Appendix 12.2

1. Hydromorphology Assessment

1.1 Introduction

This appendix to the EIAR consists of an impact appraisal of the proposed Google Ireland GIL DC3 Datacentre, hereafter referred to as the Proposed Development, under the heading of Water.

In accordance with the requirements of the Water Framework Direction (WFD) (2000/60/EC) and the South Dublin County Development Plan (2022-2028) (SDCC, 2022), this appendix identifies, describes and assesses the baseline WFD hydromorphology score for a watercourse traversing the Proposed Development site and proposes possible design measures to limit its degradation.

The chapter is set out as follows:

- Methodology
- Stage 1: Screening
- Stage 2: Scoping
- Stage 3: Detailed Assessment
- Design Options
- References

The hydromorphology lead is a Professional Scientist and experienced technical task leader of projects including high profile projects and has provided expertise internationally. Full details of relevant experience are provided in Appendix 1.1.

1.1.1 Legislation

The legislation relevant to this report is as follows:

- Water Framework Directive (WFD) (2000/60/EC);
- Water Services Act (2013); and
- Planning and Development Act (2000) as amended.

1.1.2 Planning Policies

Draft River Basin Management Plan for Ireland 2022-2027 (DHLG, 2023)

Ireland's river basin management planning process is based on a single national River Basin District, which is divided into 46 catchment management units (CMUs). The CMUs have been further sub-divided into 583 sub-catchments with waterbodies[1]-information and context for the plan, along with the-most up to date information for the status of a waterbody is provided at www.catchments.ie. Information about the use and pressures on a waterbody is provided through specific Catchment and Sub-Catchment Assessments. The current condition of water resources is assessed against the standards and environmental objectives set out in the WFD and reported in the River Basin Management Plan (RBMP). Hydromorphology impact has been identified as the second most significant pressure to rivers in the third assessment cycle (2022-2027). Measures to ensure the condition of rivers do not deteriorate will be through protection or restoration, and in some cases this requires the collection of additional evidence. Protected areas are designated because of their special importance for bathing, drinking water, shellfish habitat, water dependent habitat or species; and nutrient sensitive areas.

In Ireland there has historically been significant physical alteration to the hydromorphology of waterbodies through size, bed gradient, form, shape and functional changes to bed and banks, as well as changes to flow and water regime.

Most of the modification has been made to allow for the growth of the population and economy, as well as for drainage and flood protection of agricultural and urban land. These degraded waterbodies are heavily modified and have the environmental objective of 'Good Ecological Potential'. This accounts for their modified form.

Programme of Measures focus on hydromorphology as the basis for river and lake restoration. Controls on pressures that impact on the physical condition of waters will need to be strengthened in Ireland through a new Controlled Activities for the Protection of Waters regime and Mandatory Codes of Practice and General Binding Rules. A long-term restoration programme is also proposed to meet the WFD objective of waterbodies achieving 'good' status by 2027.

Climate Action Plan 2024 (GoI, 2024)

The Climate Action Plan identifies that Ireland has observed significant impacts of climate change, including a consistent temperature rise over the past 120 years, reduced frost days, and shorter frost seasons. Sea levels have risen steadily since the early 1990s, and projections suggest decreased spring and summer rainfall, along with more frequent heavy precipitation events in winter and autumn. These shifts are anticipated to result in widespread direct and indirect adverse effects on the water environment in Ireland. Foreseen impacts encompass heightened risks of groundwater, river, and coastal flooding, elevated coastal erosion, amplified strain on water resources and water purity, and alterations in wind velocities and storm pathways.

Although the Climate Action Plan lacks a designated water section, the measures affecting the water sector will be integrated within various related sections, including agriculture, land use, and adaptation. **Policy Measures for Ireland:** Anticipated climate change effects on Ireland's environment, society, and economic growth are projected to be extensive. These impacts encompass managed and natural ecosystems, water resources, agriculture and food security, the built environment, human health, and coastal areas. The most pressing risks Ireland faces from climate change predominantly revolve around alterations in extremes, such as floods, droughts, and storms.

According to Climate Action Plan, the Water resource and Flood Risk Management Sector is one of the Adaptation Sectors at the National Level and entails the following Sector Levels: Flood Risk Management, Water Quality, and Water Services Infrastructure.

National Biodiversity Action Plan

The National Biodiversity Action Plan outlines multiple actions meant to support the resilience and health of water ecosystems throughout Ireland. Outcome 2D: 'Biodiversity and ecosystem services in the marine and freshwater environment are conserved and restored' has the most relevance for protection of the water environment, water quality and ecosystems within the Proposed Development. Under this outcome are several targets and actions intended to achieve the outcome:

- By 2027, protection and restoration measures detailed in Ireland's third RBMP are implemented to ensure that our natural waters are sustainably managed, that freshwater resources are protected so that there is no further deterioration; and where required, Ireland's rivers, lakes and coastal water bodies are restored to at least good ecological status.
- By 2027, optimised benefits in flood risk management planning and drainage schemes are in place.
- By 2026, Ireland is meeting all requirements for its transitional, coastal, and marine environment under the Water Framework Directive (WFD) and the Marine Strategy Framework Directive (MSFD), thereby achieving and maintaining High or Good Ecological Status and Good Environmental Status, respectively.
- By 2030, 300km of rivers are restored to a free-flowing state.

Eastern and Midland Regional Assembly Regional Spatial and Economic Strategy 2019-2031 (EMRA, 2020)

The Eastern and Midland Regional Assembly region covers nine counties including South Dublin County Councils and Dublin City Council. The Region includes 3 subregions or Strategic Planning Areas (SPAs), one being Dublin SPA. Of the 16 Regional Strategic Outcomes (RSOs) under Climate Action there are four key water RSOs: Sustainable management of water, waste and other environmental resources; Build climate resilience; Enhance green infrastructure; and Biodiversity and natural heritage. Regional Policy Objectives (RPOs) relate to the use of Sustainable Urban Drainage Systems (SuDs) and green infrastructure for water regulation and amelioration. The RPOs also emphasise taking opportunities to enhance biodiversity and amenities to protect environmentally sensitive sites where flood risk measures are planned. Plans should also use an ecosystem services approach to support implementation of green infrastructure and riparian setbacks.

South Dublin County Development Plan (2022-2028) (SDCC, 2022)

SDCC Chapter 4: Green Infrastructure has a vision to establish a cohesive Green Infrastructure (GI) network in South Dublin County, collaborating with and enriching the area's existing biodiversity and natural heritage. This effort aims to enhance resilience under climate change.

The EU defines Green Infrastructure (GI) as: “a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services such as water purification, air quality, space for recreation and climate mitigation and adaptation.”

GI will be a key in climate change mitigation and adaptation. Trees, forests, and parks provide valuable carbon sequestration services, absorbing CO_2 from the atmosphere and storing it in the soil. Furthermore, they provide cooling and shade. GI planting and SuDS can also play a significant role in stormwater runoff.

A Strategic Flood Risk Assessment (SFRA) of the County is a separate document that has been prepared to support the Strategic Environmental Assessment of the County Development Plan.

Greater Dublin Strategic Drainage Study (GDSDS): Technical Documents of Regional Drainage Policies. Dublin: Dublin City Council (SDCC, 2005)

The GDSDS identifies approaches for how drainage infrastructure for new developments is managed. Sustainable drainage systems are mandatory per the GDSDS for all new developments for stormwater control and environmental improvement, except where the developer can demonstrate inclusion is impractical. The overall objective of the GDSDS is to reduce stormwater runoff and to collect and treat stormwater runoff as close to the source as possible.

SuDS measures must be provided and future maintenance of drainage assets. The goal is to implement whole-life solutions, which are gravity fed and require maintenance infrequently. SuDS require that surface water runoff is separated from wastewater and controlled on site to minimise discharge.

The GDSDS includes a Treatment Train approach, which includes techniques for pollution prevention, source control, site control and regional control. Level of service objectives include provision of flood protection, no negative aesthetic effects, social benefits and safety. Current design criteria normally require that no flooding occurs up to the 30-year return period and that properties are protected against flooding for the 100-year return period. Runoff from large storm events should be attenuated and then released at 2l/s/ha or Qbar for the 100-year return period with allowances for climate change.

Guidelines on Protection of Fisheries During Construction Works in and Adjacent to Waters (IFI, 2016)

Inland Fisheries Ireland (IFI) provides guidance on the organisation of construction activities and crossing structures to prevent damage to aquatic and riparian habitats, pollution of waters, and interference with upstream and downstream movement of aquatic life during construction activities. These include guidance around the type of culverts and structures that should be used to reduce impact on the aquatic environment and proper planning to avoid discharge of construction materials into surface waters. IFI prefers clear span river and stream crossing structures whenever possible to avoid altering or moving existing watercourses; however, when this is not possible, planning should consider options which least disrupt the riparian zone and streambed.

Nature-based Solutions to the Management of Rainwater and Surface Water Runoff in Urban Areas (DHLGH, 2022)

The Best Practice Interim Guidance Document a high-level guidance document demonstrating how urban areas can be planned and designed to address impacts related to the environment, climate change and flood risk through nature-based solutions for the management of rainwater and surface water runoff. The document has a distinct focus on planning and identifying opportunities where SuDS and nature-based solutions should be employed.

Sustainable Drainage Explanatory Design and Evaluation Guide (SDCC, 2022)

SDCC has identified SuDS as the preferred way to managed rainfall from new development in the Development Plan. This guide serves as a means to elaborate on SuDS design requirements, design process from concept design to detailed design, and components and objectives of the SuDS components.

