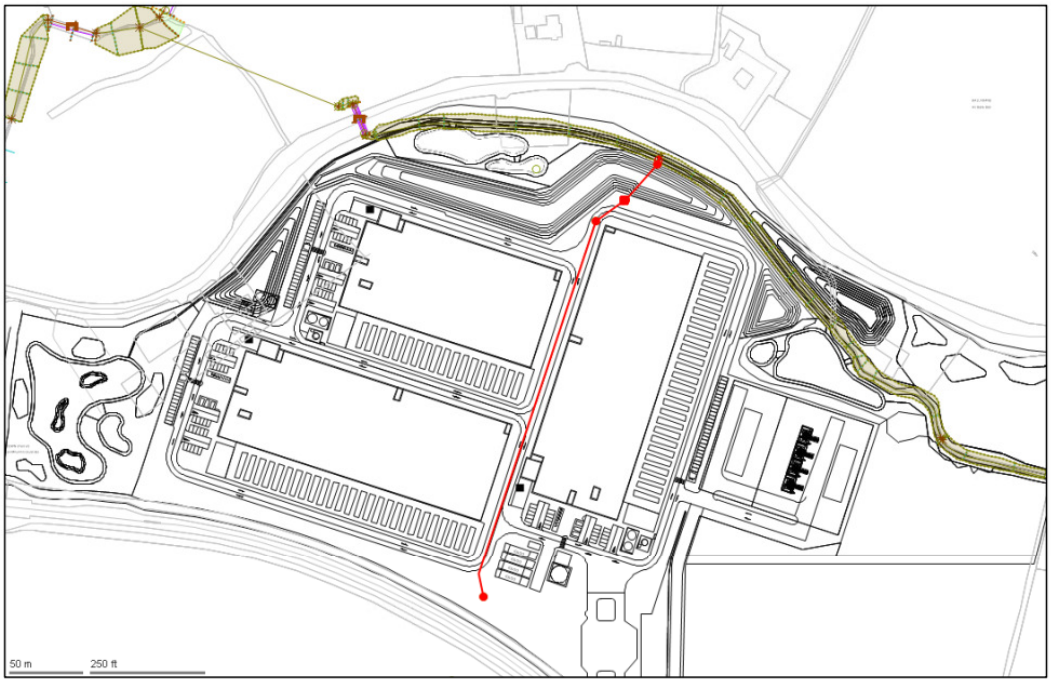


Figure 1: Proposed Solution

3 HYDRAULIC MODELLING UPDATE

The Flood Studies Update (FSU) and Institute of Hydrology no.124 (IoH 124) methods were used to calculate the 1% and 0.1% AEP peak flows for the watercourses within the Griffeen and Camac Catchments in the vicinity of the proposed development site. InfoWorks Integrated Catchment Modelling (ICM) software was used to create a combined 1D/2D hydraulic model. A channel survey and topographical/LiDAR data was collected to represent the river and the surrounding terrain. The model was calibrated and verified based on existing information used in the CFRAM. A sensitivity analysis was carried out to assess the impact on potential flooding from variations in channel roughness, floodplain roughness, bridge/ culvert head losses and peak flow.

Flood extents under the existing condition within the proposed development site were established for both the 1% and 0.1% AEP events. The flooding extent for the 0.1% AEP event within the proposed development site is shown in **Figure 2** and Drawing No. QG0011 which is included in Appendix A of this report.

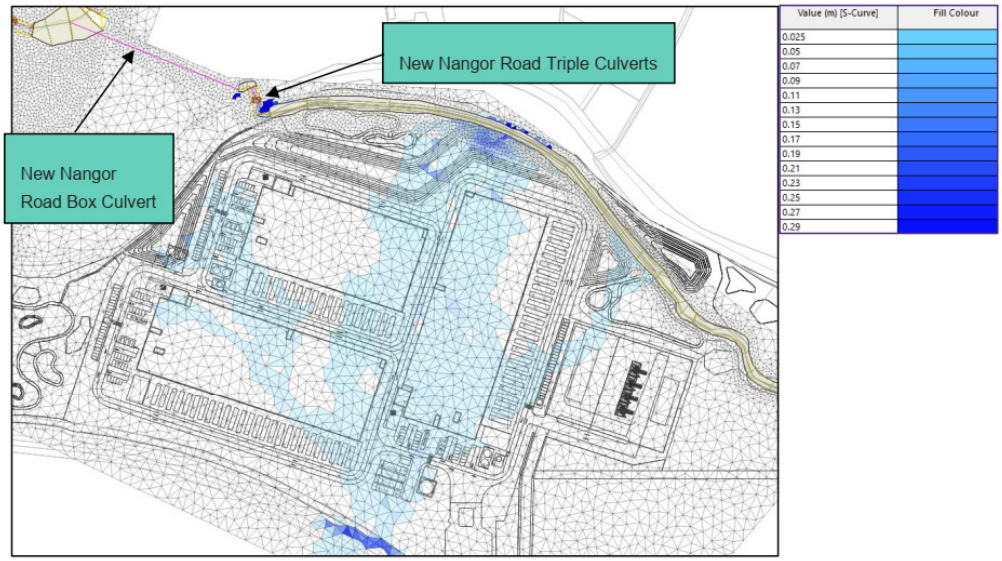


Figure 2: Existing 0.1% AEP Flood Extents at the Proposed Development Site

Flooding within the proposed development site was mainly caused by out-of-bank flooding from the River Camac. No out-of-bank flooding was observed the Baldonnell Stream for the 1% AEP event. However, there were some localised flooding at three locations from for the 0.1% AEP event, one of which was at New Nangor Road Trip Culverts as indicated in **Figure 2**. Flooding at these locations were found to have been caused by the New Nangor Road Box Culvert and Triple Culverts surcharging. It is reasoned that the flow from the south of the proposed development site in the Baldonnell Stream may have increased the flow to these Culverts resulting in surcharging.

The 2D section of the hydraulic model was updated to include the proposed re-profiling and assess the impact on out-of-bank flooding from the south and the Baldonnell River located along the northern boundary. Further adjustments were made to the proposed ground levels at the inlet location to intercept the out-of-bank flow from south and discharge to the Baldonnell Stream adjacent to the development site.

4 HYDRAULIC MODEL RESULTS

The hydraulic model was run for the 1% AEP event including climate change effects. The results, as shown in **Figure 3** and Drawing No. QG0012 included in Appendix A of the report, indicated that the proposed measures were adequate to alleviate flooding for the 1% AEP event taking account of climate change.

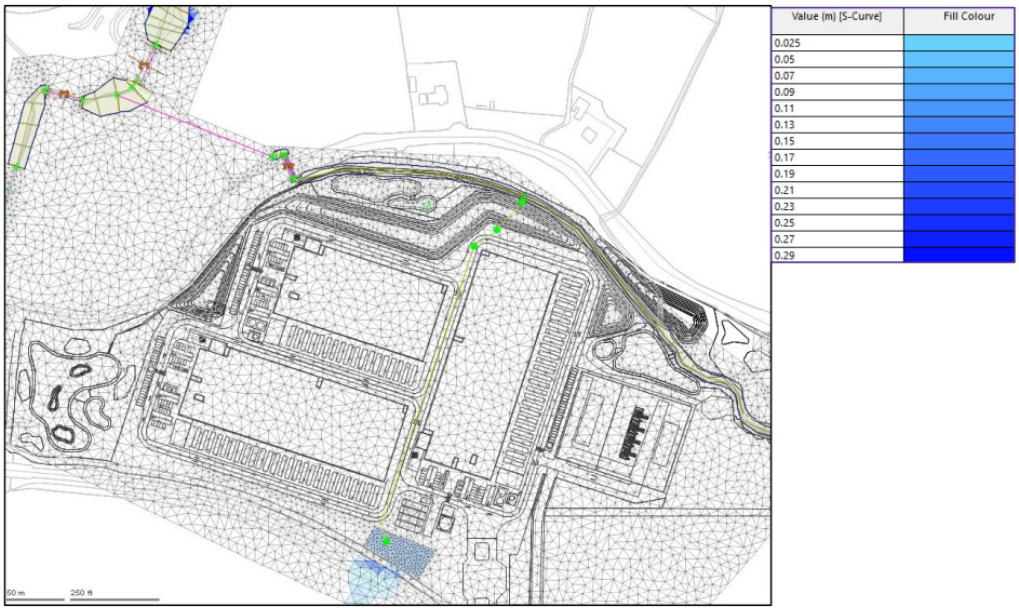


Figure 3: 1% AEP Predicted Flood Extents within Proposed Development Site

The hydraulic model was also run for the 0.1% AEP event to assess the impact of the proposed development site on flood levels within the Baldonnell River. The existing and proposed 0.1% AEP water levels are listed in **Table 1**. The locations for the river sections are shown in **Figure 4** and Drawing No. QG0013 included in Appendix A of this report.

Table 1: Baldonnell Stream 0.1% AEP Predicted Peak Water Levels adjacent to Proposed Development Site

Chainage	Existing 0.1% AEP Section level (m AD)	Proposed 0.1% AEP Section level (m AD)	Difference (mm) (Prop-Exist)
Ch.0.0	70.260	70.115	-145
Ch.21.183	70.008	69.850	-158
Ch.53.791	69.672	69.649	-23
Ch.74.117	69.534	69.535	1
Ch.89.207	69.395	69.397	2
Ch.153.154	68.991	68.989	-2
Ch.164.28	68.923	68.923	0
Ch.183.802	68.843	68.843	0
Ch.212.37	68.729	68.728	-1
Ch.257.56	68.538	68.537	-1

Chainage	Existing 0.1% AEP Section level (m AD)	Proposed 0.1% AEP Section level (m AD)	Difference (mm) (Prop-Exist)
Ch.652.423	68.363	68.361	-2
Ch.808.511	68.357	68.355	-2
Ch.989.156	68.340	68.337	-3
Ch.1193.84	68.334	68.333	-1
Ch.1428.517	68.323	68.323	0
Ch.1695.132	68.314	68.315	1
Ch.1996.974	68.310	68.311	1
Ch.2345.808	68.303	68.304	1
Ch.2710.956	68.301	68.302	1
Ch.2740.056	68.303	68.304	1
Ch.2769.901	68.299	68.301	2
Ch.2806.084	68.302	68.304	2
New Nangor Road Triple Culverts			
Ch.2827.084	68.017	68.019	2
Ch.2830.457	68.014	68.016	2
Ch.2837.514	68.016	68.017	1
Ch.2847.733	68.011	68.013	2

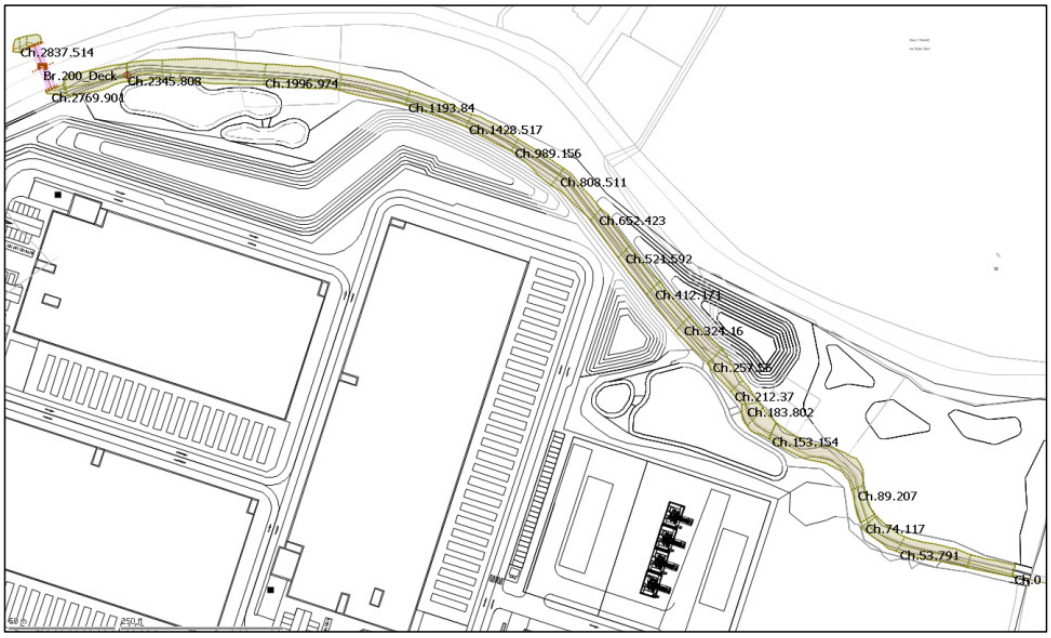


Figure 4: Baldonnell River – Chainages for Cross Section Locations

The results indicated that there was a maximum decrease of 158mm for the 0.1% AEP water level at location upstream of the New Nangor Box Culvert within the Baldonnell Stream. There was a marginal increase of 1

or 2mm at upstream and downstream locations of New Nangor Road Triple Culverts which may be attributed to the diversion of the out of bank discharge from the south, to Baldonnell Stream to the 450mm diameter pipe outfall.

Although this was not considered significant, further hydraulic modelling was carried out by including a flood storage upstream of the proposed development site to mitigate against these increase at the location indicated in **Figure 5**.

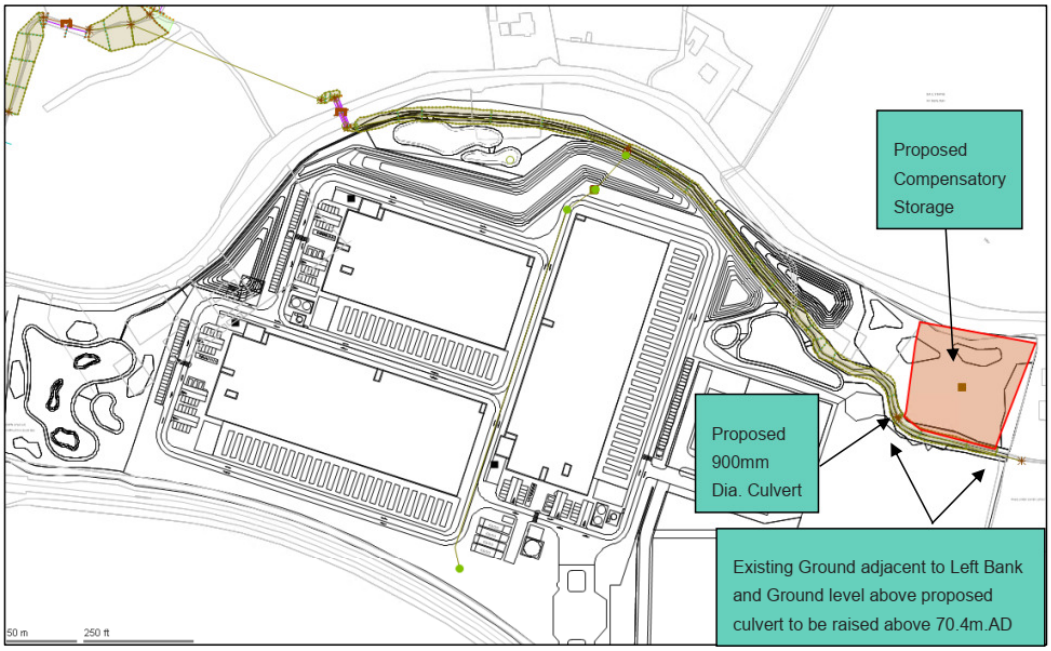


Figure 5: Proposed Flood Compensatory Storage

The right bank of the Baldonnell Stream, facing downstream towards the Griffeen River, between Ch.21.183 and Ch.72.517 was lowered by approximately 1.0m (to storage area bed level – 69.5m.AD) to allow for spillage into the storage area during the 0.1% AEP event. A 900mm diameter culvert was added to the Baldonnell River immediately downstream of the storage area to restrict the peak 0.1% AEP flow. The existing ground adjacent to left bank and deck level above proposed culvert was set above 70.4m.AD. The result of the hydraulic model simulation for the 0.1% AEP event taking account of the proposed flood compensatory storage upstream of the proposed development site is listed in **Table 2**.

Table 2: Baldonnell River 0.1% AEP Predicted Peak Water Levels adjacent to Proposed Development Site (incl. proposed flood compensatory storage)

Chainage	Existing 0.1% AEP Section level (m AD)	Proposed 0.1% AEP Section level (m AD)	Difference (mm) (Prop-Exist)
Ch.0.0	70.260	70.092	-168
Ch.21.183	70.008	70.057	49
Ch.53.791	69.672	70.054	382
Ch.74.117	69.534	69.534	0
Ch.89.207	69.395	69.395	0
Ch.153.154	68.991	68.988	-3
Ch.164.28	68.923	68.922	-1

Chainage	Existing 0.1% AEP Section level (m AD)	Proposed 0.1% AEP Section level (m AD)	Difference (mm) (Prop-Exist)
Ch.183.802	68.843	68.842	-1
Ch.212.37	68.729	68.727	-2
Ch.257.56	68.538	68.536	-2
Ch.652.423	68.363	68.358	-5
Ch.808.511	68.357	68.352	-5
Ch.989.156	68.340	68.334	-6
Ch.1193.84	68.334	68.330	-4
Ch.1428.517	68.323	68.320	-3
Ch.1695.132	68.314	68.311	-3
Ch.1996.974	68.310	68.308	-2
Ch.2345.808	68.303	68.300	-3
Ch.2710.956	68.301	68.298	-3
Ch.2740.056	68.303	68.301	-2
Ch.2769.901	68.299	68.298	-1
Ch.2806.084	68.302	68.301	-1
New Nangor Road Triple Culverts			
Ch.2827.084	68.017	68.016	-1
Ch.2830.457	68.014	68.013	-1
Ch.2837.514	68.016	68.014	-2

It can be seen that the proposed attenuation has eliminated any increase in the flood level upstream and downstream of the specified culvert location. It is noted that there was a maximum increase of 382mm in 0.1% AEP peak water level at the storage area which is directly attributed to the level retention of floodwaters. This increase is not expected to propagate upstream as the level is higher as noted in Chainage 0.0. The total storage volume storage retained was calculated to be approximately 2,785m^3 over an area of 5,500m^2.

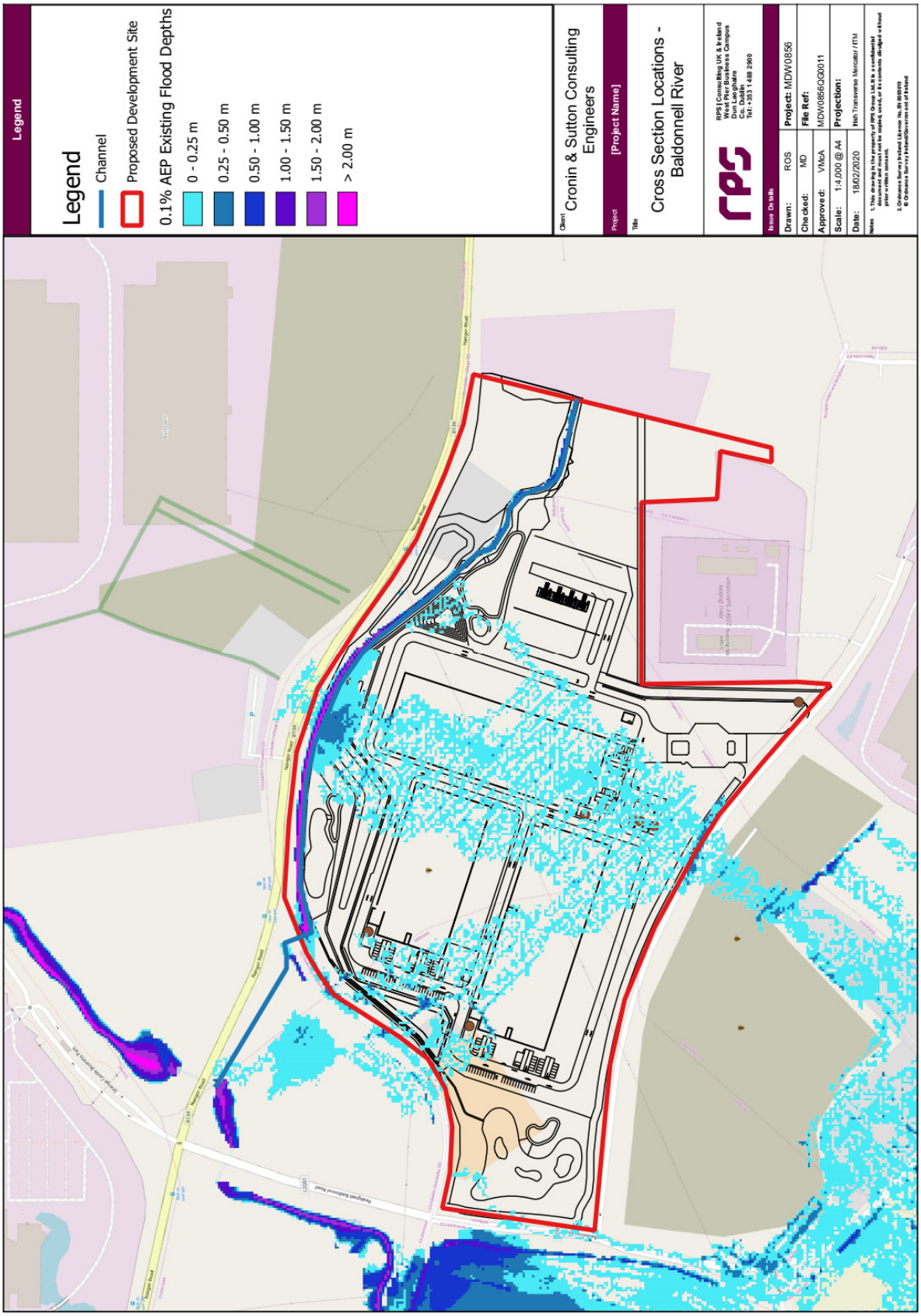
5 CONCLUSION

This additional hydraulic modelling exercise was completed to establish whether the proposed solutions in the Grangecastle Flood Study report were adequate to alleviate out-of-bank flooding from the development site without increasing flood risk elsewhere. The proposed solutions were simulated using Infoworks ICM for the 1% and 0.1% AEP events including climate change effects.