Greater Dublin Regional Code of Practice for Drainage Works: Version Draft 6.0

The Greater Dublin Strategic Drainage Study sets out the technical requirements for new drainage works and provides Local Authorities with a concise document detailing an integrated approach to drainage.

The main objectives of the Code of Practice are:

- Compliance with best environmental practices and relevant environmental legislation such as the Water Framework Directive
- To minimise the risk of flooding
- To minimise foul sewage spills to watercourses
- To provide a drainage platform for the sustainable development of the region in the future
- To ensure all drainage design is consistent cross the region and meets compliance best practices
- To codify drainage requirements across planning, construction, connection to public drainage infrastructure and the taking in charge of pipelines by local authorities.

1.1.3 Guidance and Standards

Development Hydromorphological Assessment Guidance (SDCC, 2023)

This guidance was prepared to aid applicants in meeting the objectives of the SDC County Development Plan 2022-2028 (G13: 1-4) and associated Strategic Flood Risk Assessment as they relate to Hydromorphological Assessments. The introduction of hydromorphological assessment is key to ensuring that the objectives of the Water framework Directive WFD) are met. The requirements for a hydromorphological assessment are to determine existing hydromorphological pressures, determine deviation from 'Natural' form and propose restorative measures to improve Hydromorphological integrity and resilience throughout the river reach.

River Hydromorphology Assessment Technique (RHAT) Training Manual-Version 2. (NIEA, 2014)

A detailed hydromorphology assessment will require a site walkover using River Hydromorphology Assessment Technique (RHAT). The RHAT method was developed for WFD classification, but it also has other applications including assessing morphological pressures at a site or reach scale. The RHAT can be used as a tool to determine remedial/restoration work required to improve the river habitat as well as determine deviation from a "Natural" form. The RHAT concludes by defining a WFD Hydromorphological Status (i.e. Bad, Poor, Moderate, Good, High). This stage takes into consideration mitigation measures and is an iterative process whereby a mitigation measure can be assessed to determine the most appropriate for the proposed development.

Buffer zone guidelines for wetlands, rivers and estuaries (Macfarlane and Bredin, 2017)

A technical manual for South Africa that uses a step-wise assessment procedure to determine appropriate buffer zones for rivers, wetlands and estuaries.

It provides tools to determine buffer zones and mitigation measures as a quick access point for impact mitigation. Buffer zones are seen as part of a treatment train designed to address stormwater impacts. A buffer zone is defined as a strip of land with a use, function or zoning specifically designed to protect one area of land against impacts of another. Buffer zones associated with water resources provide a wide way of functions and have been proposed as a standard measure to protect water resources and associated biodiversity. These functions include maintaining basic aquatic processes, reducing impact on water resources from upstream activities and adjoining land uses, providing habitat for aquatic and semi-aquatic species, providing habitat for terrestrial species and providing a range of ancillary societal benefits.

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Inland Fisheries Ireland (IFI) provides guidance on the organisation of construction activities and crossing structures to prevent damage to aquatic and riparian habitats, pollution of waters, and interference with upstream and downstream movement of aquatic life during construction activities. These include guidance around the type of culverts and structures that should be used to reduce impact on the aquatic environment and proper planning to avoid discharge of construction materials into surface waters. IFI prefers clear span river and stream crossing structures whenever possible to avoid altering or moving existing watercourses; however, when this is not possible, planning should consider options which least disrupt the riparian zone and streambed.

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1.1.4 Site Description

The Google Ireland Data Centre Campus is located in Grange Castle Business Park South, Dublin 22, between the N7 and N4 motorways (ITM: 703356,730251), see Figure 1.1. The facility will be developed on an existing 20.4 ha greenfield/brownfield site.

It is bounded by Baldonnel Road to the south and Profile Business Park to the east, with residential properties to the west and south. The surrounding land comprises commercial and industrial properties and agriculture. Grange Castle Golf course is west of the site, and Casement Aerodrome (Baldonnel), operated by the Department of Defence, is to the south. The subject site and the lands surrounding the site are primarily greenfield and commercial/industrial premises as shown in Figure 1.2 below.

Figure 1.1: Site location. Source: OSM Standard Map

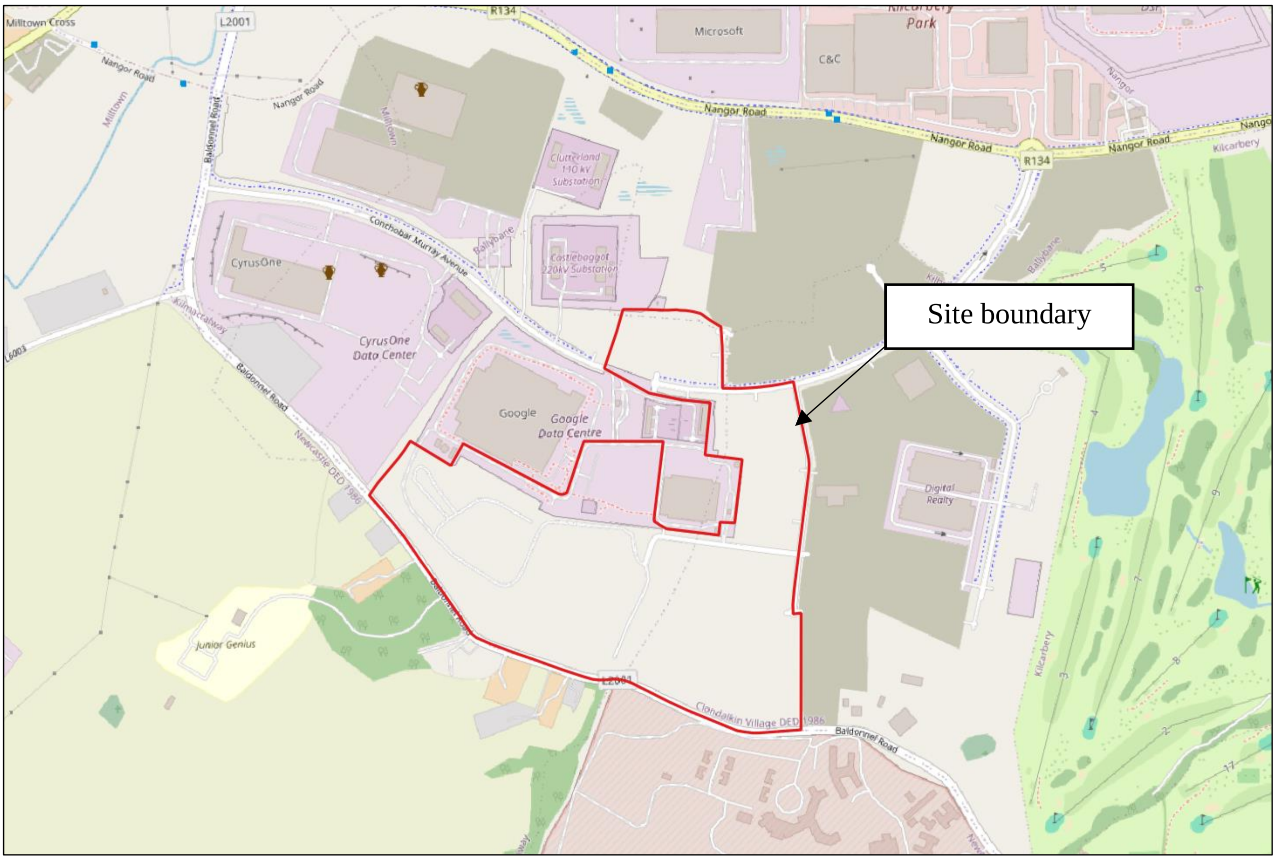

Figure 1.2: Subject Site: existing data centre, boundary of the site (red line) and land surrounding the site. Source: OSM Standard Map.

1.1.5 Proposed Development

The DC3 project comprises a main building (Data Centre), a Mechanical Yard consisting of an air-cooled chillers arrangement, an Electrical Yard including generators and modularised electrical buildings and site structures/trestles/conveyances. Details on the Proposed Development can be found in Chapter 4 of the EIAR. An illustration of the key development areas is shown in Figure 1.3. The buildings shown in pink hatch are existing datacentres.