The results indicated that the proposed measures were adequate to alleviate flooding from the proposed development site for the 1% AEP. However, the hydraulic model show a marginal (i.e. 2mm max) increase in flood levels at the proposed development site within the Baldonnell River for the 0.1% AEP event, particularly at locations immediately upstream and downstream of the New Nangor Box Culvert. Further hydraulic modelling was carried out by incorporating a compensatory flood storage upstream of the proposed development site to mitigate against this. This resulted in the elimination of all level increases of 0.1% AEP flood event at the stated locations. The volume of storage required to achieve this was approximately 2,785m^3 over an area of 5,500m^2.

Given the magnitude of level increase (i.e. 2mm) at the stated location, which may well be down to numerical accuracy of the model, we do not recommend provision of a compensatory storage. Therefore, the proposed solution of intercepting the out-of-bank flow from the River Camac and channelling it to the River Baldonnell is adequate to provide the necessary flood protection to the development site without the need for a compensatory storage and significantly impacting the water levels Baldonnell River.

Appendix A
Drawings


Legend
Legend
Channel
Proposed Development Site
0.1% AEP Existing Flood Depths
0 - 0.25 m
0.25 - 0.50 m
0.50 - 1.00 m
1.00 - 1.50 m
1.50 - 2.00 m
> 2.00 m
Client
Cronin & Sutton Consulting Engineers
Project
[Project Name]
Title
Cross Section Locations - Baldonnell River
RPS Consulting UK & Ireland
West Pier Business Campus
Dun Laoghaire
Co. Dublin
Tel: +353 1 488 2900
Issue Details
Drawn: ROS
Checked: MD
Approved: VMcA
Scale: 1:4,000 @ A4
Date: 18/02/2020
Project: MDW0856
File Ref: MDW0856GI0011
Projection:
Irish Transverse Mercator / ITM
Notes
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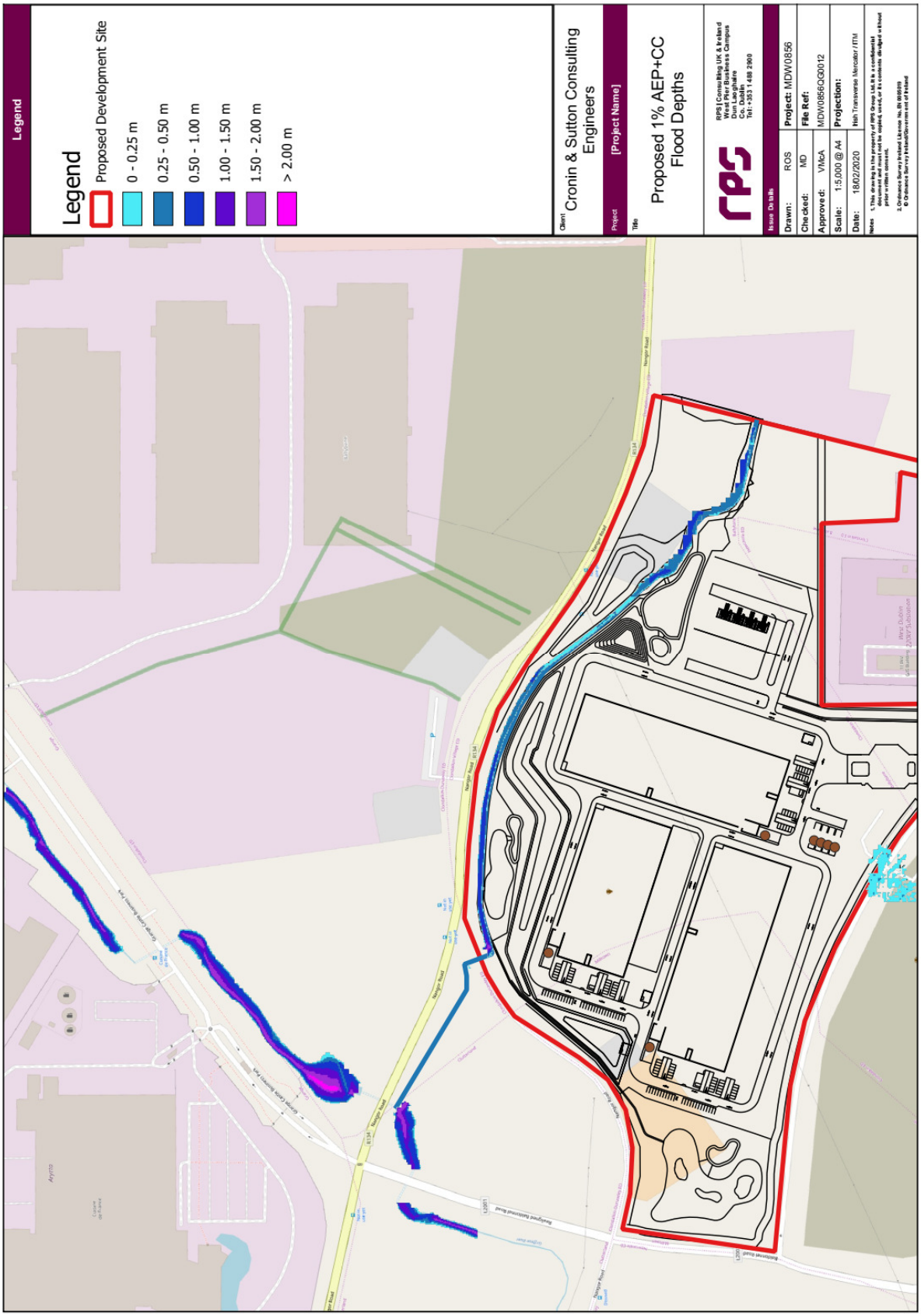
Legend
Legend
Proposed Development Site
0 - 0.25 m
0.25 - 0.50 m
0.50 - 1.00 m
1.00 - 1.50 m
1.50 - 2.00 m
> 2.00 m
Client
Cronin & Sutton Consulting Engineers
Project
[Project Name]
Title
Proposed 1% AEP+CC Flood Depths
RPS Consulting UK & Ireland
West Pier Business Campus
Dun Laoghaire
Co. Dublin
Tel: +353 1 488 2900
Issue Details
Drawn: ROS
Checked: MD
Approved: VMcA
Scale: 1:5,000 @ A4
Date: 18/02/2020
Project: MDW0856
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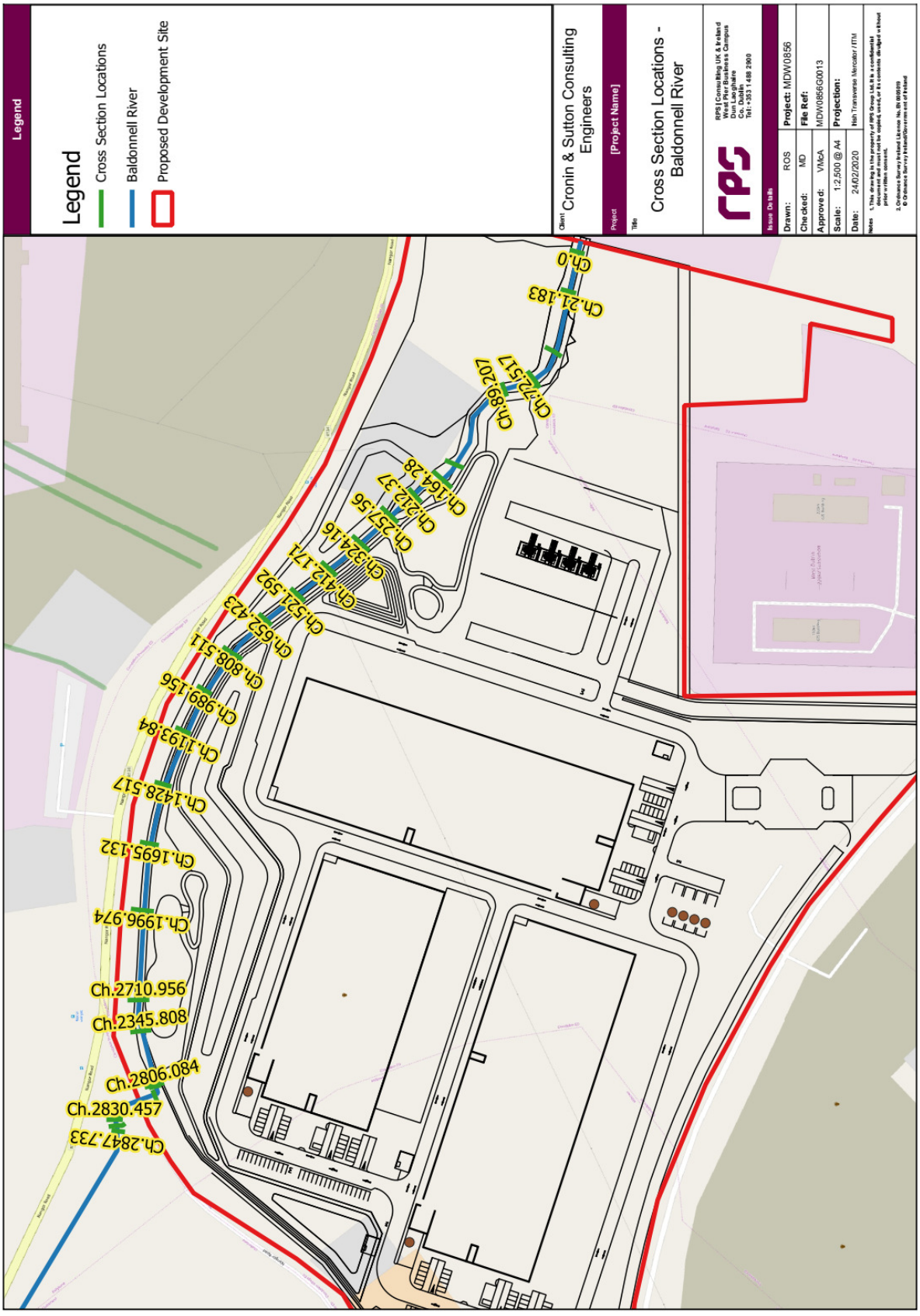
Legend
Legend
Cross Section Locations
Baldonnell River
Proposed Development Site
Client Cronin & Sutton Consulting Engineers
Project [Project Name]
Title Cross Section Locations - Baldonnell River
RPS Consulting UK & Ireland
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Dun Laoghaire
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Ch.0
Ch.21.183
Ch.72.517
Ch.89.207
Ch.164.28
Ch.212.37
Ch.257.56
Ch.324.16
Ch.412.172
Ch.521.592
Ch.652.423
Ch.808.511
Ch.989.156
Ch.1193.84
Ch.1428.517
Ch.1695.132
Ch.1996.974
Ch.2710.956
Ch.2345.808
Ch.2806.084
Ch.2830.457
Ch.2847.733

CHAPTER 9 - NOISE AND VIBRATION

Appendix 9.1 Glossary of acoustic terminology (prepared by AWN Consulting Ltd.)

ambient noise The totally encompassing sound in a given situation at a given time, usually composed of sound from many sources, near and far.

background noise The steady existing noise level present without contribution from any intermittent sources. The A-weighted sound pressure level of the residual noise at the assessment position that is exceeded for 90 per cent of a given time interval, T ($L_{AF90,T}$).

broadband Sounds that contain energy distributed across a wide range of frequencies.

dB Decibel - The scale in which sound pressure level is expressed. It is defined as 20 times the logarithm of the ratio between the RMS pressure of the sound field and the reference pressure of 20 micro-pascals (20 µPa).

dB L_{pA} An 'A-weighted decibel' - a measure of the overall noise level of sound across the audible frequency range (20 Hz – 20 kHz) with A-frequency weighting (i.e. 'A'–weighting) to compensate for the varying sensitivity of the human ear to sound at different frequencies.

Hertz (Hz) The unit of sound frequency in cycles per second.

impulsive noise A noise that is of short duration (typically less than one second), the sound pressure level of which is significantly higher than the background.

$L_{Aeq,T}$ This is the equivalent continuous sound level. It is a type of average and is used to describe a fluctuating noise in terms of a single noise level over the sample period (T). The closer the L_{Aeq} value is to either the L_{AF10} or L_{AF90} value indicates the relative impact of the intermittent sources and their contribution. The relative spread between the values determines the impact of intermittent sources such as traffic on the background.

L_{AFN} The A-weighted noise level exceeded for N% of the sampling interval. Measured using the "Fast" time weighting.

L_{AFmax} is the instantaneous slow time weighted maximum sound level measured during the sample period (usually referred to in relation to construction noise levels).

$L_{Ar,T}$ The Rated Noise Level, equal to the L_{Aeq} during a specified time interval (T), plus specified adjustments for tonal character and impulsiveness of the sound.

L_{AF90} Refers to those A-weighted noise levels in the lower 90 percentile of the sampling interval; it is the level which is exceeded for 90% of the measurement period. It will therefore exclude the intermittent features of traffic and is used to estimate a background level. Measured using the "Fast" time weighting.

L_{AT}(DW) equivalent continuous downwind sound pressure level.

L_{fT}(DW) equivalent continuous downwind octave-band sound pressure level.

L_{day} L_{day} is the average noise level during the daytime period of 07:00hrs to 19:00hrs

L_{night} L_{night} is the average noise level during the night-time period of 23:00hrs to 07:00hrs.

low frequency noise LFN - noise which is dominated by frequency components towards the lower end of the frequency spectrum.

noise Any sound, that has the potential to cause disturbance, discomfort or psychological stress to a person exposed to it, or any sound that could cause

actual physiological harm to a person exposed to it, or physical damage to any structure exposed to it, is known as noise.

noise sensitive location NSL – Any dwelling house, hotel or hostel, health building, educational establishment, place of worship or entertainment, or any other facility or other area of high amenity which for its proper enjoyment requires the absence of noise at nuisance levels.

octave band A frequency interval, the upper limit of which is twice that of the lower limit. For example, the 1,000Hz octave band contains acoustical energy between 707Hz and 1,414Hz. The centre frequencies used for the designation of octave bands are defined in ISO and ANSI standards.

rating level See $L_{Ar,T}$.

sound power level The logarithmic measure of sound power in comparison to a referenced sound intensity level of one picowatt (1pW) per m^2 where:

$$Lw = 10Log\frac{P}{P_0}\ \text{dB}$$

Where: p is the rms value of sound power in pascals; and
P_0 is 1 pW.

sound pressure level The sound pressure level at a point is defined as:

$$Lp = 20Log\frac{P}{P_0}\ \text{dB}$$

specific noise level A component of the ambient noise which can be specifically identified by acoustical means and may be associated with a specific source. In BS 4142, there is a more precise definition as follows: 'the equivalent continuous A-weighted sound pressure level at the assessment position produced by the specific noise source over a given reference time interval ($L_{Aeq, T}$)'.

tonal Sounds which cover a range of only a few Hz which contains a clearly audible tone i.e. distinguishable, discrete or continuous noise (whine, hiss, screech, or hum etc.) are referred to as being 'tonal'.

$^1/_3$ octave analysis Frequency analysis of sound such that the frequency spectrum is subdivided into bands of one–third of an octave each.

Appendix 9.2 Baseline Noise Monitoring Survey

Prepared by AWN Consulting Limited

An environmental noise survey has been conducted in order to quantify the existing noise environment. The survey was conducted in general accordance with ISO 1996: 2017: *Acoustics – Description, measurement and assessment of environmental noise*. Specific details are set out below.

Survey Details

Dates & Times of Survey

Noise measurements were conducted during typical day and night-time periods. The night-time survey represents the time of night that provides a measure of existing background noise levels during a period where people are attempting to go to sleep or are sleeping. The surveys were conducted during the following periods:

- Daytime – 10:50hrs to 14:40hrs on 9 January 2020, and;
- Night-time – 23:00hrs on 9 January to 01:25hrs on 10 January 2020.

Personnel and Instrumentation

Donal Heavey (AWN) conducted the noise level measurements during all survey periods.

The noise measurements were performed using a Brüel & Kjær Type 2250 Sound Level Analyzer (S/N 2818091). Before and after the survey the measurement apparatus was check calibrated using a Brüel & Kjær Type 4231 Sound Level Calibrator.

Measurement Locations

Figure 9.1 details the approximate location of the measurement positions identified below.

Location A Located in the vicinity of the nearest noise sensitive locations to the south west of the development site.

Figure 9.2.1 Location A

Location B Located midway along the southern boundary of the site. The lands to the immediate south are currently being developed with construction ongoing at the time of survey work completed here. This located is chosen to be representative of those noise sensitive locations further south. A review of the planning assessment completed for the development under construction has been completed in order to inform expected levels of noise in the absence of these activities at this location.

Figure 9.2.2 Location B

Location C Located in the vicinity of the nearest residential noise sensitive location to the east of the proposed development site.

Figure 9.2.3 Location C

Location D Located in the vicinity of an existing structure associated with the existing pitch and putt course.

Figure 9.2.4 Location D

Figure 9.2.5 Noise Survey Locations (Source: Google Maps)

Methodology

Measurements were conducted at the boundary location noted above. Sample periods for the noise measurements were typically 15 minutes. The results were noted onto a Survey Record Sheet immediately following each sample and were also saved to the instrument memory for later analysis if required. Survey personnel noted the primary noise sources contributing to noise build-up.

Weather

The weather during the daytime survey periods was dry with wind speeds <3m/s. Temperatures were of the order of 5°C. Cloud cover was minimal (some 20%).

The weather during the night-time survey period was dry with wind speeds <3m/s. Temperatures were of the order of 3°C. Cloud cover was minimal (some 10%).

Survey Results

Location A

The survey results for Location A are given in Table 9.2.1 below.

Table 9.2.1 Summary of Results for Location A

Start Time		Measured Noise Levels (dB re. $2x10^{-5}$ Pa)		
		L_{Aeq}	L_{AF10}	L_{AF90}
Daytime	11:48	71	68	53
	12:59	66	69	56
	14:23	63	66	54
Night-time	23:55	44	42	35
	01:09	37	38	35

Ambient daytime noise levels at this location were dominated by the road traffic noise on local roads and to a lesser extent by construction noise from nearby sites. Other noise sources noted included occasional aircraft movements overhead and birdsong. Distant road traffic noise typically dictated background noise levels along with a contribution from distant construction noise. Ambient (i.e. $L_{Aeq,15min}$) levels were in the range of 63 to 71dB with background noise levels in the range of 53 to 56dB.

Night-time noise levels were influenced by distant road traffic movements along with occasional local vehicle movements on the nearby road and wind generated noise on a nearby structure. Ambient noise levels were in the range of 37 to 44dB with background noise levels were the order of 35dB.

Location B
The survey results for Location B are given in Table 9.2.2 below.

Table 9.2.2 Summary of Results for Location B

Start Time		Measured Noise Levels (dB re. $2x10^{-5}$ Pa)		
		L_{Aeq}	L_{AF10}	L_{AF90}
Daytime	11:31	66	69	61
	12:42	65	67	61
	14:06	64	65	59
Night-time	23:36	45	41	36
	00:51	40	42	39

Ambient daytime noise levels at this location were dominated construction noise and to a lesser extent by traffic movements on local and nearby roads. Other noise sources noted included occasional aircraft movements overhead and birdsong. Construction noise and distant road traffic noise typically dictated background noise levels. Ambient (i.e. $L_{Aeq,15min}$) levels were in the range of 64 to 66dB with background noise levels in the range of 59 to 61dB.

Night-time noise levels were influenced by distant road traffic movements along with occasional local vehicle movements. Background noise levels included distant plant noise from existing operations. Ambient noise levels were in the range of 40 to 45dB with background noise levels were in the range 36 to 39dB.

Location C
The survey results for Location C are given in Table 9.2.3.

Table 9.2.3 Summary of results for Location C

Start Time		Measured Noise Levels (dB re. $2x10^{-5}$ Pa)		
		L_{Aeq}	L_{AF10}	L_{AF90}
Daytime	10:51	71	76	49
	12:07	71	76	51
	13:25	72	77	54
Night-time	23:00	66	68	39
	00:14	61	57	40

Ambient daytime noise levels at this location were dominated by traffic on the Nangor Road. Other noise sources noted including dogs barking, occasional aircraft movements overhead and construction noise in the distance. Distant road traffic noise typically dictated background noise levels. Ambient (i.e. $L_{Aeq,15min}$) levels were in the range of 71 to 72dB with background noise levels in the range of 49 to 51dB.