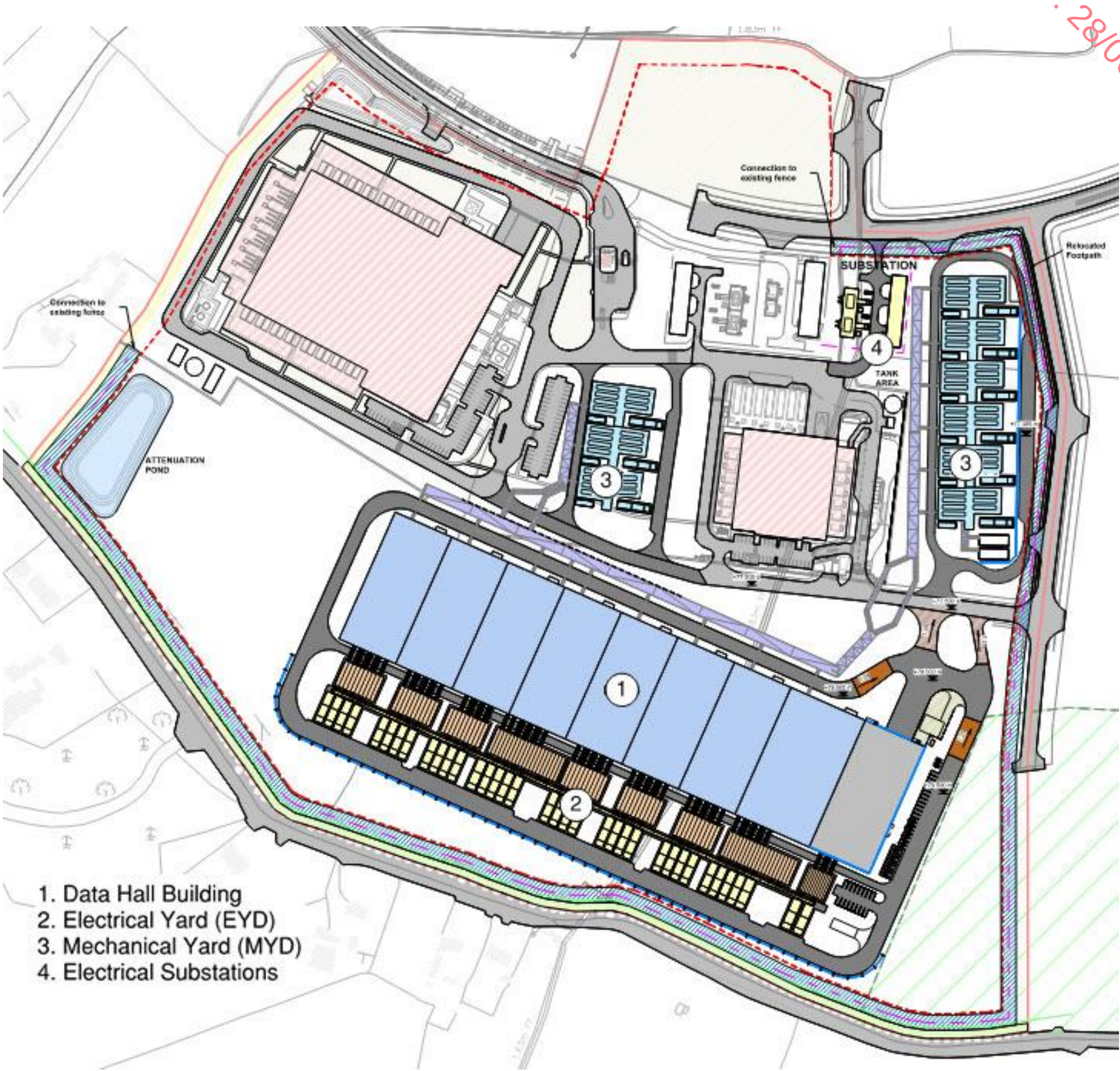

Figure 1.3: Proposed development of DC3.

The DC3 Building is a large capacity Data Centre. It includes a data hall building at the south part of the campus site. A mechanical yard, split into two blocks, will be located north of the data centre building, housing all mechanical cooling plant and future proofing for district heating. South of the data centre hall, an electrical yard will house external generators for power backup. The data hall building will connect to the rest of the campus via a network of roads, designed for car access for workers and visitors, and other vehicles for deliveries, maintenance, and part replacements.

Two attenuation ponds are serving the date hall building, west and one north of the building. The site is protected by a secure fence on the south, east, and west. The existing substation north of the site will be expanded with the addition of a substation block west of the East Mechanical yard blocks.

1.2 Methodology

This assessment methodology is in accordance with the guidance outlined in ‘Development Hydromorphological Assessment Guidance’ (SDCC, 2023). The key steps, being as follows:

- Stage 1 Screening
  - Determine whether the Proposed Development is partially or wholly within the Riparian Corridors identified as part of the Development Plan 2022-2028) (SDCC, 2022)
- Stage 2 Scoping
  - Identify existing pressures and the likely effects of the Proposed Development to determine if it may result in adverse effects to the waterbody.
- Stage 3 Detailed Assessment
  - Quantitatively assess the impact of the Proposed Development and any design measures required.

1.3 Stage 1 Screening

The Proposed Development site is not within a Riparian Corridor (SDCC, 2022) but it is within a flood zone therefore the assessment is taken to Scoping.

1.4 Stage 2 Scoping

The pressures and impacts from the Proposed Development were assessed using the Common Implementation Strategy for the Water Framework Directive[1]. The Proposed Development will include a Data Storage Facility and Site Infrastructure. A drainage ditch (referred to as the 'on-site watercourse') is currently flowing from an existing culvert (culvert 1) in a southerly direction for approximately 188 m before it discharges into another culvert under DC2 (culvert 3) and is then discharged to an off-site watercourse (Figure 1.4).

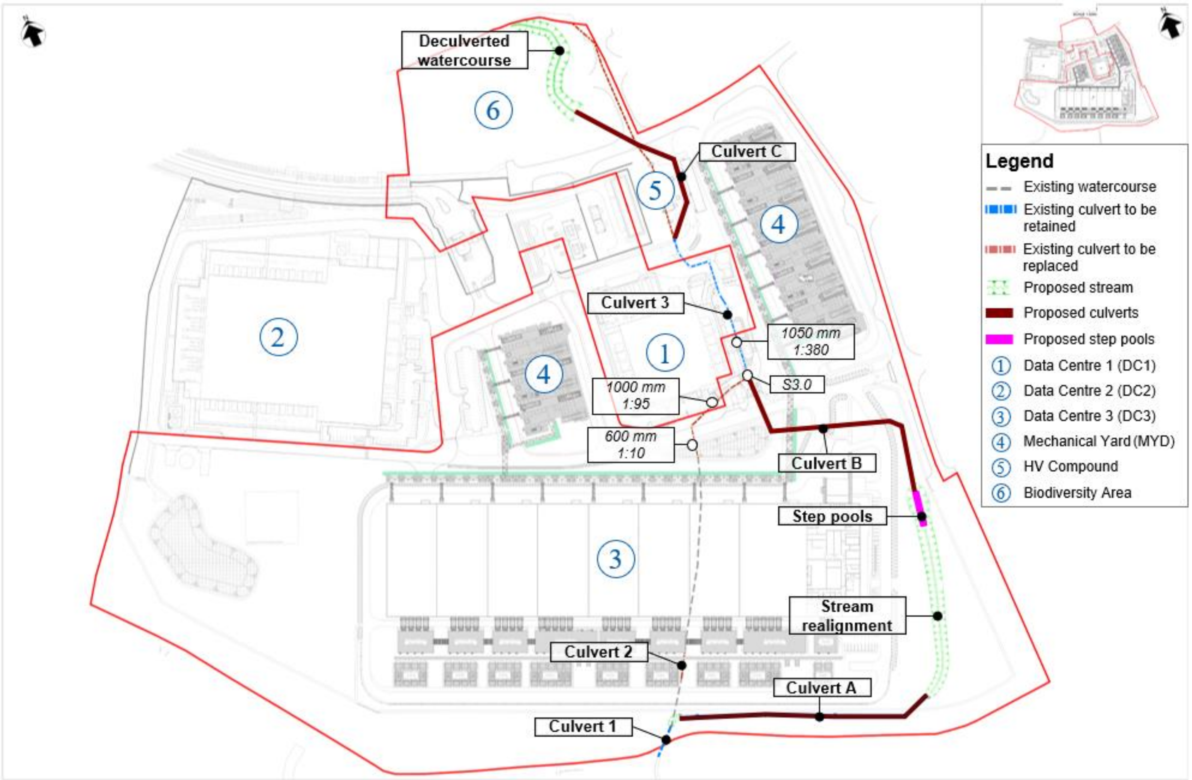

Figure 1.4: Existing watercourse and culverts (culvert 1, 2, 3) within the Proposed Development site.

The on-site watercourse is proposed to be diverted around the Data Storage Facility with proposed Culvert A diverting flow in an easterly direction before discharging into a proposed open channel and flowing north before being discharged into proposed Culvert B which joins existing culvert 3. The proposed Culvert C discharges into an open channel before being discharged into the downstream off-site watercourse.

[1] Common Implementation Strategy for the Water Framework Directive (2000/60/EC) Guidance document No 3. Analysis of Pressures and Impacts .

Assessment of the pressures and impacts related to the Proposed Development indicated that the main pressure is that the location of the Data Hall Building requires realignment of the on-site watercourse and localised culverting (Table 1.1). This will change the morphology, flow characteristics and the habitat of the on-site watercourse, compared to the baseline conditions. Therefore, a stream habitat survey under a Stage 3 Detailed Assessment is required.

Table 1.1: Pressure and impact analysis for Proposed Development.

Driving force	Proposed development requires morphological alterations of a watercourse
Pressure	Variation in flow characteristics
State	Altered flow regime and habitat
Impact	Quantity and dynamics of water flow River continuity Morphology depth and width variation Quantity, structure and substrate of the bed Structure of the Riparian zone
Response	Stream habitat survey (i.e. RHAT) and develop design measures to reduce pressure and offset impacts

1.5 Stage 3 Detailed Assessment

A detailed assessment was required to quantitatively assess the baseline condition of the on-site channel and assess the impact and design measures required for the Proposed Development. This involved a desktop survey prior to the site visit and a site walkover using the River Hydromorphology Assessment Technique (RHAT) [1]. The RHAT was developed for European Water Framework Directive (WFD) classification but has other applications such as:

- Quantify the deviation of a river from its "Natural" 2 form;
- Determine remedial/restoration work required to improve the river habitat; and
- To assess conditions before and after remedial/restoration works are carried out.