Night-time noise levels were influenced by distant road traffic movements along with occasional local vehicle movements. Background noise levels included distant plant noise from existing operations. Ambient noise levels were in the range of 61 to 66dB with background noise levels were in the range 39 to 40dB.

Location D
The survey results for Location D are given in Table 9.2.4.

Table 9.2.4 Summary of results for Location D

Start Time		Measured Noise Levels (dB re. $2x10^{-5}$ Pa)		
		L_{Aeq}	L_{AF10}	L_{AF90}
Daytime	11:08	72	76	54
	12:24	71	75	47
	13:43	71	76	50
Night-time	23:17	60	59	36
	00:32	60	55	39

Ambient daytime noise levels at this location were dominated by traffic on the Nangor Road. Other noise sources noted including dogs barking, occasional aircraft movements overhead and construction noise in the distance. Distant road traffic noise typically dictated background noise levels. Ambient (i.e. $L_{Aeq,15min}$) levels were in the range of 71 to 72dB with background noise levels in the range of 47 to 54dB.

Night-time noise levels were influenced by distant road traffic movements along with occasional local vehicle movements. Background noise levels included distant plant noise from existing operations. Ambient noise levels were in the order of 60dB with background noise levels were in the range 36 to 39dB.

Appendix 9.3 Noise modelling details & assumptions

Prepared by AWN Consulting Limited

Noise Model

A 3D computer-based prediction model has been prepared in order to quantify the noise level associated with the proposed building. This section discusses the methodology behind the noise modelling process.

DGMR iNoise

Proprietary noise calculation software has been used for the purposes of this modelling exercise. The selected software, DGMR iNoise, calculates noise levels in accordance with *ISO 9613: Acoustics – Attenuation of sound during propagation outdoors, Part 2: General method of calculation, 1996*.

DGMR iNoise is a proprietary noise calculation package for computing noise levels in the vicinity of noise sources. iNoise calculates noise levels in different ways depending on the selected prediction standard. In general, however, the resultant noise level is calculated taking into account a range of factors affecting the propagation of sound, including:

- the magnitude of the noise source in terms of A weighted sound power levels (L_{WA});
- the distance between the source and receiver;
- the presence of obstacles such as screens or barriers in the propagation path;
- the presence of reflecting surfaces;
- the hardness of the ground between the source and receiver;
- Attenuation due to atmospheric absorption; and
- Meteorological effects such as wind gradient, temperature gradient and humidity (these have significant impact at distances greater than approximately 400m).

Brief Description of ISO9613-2: 1996

ISO9613-2:1996 calculates the noise level based on each of the factors discussed previously. However, the effect of meteorological conditions is significantly simplified by calculating the average downwind sound pressure level, $L_{AT}(DW)$, for the following conditions:

- wind direction at an angle of ±45° to the direction connecting the centre of the dominant sound source and the centre of the specified receiver region with the wind blowing from source to receiver, and;
- wind speed between approximately $1ms^{-1}$ and $5ms^{-1}$, measured at a height of 3m to 11m above the ground.

The equations and calculations also hold for average propagation under a well-developed moderate ground-based temperature inversion, such as commonly occurs on clear calm nights. The basic formula for calculating $L_{AT}(DW)$ from any point source at any receiver location is given by:

$$L_{fT}(DW) = LW + Dc - A \qquad \textbf{Eqn. A}$$

Where:

$L_{fT}(DW)$ is an octave band centre frequency component of $L_{AT}(DW)$ in dB relative to $2x10^{-5}Pa$;
L_W is the octave band sound power of the point source;
D_c is the directivity correction for the point source;
A is the octave band attenuation that occurs during propagation, namely attenuation due to geometric divergence, atmospheric absorption, ground effect, barriers and miscellaneous other effects.

The estimated accuracy associated with this methodology is shown in Table 9.3.1 below:

Table 9.3.1 Estimated Accuracy for Broadband Noise of $L_{AT}(DW)$

Height, h*	Distance, d†	
	0 < d < 100m	100m < d < 1,000m
0<h<5m	±3dB	±3dB
5m<h<30m	±1dB	±3dB

* h is the mean height of the source and receiver. † d is the mean distance between the source and receiver.
N.B. These estimates have been made from situations where there are no effects due to reflections or attenuation due to screening.

Input Data and Assumptions

The noise model has been constructed using data from various source as follows:

Site Layout The general site layout has been obtained from the drawings forwarded by HJL Architects.
Local Area The location of noise sensitive locations has been obtained from a combination of site drawings provided by HJL Architects and others obtained from Ordinance Survey Ireland (OSI).
Heights The heights of buildings on site have been obtained from site drawings forwarded by HJL Architects. Off-site buildings have been assumed to be 8m high for houses with the exception of industrial buildings where a default height of 15m has been assumed.
Contours Site ground contours/heights have been obtained from site drawings forwarded by HJL Architects where available.

The final critical aspect of the noise model development is the inclusion of the various plant noise sources. Details are presented in the following section.

Source Sound Power Data
The noise modelling competed indicates the following limits in relation to various items of plant associated with the overall site development. Plant items will be selected in order to achieve the stated noise levels and or appropriate attenuation will be incorporated into the design of the plant/building in order that the plant noise emission levels are achieved on site (including any system regenerated noise).

Table 9.3.2 L_{wA} levels Utilised in Noise Model

Source	L_{wA} - Octave Band Centre Frequency								dB (A)
	63	125	250	500	1k	2k	4k	8k	
Roof Fan Note A	56	59	67	71	69	66	62	62	75
AHU & CRAH Louvres Note B	55	61	55	51	46	44	41	32	54
Condensers	55	63	68	72	72	67	61	52	77
Generator Intake Note C	88	90	82	83	83	80	78	76	94
Generator Rear Note C	88	90	82	83	83	80	78	76	94
Generator Stack Note D	84	77	77	73	69	74	71	71	86
Generator Sides & Roof Note C	82	93	92	94	94	93	88	75	101
Transformers	64	66	69	74	72	68	63	53	78

Note A Roof exhaust with attenuator – as advised by client.
Note B Per m^2
Note C Assuming generator housing dimensions of 17m (L) x 4m (W) x 4m (H). Data based on CAT data supplied in relation to previous sites.
Note D Additional attenuation due to 20m stack and additional bends assumed.
Note E The following extract from *the "EirGrid Evidence Based Environmental Studies Study 8: Noise – Literature review and evidence-based field study on the noise effects of high voltage transmission development (May 2016)* states the following in relation to noise impacts associated with 110KvA transformer installations:

> *"The survey on the 110kV substation at Dunfirth indicated that measured noise levels (L_{Aeq}) were less than 40dB(A) at 5m from each of the boundaries of the substation. This is below the WHO night-time free-field threshold limit of 42dB for preventing effects on sleep and well below the WHO daytime threshold limits for serious and moderate annoyance in outdoor living areas (i.e. 55dB and 50dB respectively). Spectral analysis of the data recorded at this site demonstrated that there were no distinct tonal elements to the recorded noise level. To avoid any noise impacts from 110kV substations at sensitive receptors, it is recommended that a minimum distance of 5m is maintained between 110kV substations and the land boundary of any noise sensitive property."*
>
> Assuming the proposed substation installation has comparable noise emissions to the 110kV unit discussed above and considering the distance between the 110kV substation and the nearest off site i.e. >250m) noise from this installation is not predicted to be an issue off site.

Considering the above, it is concluded that there will be no significant noise emissions from the operation of the cable installations or substation. Consequently, there is no requirement to assess any operational noise emissions.

It is assumed that the plant parapets will be at least 0.5m higher than the highest dimension of the roof mounted plant.

Figure 9.3.1 presents a 3D render of the developed site noise model for the current proposals.

Figure 9.3.1 Images of Developed Noise Model – View of Site

Modelling Calculation Parameters[15]

Prediction calculations for plant noise have been conducted in accordance with *ISO 9613: Acoustics – Attenuation of sound during propagation outdoors, Part 2: General method of calculation, 1996*.

Ground attenuation factors of 1.0 have been assumed. No metrological corrections were assumed for the calculations. The atmospheric attenuation outlined in Table 9.3.3 has been assumed for all calculations.

Table 9.3.3 Atmospheric Attenuation Assumed for Noise Calculations (dB per km)

Temp (ºC)	% Humidity	Octave Band Centre Frequencies (Hz)							
		63	125	250	500	1k	2k	4k	8k
10	70	0.12	0.41	1.04	1.92	3.66	9.70	33.06	118.4

15 See Appendix 9.5 for further discussion of calculation parameters.

Appendix 9.4 Indicative construction noise & vibration management plan

Prepared by AWN Consulting Limited

This Noise and Vibration Management Plan (NVMP) details a *'Best Practice'* approach to dealing with potential noise and vibration emissions during the construction phase of the development. The Plan should be adopted by all contractors and sub-contractors involved in construction activities on the site. The Site Manager should ensure that adequate instruction is provided to contractors regarding the noise and vibration control measures contained within this document.

The environmental impact assessment (EIA) Report conducted for the construction activity has highlighted that the construction noise and vibration levels can be controlled to within the adopted criteria. However, mitigation measures should be implemented, where necessary, in order to control impacts to nearby sensitive areas within acceptable levels.

Nearby sensitive properties in the vicinity of the proposed development are summarised in Figure 9.4.1 below:

Figure 9.4.1 Sensitive Receptors

R01 Located at a private residence to the south west of the proposed site at a distance of some 300m from the site boundary.

R02 Located at a private residence to the south west of the proposed site at a distance of some 250m from the site boundary.

R03 Located at a private residence along the Baldonnel Road, to the south of the site, on the opposite side of the Cyrus One facility under construction, some 220m from the site boundary.

R04 Located at a private residence along the Baldonnel Road, to the south of the site, on the opposite side of the Cyrus One facility under construction, some 230m from the site boundary.

R05 Located at a private residence along the Baldonnel Road, to the south of the site, on the opposite side of the Cyrus One facility under construction, some 250m from the site boundary.

R06 Located at a private residence along the Baldonnel Road, to the south of the site, on the opposite side of the Cyrus One facility under construction, some 270m from the site boundary.

R07 Located at a private residence along the Baldonnel Road, to the south of the site, on the opposite side of the Cyrus One facility under construction, some 375m from the site boundary.

R08 Located at a private residence along the Baldonnel Road, to the south of the site, on the opposite side of the Cyrus One facility under construction, some 380m from the site boundary.

R09 Located at a private residence, adjoining a nearby pitch and putt course on the opposite side of the New Nangor Road, to the north of the site, some 50m from the northern site boundary.

R09 Located at a private residence, adjoining a nearby pitch and putt course on the opposite side of the New Nangor Road, to the north of the site, some 50m from the northern site boundary.

R10 Located at nearby commercial site, on the opposite side of the Old Nangor Road, some 55m from the northern site boundary.

R11/12 Located at nearby commercial site, opposite the eastern boundary of the site.

R13 Located at a private residence located off the Old Nangor Road, to the east of the site some 120m from the eastern site boundary. It is understood this property is abandoned and is unlikely to be reoccupied going forward.

Figure 9.5.1 illustrates three other properties (yellow dots) to the south of the site, on the opposite side of the Cyrus One building (currently under construction). These properties are within the site boundaries of nearby commercial operations and are not occupied and are due for demolition. For the purposes of this assessment these are not considered noise sensitive receptors.

Construction Noise Criteria

As referenced in the EIA Report prepared for the proposed development, appropriate criteria relating to permissible construction noise levels for a development of this scale may be found in the Transport Infrastructure Ireland (TII) publication *Guidelines for the Treatment of Noise and Vibration in National Road Schemes*[16] which indicates the following criteria and hours of operation.

Table 9.4.1 Construction Noise Limit Values

Days and Times	Noise Levels (dB re. 2x10-5 Pa)	
	$L_{Aeq(1hr)}$	L_{Amax}
Monday to Friday 07:00hrs to 19:00hrs	70	80
Monday to Friday 19:00 to 22:00hrs	60*	65*
Saturdays 08:00hrs to 13:00hrs	65	75

Note * Construction activity at these times, other than that required for emergency works, will normally require the explicit permission of the relevant local authority.

Construction Vibration Criteria

It is recommended in this EIA Report that vibration from construction activities to off-site residences be limited to the values set out in Table 9.4.2. It should be noted that these limits are not absolute but provide guidance as to magnitudes of vibration that are very unlikely to cause cosmetic damage. Magnitudes of vibration slightly greater than those in the table are normally unlikely to cause cosmetic damage, but

[16] *Guidelines for the Treatment of Noise and Vibration in National Road Schemes, Revision 1, 25 October 2004*, Transport Infrastructure Ireland

construction work creating such magnitudes should proceed with caution. Where there is existing damage these limits may need to be reduced by up to 50%.

Table 9.4.2 Construction Vibration Limit Values

Allowable vibration (in terms of peak particle velocity) at the closest part of sensitive property to the source of vibration, at a frequency of		
Less than 10Hz	**10 to 50Hz**	**50 to 100Hz (and above)**
8 mm/s	12.5 mm/s	20 mm/s

Hours of Work

The proposed general construction hours are 07:00 to 18:00hrs, Monday to Friday and 08:00 to 14:00 on Saturdays. However, weekday evening works may also be required from time to time.

Weekday evening activities should be significantly reduced and generally only involve internal activities and concrete pouring which will be required during certain phases of the development. As a result, noise emissions from evening activities are expected to be significantly lower than for other general daytime activities.

Best Practice Guidelines for the Control of Noise & Vibration

BS5228 includes guidance on several aspects of construction site mitigation measures, including, but not limited to:

- selection of quiet plant;
- control of noise sources;
- screening;
- hours of work;
- liaison with the public, and;
- monitoring.

Detailed comment is offered on these items in the following paragraphs. Noise and vibration control measures that will be considered include the selection of suitable plant, enclosures and screens around noise sources, limiting the hours of work and monitoring.

Selection of Quiet Plant

This practice is recommended in relation to sites with static plant such as compressors and generators. It is recommended that these units be supplied with manufacturers' proprietary acoustic enclosures where possible. The potential for any item of plant to generate noise will be assessed prior to the item being brought onto the site. The least noisy item should be selected wherever possible. Should a particular item of plant already on the site be found to generate high noise levels, the first action should be to identify whether or not said item can be replaced with a quieter alternative.

General Comments on Noise Control at Source

If replacing a noisy item of plant is not a viable or practical option, consideration should be given to noise control "at source". This refers to the modification of an item of plant or the application of improved sound reduction methods in consultation with the supplier. For example, resonance effects in panel work or cover plates can be reduced through stiffening or application of damping compounds; rattling and grinding noises can often be controlled by fixing resilient materials in between the surfaces in contact.

BS5228 states that *"as far as reasonably practicable sources of significant noise should be enclosed"*. In applying this guidance, constraints such as mobility, ventilation, access and safety must be taken into account. Items suitable for enclosure include pumps and generators. Demountable enclosures will also be used to screen operatives using hand tools and will be moved around site as necessary.

In practice, a balance may need to be struck between the use of all available techniques and the resulting costs of doing so. As with Ireland's Environmental Protection Act legislation, we propose that the concept of *"best available techniques not entailing excessive cost "*(BATNEEC) be adopted. Furthermore, proposed noise control techniques should be evaluated in light of their potential effect on occupational safety etc.

BS5228 makes a number of recommendations in relation to "use and siting of equipment". These are all directly relevant and hence are reproduced in full. These recommendations will be adopted on site.

> *"Plant should always be used in accordance with manufacturers' instructions. Care should be taken to site equipment away from noise-sensitive areas. Where possible, loading and unloading should also be carried out away from such areas. Special care will be necessary when work has to be carried out at night.*
>
> *Circumstances can arise when night-time working is unavoidable. Bearing in mind the special constraints under which such work has to be carried out, steps should be taken to minimise disturbance to occupants of nearby premises.*
>
> *Machines such as cranes that may be in intermittent use should be shut down between work periods or should be throttled down to a minimum. Machines should not be left running unnecessarily, as this can be noisy and waste energy.*
>
> *Plant known to emit noise strongly in one direction should, when possible, be orientated so that the noise is directed away from noise-sensitive areas. Attendant operators of the plant can also benefit from this acoustical phenomenon by sheltering, when possible, in the area with reduced noise levels.*
>
> *Acoustic covers to engines should be kept closed when the engines are in use and idling. The use of compressors that have effective acoustic enclosures and are designed to operate when their access panels are closed is recommended.*
> *Materials should be lowered whenever practicable and should not be dropped. The surfaces on to which the materials are being moved could be covered by resilient material."*

All items of plant should be subject to regular maintenance. Such maintenance can prevent unnecessary increases in plant noise and can serve to prolong the effectiveness of noise control measures.

Screening
Typically, screening is an effective method of reducing the noise level at a receiver location and can be used successfully as an additional measure to all other forms of noise control. The effectiveness of a noise screen will depend on the height and length of the screen and its position relative to both the source and receiver.

The length of the screen should in practice be at least five times the height, however, if shorter sections are necessary then the ends of the screen should be bent around the source. The height of any screen should be such that there is no direct line of sight between the source and the receiver.

BS5228 states that on level sites the screen should be placed as close as possible to either the source or the receiver. The construction of the barrier should be such that there are no gaps or openings at joints in the screen material. In most practical situations the effectiveness of the screen is limited by the sound transmission over the top of the barrier rather than the transmission through the barrier itself. In practice screens constructed of materials with a mass per unit of surface area greater than 7 kg/m^2 will give adequate sound insulation performance.

In addition, careful planning of the site layout should also be considered. The placement of site buildings such as offices and stores and in some instances, materials such as topsoil or aggregate can provide a degree of noise screening if placed between the source and the receiver.

Vibration

The vibration from construction activities will be limited to the values set out in Table 2. It should be noted that these limits are not absolute but provide guidance as to magnitudes of vibration that are very unlikely to cause cosmetic damage. Magnitudes of vibration slightly greater than those in the table are normally unlikely to cause cosmetic damage, but construction work creating such magnitudes should proceed with caution. Where there is existing damage, these limits may need to be reduced by up to 50%.

Liaison with the Public
The Contractor will provide proactive community relations and will notify the public and sensitive premises before the commencement of any works forecast to generate appreciable levels of noise or vibration,

explaining the nature and duration of the works. The Contractor will distribute information circulars informing people of the progress of works and any likely periods of significant noise and vibration.

A designated noise liaison should be appointed to site during construction works. Any complaints should be logged and followed up in a prompt fashion. In addition, prior to particularly noisy construction activity, e.g. rock breaking, piling, etc., the site contact should inform the nearest noise sensitive locations of the time and expected duration of the works.

Noise Monitoring
During the construction phase consideration should be given to noise monitoring at the nearest sensitive locations.

Noise monitoring should be conducted in accordance with the International Standard ISO 1996: 2017: *Acoustics – Description, measurement and assessment of environmental noise* and be located a distance of greater than 3.5m away from any reflective surfaces, e.g. walls, in order to ensure a free-field measurement without any influence from reflected noise sources.

Vibration Monitoring
During the construction phase consideration should be given to vibration monitoring at the nearest sensitive locations.

Vibration monitoring should be conducted in accordance with BS7385-1 (1990) *Evaluation and measurement for vibration in buildings — Part 1: Guide for measurement of vibrations and evaluation of their effects on buildings* or BS6841 (1987) *Guide to measurement and evaluation of human exposure to whole-body mechanical vibration and repeated shock*.

The mounting of the transducer to the vibrating structure should comply with BS ISO 5348:1998 *Mechanical vibration and shock – Mechanical mounting of accelerometers*. In summary, the following ideal mounting conditions apply:

- the transducer and its mountings are as rigid as possible;
- the mounting surfaces should be as clean and flat as possible;
- simple symmetric mountings are best, and;
- the mass of the mounting should be small in comparison to that of the structure under test.

In general, the transducer will be fixed to the floor of a building or concrete base on the ground using expansion bolts. In instances where the vibration monitor will be placed outside of a building a flat and level concrete base with dimensions of approximately 1m x 1m x 0.1m will be required.

Appendix 9.5 Noise model parameters

Prepared by AWN Consulting Limited

Prediction calculations for noise emissions have been conducted in accordance with *ISO 9613: Acoustics – Attenuation of sound during propagation outdoors, Part 2: General method of calculation, 1996*. The following are the main aspects that have been considered in terms of the noise predictions presented in this instance.

Directivity Factor: The directivity factor (D) allows for an adjustment to be made where the sound radiated in the direction of interest is higher than that for which the sound power level is specified. In this case the sound power level is measures in a down wind direction, corresponding to the worst-case propagation conditions and needs no further adjustment.

Ground Effect: Ground effect is the result of sound reflected by the ground interfering with the sound propagating directly from source to receiver. The prediction of ground effects is inherently complex and depend on source height receiver height propagation height between the source and receiver and the ground conditions. The ground conditions are described according to a variable defined as G, which varies between 0.0 for hard ground (including paving, ice concrete) and 1.0 for soft ground (includes ground covered by grass trees or other vegetation) Our predictions have been carried out using various source height specific to each plant item, a receiver heights of 1.6m for single storey properties and 4m for double. An assumed ground factor of G = 1.0 has been applied off site. Noise contours presented in the assessment have been predicted to a height of 4m in all instances. For construction noise predictions have been made at a level of 1.6m as these activities will not occur at night.