The output of the RHAT is a baseline WFD Hydromorphological Status (i.e. Bad, Poor, Moderate, Good, High) for a watercourse. This assessment can then consider design measures in an iterative way to determine the most appropriate measures for the Proposed Development.

1.5.1 Desktop Survey

A desktop survey was carried out prior to the site walkover using RHAT to get an understanding of the river typology and wider geomorphological processes at a catchment level utilising:

- EPA Unified GIS Application (https://gis.epa.ie/EPAMaps/ accessed March 2023)
- River Basin Management Plan (RBMP) for Ireland 2018 -2021, Cycle 2 (Department of Housing, Planning and Local Government, 2018);
- Draft RBMP for Ireland 2022-2027, Cycle 3 (Department of Housing, Planning and Local Government, 2023);
- Liffey and Dublin Bay Catchment Summary WFD Cycle 3 (EPA, 2021);
- Liffey_SC_090 Sub-Catchment Summary WFD Cycle 2 (EPA, 2018);
- Google Earth aerial imagery (accessed in April, 2023);

[2] It is assumed that natural systems support ecology better than modified systems. Hence the RHAT method classifies river hydromorphology based on a departure from naturalness. It assigns a morphological classification directly related to that of the WFD: High, Good, Moderate, Poor and Bad, based on semi-qualitative and quantitative criteria.

- Historical maps (ITM historic 6 inch 1837 – 1842, ITM Ortho 2005, Google Hybrid 2015);
- Agriculture and Food Development Authority (Teagasc) and Geological Survey of Ireland (GSI) maps
- Site survey topographic survey from Land Surveys (October 2019) included in Appendix A;
- Stream topographic survey from Murphy Geospatial (February 2024) included in Appendix B;
- Data Centre Development DC3 - Flood Risk Assessment report

The outcome of the desktop study is summarised in the following subsections.

1.5.1.1 Catchment-Scale Controls

The Proposed Development occurs within the Liffey and Dublin Bay WFD Catchment, which covers an area of 1,624 km^2 (Figure 1.5). The Liffey River originates in the Wicklow Mountains at an elevation of approximately 900 mAOD and it curves for more than 129 km before reaching Dublin Bay, where it flows into the sea. The catchment includes the area drained by the river Liffey and all streams entering tidal water between Sea Mount and Sorrento Point in County Dublin (EPA, 2021). The lower catchment area is heavily urbanised and industrialised.

The project site is within WFD Sub Catchment: Liffey_SC_090 and WFD Sub-Basin Liffey_170 (EPA, 2021). The main waterbody within Liffey_170 is the Griffeen River. Griffeen River originates in the Saggart Hill in South Dublin. It flows towards Lucan until it reaches the Griffeen Valley Park (Figure 1.6). After leaving the park it discharges to the Liffey River at the Lucan Weir.

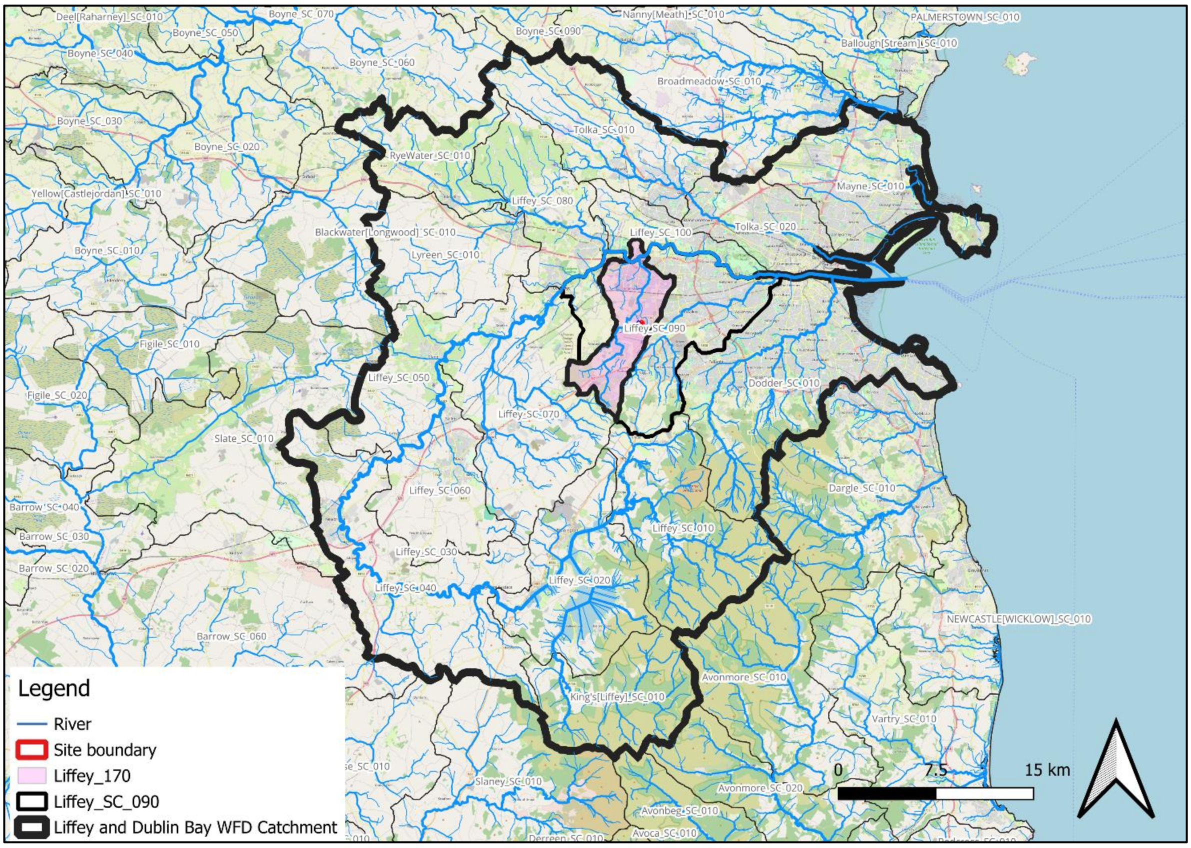

Figure 1.5: Location of site within the WFD catchments. Source: EPA, 2021

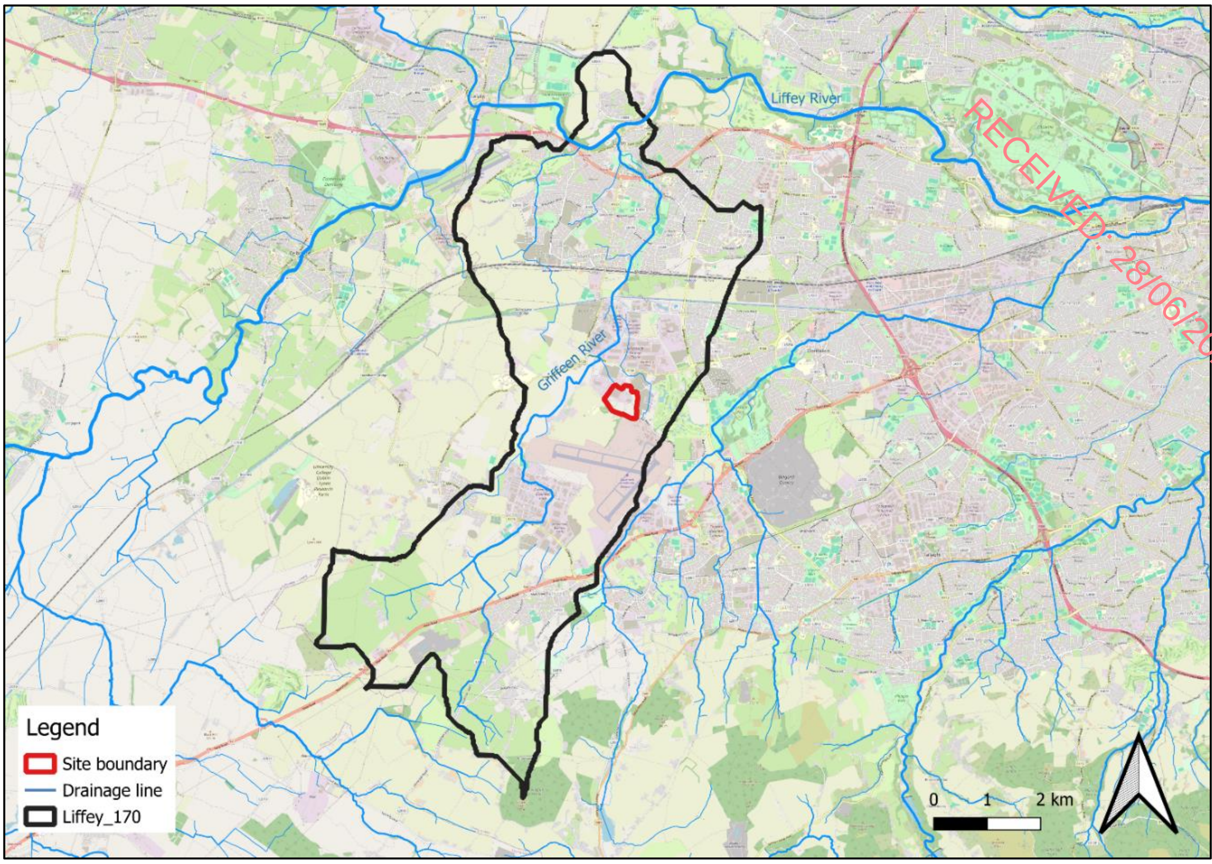

Figure 1.6: Site location within Liffey_170 WFD river subbasin. Source: EPA, 2021

Longitudinal Profile

The topography of the Liffey and Dublin Bay WFD Catchment is dominated by the Wicklow Mountains to the south and the discharge to sea level in the east (Figure 1.7). The longitudinal profile of the watercourse traversing the Proposed Development site indicates an average bed gradient of 1.24% (Figure 1.8). The Proposed Development occurs in a generally flat terrain, with an average elevation of 82 mOD, and two notable fluctuations in the topographic level on each side of the watercourse associated with spoil heaps (Figure 1.9).

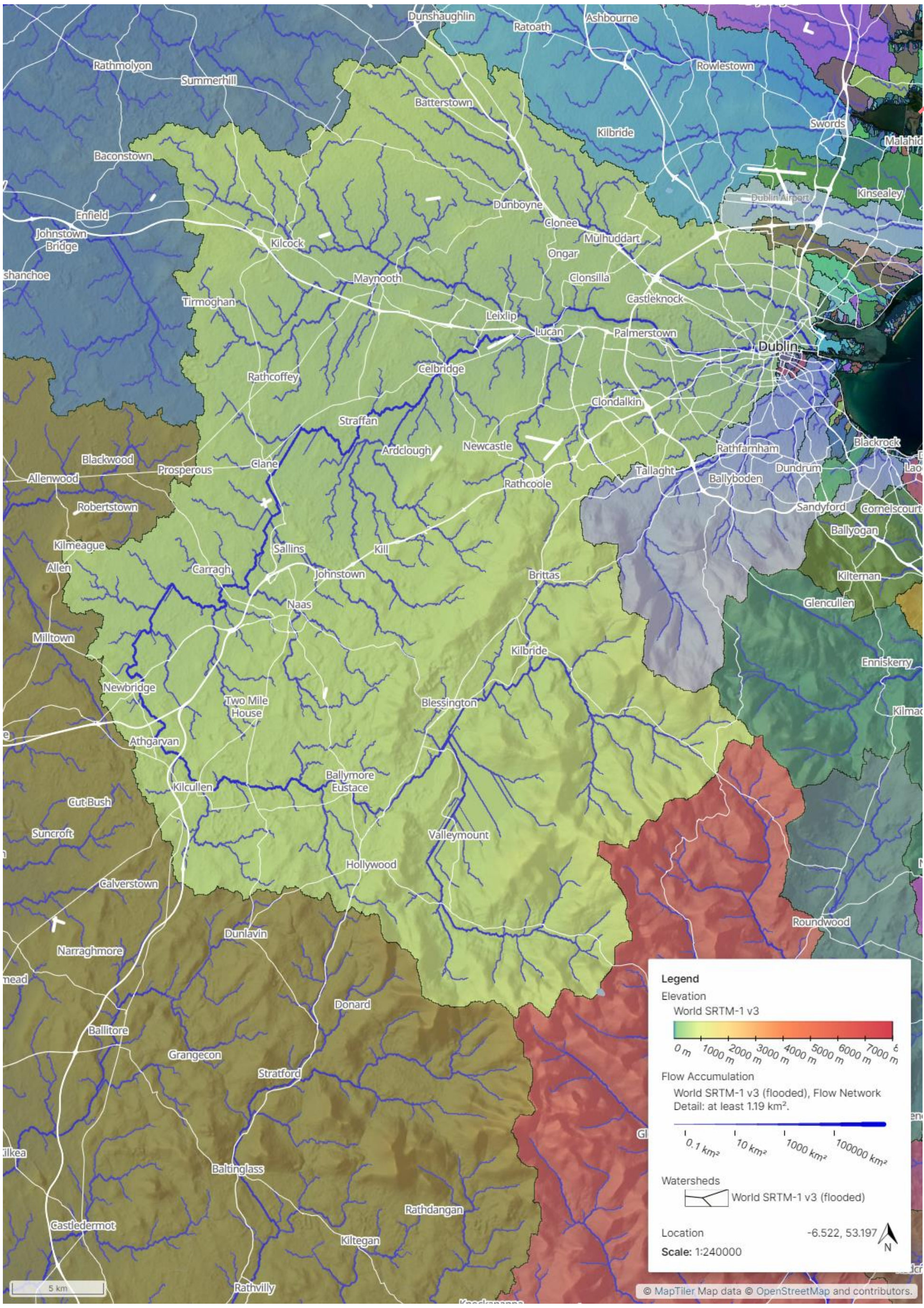

Figure 1.7: Elevation of Liffey River Catchment. Source: Scalgo

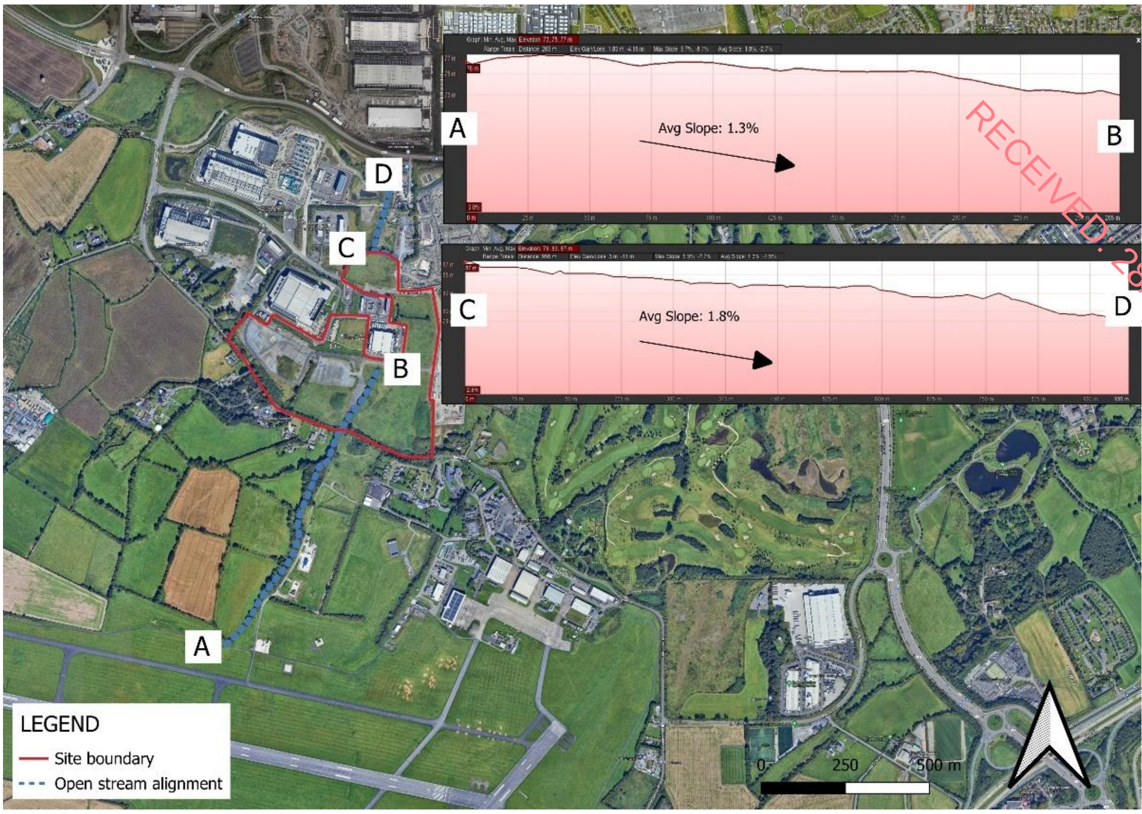

Figure 1.8: Longitudinal profile of watercourse along reach A-B and C-D. Source: Google Earth Pro[3]