Geometrical Divergence This term relates to the spherical spreading in the free-field from a point sound source resulting in attenuation depending on distance according to the following equation:

$$A_{geo} = 20 \times \log (\text{distance from source in meters}) + 11$$

Atmospheric Absorption Sound propagation through the atmosphere is attenuated by the conversion of the sound energy into heat. This attenuation is dependent on the temperature and relative humidity of the air through which the sound is travelling and is frequency dependent with increasing attenuation towards higher frequencies. In these predictions a temperature of 10°C and a relative humidity of 70% have been used, which give relativity low levels of atmosphere attenuation and corresponding worst case noise predictions.

Table 9.5.1 Atmospheric Attenuation Assumed for Noise Calculations (dB per km)

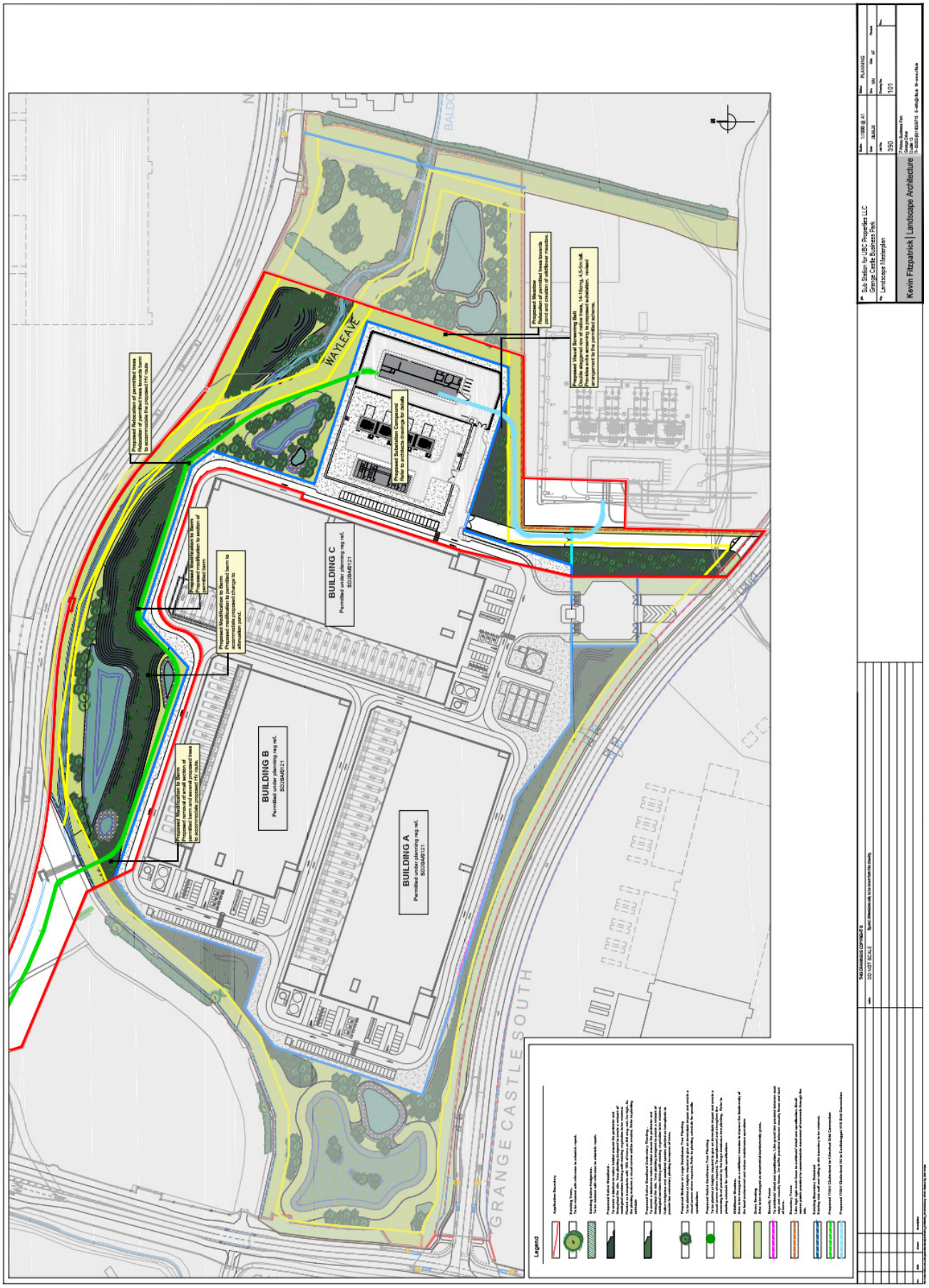
Temp (°C)	% Humidity	Octave Band Centre Frequencies (Hz)							
		63	125	250	500	1k	2k	4k	8k
10	70	0.12	0.41	1.04	1.92	3.66	9.70	33.06	118.4

Barrier Attenuation The effect of any barrier between the noise source and the receiver position is that noise will be reduced according to the relative heights of the source, receiver and barrier and the frequency spectrum of the noise.

CHAPTER 11 - LANDSCAPE AND VISUAL IMPACT

Appendix 11.1 Permitted Landscape master plan as permitted under SDCC Planning Reg. Ref. SD20A/0121

Appendix 11.2 Proposed Landscape master plan under Proposed Development



Sub Station for UBC Properties LLC

Photomontages for Planning Submission

Method Statement - Photomontage production.

1. Photographs are taken from locations as advised with a professional SLR digital camera. The photographs are taken horizontally with a survey level attached to the camera. The photographic positions are marked (for later surveying), the height of the camera and the focal length of the image recorded.

2. In each photograph, a minimum of 3 No visible fixed points are marked for surveying. These are control points for model alignment within the photograph.

3. The photographic positions and the control points are geographically surveyed and these positions are plotted on the site survey drawing.

4. Import, prepare and texture supplied 3d digital model. Model is aligned to the survey drawing with the camera positions.

5. Using 3d software, virtual 3d cameras are positioned according to the survey co-ordinates. The focal length of the photograph is input into the software. Pitch and rotation are adjusted using the survey control points to align the virtual camera to the photograph.

6. The proposed development is output from the 3D software using this camera and the image is then blended with the original photograph to give an accurate image of what the proposed development will look like in this setting with the previously permitted scheme (Planning reg. ref. SD20A/0121) also shown.

7. To clarify which elments in the view are of this proposed development , the roof line of the development is outlined in red.

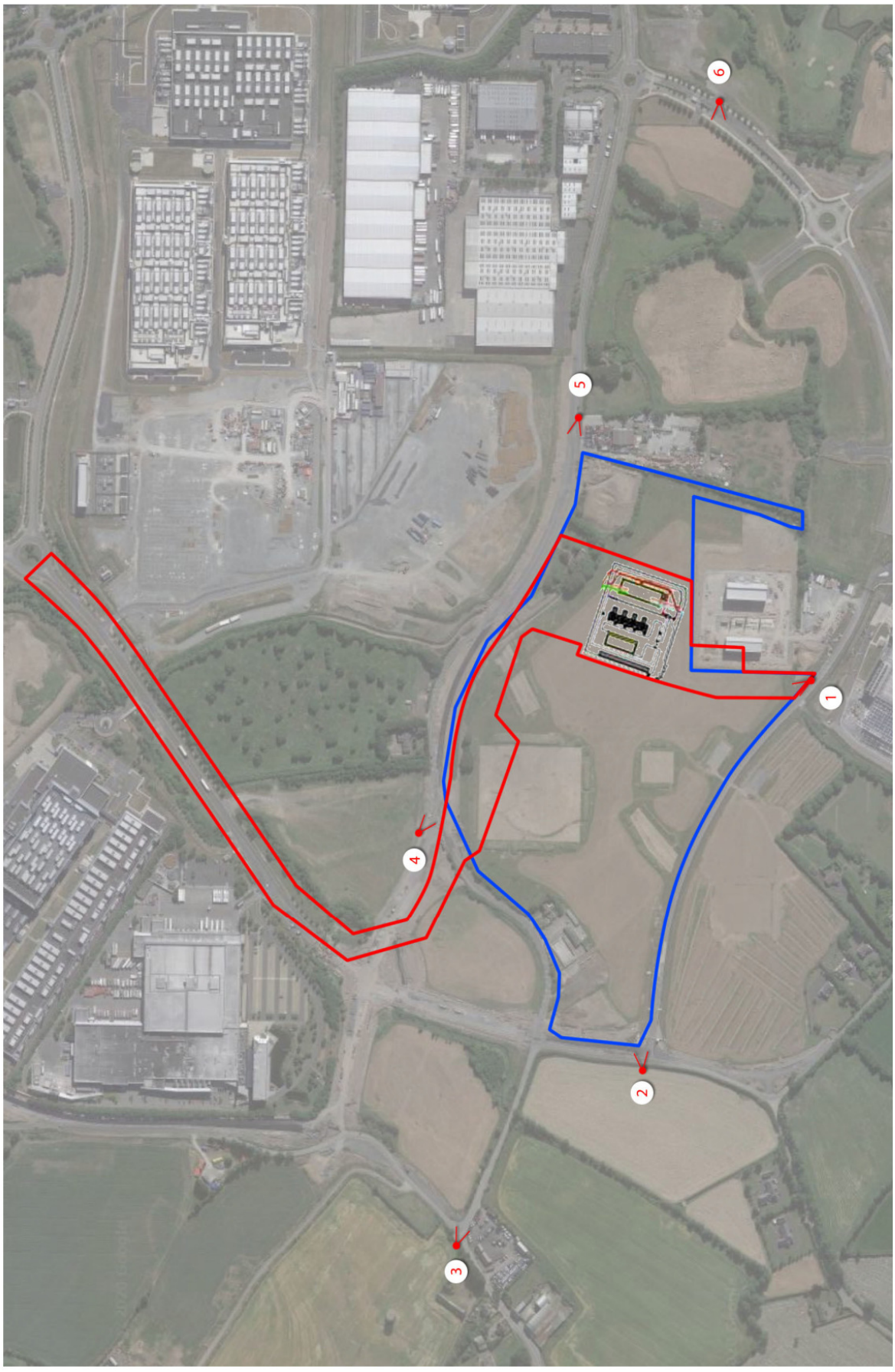
8. The following dicument contains the following information.

a) Site location map with view locations plotted.

b) Photo-montage sheet showing
   1) Existing and proposed conditions.
   2) View with surveyed control alignment points.
   3) Reference information including field of view/focal
   4) length, range to site/development, Date of photograph.

Project: Sub Station for UBC properties LLC

digital dimensions
architectural visualisation


6
5
1
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2
3
digital dimensions
architectural visualisation
Location Map
Project: Sub Station for UBC properties LLC

Location	Date	Field of view	35mm equivalent	Distance to site	Camera model
View 1 Existing	13-12-2019	84°	20mm	14.5m	Canon EOS 5DS

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digital dimensions
architectural visualisation

Location	Date	Field of view	35mm equivalent	Distance to site	Camera model
View 1 Proposed & Permitted	13-12-2019	84°	20mm	14.5m	Canon EOS 5DS

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digital dimensions
architectural visualisation

Location	Date	Field of view	35mm equivalent	Distance to site	Camera model
View 2 Existing	13-12-2019	74°	24mm	32.2m	Canon EOS 5DS

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digital dimensions
architectural visualisation

Location	Date	Field of view	35mm equivalent	Distance to site	Camera model
View 2 Proposed & Permitted	13-12-2019	74°	24mm	32.2m	Canon EOS 5DS

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digital dimensions
architectural visualisation

Location	Date	Field of view	35mm equivalent	Distance to site	Camera model
View 3 Existing	13-12-2019	74°	24mm	269m	Canon EOS 5DS

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digital dimensions
architectural visualisation

Location	Date	Field of view	35mm equivalent	Distance to site	Camera model
View 3 Proposed & Permitted	13-12-2019	74°	24mm	269m	Canon EOS 5DS

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digital dimensions
architectural visualisation

Location	Date	Field of view	35mm equivalent	Distance to site	Camera model
View 4 Existing	13-12-2019	74°	24mm	42m	Canon EOS 5DS

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digital dimensions
architectural visualisation

Location	Date	Field of view	35mm equivalent	Distance to site	Camera model
View 4 Proposed & Permitted	13-12-2019	74°	24mm	42m	Canon EOS 5DS

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digital dimensions
architectural visualisation

Location	Date	Field of view	35mm equivalent	Distance to site	Camera model
View 5 Existing	13-12-2019	72°	25mm	49.2m	Canon EOS 5DS

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digital dimensions
architectural visualisation

Location	Date	Field of view	35mm equivalent	Distance to site	Camera model
View 5 Proposed & Permitted	13-12-2019	72°	25mm	49.2m	Canon EOS 5DS

Project: Sub Station for UBC properties LLC

digital dimensions
architectural visualisation

Location	Date	Field of view	35mm equivalent	Distance to site	Camera model
View 6 Existing	13-12-2019	72°	25mm	444.8m	Canon EOS 5DS

Project: Sub Station for UBC properties LLC

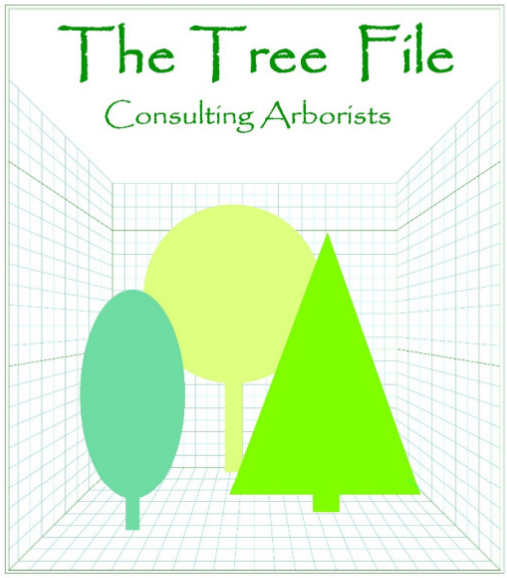
digital dimensions
architectural visualisation

Location	Date	Field of view	35mm equivalent	Distance to site	Camera model
View 6 Proposed & Permitted	13-12-2019	72°	25mm	444.8m	Canon EOS 5DS

Project: Sub Station for UBC properties LLC

digital dimensions
architectural visualisation

Appendix 11.4 Tree survey



Base-line Tree Survey and Report
Trees at Proposed Site at
Grange Castle
Dublin 22

January 2020

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Contents

This report should be read in conjunction with the "Tree Constraints Plan" drawing "D1-TCP-Grange Castle-01-20"

Report Context

This survey has been undertaken at the instruction of: -

Kevin Fitzpatrick Landscape Architecture
7 Abbey Business Park
Grange Drive
Baldoyle
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D13 R1W1

The survey has been prepared by-
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Report Brief

In accordance with the request for information, the intention of the tree survey is to register, describe and evaluate the trees regarding their current health status and current condition within their current context. The survey is based upon and has been compiled considering the recommendations of BS5837: 2012 Trees in Relation to Design, Demolition and Construction – Recommendations.

Report Context

In line with the recommendations of "BS5837: 2012 Trees in Relation to Design, Demolition and Construction – Recommendations", this assessment has been advised by the results and findings of a tree survey, the findings of which are included as "Appendix 1" to this report.

In line with client instructions, this report comprises a simple qualitative tree survey and a summary report describing the material of Arboricultural interest, upon and adjoining the subject site.

This information has been provided without any review of possible construction or development works. Accordingly, this information does not include any "Arboricultural Implication Assessment", nor does not provide an "Arboricultural Method Statement" or "Tree Protection Plan" and therefore is not a full Arboricultural report.

It does however provide some of the basic information that would assist in the compilation of such information and documentation, should it be requested/required in the future.

This tree report should be read in conjunction with the combined tree constraints plan "D1-TCP-Grange Castle-01-20". This drawing provides a graphic representation of the tree survey depicting the constraints and the spatial retention requirements of the trees, as well as colour coded categorisation their condition and potential value.

Accordingly, and in line with BS5837:2012 Trees in Relation to Design, Demolition and Construction – Recommendations, this documentation does provide an invaluable "design tool" in respect of the review of potentially sustainable trees on a particular site.

Report Limitations

This report is based on the Arborists interpretation of information provided to his prior to report compilation and gained from the site during the undertaking of the site review. The site review data is subject to the limitation as set out under "Inspection and Evaluation Limitations and Disclaimers" in "Appendix 1" to this report. The findings and recommendations made within this report are based upon the knowledge and expertise of the inspecting Arborist.

Summary of Findings

The site supports limited vegetation. Much of this vegetation comprises one of two types, that being agricultural field boundary hedges, typically comprising Hawthorne alignments or ornamental/demarcation tree alignments apparently associated with previous domiciliary/garden enclosures.

The site appears to have undergone substantial drainage engineering in recent times and this appears to have affected much of the original site vegetation and has disturbed much of that which remains. In this respect, many of the trees and hedges remaining on the site appear now to arise from substantially disturbed ground, the extent of the disturbance being unknown and therefore its effect on tree health difficult to appraise. Nonetheless and with regard to trees 3 to 9, the ground modification appears extensive and of an extent and nature that would suggest that tree health will be dramatically impaired as will any expectation of sustainability.

Additional issues exist regarding species/context relationships. The site supports several Monterey Cypress groups that on initial review, would appear to be of reasonable health however all specimens exhibit classic evidence of species typical mechanical deterioration and failure. This is compounded with regard to the above-mentioned group of trees in that the ground space from which the trees arise has been chronically disturbed however Cypress No.12 to the west of these was equally be regarded with caution as the trees are in a state of ongoing mechanical failure. Such trees cannot readily be regarded as suitable for retention within an area that will attain high use and occupation as a result of the threat presented by the high likelihood of continued/ongoing mechanical failure.

In some instances, and particularly to the east of the site note is made that hedge 1 is physiologically detached from the site. The hedge effectively arises from the eastern side of a substantial ditch structure that is of a form that will have acted as a natural barrier to tree root development. Accordingly, any activity to the West of this ditch alignment is highly unlikely to have any effect whatsoever on the trees however, any required to convert or modify the ditch profile itself would have a particularly high potential for resulting in tree damage.

In conclusion and as a result of the combination of contextual issues and prior ground disturbance, the site appears to support little large-scale vegetation that offers any substantive degree of sustainability within the developed context.

Management Recommendations

Preliminary management recommendations have been put forward within the context of the survey table (see column PMR). Such recommendations are based on the current and “do nothing” site scenario. They do not consider any possible construction activity or site developments that may affect the trees.

In the case of construction or development works, it will be necessary for the project Arborist to re-assess all trees in respect of development impacts and implications, including shelter loss and exposure and any other changes in site context.

Regardless of any possible site development, it is advised that all retained trees be reviewed on regular basis and particularly, after any actions that may affect the trees, be those site development works, or tree management works that involve tree removal or pruning.

It should be appreciated that some of the concerns raised in the tree survey were based on evidence suggesting a high likelihood ongoing decline or mechanical failure. Such deterioration may well continue to a point where additional trees need to be removed. For this reason, trees must be reviewed regularly so that early intervention and action can be applied in a timely manner.

Additionally, many of the sites larger trees were affected by Ivy development. Whilst itself not an indicator of ill-health, Ivy cover can readily obscure signs and symptoms of ill-health or physical defect. Therefore, and whilst nominal assessments have been made for the purposes of this survey, the true condition of trees affected by Ivy cover might not be fully known until Ivy cover has been dealt with, either by cutting resulting in shedding or by the undertaking of climbing inspections.

Development Implications

This document comprises only a review of trees that exist upon or adjoining the site in respect to its existing context and relating to the "do nothing" scenario. It is appreciated that site development works may alter this scenario or may affect the suitability of various trees to be retained.

In respect of this, any development proposals must be reviewed under the auspices of an "Arboricultural Implication Assessment" that will review the development proposals and provide an assessment of the potential for tree retention within the new context. This information can then be used to develop an "Arboricultural Method Statement" and a "Tree Protection Plan" to control and guide site works in a manner that will be least detrimental to tree health and thus may maximise tree sustainability.

Appendix 1 – Tree Survey

Nature of Survey

This survey has been based upon many of the criteria put forward in BS 5837: 2012 – Trees in Relation to Design, Demolition and Construction – Recommendations. The data collected has been represented in table form as "Table 1" within "Appendix 1" to this report. This appendix includes a Survey Methodology, Survey Key, Survey Abbreviations, Condition Category Definitions.

The survey relates to the site and the conditions thereon at the time of the survey. It is likely that changes in site usage, development or other environmental changes will require an amendment of recommendations and in some instances, may require the re-classification of a tree's category and/or suitability for retention.

Drawing References

The survey must be read in conjunction with drawing "D1-TCP-Grange Castle-01-20". This provides a scaled graphic representation of tree positions, crown forms, "RPA" (root protection area) extents and a colour reference to category systems. Where tree positions were not indicated on the supplied topographical drawing, their positions may have been given a "sketched" location within "D1-TCP-Grange Castle-01-20". It is advised that any such trees are accurately located by professional means so that the constraints such trees have upon the site can be accurately gauged.

Each tree is represented by a coloured spline, scaled to represent the north, east, south and west crown radii as denoted in the survey table. Each tree (categories A-green, B-blue and C-grey only) have been apportioned a "Root Protection Area" (RPA) denoted as a dashed orange circle. This circle represents the nominal minimum area requiring protection from the effects of development activity. It should, for the purposes of design, be considered, as approximating the position of the tree protection fencing that must be erected prior to the commencement of any site works, thus excluding all site activities other than those dealt with by way of the "Arboricultural Implication Assessment" and "Arboricultural Method Statement"

Survey Intent and Context

Intention of this document is to describe the extent, nature and quality of material of Arboricultural interest on the site in question.

Site Description

The site in question comprises substantially modified agricultural land and thus supports only limited Tree and Hedge populations. Such material tends to be limited to the northern and north-western boundary is and in vicinity of areas previously supporting dwellings and farm structures.

Much of the ground space within the site has suffered substantial modification and conversion with particular noted being made of soil dumping and level raising particularly about the North of the site as well as the re-engineering of an original drainage ditch. Much of the vegetation would have comprised enclosure structures to fields or dwellings and their associated gardens.

Notwithstanding the above modifications, the site can be broadly regarded as being level with no obvious signs of drainage issues at the time of the site review.

Survey Data Collection and Methodology

The Survey

The primary survey was carried out in January of 2020. This survey is not an Implication Assessment though but provided some of the basic information regarding its compilation. The survey has been undertaken under the recommendations of BS 5837: 2012. This survey includes only tree of a stem diameter exceeding 150mm at approximately 1.50 metres from ground level. The survey relates to current site conditions, setting and context.

Identification

Each of the trees described within the text has been affixed with a consecutively numbered, alloy disk that relates directly to the survey text, positioned at approximately 1.50m from ground level.

Measurements

Measurements are metric and defined in metres and millimetres. All trees referred to in the survey text have been measured to provide information regarding canopy height and canopy spread (north, east, south and west radii), level of canopy base and stem diameter at 1.50 meters from ground level. The dimensions provided are intended to provide a reasonable representation of a trees size and form. Whilst efforts are made to maintain accuracy, visual obstruction, especially regarding trees in groups, requires that some tree dimensions are estimated only.

Inspection and Evaluation Limitations and Disclaimers

The information set out in this report relates to the review of a tree population on the site in question. As such, the information provided is based on a general review of trees and does not constitute a detailed review of any one of the individual specimens. Such an evaluation (tree report) would require the gathering of substantially more information than that dealt with in this survey.

The survey is not a safety assessment and the parameters reviewed within this survey context would be substantially deficient in extent to provide for a reliable safety assessment. The survey is intended to provide a general and qualitative review to assist in gauging the suitability of an individual tree for retention within a development context. All trees are subject to impromptu failure and damage and the assessment of risk as may be presented by a tree requires the review of numerous factors more than those noted herein and as such, remains outside the scope of this document and any attempt to use the information herein for such proposes will render the information invalid.

A competent and experienced Arborist has completed all inspection and tree assessment. The inspection involves visual assessment only, which has been carried out from ground level. No below ground, internal, invasive or aerial (climbing) inspection has been carried out.

Trees are living organisms whose health, condition and safety can change rapidly. It is recommended that all trees should be re-evaluated regarding their condition on an annual basis or after substantial trauma such a storm event, other damage or injury. It is advised that the results and recommendations of this survey will require review and reassessment after one year from the date of execution. This survey does not constitute a review of tree or site safety. Attempts to use the contents herein for such purposes will render the contents invalid.

Throughout the undertaking of the survey, several factors acted against the inspectors, contriving to reduce the accuracy of the survey.

Seasonality

The survey was commenced during the winter period. Some of the signs, typically symptomatic of ill-health or defect within a tree, may not have been available to view at the time of the survey or may have been obscured by seasonality related factors. Some of the fruiting bodies of various fungi, parasitic upon or causing decay or disease in trees, may have been out of season and unavailable to view. This survey can only comment upon symptoms of ill-health or defects visible at the time of the inspection.

Survey Key

Species.....	Refers to the specific tree species
Age.....	Referred to in generalized categories including: -
Y - Young.....	A young and typically small tree specimen.
S/M - Semi-Mature.....	A young tree, having attained dimensions that allow it to be regarded independently of its neighbours but typically, would be less than 50% of its ultimate size.
E/M - Early-Mature.....	A specimen, typically 50% - 100% of ultimate dimensions but with substantial capacity for mass and dimensional increase remaining.
M - Mature.....	A specimen of dimensions typical of a full-grown specimen of its species. Future growth would tend to be extremely slow with little if any dimensional increase.
O/M - Over-Mature.....	An old specimen of a species having already attained or exceeded its naturally expected longevity.
V - Veteran.....	An extremely old, veteran specimen of a species, usually of low vigour and typically subject to rapid decline and deterioration or of very limited future longevity.
Tree Dimensions	All dimensions are in meters. See notes regarding limitation of accuracy.
Ht.....	Tree Height
C-Ht.....	Lowest canopy height
FSB.....	Level of First Significant Branch
Sp: R.....	Tree Canopy Spread measured by radii at north, east, south and west
Dia.....	Stem diameter at approx. 1.50m from ground level.
RPA.....	Root Protection Area, as a radius measured from the tree's stem centre.
Con	Physical Condition
G Good.....	A specimen of generally good form and health
G/F Good/Fair.....	
F Fair.....	A specimen with defects or ill health that can be either rectified or managed typically allowing for retention
F/P Fair/Poor.....	
P Poor.....	A specimen whom through defect, disease attack or reduced vigour has a limited longevity or may be un-safe
D Dead.....	A dead tree
Structural Condition	Information on structural form, defects, damage, injury or disease supported by the tree
PMR – Preliminary Management Recommendations	Recommendation for Arboricultural actions or works considered necessary at the time of the inspection and relating to the existing site context and tree condition. Note is also made of works considered as urgent.
Retention Period	
S – Short.....	Typically 0 -10 years
M – Medium.....	Typically 10 -20 years
L – Long.....	Typically 20 – 40 years
L+.....	Typically in excess of 40 years
Category System.....	The Category System is intended to quantify a tree regarding its Arboricultural value as well as a combination of its structural and physical health. Note should be made of the fact that tree categorization relates to the current site and tree locations therein. As site changes occur, it may become necessary to re-evaluate trees regarding their relationship to new features.
Category U.....	Typically relates to trees that are dead, dying or dangerous. Such trees may present a threat of suffer from a defect or disease that is considered irremediable.
Category A.....	A typically a good quality specimen, which is considered to make a substantial Arboricultural contribution
Category B.....	Typically including trees regarded as being of moderate quality
Category C.....	Typically including generally poor-quality trees that may be of only limited value. The above categories (A, B and C) will be further subdivided regarding the nature of their values or qualities. A tree may be awarded one or more value categories as below, but such attributes do note infer any additional value and it may be possible for a tree may qualify for one or more of the categories as below.
Sub-Category 1.....	Values such as species interest, species context, landscape design or prominent aspect.
Sub-Category 2.....	Mainly cumulative landscape values such as woods, groups, avenues, lines.
Sub-Category 3.....	Mainly cultural values such as conservation, commemorative or historical links.

Table 1 – Tree Data Table

No.	Species	Age	Con	Ht	CH	N	E	S	W	Stm	Dia	RPA	Structural Condition	PMR	Yrs	Cat
1	Ash *(Fraxinus excelsior)*	S/M	G/F	7.00	1.00	3.00	3.00	3.00	3.00	1	376	4.51	Young and vigorous, arising from northern edge of drainage ditch. Centre crown supports extensive Ivy cover.		L	B2
2	Ash *(Fraxinus excelsior)*	S	G/F	7.00	1.50	3.50	3.00	2.50	2.00	1	274	3.29	Distorted a multi-stemmed with slight imbalance. Arises from northern edge of field drainage ditch.		L	B2
3	Ash *(Fraxinus excelsior)*	E/M	P	13.00	3.50	3.50	4.00	4.00	4.00	1	462	5.54	Affected by chronic cavity near ground level suggesting 2nd forked stem having collapsed and history. Unsuitable for retention.	Remove.	N/A	U
TG1	Tree Group 1 Ash *(Fraxinus excelsior)*	S/M	P	12.00-15.00	0.00-2.00	Spread Contiguous				1	207	2.48	A lapsed and outgrown element of hedge is now dominated by a close-knit multitude of naturally arising ash stems. Most specimens are relatively small and slender with slightly larger specimens to the south of the alignment. All specimens arise from the western embankment of an original ditch line however, demolition works and landfill to the West of the alignment sees many specimens encroached upon by chronic burial and ground level raising. Expectation of decline and deterioration is high. Larger specimens at southern end of line include a southernmost specimen that has suffered catastrophic failure and collapse from circa 3.00 m. Alignment is considered unsuitable for retention.	Remove.	N/A	U

No.	Species	Age	Con	Ht	CH	N	E	S	W	Stm	Dia	RPA	Structural Condition	PMR	Yrs	Cat
4	Ash *(Fraxinus excelsior)*	E/M	F	12.00	1.00	4.50	4.50	3.00	2.00	1	493	5.92	Relatively young but distorted specimen heavily enveloped in Ivy cover. Has been affected by partial burial and soil level raising works immediately to north of stem. Lower western crown has suffered prior mechanical damage. Sustainability and or suitability for retention is questionable.		S	C2
5	Ash *(Fraxinus excelsior)*	E/M	F/P	12.00	2.00	5.00	3.00	0.00	4.00	1	471	5.65	Heavily unbalanced and north and affected by soil level raising adjoining stem. Tree appears to have suffered prior damage and appears to be a relic of a previously, partially collapsed tree. Is considered unsuitable for retention.	Remove.	N/A	U
6	Crack Willow *(Salix fragilis)*	E/M	P	7.00	0.00	5.00	6.00	4.50	3.00	5	525	6.30	Large multi-stem specimen having suffered chronic mechanical failure and loss of limb to north-east. Is unsuitable for attention.	Remove.	N/A	U
7	Sycamore *(Acer pseudoplatanus)*	S/M	F	6.00	1.00	3.00	2.00	2.00	3.00	1	366	4.39	Triple-stemmed from low level and suppressed by adjoining trees. Is substantially encroached upon by substantial ground level raising immediately to north of stem. Sustainability is questionable.		S	C2

No.	Species	Age	Con	Ht	CH	N	E	S	W	Stm	Dia	RPA	Structural Condition	PMR	Yrs	Cat
TG2	Tree Group 2	M	F	20.00	0.00-2.00	Spread Contiguous				1	987	11.84	A close-knit and contiguous group of 6 individual trees presumed have been planted as a hedge but now having become hugely outgrown. All specimens exhibit varying degrees of species typical mechanical failure and deadwood development associated with normally expected mechanical sustainability during mid and later life. Trees arise from northern bank of substantial ditch and have been widely affected by substantial ground level raising activities across entire ground space to north of stems. Issues of health and sustainability arise and contextual issues relating to an inability to actively manage this species at this stage of life.		S	C1-2
8	Lime *(Tilia europea)*	S/M	F/P	6.00	1.50	3.00	3.50	3.00	3.00	1	548	6.57	Has suffered substantial lower Crown mechanical damage about northern crown. Tree arises from a modified ground space with entire root protection area having sustained substantial levelling and raising works. Health repercussions are expected that will greatly diminish and sustainability.		S	C2

No.	Species	Age	Con	Ht	CH	N	E	S	W	Stm	Dia	RPA	Structural Condition	PMR	Yrs	Cat
9	Monterey Pine *(Pinus radiata)*	E/M	F/P	13.00	1.00	4.50	5.00	4.00	4.50	2	439	5.27	Two adjoining stems arise to create a singular crown form. Both trees have suffered chronic, widespread and extensive soil level raising and stem base burial suggesting some potential for tree to be a forked specimen as opposed to adjoining trees. Environmental modification in vicinity of trees is considered such as to raise high likelihood of negative health implications and decline.		S	C2
10	Sycamore *(Acer pseudoplatanus)*	E/M	G/F	12.00	1.00	4.00	4.00	4.00	4.00	1	535	6.42	A young and relatively vigorous tree supporting developing Ivy cover about middle crown. Evidence suggests substantial ground modification in areas adjoining tree though extent of this is unknown.	Review regularly.	M	C2
11	Beech *(Fagus sylvatica)*	E/M	P	10.00	0.50	3.00	5.00	2.50	0.00	1	347	4.16	Chronically suppressed and heavily unbalanced to east. Appears to comprise an outgrown element of the prior hedge. Is of questionable suitability for retention.		S	C2
12	Monterey Cypress *(Cupressus macrocarpa)*	M	F/P	17.00	2.50	6.50	7.00	6.50	5.00	1	1171	14.06	Large, expose specimen exhibiting age typical mechanical deterioration and storm damage. Tree arises from area that appears to have suffered widespread ground modification and therefore there may well be health repercussions over time. Retention must consider contextual issues and inability to manage this species at this age.		S	C1-2
13	Ash *(Fraxinus excelsior)*	S/M	F	8.00	1.50	4.00	4.00	4.00	4.00	5	525	6.30	A young, multi-stem specimen arising from eastern side of substantial drainage ditch. Remains vigorous but is mechanically impaired and supports extensive Ivy development.		M	C2

11

No.	Species	Age	Con	Ht	CH	N	E	S	W	Stm	Dia	RPA	Structural Condition	PMR	Yrs	Cat
14	Purple Plum *(Prunus cerasifera)*	E/M	F	4.50	1.00	2.50	2.00	2.50	2.50	1	229	2.75	Comprises a remnant element of an original garden landscapes. Is of small stature and heavily affected by Ivy cover.		M	C2
15	Purple Plum *(Prunus cerasifera)*	E/M	F	4.50	1.00	2.50	2.00	2.50	2.50	1	223	2.67	Comprises a remnant element of an original garden landscapes. Is of small stature and heavily affected by Ivy cover.		M	C2
16	Variegated Poplar *(Populus Sp.)*	S/M	P	6.00	1.50	2.00	2.00	2.50	2.50	1	306	3.67	Suffering chronic canker damage and dieback.	Remove.	N/A	U
17	Purple Plum *(Prunus cerasifera)*	M	F	5.00	1.75	2.00	3.00	3.50	3.50	1	309	3.71	Vigorous but supporting extensive Ivy cover. Is heavily one-sided through suppression regarding position adjoining cypress hedge. Is of questionable sustainability.		M	C2
18	Ash *(Fraxinus excelsior)*	S/M	P	5.50	1.50	3.00	4.00	3.00	3.00	1	286	3.44	Distorted and damaged, encroached upon by substantial rubble and dumping. Is considered unsustainable.		S	C2

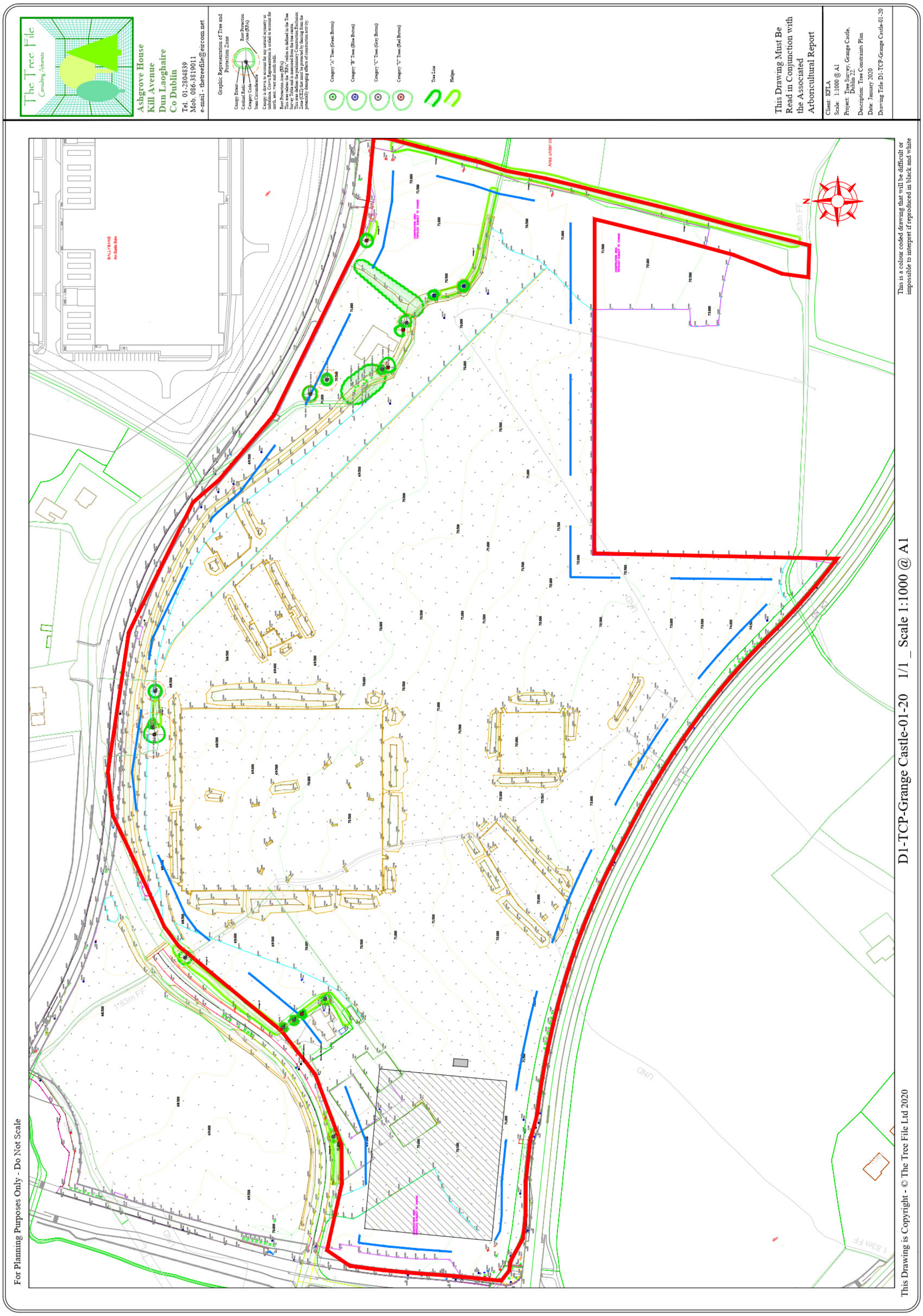
Tree Lines and Hedges

H1	Hedge 1 Hawthorn *(Crataegus monogyna)* Blackthorn *(Prunus spinosa)* Elder *(Sambucus nigra)* Bramble *(Rubus fruticosus)* Ivy *(Hedera helix)* Goat Willow *(Salix caprea)*	M	F	4.00-7.00	0.00	Spread 4.00-6.00	Multi-stem	207	2.48	What appears to be an original but lapsed and unmanaged agricultural field hedgerow appears, for the most part, to be associated with the eastern bank of a substantial land drainage ditch and thus is at least in part, this associated from the main site lands by a physiological feature. The hedge itself appears to be broadly continuous however the original Hawthorn content is variable and intermittent with the greatest element of continuity being provided for by lower level Bramble and elder thicket. Eradication of low-level Bramble thicket will greatly diminish visual significance of hedge and continuity.		L	C
H2	Hedge 2 Hawthorn *(Crataegus monogyna)* Blackthorn *(Prunus spinosa)* Bramble *(Rubus fruticosus)* Ivy *(Hedera helix)*	M	F/P	1.00-4.50	0.00	Spread 3.00-5.00	Multi-stem	207	2.48	A lapsed and substantially dilapidated agricultural field boundary hedge where the original Hawthorn content is now sporadic, intermittent and disjointed. The greater degree of continuity comprises a low-level Bramble thicket. Quality is poor and potential for improvement is limited. hedge is associated with northern bank of field drainage ditch.		L	C
H3	Hedge 3 Hawthorn *(Crataegus monogyna)* Bramble *(Rubus fruticosus)* Ivy *(Hedera helix)*	M	P	3.50	0.00	Spread 4.00	Multi-stem	207	2.48	A short, lap section of hedge still dominated by Hawthorn but including substantial elements of Ivy and Bramble.		L	C

13

H4	Hedge 4 Beech *(Fagus sylvatica)* Lawson Cypress *(Chamaecyparis lawsoniana)*	S/M	P	1.00-5.00	0.00	Spread 1.00-4.00	Multi-stem	175	2.10	A lapsed element of domestic garden hedging Originally planted as a beech hedge. Is now suffering from non-management and growth. Is of minimal sustainability or retention merit.		S	C
H5	Hedge 5 Hawthorn *(Crataegus monogyna)* Blackthorn *(Prunus spinosa)* Bramble *(Rubus fruticosus)* Ivy *(Hedera helix)* Ash *(Fraxinus excelsior)*	M	F/P	3.00-5.00	0.00	Spread 5.00-7.00	Multi-stem	207	2.48	A lapsed and variable hedge arising from eastern side of drainage ditch. Originally comprising a Hawthorne hedge, much of the Hawthorn is now superseded by Blackthorn and Bramble thicket.		L	C
H6	Hedge 6 Lawson Cypress *(Chamaecyparis lawsoniana)* Leyland Cypress *(Cuppressocyparis leylandii)*	S/M-E/M	F/P	4.00-7.00	1.00-0.00	Spread 2.00-5.00	Multi-stem	207	2.48	A highly intermittent and variable hedge presumably installed to create a screen/shelter to the original dwelling. The alignment is now intermittent with evidence suggesting trees having been lost and many specimens being suppressed and elongated. Specimens exhibit no evidence of recent management and thus are becoming outgrown. Sustainability is considered minimal.	Consider early removal.	N/A	U