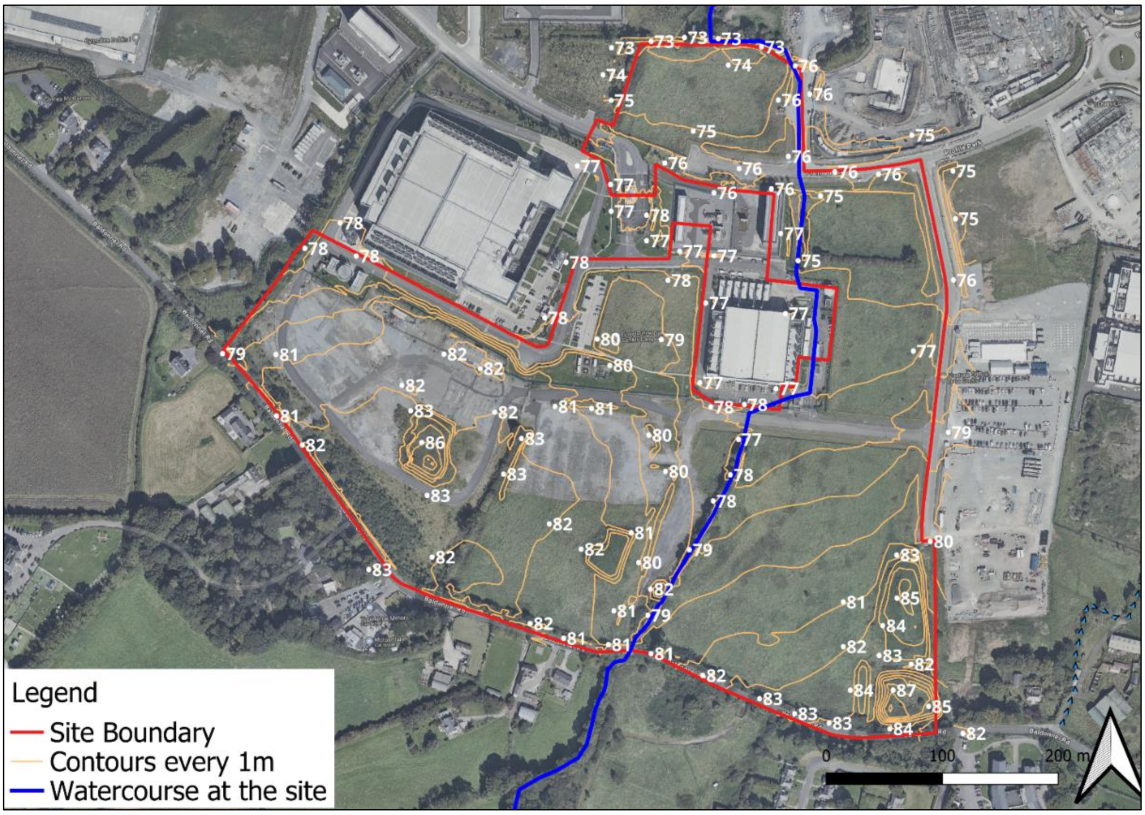

Figure 1.9: Topography of the Proposed Development site (generated from the site-specific topographic survey).

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[3] Google Earth data are use digital elevation model (DEM) data collected by NASA Shuttle Radar Topography Mission (SRTM). Therefore, longitudinal profiles are representative, and do not accurately represent bed elevations.

1.5.1.2 *Catchment Hydrology*

Griffeen River flows approximately 500m to the west of the site and Baldonnell Stream flows about 120m to the east of the site (Figure 1.10). Another stream, noted as Milltown 09, originating at the boundary to the north of the site flows towards the Griffeen River and confluences at the point eastern of townland Milltown, to the south of the Nangor Road. At the southern boundary of the site, there is an open channel watercourse that transitions into a culverted watercourse beneath the DC2 building at the northern border of the site. It emerges from the northern side of the site and continues in a northerly direction and ultimately connects with Baldonnell Stream at the north of the site. This watercourse is referred to as a tributary of Baldonnell Stream in Figure 1.10, which also depicts its contributting catchment area.

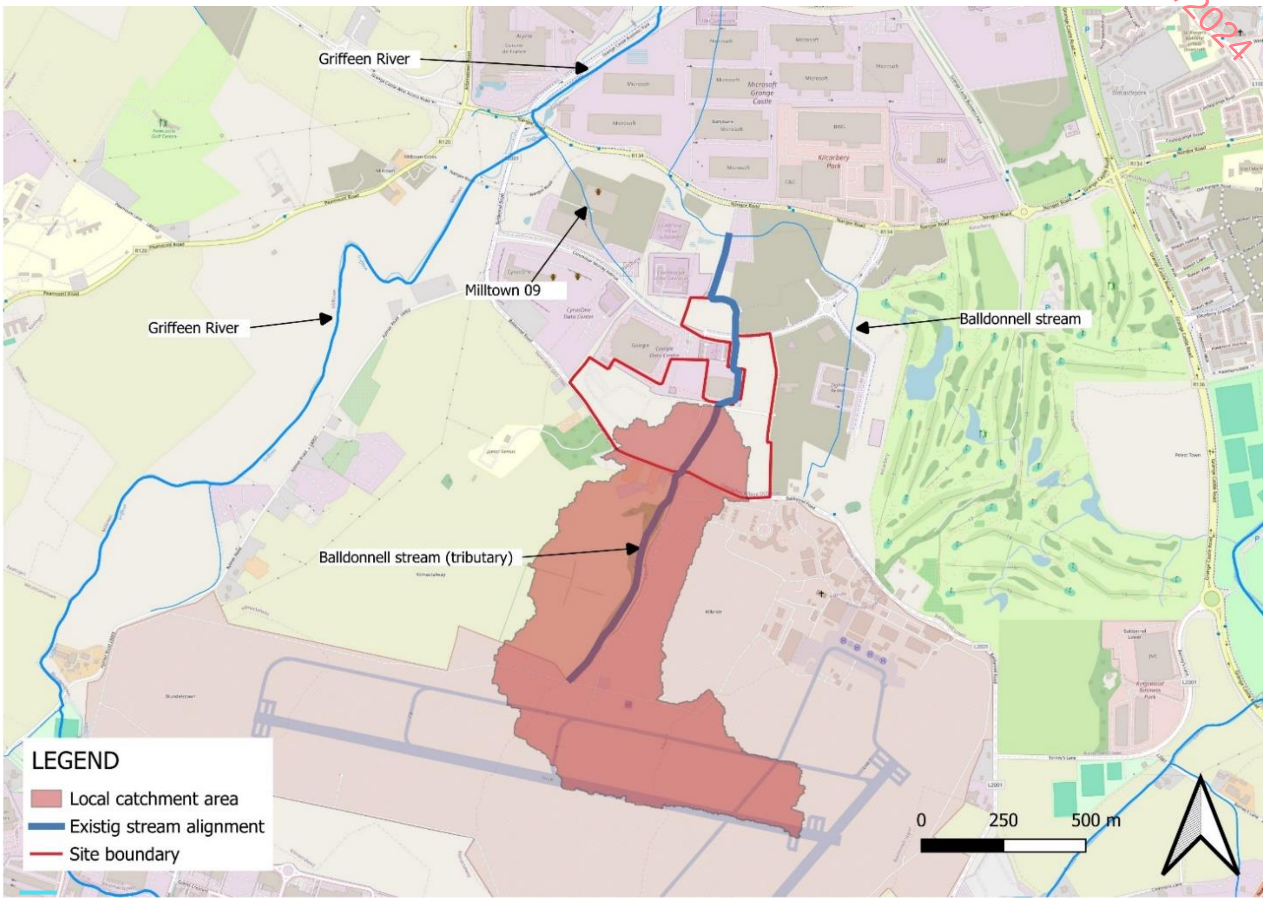

Figure 1.10: Contributing catchment for the tributary of Baldonnell Stream. Source: EPA Maps.

The peak flood flows for the on-site watercourse has been estimated using the FSU4.2a (5-variable) equation for small and urbanised catchments (FSU WP4.2, OPW). The mean discharge of water expected in the stream is Qmed = 0.46 m^3/s, with a 95% confidence interval.

1.5.1.3 *Impelling and Resisting Forces*

The headwaters in the south-east of the Liffey River Catchment are underlain by granites and a densely populated flat, low lying limestone area extends over the remainder of the catchment (CSO, 2022). The underlying geology the Proposed Development is characterized by the Upper Carboniferous Limestone, known as the Lucan formation. Alluvium is derived from limestone.

Geomorphic work within the watercourse has been assessed through stream power. Typical thresholds associated with geomorphological behaviour and trends are summarised below:

- Aa unit stream power value <10W/m^2 will generally indicate a depositional/aggradation trend;
- A unit stream power value >35W/m^2 will generally indicate an erosional/degradation trend;
- A unit stream power value of between 10 and 35W/m^2 will generally indicate no trend (i.e. a transport reach) [2].

The above thresholds do not categorically prove the characteristics of a given river reach. However, they provide a general guide and quantitative assessment of the amount of energy available within a given river channel.

Erosion is typically associated with flows higher than those associated with a 1 in 5 year flood event (0.56 m^3/s) (Table 1.2). For flows lower than 0.2 m^3/s, some deposition trends can be expected. For flows between 0.2 m^3/s and the flows associated with a 1 in 5 year flood event, neither deposition nor erosion trends are anticipated.

Table 1.2: Stream power for the watercourse.

	1 in 2yr	1 in 5yr	1 in 25 yr	1 in 50 yr	1 in 100 yr	1 in 200 yr	Units	Data source
Discharge, Q	0.44	0.56	0.74	0.82	0.91	0.99	m^3/s	FSU4.2 Experimental method
Bed gradient, S	0.0124	0.0124	0.0124	0.0124	0.0124	0.0124	m/m	Stream survey
Channel width, b	2.187	2.251	2.363	2.427	2.489	2.535	m	Stream survey (Bankfull width)
Density of water, ρ	1000	1000	1000	1000	1000	1000	kg/m^3	Constant value
Stream power, $\Omega = \rho gQS$	53.5	68.1	90.0	99.75	110.7	120.4	W/m	Calculated
Unit stream power, $\omega = \rho gQS/b$	24.473	30.262	38.094	41.1	44.5	47.5	W/m^2	Calculated
Likely predominant trend	No Trend	No Trend	Erosion	Erosion	Erosion	Erosion		Erosion if $\omega > 35 W/m^2$, deposition if $\omega < 10 W/m^2$

1.5.1.4 Human Impacts

Maps from 1837 to 1842 indicate that the on-site watercourse has been artificially straightened and re-sectioned for agricultural purposes. It should be noted that no aerial imagery is available prior to this period (Figure 1.11). The tributary flowed along agricultural field drains and farm boundaries before joining Baldonnell Stream. By 1995, the development of the airport disrupted the watercourse longitudinal continuity, introducing a physical barrier to natural flow. In 2008 the area started experiencing significant industrial development, in 2009 the current DC building site required the watercourse to be culverted. It can be concluded that this tributary has been modified from its natural state for almost 200 years. By confining it into an unnatural drainage ditch profile and by culverting it, natural lateral and longitudinal connectivity in the river has been greatly reduced. In turn, this will result in the loss of natural processes (flow, hydromorphology and associated features/habitats), and prohibit their recovery/restoration.