GS	Garden Shrubbery Lawson Cypress *(Chamaecyparis lawsoniana)* Viburnam *(Viburnam Sp.)* Holly *(Ilex aquifolium)* Cotoneaster *(Cotoneaster Sp)* Elder *(Sambucus nigra)* Bramble *(Rubus fruticosus)*	E/M	F/P	1.00-2.50	0.00	Spread Contiguous-variable		159	1.91	General note for garden area, substantially overgrown and exhibiting evidence of ornamental planting including cypress, Variegated Holly Viburnam however, boundary elements now tend to be overgrown with invasive plants including Elder and Bramble.		S	C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This Drawing Must Be Read in Conjunction with the Associated Arboricultural Report
Client: KFLA
Scale: 1:1000 @ A1
Project: Tree Survey, Grange Castle, Dublin 22.
Description: Tree Constraints Plan
Date: January 2020
Drawing Title: D1-TCP-Grange Castle-01-20
D1-TCP-Grange Castle-01-20 1/1 _ Scale 1:1000 @ A1
For Planning Purposes Only - Do Not Scale
This Drawing is Copyright - © The Tree File Ltd 2020
This is a colour coded drawing that will be difficult or impossible to interpret if reproduced in black and white

CHAPTER 13 CULTURAL HERITAGE

Appendix 13.1 RMP/SMR Sites within the surrounding area

SMR No.	DU021-108
RMP Status	Scheduled for inclusion in the next revision of the RMP
Townland	Ballybane
Parish	Clondalkin
Barony	Uppercross
I.T.M.	703059/730984
Classification	Concentric enclosure
Dist. From Development	Partially within Proposed Development site
Description	Not indicated on any OS map a large concentric enclosure is visible as a crop-mark on an aerial photo. A second enclosure (DU021-109) is visible to the SW (now fully excavated).
Reference	www.archaeology.ie/ SMR file

SMR No.	DU021-109
RMP Status	Scheduled for inclusion in the next revision of the RMP
Townland	Ballybane
Parish	Clondalkin
Barony	Uppercross
I.T.M.	702937/730713
Classification	Enclosure
Dist. From Development	c. 262m west
Description	Not indicated on any OS map this enclosure is as a crop-mark on an aerial photo. A second larger enclosure (DU021-108) is visible to the NE (now fully excavated).
Reference	www.archaeology.ie/ SMR file

Appendix 13.2 Architectural Heritage Sites within the Surrounding Area

RPS No.	n/a
NIAH No.	11208008
Townland	Milltown
Parish	Kilmactalway
Barony	Newcastle
I.T.M.	702683/ 731574
Classification	Farm house
Dist. From Development	c. 375m west
Description	Description Detached four-bay two-storey farm house, c.1850. Roughcast rendered walls. uPVC door and casement windows. Replacement pitched slate roof with terracotta ridge tiles and gable coping. Two central brick chimney stacks. Later drip moulding over northern front window. Lean-to extension to the rere, and shed to side. Appraisal A tidy detached farm house which retains its original form and an unusually formal front garden, still serving the farm to the rere.
Reference	NIAH South County Dublin

RPS No.	n/a
NIAH No.	11208016
Townland	Milltown
Parish	Kilmactalway
Barony	Newcastle
I.T.M.	702520/731042
Classification	House
Dist. From Development	c. 378m west
Description	Description Formerly detached four-bay two-storey former house, c.1790, in use as public house. Roughcast rendered walls with parallel render quoins. Timber casement windows. Timber door with iron fittings. Pitched slate roof with single rendered chimney stack. Series of nineteenth- and twentieth-century extensions to south and west. Appraisal This site has long been in use as a public house as shown by the extensions surrounding the original modest rural house. Its presence gives a focus to this important and formerly more developed junction.
Reference	NIAH South County Dublin

RPS No.	155
NIAH No.	11208015
Townland	Milltown
Parish	Kilmactalway
Barony	Newcastle
I.T.M.	702446/731071
Classification	Farm house
Dist. From Development	c. 439m west
Description	Description Detached four-bay two-storey farm house, c.1760, with attached outbuildings. Rendered rubble stone walls. Glazed timber door in gabled porch. Timber sash windows. Some openings blocked. Possible traces of carriage arch to central bay. Pitched slate roof with two rendered chimney stacks. House possibly originally single-storey. Adjoining outbuildings to north with hayloft, and enlarged openings inserted recently. Partial tubular iron sunburst gate. Original fir tree stand to south. Appraisal A fine example of an eighteenth-century farm cottage and barn, demonstrating a classic sequence of vernacular evolution. Retains many period features.
Reference	NIAH South County Dublin/ South Dublin County Development Plan 2016–2022

RPS No.	n/a
NIAH No.	11208006
Townland	Milltown
Parish	Kilmactalway
Barony	Newcastle
I.T.M.	702446/730989
Classification	Outbuilding
Dist. From Development	c. 469m west
Description	Description Detached two-storey farm outbuilding, c.1850, with two-bay gable ends. Rendered walls. Blind wall to street with chamfered corners. Timber sash and casement windows. Corrugated aluminium pitched roof. Adjoining rubble stone walls of demolished outbuildings to south-east and ruinous cottages to north-east. Appraisal The chamfered corners of this outbuilding indicate the volume of horse-drawn traffic originally passing into the farm complex. Such buildings following the road line sheltered the farm yard and were a characteristic feature of Irish agriculture. This farm was associated with the now-demolished Milltown House.
Reference	NIAH South County Dublin

Appendix 13.3 Legislation protecting the archaeological resource

Protection of Cultural Heritage

The cultural heritage in Ireland is safeguarded through national and international policy designed to secure the protection of the cultural heritage resource to the fullest possible extent (Department of Arts, Heritage, Gaeltacht and the Islands 1999, 35). This is undertaken in accordance with the provisions of the *European Convention on the Protection of the Archaeological Heritage* (Valletta Convention), ratified by Ireland in 1997.

The Archaeological Resource

The *National Monuments Act 1930 to 2014* and relevant provisions of the *National Cultural Institutions Act 1997* are the primary means of ensuring the satisfactory protection of archaeological remains, which includes all man-made structures of whatever form or date except buildings habitually used for ecclesiastical purposes. A National Monument is described as 'a monument or the remains of a monument the preservation of which is a matter of national importance by reason of the historical, architectural, traditional, artistic or archaeological interest attaching thereto' (National Monuments Act 1930 Section 2). A number of mechanisms under the National Monuments Act are applied to secure the protection of archaeological monuments. These include the Register of Historic Monuments, the Record of Monuments and Places, and the placing of Preservation Orders and Temporary Preservation Orders on endangered sites.

Ownership and Guardianship of National Monuments

The Minister may acquire national monuments by agreement or by compulsory order. The state or local authority may assume guardianship of any national monument (other than dwellings). The owners of national monuments (other than dwellings) may also appoint the Minister or the local authority as guardian of that monument if the state or local authority agrees. Once the site is in ownership or guardianship of the state, it may not be interfered with without the written consent of the Minister.

Register of Historic Monuments

Section 5 of the 1987 Act requires the Minister to establish and maintain a Register of Historic Monuments. Historic monuments and archaeological areas present on the register are afforded statutory protection under the 1987 Act. Any interference with sites recorded on the register is illegal without the permission of the Minister. Two months' notice in writing is required prior to any work being undertaken on or in the vicinity of a registered monument. The register also includes sites under Preservation Orders and Temporary Preservation Orders. All registered monuments are included in the Record of Monuments and Places.

Preservation Orders and Temporary Preservation Orders

Sites deemed to be in danger of injury or destruction can be allocated Preservation Orders under the 1930 Act. Preservation Orders make any interference with the site illegal. Temporary Preservation Orders can be attached under the 1954 Act. These perform the same function as a Preservation Order but have a time limit of six months, after which the situation must be reviewed. Work may only be undertaken on or in the vicinity of sites under Preservation Orders with the written consent, and at the discretion, of the Minister.

Record of Monuments and Places

Section 12(1) of the 1994 Act requires the Minister for Arts, Heritage, Gaeltacht and the Islands (now the Minister for the Department of Culture, Heritage and the Gaeltacht) to establish and maintain a record of monuments and places where the Minister believes that such monuments exist. The record comprises a list of monuments and relevant places and a map/s showing each monument and relevant place in respect of each county in the state. All sites recorded on the Record of Monuments and Places receive statutory protection under the National Monuments Act 1994. All recorded monuments on the Proposed Development site are represented on the accompanying maps.

Section 12(3) of the 1994 Act provides that 'where the owner or occupier (other than the Minister for Arts, Heritage, Gaeltacht and the Islands) of a monument or place included in the Record, or any other person, proposes to carry out, or to cause or permit the carrying out of, any work at or in relation to such a monument or place, he or she shall give notice in writing to the Minister of Arts, Heritage, Gaeltacht and the Islands to carry out work and shall not, except in case of urgent necessity and with the consent of the Minister, commence the work until two months after giving of notice'.

Under the National Monuments (Amendment) Act 2004, anyone who demolishes or in any way interferes with a recorded site is liable to a fine not exceeding €3,000 or imprisonment for up to 6 months. On summary conviction and on conviction of indictment, a fine not exceeding €10,000 or imprisonment for up to 5 years is the penalty. In addition, they are liable for costs for the repair of the damage caused.

In addition to this, under the *European Communities (Environmental Impact Assessment) Regulations 1989,* Environmental Impact Statements (EIS) are required for various classes and sizes of development project to assess the impact the Proposed Development will have on the existing environment, which includes the cultural, archaeological and built heritage resources. These document's recommendations are typically incorporated into the conditions under which the Proposed Development must proceed, and thus offer an additional layer of protection for monuments which have not been listed on the RMP.

The Planning and Development Act 2000

Under planning legislation, each local authority is obliged to draw up a Development Plan setting out their aims and policies with regard to the growth of the area over a five-year period. They cover a range of issues including archaeology and built heritage, setting out their policies and objectives with regard to the protection and enhancement of both. These policies can vary from county to county. The Planning and Development Act 2000 recognises that proper planning and sustainable development includes the protection of the archaeological heritage. Conditions relating to archaeology may be attached to individual planning permissions.

South Dublin County Council Development Plan, 2016–2022

It is the policy of the Council to manage development in a manner that protects and conserves the Archaeological Heritage of the County and avoids adverse impacts on sites, monuments, features or objects of significant historical or archaeological interest.

HCL2 Objective 1:
To favour the preservation in-situ of all sites, monuments and features of significant historical or archaeological interest in accordance with the recommendations of the Framework and Principles for the Protection of Archaeological Heritage, DAHGI (1999), or any superseding national policy document.

HCL2 Objective 2:
To ensure that development is designed to avoid impacting on archaeological heritage that is of significant interest including previously unknown sites, features and objects.

HCL2 Objective 3:
To protect and enhance sites listed in the Record of Monuments and Places and ensure that development in the vicinity of a Recorded Monument or Area of Archaeological Potential does not detract from the setting of the site, monument, feature or object and is sited and designed appropriately.

HCL2 Objective 4:
To protect and preserve the archaeological value of underwater archaeological sites including associated features and any discovered battlefield sites of significant archaeological potential within the County.

HCL2 Objective 5:
To protect historical burial grounds within South Dublin County Council and encourage their maintenance in accordance with conservation principles.

Appendix 13.4 Legislation protecting the Architectural Resource

The main laws protecting the built heritage are the *Architectural Heritage (National Inventory) and National Monuments (Miscellaneous Provisions) Act 1999* and the *Local Government (Planning and Development) Acts 1963–1999*, which has now been superseded by the *Planning and Development Act, 2000*. The Architectural Heritage Act requires the Minister to establish a survey to identify, record and assess the architectural heritage of the country. The background to this legislation derives from Article 2 of the 1985 Convention for the Protection of Architectural Heritage (Granada Convention). This states that:

For the purpose of precise identification of the monuments, groups of structures and sites to be protected, each member state will undertake to maintain inventories of that architectural heritage.

The National Inventory of Architectural Heritage (NIAH) was established in 1990 to fulfil Ireland's obligation under the Granada Convention, through the establishment and maintenance of a central record, documenting and evaluating the architecture of Ireland (NIAH Handbook 2005:2). As inclusion in the inventory does not provide statutory protection, the survey information is used in conjunction with the *Architectural Heritage Protection Guidelines for Planning Authorities* to advise local authorities on compilation of a Record of Protected Structures as required by the *Planning and Development Act, 2000*.

Protection under the Record of Protected Structures and County Development Plan
Structures of architectural, cultural, social, scientific, historical, technical or archaeological interest can be protected under the Planning and Development Act, 2000, where the conditions relating to the protection of the architectural heritage are set out in Part IV of the act. This act superseded the Local Government (Planning and Development) Act, 1999, and came into force on 1st January 2000.

The act provides for the inclusion of Protected Structures into the planning authorities' development plans and sets out statutory regulations regarding works affecting such structures. Under new legislation, no distinction is made between buildings formerly classified under development plans as List 1 and List 2. Such buildings are now all regarded as 'Protected Structures' and enjoy equal statutory protection. Under the act the entire structure is protected, including a structure's interior, exterior, attendant grounds and also any structures within the attendant grounds.

The act defines a Protected Structure as (a) a structure, or (b) a specified part of a structure which is included in a Record of Protected Structures (RPS), and, where that record so indicates, includes any specified feature which is in the attendant grounds of the structure and which would not otherwise be included in this definition. Protection of the structure, or part thereof, includes conservation, preservation, and improvement compatible with maintaining its character and interest. Part IV of the act deals with architectural heritage, and Section 57 deals specifically with works affecting the character of Protected Structures or proposed Protected Structures and states that no works should materially affect the character of the structure or any element of the structure that contributes to its special architectural, historical, archaeological, artistic, cultural, scientific, social or technical interest. The act does not provide specific criteria for assigning a special interest to a structure. However, the National Inventory of Architectural Heritage (NIAH) offers guidelines to its field workers as to how to designate a building with a special interest, which are not mutually exclusive. This offers guidance by example rather than by definition:

Archaeological
It is to be noted that the NIAH is biased towards post-1700 structures. Structures that have archaeological features may be recorded, providing the archaeological features are incorporated within post-1700 elements. Industrial fabric is considered to have technical significance, and should only be attributed archaeological significance if the structure has pre-1700 features.

Architectural
A structure may be considered of special architectural interest under the following criteria:

- *Good quality or well executed architectural design*
- *The work of a known and distinguished architect, engineer, designer, craftsman*
- *A structure that makes a positive contribution to a setting, such as a streetscape or rural setting*
- *Modest or vernacular structures may be considered to be of architectural interest, as they are part of the history of the built heritage of Ireland.*
- *Well-designed decorative features, externally and/or internally*

Historical
A structure may be considered of special historical interest under the following criteria:

- *A significant historical event associated with the structure*
- *An association with a significant historical figure*
- *Has a known interesting and/or unusual change of use, e.g. a former workhouse now in use as a hotel*
- *A memorial to a historical event.*

Technical
A structure may be considered of special technical interest under the following criteria:

- *Incorporates building materials of particular interest, i.e. the materials or the technology used for construction*
- *It is the work of a known or distinguished engineer*
- *Incorporates innovative engineering design, e.g. bridges, canals or mill weirs*
- *A structure which has an architectural interest may also merit a technical interest due to the structural techniques used in its construction, e.g. a curvilinear glasshouse, early use of concrete, cast-iron prefabrication.*
- *Mechanical fixtures relating to a structure may be considered of technical significance.*

Cultural
A structure may be considered of special cultural interest under the following criteria:

- *An association with a known fictitious character or event, e.g. Sandycove Martello Tower, which featured in Ulysses.*
- *Other structure that illustrate the development of society, such as early schoolhouses, swimming baths or printworks.*

Scientific
A structure may be considered of special scientific interest under the following criteria:

- *A structure or place which is considered to be an extraordinary or pioneering scientific or technical achievement in the Irish context, e.g. Mizen Head Bridge, Birr Telescope.*

Social
A structure may be considered of special social interest under the following criteria:
    - *A focal point of spiritual, political, national or other cultural sentiment to a group of people, e.g. a place of worship, a meeting point, assembly rooms.*
    - *Developed or constructed by a community or organisation, e.g. the construction of the railways or the building of a church through the patronage of the local community*
    - *Illustrates a particular lifestyle, philosophy, or social condition of the past, e.g. the hierarchical accommodation in a country house, philanthropic housing, vernacular structures.*

Artistic
A structure may be considered of special artistic interest under the following criteria:

- *Work of a skilled craftsman or artist, e.g. plasterwork, wrought-iron work, carved elements or details, stained glass, stations of the cross.*
- *Well-designed mass-produced structures or elements may also be considered of artistic interest.*

(From the NIAH Handbook 2003 & 2005 pages 15–20)

The Local Authority has the power to order conservation and restoration works to be undertaken by the owner of the protected structure if it considers the building to need repair. Similarly, an owner or developer must make a written request to the Local Authority to carry out any works on a protected structure and its environs, which will be reviewed within three months of application. Failure to do so may result in prosecution.

South Dublin County Council Development Plan, 2016–2022

It is the policy of the Council to conserve and protect buildings, structures and sites contained in the Record of Protected Structures and to carefully consider any proposals for development that would affect the special character or appearance of a Protected Structure including its historic curtilage, both directly and indirectly.

HCL3 Objective 1:
To ensure the protection of all structures (or parts of structures) and the immediate surroundings including the curtilage and attendant grounds of structures contained in the Record of Protected Structures.

HCL3 Objective 2:
To ensure that all development proposals that affect a Protected Structure and its setting including proposals to extend, alter or refurbish any Protected Structure are sympathetic to its special character and integrity and are appropriate in terms of architectural treatment, character, scale and form. All such proposals shall be consistent with the Architectural Heritage Guidelines for Planning Authorities, DAHG (2011) including the principles of conservation.

HCL3 Objective 3:
To address dereliction and encourage the rehabilitation, renovation, appropriate use and re-use of Protected Structures.

HCL3 Objective 4:
To prevent demolition and inappropriate alteration of Protected Structures.

It is the policy of the Council to preserve and enhance the historic character and visual setting of Architectural Conservation Areas and to carefully consider any proposals for development that would affect the special value of such areas.

HCL4 Objective 1:
To avoid the removal of structures and distinctive features that positively contribute to the character of Architectural Conservation Areas including buildings, building features, shop fronts, boundary treatments, street furniture, landscaping and paving.

HCL4 Objective 2:
To ensure that new development, including infill development, extensions and renovation works within or adjacent to an Architectural Conservation Area (ACA) preserves or enhances the special character and visual setting of the ACA including vistas, streetscapes and roofscapes.

HCL4 Objective 3:
To address dereliction and promote appropriate and sensitive reuse and rehabilitation of buildings, building features and sites within Architectural Conservation Areas.

HCL4 Objective 4:
To reduce and prevent visual and urban clutter within Architectural Conservation Areas including, where appropriate, traffic management structures, utility structures and all signage.

HCL4 Objective 5:
To support public realm improvements proposed within Architectural Conservation Areas under South Dublin County Council's Villages Initiative subject to compliance with the Architectural Heritage Protection Guidelines for Planning Authorities (DAHG, 2011).

HCL4 SLO 1:
To secure the preservation and enhancement of the Palmerstown Lower (Mill Complex) ACA, to actively promote the restoration of industrial heritage including the former mills, mill races and other buildings on Mill Lane and to explore their use for residential, tourism/outdoor recreation and/or commercial purposes.

It is the policy of the Council to encourage the preservation of older features, buildings, and groups of structures that are of historic character including 19th Century and early to mid-20th Century houses, housing estates and streetscapes.

HCL5 Objective 1:
To retain existing houses that, while not listed as Protected Structures, are considered to contribute to historic character, local character, visual setting, rural amenity or streetscape value within the County.

HCL5 Objective 2:
To ensure that the redevelopment of older buildings, including extensions and renovation works do not compromise or erode the architectural interest, character or visual setting of such buildings including surrounding housing estates or streetscapes.

HCL5 Objective 3:
To encourage the retention, rehabilitation, renovation and re-use of older buildings and their original features where such buildings and features contribute to the visual setting, collective interest or character of the surrounding area.

HCL5 Objective 4:
To ensure that infill development is sympathetic to the architectural interest, character and visual amenity of the area.

Appendix 13.5 Impact Assessment and the Cultural Heritage Resource

Potential Impacts on Archaeological and Historical Remains

Impacts are defined as 'the degree of change in an environment resulting from a development' (Environmental Protection Agency 2017). They are described as profound, significant or slight impacts on archaeological remains. They may be negative, positive or neutral, direct, indirect or cumulative, temporary or permanent.