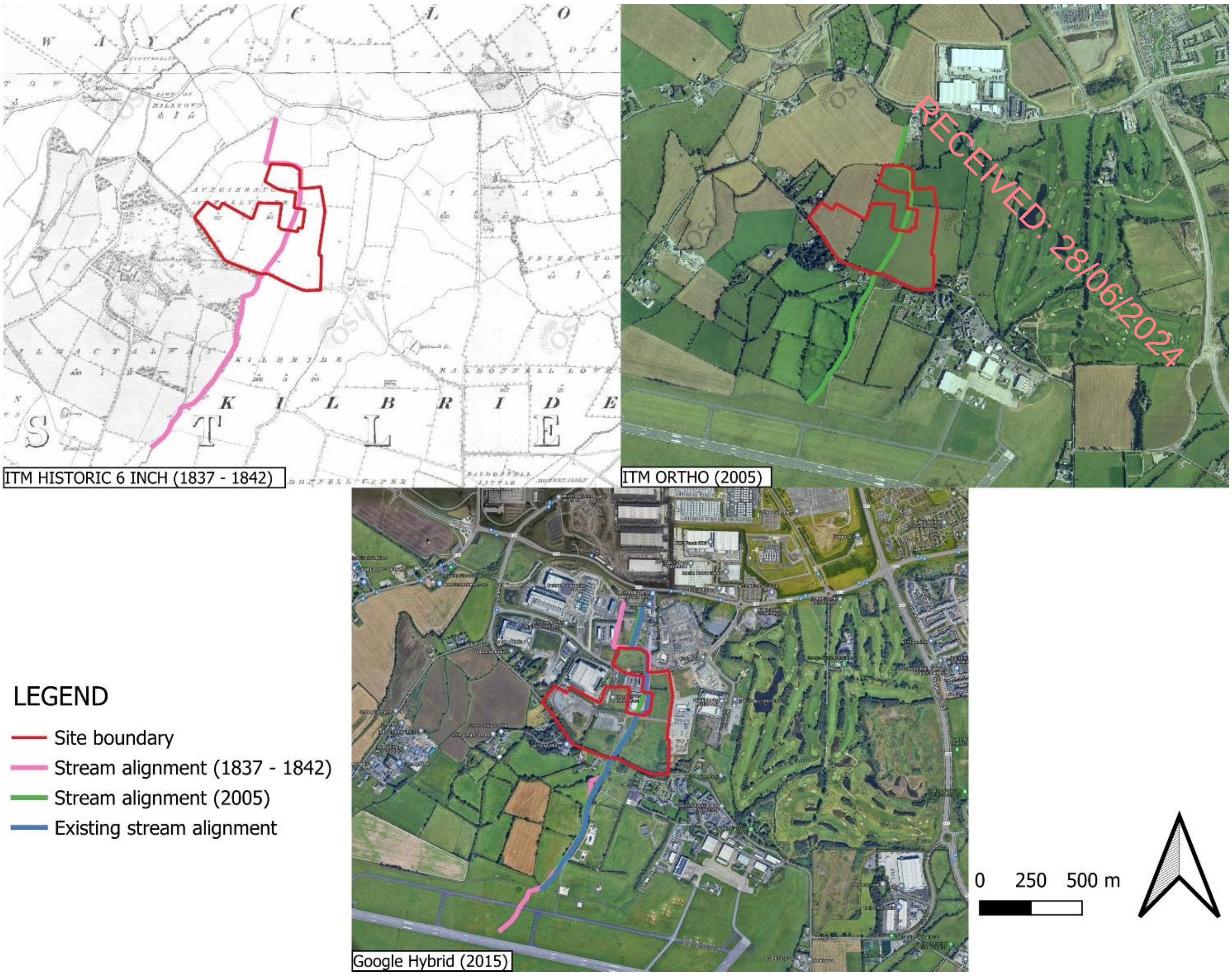

Figure 1.11: Historical imagery. Source: OSI and Google Imagery

1.5.1.5 River Typology

Based on the desktop survey conducted, the assessed river falls under the typology of a Lowland Meandering River (LLM). This type is characterized by a low to no gradient, smooth flow, and fine substrates.

1.5.2 Baseline Hydromorphological Condition Assessment

The baseline hydromorphology has been assessed using a site walkover, followed by analysis of results and scoring using the River Hydromorphology Assessment Technique (RHAT) methodology for detailed assessment. Detailed field observations, photographs, and the results of the field assessment of morphological condition included in Appendix C.

A site walkover was carried out on the 23rd of April 2024. During the visit the team met with representatives from Inland Fisheries Ireland (IFI) who provided comments on the current status of the watercourse and made recommendations for fishery related design measures and design of the open stream, summarised in section 1.6.1.

Field observations were conducted approximately every 60 meters along the reach of the on-site watercourse (points 1 to 4) and approximately every 40 meters in the off-site watercourse downstream from the Proposed Development site (points 5 to 7) (Figure 1.12). The exact locations of the survey points were determined by accessibility on site, as dense vegetation made access difficult in certain areas. This assessment excludes the culverted reach of watercourse and provides an overall RHAT score and WFD status for the on-site watercourse.

Figure 1.12: RHAT observation points for the on-site watercourse traversing the Proposed Development (points 1-4) and the off-site watercourse downstream of the Proposed Development (points 5-7).

The RHAT is a method developed to classify and assess river hydromorphology in compliance with the European Water Framework Directive (WFD) 2000/60/EC. It evaluates rivers based on eight criteria and classifies river hydromorphology based on a departure from naturalness. The RHAT scores for the assessment are based on the condition categories in Appendix 2 of the RHAT guidelines. The attributes assessed for a change from natural were as follows:

- **Channel form and flow types:** This evaluates the river's natural form, including the platform, cross-section, natural bed forms, flow types and obstructions. For Low Land Meandering river types a natural condition would be silt, sand, gravel or pebble bed rivers associated with lowland regions. Bars and pools occur in association with the bends and crossing of the meander pattern. Bed forms are associated with a range of flow depths, velocities and pool sizes. The flow regime is generally smooth with turbulent flow uncommon.
- **Channel vegetation:** This assesses the presence, diversity, and habitat potential of vegetation within the river channel, including woody habitat, leaf litter, and tree roots. It considers the influence of river type and riparian land cover on vegetation diversity and quantity. For Low Land Meandering river types a natural condition would have rooted aquatic vegetation present during the growing season and fringing reed beds should be present but not extensive.
- **Substrate condition:** This assesses the river's substrate type, quantity, and diversity, and cleanliness, considering natural and anthropogenic influences. For Low Land Meandering river types a natural condition would be dominated by silt, sand and fine gravel, with coarser particles accumulating in bars on the inside of meander bends. These fine particle accumulations are mobile even in relatively small flood events.
- **Barriers to connectivity:** This assesses in-stream barriers affecting velocity variation and river continuity. It considers impacts like widening, over deepening, straightening, impoundments, weirs and dams on water flow, sediment, and fish migration.

For Low Land Meandering river types a natural condition would have low flow conditions where some bars or islands may be exposed, but water fills the most of the channel. These rivers are normally sinuous with smooth flow. Areas of low velocity are often present around the margins, and on river channels with little slope.

- **Bank structure and stability:** This assesses the shape and stability of a river bank. It considers natural factors like typology, geology, soil type and hydrology. For Low Land Meandering river types a natural condition would have bank stability dependent on the erodibility of the bank material and the position within the pool-riffle sequence. These rivers occur in geologies with high and low threshold to movement and bank top vegetation may enhance the bank stability. The outside of bends between pools and banks are more likely to be eroding or undercut, whilst deposition in riffles and bars protects banks and leads to shallower profiles. Irregular bank forms provide a variety of habitats for in-stream biota.
- **Bank and bank-top vegetation:** This assesses the types, continuity, and canopy layers of vegetation along the riverbank. It considers the variety of vegetation classes, degree of shading, presence of alien species, and human management. For Low Land Meandering river types interact regularly with their floodplains so wetland plants may characterise the margins. Areas of moorland, wetland and wet grassland may characterise the riparian zones, although mature wet woodland may also be present at the lower gradient end of the system. Native broadleaf vegetation may be expected in many locations.
- **Riparian land use:** This assesses land cover within the zone adjacent to the river from 1m to 21m back from the bank top. The assessment considers the amount and type of vegetation, including whether it is native, as well as evidence of human activities. For Low Land Meandering river these river types interact regularly with their floodplains. Areas of moorland, wetland and wet grassland may characterise the riparian zones, although mature wet woodland may also be present at the lower gradient end of the system.
- **Floodplain connectivity – channel lateral connectivity:** This assesses the lateral connectivity between the river channel and the floodplain, considering natural river type and valley confinement. The score reflects how much channel and bank modifications (like deepening, widening, straightening, reinforcement, and protection) have altered flow regimes. For Low Land Meandering river types at high discharge there is often over-bank flooding.

The method involves both desktop studies and field surveys, providing a hydromophological classification into five categories, related to that of the WFD:

- High: Minimal deviation from natural conditions.
- Good: Slight modifications from natural conditions.
- Moderate: Noticeable modifications from natural conditions.
- Poor: Extensive modifications from natural conditions.
- Bad: Severe modifications with major deviations from natural conditions.