Impacts can be identified from detailed information about a project, the nature of the area affected and the range of archaeological and historical resources potentially affected. Development can affect the archaeological and historical resource of a given landscape in a number of ways.

- *Permanent and temporary land-take, associated structures, landscape mounding, and their construction may result in damage to or loss of archaeological remains and deposits, or physical loss to the setting of historic monuments and to the physical coherence of the landscape.*
- *Archaeological sites can be affected adversely in a number of ways: disturbance by excavation, topsoil stripping and the passage of heavy machinery; disturbance by vehicles working in unsuitable conditions; or burial of sites, limiting accessibility for future archaeological investigation.*
- *Hydrological changes in groundwater or surface water levels can result from construction activities such as de-watering and spoil disposal, or longer-term changes in drainage patterns. These may desiccate archaeological remains and associated deposits.*
- *Visual impacts on the historic landscape sometimes arise from construction traffic and facilities, built earthworks and structures, landscape mounding and planting, noise, fences and associated works. These features can impinge directly on historic monuments and historic landscape elements as well as their visual amenity value.*
- *Landscape measures such as tree planting can damage sub-surface archaeological features, due to topsoil stripping and through the root action of trees and shrubs as they grow.*
- *Ground consolidation by construction activities or the weight of permanent embankments can cause damage to buried archaeological remains, especially in colluviums or peat deposits.*
- *Disruption due to construction also offers in general the potential for adversely affecting archaeological remains. This can include machinery, site offices, and service trenches.*

Although not widely appreciated, positive impacts can accrue from developments. These can include positive resource management policies, improved maintenance and access to archaeological monuments, and the increased level of knowledge of a site or historic landscape as a result of archaeological assessment and fieldwork.

Predicted Impacts

The severity of a given level of land-take or visual intrusion varies with the type of monument, site or landscape features and its existing environment. Severity of impact can be judged taking the following into account:

- *The proportion of the feature affected and how far physical characteristics fundamental to the understanding of the feature would be lost;*
- *Consideration of the type, date, survival/condition, fragility/vulnerability, rarity, potential and amenity value of the feature affected;*
- *Assessment of the levels of noise, visual and hydrological impacts, either in general or site-specific terms, as may be provided by other specialists.*

Appendix 13.6 Mitigation Measures and the Cultural Heritage Resource

Potential Mitigation Strategies for Cultural Heritage Remains

Mitigation is defined as features of the design or other measures of the Proposed Development that can be adopted to avoid, prevent, reduce or offset negative effects.

The best opportunities for avoiding damage to archaeological remains or intrusion on their setting and amenity arise when the site options for the development are being considered. Damage to the archaeological resource immediately adjacent to developments may be prevented by the selection of appropriate construction methods. Reducing adverse effects can be achieved by good design, for example by screening historic buildings or upstanding archaeological monuments or by burying archaeological sites undisturbed rather than destroying them. Offsetting adverse effects is probably best illustrated by the full investigation and recording of archaeological sites that cannot be preserved *in situ*.

Definition of Mitigation Strategies

Archaeological Resource

The ideal mitigation for all archaeological sites is preservation *in situ*. This is not always a practical solution, however. Therefore, a series of recommendations are offered to provide ameliorative measures where avoidance and preservation *in situ* are not possible.

Archaeological Test Trenching can be defined as 'a limited programme of intrusive fieldwork which determines the presence or absence of archaeological features, structures, deposits, artefacts or ecofacts within a specified area or site on land, inter-tidal zone or underwater. If such archaeological remains are present field evaluation defines their character, extent, quality and preservation, and enables an assessment of their worth in a local, regional, national or international context as appropriate' (CIfA 2014a).

Full Archaeological Excavation can be defined as 'a programme of controlled, intrusive fieldwork with defined research objectives which examines, records and interprets archaeological deposits, features and structures and, as appropriate, retrieves artefacts, ecofacts and other remains within a specified area or site on land, inter-tidal zone or underwater. The records made and objects gathered during fieldwork are studied and the results of that study published in detail appropriate to the project design' (CIfA 2014b).

Archaeological Monitoring can be defined as 'a formal programme of observation and investigation conducted during any operation carried out for non-archaeological reasons. This will be within a specified area or site on land, inter-tidal zone or underwater, where there is a possibility that archaeological deposits may be disturbed or destroyed. The programme will result in the preparation of a report and ordered archive (CIfA 2014c).

Underwater Archaeological Assessment consists of a programme of works carried out by a specialist underwater archaeologist, which can involve wade surveys, metal detection surveys and the excavation of test pits within the sea or riverbed. These assessments are able to access and assess the potential of an underwater environment to a much higher degree than terrestrial based assessments.

Architectural Resource

The architectural resource is generally subject to a greater degree of change than archaeological sites, as structures may survive for many years but their usage may change continually. This can be reflected in the fabric of the building, with the addition and removal of doors, windows and extensions. Due to their often more visible presence within the landscape than archaeological sites, the removal of such structures can sometimes leave a discernable 'gap' with the cultural identity of a population. However, a number of mitigation measures are available to ensure a record is made of any structure that is deemed to be of special interest, which may be removed or altered as part of a Proposed Development.

Conservation Assessment consists of a detailed study of the history of a building and can include the surveying of elevations to define the exact condition of the structure. These assessments are carried out by Conservation Architects and would commonly be carried out in association with proposed alterations or renovations on a Recorded Structure.

Building Survey may involve making an accurate record of elevations (internal and external), internal floor plans and external sections. This is carried out using an EDM (Electronic Distance Measurer) and GPS technology to create scaled drawings that provide a full record of the appearance of a building at the time of the survey.

Historic Building Assessment is generally specific to one building, which may have historic significance, but is not a Protected Structure or listed within the NIAH. A full historical background for the structure is researched and the site is visited to assess the standing remains and make a record of any architectural features of special interest. These assessments can also be carried out in conjunction with a building survey.

Written and Photographic record provides a basic record of features such as stone walls, which may have a small amount of cultural heritage importance and are recorded for prosperity. Dimensions of the feature are recorded with a written description and photographs as well as some cartographic reference, which may help to date a feature.

CHAPTER 14 – WASTE MANAGEMENT

Appendix14.1 Outline Construction and Demolition Waste Management Plan

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APPENDIX 14.1

CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT PLAN

PROPOSED GIS SUBSTATION, 110KV TRANSMISSION LINE, 49KVA CABLE INSTALLATION, AND NEW CABLE BAYS, GRANGE CASTLE, DUBLIN 22

Technical Report Prepared By

Jonathan Gauntlett, Environmental Consultant

Our Reference

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Signature		
Name	Jonathan Gauntlett	Elaine Neary
Title	Environmental Consultant	Associate
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CONTENTS

1.0 INTRODUCTION

AWN Consulting Ltd. (AWN) has prepared this Construction and Demolition (C&D) Waste Management Plan (WMP) to accompany a Strategic Infrastructure Development planning application to An Bord Pleanála (ABP).

The purpose of this C&D WMP is to provide information necessary to ensure that the management of C&D waste at the site is undertaken in accordance with current legal and industry standards including the *Waste Management Acts 1996-2011* and associated Regulations [1], *Protection of the Environment Act 2003* as amended [2], *Litter Pollution Act 1997* as amended [3] and the *Eastern-Midlands Region Waste Management Plan 2015-2021* [4]. In particular, this C&D WMP aims to ensure maximum recycling, re-use and recovery of waste with diversion from landfill, where possible. It also seeks to provide guidance on the appropriate collection and transport of waste to prevent issues associated with litter or more serious environmental pollution (e.g. contamination of soil or water resources).

In the preparation of the C&D WMP consideration has been given to the requirements of National and Regional waste policy, legislation and other guidelines (referred to in Section 2.0). However, in determining the structure and content of the document, the following two publications have been referenced in particular:

- Department of the Environment, Heritage and Local Government (DoEHLG), *Best Practice Guidelines on the Preparation of Waste Management Plans for Construction and Demolition Projects* (2006) [5].
- FÁS and the Construction Industry Federation (CIF), *Construction and Demolition Waste Management – a handbook for Contractors and Site Managers,* (2002) [6].

These Guidance Documents are considered to define best practice for C&D projects in Ireland and describe how C&D projects are to be undertaken such that environmental impacts and risks are minimised and maximum levels of waste recycling are achieved.

2.0 OVERVIEW OF WASTE MANAGEMENT IN IRELAND

2.1 National Level

The Government issued a policy statement in September 1998 titled as *'Changing Our Ways'* [7] which identified objectives for the prevention, minimisation, reuse, recycling, recovery and disposal of waste in Ireland [7]. The target for C&D waste in this Strategy was to recycle at least 50% of C&D waste within a five-year period (by 2003), with a progressive increase to at least 82% over fifteen years (by 2013) [7].

In response to the *Changing Our Ways* report, a task force (Task Force B4) representing the waste sector of the already established Forum for the Construction Industry, released a report titled *Recycling of Construction and Demolition Waste* [8] concerning the development and implementation of a voluntary construction industry programme to meet the governments objectives for the recovery of construction and demolition waste.

A number of additional National and Regional Waste Policies, Strategies and Reports have been issued in previous years including:

- Department of the Environment, Heritage and Local Government (DoEHLG), *Preventing and Recycling Waste - Delivering Change* (2002);
- DoEHLG, *Making Ireland's Development Sustainable – Review, Assessment and Future Action, World Summit on Sustainable Development* (2002);
- DoEHLG, *Taking Stock and Moving Forward* (2004);
- DoEHLG, *National Strategy on Biodegradable* Waste (2006); and
- DoEHLG, *A Resource Opportunity* (2012).

The most recent national policy document was published in July 2012, entitled *A Resource Opportunity - Waste Management Policy in Ireland* [9]. This document stresses the environmental and economic benefits of better waste management, particularly in relation to waste prevention. The document sets out a number of actions in relation to C&D waste - it commits to undertake a review of specific producer responsibility requirements for C&D projects over a certain threshold.

The National Construction and Demolition Waste Council (NCDWC) was launched in June 2002, as one of the recommendations of the Forum for the Construction Industry, in the Task Force B4 final report. The NCDWC subsequently produced *Best Practice Guidelines for the Preparation of Waste Management Plans for Construction and Demolition Projects* in July 2006 in conjunction with the Department of the Environment, Heritage and Local Government (DoEHLG).

The guidelines outline the issues that need to be addressed at the pre-planning stage of a development all the way through to its completion. These guidelines have been followed in the preparation of this document and include the following elements:

- Predicted construction and demolition wastes;
- Procedures to prevent and minimise wastes;
- Options for reuse/recycling/recovery/disposal of construction and demolition wastes;
- Provision of training for Waste Manager and site crew;
- Details of proposed record keeping system;
- Details of waste audit procedures and plan; and
- Details of proposed consultation with relevant bodies i.e. waste recycling companies, South Dublin County Council, etc.

2.2 Regional Level

The proposed development is located in the Local Authority area of South Dublin County Council (SDCC).

The Eastern-Midlands Region (EMR) Waste Management Plan 2015 – 2021 is the current regional waste management plan for the DCC area. The plan does not set specific targets for construction and demolition (C&D) waste, however, the Waste Framework Directive (WFD) sets a target for Member States of "70% preparing for reuse, recycling and other recovery of construction and demolition waste (excluding natural soils and stones and hazardous wastes)" to be achieved by 2020, which is highlighted in the regional plan. Other mandatory targets set in the Plan include:

- A 1% reduction per annum in the quantity of household waste generated over the period of the plan;
- Achieve a reuse/recycling rate of 50% of municipal waste by 2020; and

- Reduce to 0% the direct disposal of residual municipal waste to landfill (from 2016 onwards) in favour of higher value pre-treatment processes and indigenous recovery practices.

Municipal landfill charges in Ireland are based on the weight of waste disposed. Landfill charges in the region are approximately €130-150 per tonne of waste which includes a €75 per tonne landfill levy introduced under the *Waste Management (Landfill Levy) (Amendment) Regulations 2012*.

The *South Dublin County Council Development Plan 2016 – 2022* [10] sets out a number of objectives and actions for the South Dublin area in line with the objectives of the waste management plan.

Waste objectives and actions with a particular relevance to the proposed development are as follows:

Objectives:

- **IE5 Objective 1:** To support the implementation of the Eastern–Midlands Region Waste Management Plan 2015-2021 by adhering to overarching performance targets, policies and policy actions.
- **IE5 Objective 2:** To support waste prevention through behavioural change activities to de-couple economic growth and resource use.
- **IE5 Objective 3:** To encourage the transition from a waste management economy to a green circular economy to enhance employment and increase the value recovery and recirculation of resources.
- **IE5 Objective 8:** To secure appropriate provision for the sustainable management of waste within developments, including the provision of facilities for the storage, separation and collection of such waste.

Actions:

- Support and facilitate the separation of waste at source into organic and non-organic streams or other waste management systems that divert waste from landfill and maximise the potential for each waste type to be re-used and recycled or composted and divert organic waste from landfill, in accordance with the National Strategy on Biodegradable Waste (2006).
- Implement the objectives of the National Waste Prevention Programme at a local level with businesses, schools, householders, community groups and within the Council's own activities.
- Promote an increase in the amount of waste re-used and recycled consistent with the Regional Waste Management Plan and Waste Hierarchy and facilitate recycling of waste through adequate provision of facilities and good design in new developments.
- Implement the South Dublin Litter Management Plan 2015 - 2019.

2.3 Legislative Requirements

The primary legislative instruments that govern waste management in Ireland and applicable to the project are:

- Waste Management Act 1996 (No. 10 of 1996) as amended. Sub-ordinate legislation includes:
  - European Communities (Waste Directive) Regulations 2011 (SI 126 of 2011) as amended

  - Waste Management (Collection Permit) Regulations (S.I No. 820 of 2007) as amended
  - Waste Management (Facility Permit and Registration) Regulations 2007, (S.I No. 821 of 2007) as amended
  - Waste Management (Licensing) Regulations 2004 (S.I. No. 395 of 2004) as amended
  - Waste Management (Packaging) Regulations 2014 (S.I. 282 of 2014) as amended
  - Waste Management (Planning) Regulations 1997 (S.I. No. 137 of 1997)
  - Waste Management (Landfill Levy) Regulations 2015 (S.I. No. 189 of 2015)
  - European Union (Waste Electrical and Electronic Equipment) Regulations 2014 (S.I. No. 149 of 2014)
  - European Union (Batteries and Accumulators) Regulations 2014 (S.I. No. 283 of 2014) as amended
  - Waste Management (Food Waste) Regulations 2009 (S.I. 508 of 2009), as amended
  - European Union (Household Food Waste and Bio-waste) Regulation 2015 (S.I. No. 191 of 2015)
  - Waste Management (Hazardous Waste) Regulations, 1998 (S.I. No. 163 of 1998) as amended
  - Waste Management (Shipments of Waste) Regulations, 2007 (S.I. No. 419 of 2007) as amended
  - Waste Management (Movement of Hazardous Waste) Regulations, 1998 (S.I. No. 147 of 1998)
  - European Communities (Transfrontier Shipment of Waste) Regulations 1994 (SI 121 of 1994)
  - European Union (Properties of Waste which Render it Hazardous) Regulations 2015 (S.I. No. 233 of 2015) as amended.
- Environmental Protection Act 1992 (No. 7 of 1992) as amended.
- Litter Pollution Act 1997 (No. 12 of 1997) as amended.
- Planning and Development Act 2000 (No. 30 of 2000) as amended.

These Acts and subordinate Regulations enable the transposition of relevant European Union Policy and Directives into Irish law.

One of the guiding principles of European waste legislation, which has in turn been incorporated into the Waste Management Acts 1996 – 2011 and subsequent Irish legislation, is the principle of *"Duty of Care"*. This implies that the waste producer is responsible for waste from the time it is generated through until its legal reuse, recycling, recovery and/or disposal (including its method of reuse, recycling, recovery and/or disposal). As it is not practical in most cases for the waste producer to physically transfer all waste from where it is produced to the final destination, waste contractors will be employed to physically transport waste to the final waste reuse, recycling, recovery and/or disposal site. Following on from this is the concept of *"Polluter Pays"* whereby the waste producer is liable to be prosecuted for pollution incidents, which may arise from the incorrect management of waste produced, including the actions of any contractors engaged (e.g. for transportation and disposal/recovery/recycling of waste).

It is therefore imperative that the appointed construction contractor(s) are legally compliant with respect to waste transportation, reuse, recycling, recovery and disposal. This includes the requirement that a contractor handle, transport and reuse/recycle/recover/dispose of waste in a manner that ensures that no adverse environmental impacts occur as a result of any of these activities.

A collection permit to transport waste must be held by each waste contractor which is issued by the National Waste Collection Permit Office (NWCPO). Waste receiving facilities must also be appropriately permitted or licensed. Operators of such facilities cannot receive any waste, unless in possession of a Certificate of Registration (COR) or waste permit granted by the relevant Local Authority under the *Waste Management (Facility Permit & Registration) Regulations 2007* as amended, or a waste or Industrial Emissions (IE) licence granted by the EPA. The COR/permit/licence held will specify the type and quantity of waste able to be received, stored, sorted, recycled, recovered and/or disposed of at the specified site.

3.0 DESCRIPTION OF THE PROJECT

3.1 Location, Size and Scale of the Development

The Proposed Development will consist of:

- 110kV GIS substation includes the provision of four transformers, a two storey GIS substation building (with a gross floor area of 1,447sqm) within a 2.6m high fenced compound;
- Underground single circuit 110kV transmission line from the proposed Clutterland 110kV GIS Substation to the existing 220kV / 110kV Castlebaggot Substation to the immediate south. The proposed transmission line covers a distance of approximately 180m within the townlands of Ballybane, and Aungierstown and Ballybane;
- Underground single circuit 110kV transmission line from the proposed Clutterland 110kV GIS Substation connecting to the existing 110kV underground Kilmahud-Corkagh circuit to the north-west. The proposed transmission line covers a distance of approximately 1.1km within the townlands of Ballybane and Grange and will include 2 joint bays along its length;
- provision of a 49kVA electricity connection (approximately 300m in length to the Grange Castle South Business Park access road to the south of the proposed substation) for the proposed substation building;
- Adjacent access paths, connections to the two substations (existing and proposed as well as to the Kilmahud-Corkagh circuit);
- provision of car parking within the substation compound;
- changes to landscaping permitted under SDCC Reg. Ref. SD20A/0121; and
- security fencing, services, all associated construction works and all ancillary works.

A detailed description of the development is provided in Chapter 2 (Description of the Proposed Development) of the EIA Report. A description of the characteristics of the development relevant to waste are described in Section 14.20 – 14.35 of Chapter 14 (Waste Management).

3.2 Overview of the Non-Hazardous Wastes to be produced

The construction of foundations for the GIS substation, the installation of ducting for the 220kV transmission line and the 49kVA cable installation and construction of concrete bases for the new cable bays will require the excavation of made ground, topsoil, subsoil and possibly bedrock (if encountered).

CSEA have estimated that c. 24,300m^3 of excavated material will be generated, i.e. c. 2,000m^3 of made ground (predominantly tarmacadam, concrete and engineering fill) and c. 22,300m^3 of soils/stones (refer to Table 14.1). Suitable soils and stones will be

reused on site as backfill in the grassed areas, where possible. However, it is currently envisaged that majority of the excavated material will require removal offsite. The importation of fill materials will be required for construction of foundations and to reinstate the trenches.

Other than excavated material, it is estimated that c. 10m^3 of trees/shrubbery will require removal offsite as a waste.

During the construction phase of the proposed substation and cable bays, waste produced will include surplus steel and other metal materials and broken/off-cuts of timber, plasterboard, concrete etc. Waste from packaging (cardboard, plastic, timber) and oversupply of materials are also likely to be generated.

Waste will also be generated by construction workers. These wastes would generally be organic/food waste, dry mixed recyclables (waste paper, newspaper, plastic bottles, packaging, aluminium cans, tins and Tetra Pak cartons), mixed non-recyclables and potentially sewage sludge from temporary welfare facilities provided at the site compound during the construction phase. Waste printer/toner cartridges, waste electrical and electronic equipment (WEEE) and waste batteries may also be generated infrequently from site offices. The welfare facilities and site office for the proposed development will be located in the site compound for the concurrent development SD20A/0121.

The contractor will be required to ensure that oversupply of materials is kept to a minimum and opportunities for reuse of suitable materials is maximised.

3.3 Potentially Hazardous Waste

3.3.1 Contaminated Soil

Any surplus material that requires removal from site for offsite reuse, recovery and/or disposal as a waste and any potentially contaminated material (in the unlikely event that it is encountered), should be segregated, tested and classified as either non-hazardous or hazardous in accordance with the EPA publication entitled *'Waste Classification: List of Waste & Determining if Waste is Hazardous or Non-Hazardous'* using the *HazWasteOnline* application (or similar approved classification method). If the material is to be disposed of to landfill, it will then need to be classified as clean, inert, non-hazardous or hazardous in accordance with the *EC Council Decision 2003/33/EC* and landfill specific criteria. This legislation sets limit values on landfills for acceptance of waste material based on properties of the waste including potential pollutant concentrations and leachability.

Excavation works will be carefully monitored by a suitably qualified person to ensure any potentially contaminated soil is identified and segregated in accordance with the above procedure.

A geotechnical site investigation was conducted at the site in May 2019 by IGSL Limited on behalf of O'Connor Sutton Cronin for the concurrent application SD20A/0121. The ground investigation report shows there was no evidence of subsurface contamination encountered during the site investigation works. The report is included as Appendix 7.2 of Chapter 7 (Land, Soils, Geology and Hydrogeology) of the EIA included with the concurrent application SD20A/0121. It is not anticipated that subsurface contamination will be encountered along the proposed services routes.

Further details on the soil quality at the site is provided in Chapter 7 (Land, Soils, Geology and Hydrogeology).

3.3.2 Fuel/Oils

As fuels and oils are classed as hazardous materials, any on-site storage of fuel/oil, all storage tanks and all draw-off points will be bunded and located in a dedicated, secure area of the site. Provided that these requirements are adhered to and the site crew are trained in the appropriate refuelling techniques, it is not expected that there will be any fuel/oil waste generated at the site.

3.3.3 Invasive Species

Ecological site surveys have been undertaken by Scott Cawley (SC) at this site and in the surrounding area as part of the site ecological assessment. This included walkover surveys of the entire site and the perimeter of the site in September 2020.

There were no species listed on the Third Schedule of the European Communities (Birds and Natural Habitats) Regulations, 2011 present onsite.

There was 1 no. non-scheduled non-native invasive species butterfly-bush (*Buddleia davidii)* recorded within the development site boundary, this is not subject to legal restrictions.

Further details regarding the management of the invasive species present on site can be found in Chapter 6 (Biodiversity) of the EIAR. Management details will also be available in the Construction and Environmental Management Plan (CEMP) for the proposed development.

3.3.4 Other Known Hazardous Substances

Paints, glues, adhesives and other known hazardous substances will be stored in designated areas, if generated. They will generally be present in small volumes only or may not arise at all. If these wastes are generated, storage of these waste types will be kept to a minimum. Wastes will be stored in appropriate receptacles pending collection by an authorised waste contractor.

In addition, waste electrical and electronic equipment (WEEE) containing hazardous components and batteries (Lead, Ni-Cd or Mercury) may be generated from the temporary site office during construction works. These wastes will be stored in appropriate receptacles in designated areas of the site pending collection by an authorised waste contractor.

3.4 Main Construction and Demolition Waste Categories

The main non-hazardous and hazardous waste streams that may typically be generated by the construction activities at the proposed site are presented in Table 3.1. The List of Waste code (also referred to as the European Waste code or EWC) for each waste stream is also shown.

Table 3.1. Typical waste types generated, and List of Waste Codes (* individual waste type may contain hazardous materials)

Main Waste Material Types	**List of Waste Code**
Soil and stones	17 05
Biodegradable/Green Waste	20 02 01
Bituminous mixtures*	17 03 01/02
Other Waste Types (*which may be generated*)	**List of Waste Code**
Electrical and electronic components	20 01 35 & 36
Paper and cardboard	20 01 01
Mixed municipal waste	23 03 01
Mixed C&D waste	17 09 04
Batteries and accumulators*	20 01 33 & 34
Liquid fuels*	13 07 01, 02 & 03

4.0 ESTIMATED WASTE ARISINGS

4.1 Demolition Waste Generation

No demolition will be required to facilitate the construction of the proposed development.

4.2 Construction Waste Generation

The quantity of excavated material that will be generated has been estimated by the project engineers, CSEA, to be c. 24,300m^3. It anticipated that the majority of the material will be removed off site for reuse and recycle/recovery, with some being reused as backfill in the grassed areas, where possible. In addition, it is estimated that c. 10m^3 of trees/shrubbery (green) waste will be produced.

It is expected that wastes generated (other than excavated material and trees/shrubbery) from other construction activities will be negligible and will generally comprise waste generated from construction workers. These wastes would generally be organic/food waste, dry mixed recyclables (waste paper, newspaper, plastic bottles, packaging, aluminium cans, tins and Tetra Pak cartons), mixed non-recyclables and potentially sewage sludge from temporary welfare facilities provided at the site compound during the construction phase. Waste printer/toner cartridges, waste electrical and electronic equipment (WEEE) and waste batteries may also be generated infrequently from the site office.

The welfare facilities and site office for the proposed development will be located in the site compound for the concurrent development.

It should be noted that until final materials and detailed construction methodologies have been confirmed, it is difficult to predict with a high level of accuracy the construction waste that will be generated from the proposed works as the exact materials and quantities may be subject to some degree of change and variation during the construction process.

An outline Construction Environmental Management Plan (CEMP) has been prepared to accompany the planning application. The appointed main contractor will be required to prepare a detailed CEMP prior to commencement of construction which may refine the above waste estimates.

4.3 Proposed Waste Management Options

Waste materials generated will be segregated on-site, where it is practical. Where the on-site segregation of certain wastes types is not practical, off-site segregation will be carried out. There will be skips and receptacles provided to facilitate segregation at source. All waste receptacles leaving site will be covered or enclosed. The appointed waste contractor will collect and transfer the wastes as receptacles are filled.

All waste arisings will be handled by an approved waste contractor holding a current waste collection permit. All waste arisings requiring reuse, recycling, recovery or disposal off-site will be transferred to a facility holding the appropriate COR, permit or licence, as required.

Mixed C&D waste (classified under the List of Waste code 17 09 04) is permitted for acceptance at a number of waste facilities in the region including Integrated Material Solutions landfill in north Dublin and a number of waste transfer stations.

Written records will be maintained by the contractor detailing the waste arising throughout the construction phase, the classification of each waste type, the contact details and waste collection permit number of all waste contractors who collect waste from the site and the end destination details for all waste removed and disposed offsite.

Dedicated storage containers will be provided for hazardous wastes which may arise such as batteries, paints, oils, chemicals etc., as required. The containers used for storing hazardous liquids will be appropriately bunded or will be stored on suitably sized spill pallets.

The management of the main construction waste streams are detailed as follows:

Soil and Stone
The Waste Management Hierarchy states that the preferred option for waste management is prevention and minimisation of waste, followed by preparing for reuse and recycling/recovery, energy recovery (i.e. incineration) and, least favoured of all, disposal. The volume of soil and stone to be excavated is estimated to be 24,300m^3. It is currently anticipated that majority of the excavated material will be require removal off site, with some being used as backfill in the grassed areas, where possible.

The majority of soil & stone will need to be removed off-site either as a waste or, where appropriate, as a by-product. Where the material is to be reused on another site as a by-product (and not as a waste), this will be done in accordance with Article 27 of the European Communities (Waste Directive) Regulations 2011. EPA agreement will be obtained before re-using the material as a by-product.

The next option (beneficial reuse) may be appropriate for the excavated material, subject to environmental testing to classify the material as hazardous or non-hazardous in accordance with the EPA Waste Classification – List of Waste & Determining if Waste is Hazardous or Non-Hazardous publication. Clean material may be used as fill material in other construction projects or engineering fill for waste licensed sites. Beneficial reuse of surplus excavation material as engineering fill may be subject to further testing to determine if materials meet the specific engineering standards for their proposed end-use.

Any nearby sites requiring clean fill/capping material could be contacted to investigate reuse opportunities for clean and inert material. If any soils/stones are imported onto the site from another construction site as a by-product (and not as a waste), this will

also be done in accordance with Article 27. However, it is not expected that this will be necessary.

If the material is deemed to be a waste, then removal and reuse/recycling/ recovery/disposal of the material will be carried out in accordance with the Waste Management Acts 1996 as amended, the Waste Management (Collection Permit) Regulations 2007 as amended and the Waste Management (Facility Permit & Registration) Regulations 2007 as amended. The volume of waste removed will dictate whether a COR, permit or licence is required by the receiving facility. Once all available beneficial reuse options have been exhausted, the options of recycling and recovery at waste permitted and licensed sites will be considered.

In the unlikely event that contaminated material is encountered and subsequently classified as hazardous, this material will be stored separately to any inert/non-hazardous material. It will require off-site treatment at a suitable facility or disposal abroad via Transfrontier Shipment of Wastes (TFS).

Tarmacadam
Tarmacadam excavated will be segregated and transferred off site for appropriate reuse, recycling, recovery and/or disposal.

Concrete
Concrete will be segregated and transferred off site for appropriate reuse, recycling, recovery and/or disposal.

Biodegradable/Green Waste
Trees and shrubbery removed will be transferred off site for appropriate reuse and/or recovery.

Waste Electrical and Electronic Equipment (WEEE)
Any WEEE generated in the site office will be stored in a dedicated container in the site office pending collection for recycling.

Batteries
Any waste batteries generated in the site office will be stored in a dedicated container in the site office pending collection for recycling.

Other Recyclables
Where any other recyclable wastes such as cardboard and soft plastic are generated at the site compound, these will be segregated at source into dedicated receptacles and removed off-site.

Non-Recyclable Waste
C&D waste which is not suitable for reuse or recovery, such as polystyrene, some plastics and some cardboards, will be placed in separate receptacles in the site compound. Prior to removal from site, the non-recyclable waste receptacle will be examined by a member of the waste team (see Section 7.0) to determine if recyclable materials have been placed in there by mistake. If this is the case, efforts will be made to determine the cause of the waste not being segregated correctly and recyclable waste will be removed and placed into the appropriate receptacle.

Other Hazardous Wastes
On-site storage of any hazardous wastes produced e.g. contaminated soil during excavations or waste fuels at the site compound will be kept to a minimum, with removal off-site organised on a regular basis. Storage of all hazardous wastes will be

undertaken so as to minimise exposure to on-site personnel and the public and to also minimise potential for environmental impacts. Hazardous wastes will be recovered, wherever possible, and failing this, disposed of appropriately.

It should be noted that it is not possible to provide information on the specific destinations of each waste stream at this stage of the project. Prior to commencement of construction and removal of any construction waste offsite, details of the proposed destination of each waste stream will be provided to SDCC for approval.

4.4 Tracking and Documentation Procedures for Off-Site Waste

All waste will be documented prior to leaving the site. Waste will be weighed by the waste contractor, either by weighing mechanism on the truck or at the receiving facility. These waste records will be maintained on site by the contractor.

All movement of waste and the use of waste contractors will be undertaken in accordance with the *Waste Management Acts 1996 – 2011* as amended, *Waste Management (Collection Permit) Regulations 2007* as amended and *Waste Management (Facility Permit & Registration) Regulations 2007* as amended. This includes the requirement for all waste contractors to have a waste collection permit issued by the NWCPO. The nominated project Waste Manager (see Section 6.0) will maintain a copy of all waste collection permits on-site.

If the waste is being transported to another site, a copy of the Local Authority COR, waste permit or EPA Waste/IE Licence for that site will be provided to the nominated project Waste Manager. If the waste is being shipped abroad, a copy of the TFS document will be obtained from Dublin City Council (as the relevant authority on behalf of all local authorities in Ireland) and kept on-site along with details of the final destination (permits, licences etc.). A receipt from the final destination of the material will be kept as part of the on-site waste management records.

If any surplus soil or stone is being removed from the site for reuse on another construction site as a by-product, this will need to be done in accordance with Article 27 of the *EC (Waste Directive) Regulations, 2011*.

All information will be entered in a waste management recording system to be maintained on site.

5.0 ESTIMATED COST OF WASTE MANAGEMENT

An outline of the costs associated with different aspects of waste management is provided below. The total cost of construction waste management will be measured and will take into account handling costs, storage costs, transportation costs, revenue from rebates and disposal costs.

5.1 Reuse

By reusing materials on site, there will be a reduction in the transport and offsite recycling/recovery/disposal costs associated with the requirement for a waste contractor to take the material away to landfill.

Clean and inert excavated material which cannot be reused on site may be used as capping material for landfill sites, or for the reinstatement of quarries, etc. as previously discussed. This material is often taken free of charge for such purposes, reducing final waste disposal costs.

5.2 Recycling

Salvageable metals will earn a rebate which can be offset against the costs of collection and transportation of the skips. Clean uncontaminated cardboard and certain hard plastics can also be recycled. Waste contractors will typically charge less to take segregated wastes, such as recyclable waste, from a site than mixed waste streams.

5.3 Disposal

Landfill charges in the Eastern-Midlands region are currently at around €130-150 per tonne (which includes a €75 per tonne landfill levy specified in the *Waste Management (Landfill Levy) Regulations 2015*. In addition to disposal costs, waste contractors will also charge a fee for provision and collection of skips.

Collection of segregated construction waste usually costs less than municipal waste. Specific C&D waste contractors take the waste off-site to a registered, permitted or licensed facility and, where possible, remove salvageable items from the waste stream before disposing of the remainder to landfill.

6.0 TRAINING PROVISIONS

A member of the construction team will be appointed as the Waste Manager to ensure commitment, operational efficiency and accountability during the construction phase of the project.

6.1 Waste Manager Training and Responsibilities

The nominated Waste Manager will be given responsibility and authority to select a waste team if required, i.e. members of the site crew that will aid him/her in the organisation, operation and recording of the waste management system implemented on site. The Waste Manager will have overall responsibility to oversee, record and provide feedback to the Project Manager on everyday waste management at the site. Authority will be given to the Waste Manager to delegate responsibility to subcontractors, where necessary, and to coordinate with suppliers, service providers and sub-contractors to prioritise waste prevention and material salvage.

The Waste Manager will be trained in how to set up and maintain a record keeping system, how to perform an audit and how to establish targets for waste management on site. The Waste Manager will also be trained in the best methods for segregation and storage of recyclable materials, have information on the materials that can be reused on site and be knowledgeable in how to implement this C&D WMP.

6.2 Site Crew Training

Training of the site crew is the responsibility of the Waste Manager and, as such, a waste training program should be organised. A basic awareness course will be held for all site crew to outline the C&DWMP and to detail the segregation of waste materials at source. This may be incorporated with other site training needs such as general site induction, health and safety awareness and manual handling.

This basic course will describe the materials to be segregated, the storage methods and the location of the waste storage areas. A sub-section on hazardous wastes will be incorporated into the training program and the particular dangers of each hazardous waste will be explained.

7.0 RECORD KEEPING

Records should be kept for all waste material which leaves the site, either for reuse on another site, recycling or disposal. A recording system will be put in place to record the waste arising's on site.

A waste tracking log should be used to track each waste movement from the site. On exit from the site the waste collection vehicle driver should stop at the site office and sign out as a visitor and provide the security personnel or waste manager with a waste docket (or WTF for hazardous waste) for the waste load collected. At this time, the security personnel should complete and sign the Waste Tracking Register with the following information:

- Date
- Time
- Waste Contractor
- Company waste contractor appointed by e.g. Contractor or subcontractor name
- Collection Permit No.
- Vehicle Reg.
- Driver Name
- Docket No.
- Waste Type
- EWC/LoW

The waste transfer dockets will be transferred to the site waste manager on a weekly basis and can be placed in the Waste Tracking Log file. This information will be forwarded onto the Waste Regulation Unit on a monthly basis.

Alternatively, each subcontractor that has engaged their own waste contractor will be required to maintain a similar waste tracking log with the waste dockets/WTF maintained on file and available for inspection on site by the main contractor as required.

A copy of the Waste Collection Permits, CORs, Waste Facility Permits and Waste Licences will be maintained on site at all times. Subcontractors who have engaged their own waste contractors, should provide the main contractor with a copy of the waste collection permits and COR/permit/licence for the receiving waste facilities and maintain a copy on file available for inspection on site as required.

8.0 OUTLINE WASTE AUDIT PROCEDURE

8.1 Responsibility for Waste Audit

The appointed Waste Manager will be responsible for auditing the site during the construction and demolition phases of the project.

8.2 Review of Records and Identification of Corrective Actions

A review of all the records for the waste generated and transported on or off-site should be undertaken mid-way through the project. If waste movements are not accounted for, the reasons for this should be established in order to see if and why the record

keeping system has not been maintained. The waste records will be compared with the established reuse/recovery/recycling/disposal targets for the site.

Each material type will be examined, in order to see where the largest percentage waste generation is occurring. The waste management methods for each material type will be reviewed in order to highlight how the targets can be achieved. Waste management costs will also be reviewed.

Upon completion of the construction phase, a final report will be prepared, summarising the outcomes of waste management processes adopted and the total reuse, recycling, recovery and disposal figures for the development.

9.0 CONSULTATION WITH RELEVANT BODIES

9.1 Local Authority

Once the main contractor has been appointed and prior to removal of any waste materials offsite, details of the proposed destination of each waste stream will be provided to SDCC for their approval.

SDCC will also be consulted, as required, throughout the construction phase in order to ensure that all available waste reduction, reuse and recycling opportunities are identified and utilised and that compliant waste management practices are carried out.

9.2 Recycling/Salvage Companies

Companies that specialise in C&D waste management will be contacted to determine their suitability for engagement. Where a waste contractor is engaged, each company will be audited in order to ensure that relevant and up-to-date waste collection permits and facility COR/permits/licences are held. In addition, information regarding individual construction materials will be obtained, including the feasibility of recycling each material, the costs of recycling/reclamation, the means by which the wastes will be collected and transported off-site and the recycling/reclamation process each material will undergo off site.

10.0 REFERENCES

1. Waste Management Act 1996 (No. 10 of 1996) as amended 2001 (No. 36 of 2001), 2003 (No. 27 of 2003) and 2011 (No. 20 of 2011). Subordinate and associated legislation includes:
    - European Communities (Waste Directive) Regulations 2011 (S.I. No. 126 of 2011) as amended 2011 (S.I. No. 323 of 2011)
    - Waste Management (Collection Permit) Regulations 2007 (S.I No. 820 of 2007) as amended 2008 (S.I. No. 87 of 2008) and 2016 (S.I. No. 24 of 2016)
    - Waste Management (Facility Permit and Registration) Regulations 2007 (S.I. No. 821 of 2007) as amended 2008 (S.I. No. 86 of 2008), 2014 (S.I. No. 310 and S.I. No. 546 of 2014) and 2015 (S.I. No. 198 of 2015)
    - Waste Management (Licensing) Regulations 2000 (S.I. No. 185 of 2000) as amended 2004 (S.I. No. 395 of 2004) and 2010 (S.I. No. 350 of 2010)
    - Waste Management (Planning) Regulations 1997 (S.I. No. 137 of 1997) as amended 1998 (S.I. No. 164 of 1998), 2001 (S.I. No. 356 of 2002) and 2011 (S.I. No. 126 and No. 192 of 2011)
    - Waste Management (Landfill Levy) Regulations 2015 (S.I. No. 189 of 2015)
    - European Communities (Waste Electrical and Electronic Equipment) Regulations 2014 (S.I. No. 149 of 2014)
    - Waste Management (Food Waste) Regulations 2009 (S.I. No. 508 of 2009) as amended 2015 (S.I. No. 190 of 2015)
    - European Union (Household Food Waste and Bio-waste) Regulations 2015 (S.I. No. 191 of 2015)
    - European Union (Packaging) Regulations 2014 (S.I. No. 282 of 2014) as amended 2015 (S.I. No. 542 of 2015)
    - European Union (Waste Electrical and Electronic Equipment) Regulations 2014 (S.I. No. 149 of 2014)
    - European Union (Batteries and Accumulators) Regulations 2014 (S.I. No. 283 of 2014) as amended 2014 (S.I. No. 349 of 2014) and 2015 (S.I. No. 347 of 2015)
    - Waste Management (Hazardous Waste) Regulations 1998 (S.I. No. 163 of 1998) as amended 2000 (S.I. No. 73 of 2000)
    - Waste Management (Shipments of Waste) Regulations 2007 (S.I. No. 419 of 2007) as amended by European Communities (Shipments of Hazardous Waste exclusively within Ireland) Regulations 2011 (S.I. No. 324 of 2011)
    - The European Communities (Trans frontier Shipment of Hazardous Waste) Regulations 1988 (S.I. No. 248 of 1988) ○ European Union (Properties of Waste Which Render It Hazardous) Regulations 2015 (S.I. No. 233 of 2015)
2. Environmental Protection Act 1992 (Act No. 7 of 1992) as amended by the Protection of the Environment Act 2003 (Act No. 27 and S.I. No. 413 of 2003) and amended by the Planning and Development Act 2000 (Act No. 30 of 2000) as amended.
3. Litter Pollution Act 1997 (Act No. 12 of 1997) as amended by the Litter Pollution Regulations 1999 (S.I. No. 359 of 1999) and Protection of the Environment Act 2003, as amended.
4. Eastern-Midlands Waste Region, *Eastern-Midlands Region Waste Management Plan 2015 – 2021* (2015).

5. Department of the Environment, Heritage and Local Government (DoEHLG), *Best Practice Guidelines on the Preparation of Waste Management Plans for Construction and Demolition Projects*, (2006).
6. FÁS and the Construction Industry Federation (CIF), *Construction and Demolition Waste Management – a handbook for Contractors and Site Managers*, (2002).
7. Department of Environment and Local Government (DoELG) *Waste Management – Changing Our Ways, A Policy Statement* (1998).
8. Forum for the Construction Industry, *Recycling of Construction and Demolition Waste* (1999).
9. Department of Environment, Communities and Local Government (DoECLG), *A Resource Opportunity - Waste Management Policy in Ireland* (2012).
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11. Environmental Protection Agency (EPA), *Waste Classification – List of Waste & Determining if Waste is Hazardous or Non-Hazardous* (2015).
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