The site assessment confirmed the lack of naturalness that was already identified in the desktop study (Table 1.3).

Table 1.3: Field assessment of morphological condition results.

	On-site watercourse		Off-site watercourse (downstream of site)		Average		Comment
Attribute	**Bank**	**Score (RHAT)**	**Bank**	**Score (RHAT)**	**Bank**	**Score (RHAT)**	
1. Channel form and flow types	NA	1	NA	1	NA	1	The on-site channel has been modified from its natural state for almost 200 years. There is evidence of significant straightening, fencing and culverting (Figure 1.13). There is evidence of recovery such as substrate deposition (silt, sand and gravel as expected in a low-land meandering river type), revegetation, and habitat creation.
2. Channel vegetation	NA	2	NA	2	NA	2	The riparian vegetation along the stream is mainly composed of bramble and thistle, as well as some large trees including oak, ash, willow, and hawthorn. A dense canopy cover significantly reduces light penetration, creating over-shading conditions. No evidence of vegetation management is present (Figure 1.14). Additionally, the banks feature extensive invasive species such as nettles and non-natives such as sycamore.
3. Substrate condition	NA	1	NA	1	NA	1	The watercourse presents evidence of anthropogenic changes in the channel bed such as: Masonry blocks, concrete rubble, tipping (rubbish), oil spillage, trash debris and channel bed protection (concrete)at some locations (Figure 1.15). There is also a high percentage of fines and silt which is what is expected for this river type. Despite this the cleanliness of the water (from a visual assessment) seems moderate.
4. Barriers to continuity	NA	1	NA	1	NA	1	The stream's longitudinal connectivity has been disrupted by culverts, which accelerate flow velocity. This makes it improbable for fish to navigate through. During the visit there were no signs of any aquatic species (although the habitat is considered suitable for breeding amphibians such as common frog and smooth newt). Lateral connectivity has been altered by channel straightening and resectioning of the channel carried out during agricultural development in the 1800s. In the off-site downstream channel, there's a small bridge crossing the stream with a very narrow culvert (approximately 0.3 meters in diameter) underneath to maintain connectivity (Figure 1.16). Overall, the culverts in the stream seem inadequate for managing high flood conditions.
5. Bank structure & stability L/R	L	0.5	L	0.5	L	0.5	The open channel shows clear evidence of extensive alteration to bank structure. The channel was embanked at some point during the 1800's as part of the channel straightening carried out during the agricultural development of the area. A 5 m section of the channel bank is concreted at the entrance of the on-site reach (Figure 1.17). A 10 m section of the right bank (facing downstream) of the downstream off-site reach appears very degraded, likely due to frequent poaching by horses. Horses seem to access the river to drink water without designated entry points.
	R	0.5	R	0	R	0	

	On-site watercourse		Off-site watercourse (downstream of site)		Average		Comment
Attribute	Bank	Score (RHAT)	Bank	Score (RHAT)	Bank	Score (RHAT)	
							This poaching resulting in trampling and erosion along the channel banks, with sediment input into the channel
6. Bank vegetation L/R	L	0.5	L	0.5	L	0.5	Both riverbanks are densely populated with brambles and thistles, which are invasive species that are outcompeting endemic plants (Figure 1.18). Additionally, evidence of invasive nettles and non-native sycamores was observed. Some large trees, such as oak, ash, willow, and hawthorn, were also present. Overhanging branches extend across the channel, contributing organic matter, but in certain areas, they create excessive shading. There is no indication of recent/active vegetation management. There is evidence of rabbit presence along the banks of the river, in the form of burrows.
	R	0.5	R	0.5	R	0.5	
7. Riparian land use L/R	L	0	L	1	L	0.5	The right bank is generally rough pasture for the on-site riparian land use (Figure 1.19). The off-site reach has limited riparian buffer zone as a private property is close to the stream over the length of the reach. Part of the right banks servers as a dumping site for trash and for keeping horses. There is a man-made gravel area and evidence of previous earthworks spoil on the left bank of the on-site reach. The left bank of the downstream off-site reach is rough pasture
	R	1	R	0	R	0.5	
8. Floodplain connectivity L/R	L	0	L	0	L	0	During the 1800s, agricultural development led to the embankment of the stream, reducing its lateral connectivity. Recent urban development further disrupted this connectivity by fencing (Figure 1.20) downstream areas. As a result, the stream may no longer overtops its banks during high flows. Under natural conditions, rivers should overtop their banks approximately every 1 to 2 years during bankful flood events. This lateral connectivity no longer occurs in the modified stream system.
	R	0	R	0	R	0	
TOTAL	**NA**	**8**	**NA**	**7.5**	**NA**	**7.5**	

* Attributes 1-4 scored from 0 to 4 by 1; Attributes 5-8 score LB / RB separately 0 to 2 by 0.5.

**Scores based on information presented in Appendix 2 of the RHAT Training Manual - Version 2. https://www.daera-ni.gov.uk/publications/river-hydromorphology-assessment-technique-training-manual

Figure 1.13: Example of on-site and downstream off-site channel form.

Figure 1.14: Example of on-site and downstream off-site channel vegetation.

Figure 1.15: Example of on-site and downstream off-site substrate condition.

Figure 1.16: Example of on-site and downstream off-site barriers to connectivity.

Figure 1.17: Example of on-site and downstream off-site bank structure and stability.

Figure 1.18: Example of on-site and downstream off-site bank vegetation.

Figure 1.19: Example of on-site and downstream off-site riparian vegetation.

Figure 1.20: Example of on-site and downstream off-site floodplain connectivity.

1.5.3 Baseline Hydromorphological Classification

Considering the eight criteria that are scored by the RHAT to determine a morphological classification (as presented in Table 1.4) the on-site watercourse is in a 'Poor' hydromorphological condition (i.e. sum of RHAT score is ⩾6.5 to <13).

Table 1.4: WFD classes [1]

WFD Class	HM Score (RHAT)	∑ Att scores (RHAT)
High	⩾0.8	⩾26
Good	0.6 – <0.8	⩾19.5 to <26
Moderate	0.4 – <0.6	⩾13 to <19.5
Poor	**0.2 – <0.4**	**⩾6.5 to <13**
Bad	< 0.2	< 6.5

HM score = Σ Attribute scores/32

1.6 Design Options

1.6.1 Design Considerations for Flood Risk

Efforts have been made to keep the re-aligned watercourse as an open channel as much as practically possible. This will provide flood risk benefits, including helping to reduce risks of blockage that are inherent to culverts, and to provide opportunities for hydromorphology and biodiversity to be restored within the watercourse. The following design criteria have been identified, which have resulted in the introduction of 2 culverts within the site and alteration of an existing culvert.

- The new re-aligned watercourse is designed to convey the 1 in 100-year design flood event with 20% increase in flow allowance to account for climate change. Where the watercourse is designed as open stream, a minimum of 300mm freeboard to the bank top is allowed;
- At the south part of the site, the corridor between the perimeter road of the development and the site boundary is relatively narrow. There are several utilities that run west to east parallel to the building that reduce the corridor even further. Consideration has been given to the use of an open box culvert (concrete channel with 1:1 slopes); however, the health and safety concerns outweigh the few biodiversity benefits of a narrow and shaded open concrete stream. As such, a 1.5m x 1m box culvert is considered the most viable option at the location (Culvert A);
- At the east part of the development, an open stream section is proposed to re-route the watercourse to the north. The open stream is designed with 1m base width, to mimic existing low flow conditions, 1:3 banks and a minimum of 300mm freeboard above the design flood event. The channel cross-section and gradient has been designed to ensure low velocities within the channel (<1m/s);
- The inlet of the existing Culvert 3 is 600mm in diameter with an initial slope of 1:10, increasing to 1000mm downstream. From the culvert has a gentle slope and increases in size to 1050mm to manhole S3.0. As such, it is proposed that the 600mm inlet is avoided and the new Culvert B connects directly to the 1050mm pipe (S3.0). At this location, the existing culvert is much lower than the existing watercourse levels (S3.0 IL:73.92m OD);
- The proposed ground levels at the site are set to 80m OD. A potential stream at the location of Culvert B would require a depth of ~3-4m, which is extremely deep. Other spatial limitations prevent the use of an open stream: the watercourse is proposed to be crossed by 2 road crossings and a stormwater attenuation pond is proposed adjacent to the watercourse. As such, an open stream is not possible at this location and the most suitable type of watercourse is a circular culvert (Culvert B);
- Between the open stream and Culvert B, there is a 2m vertical transition, designed to allow for shallow slopes and reduced velocities within both the stream and Culverts A and B. To enable the 2m vertical transition, a series of 4 step pools of 0.5m height and 5m length each will be positioned between the two. The total length of the step pools is 25m (to include 5m of gentle slope at the end of the step pools and before entering Culvert B. The step pools should allow movement of any potential fish. They are designed with stones and coarse bed material to prevent erosion due to the high local velocities. They will also provide energy dissipation. The surrounding proposed ground levels are set to 80m OD. As the base of the step pools will be between 75.7-77.75m OD, the difference with surrounding levels varies from 2.25m - 4.3m. A combination of retaining structure at the base and sloping grounds at higher levels is proposed to accommodate the vertical transition;
- The existing culvert is required to be diverted around the proposed substation. This is referred to as Culvert C and it is 140m long; and
- Efforts are made to de-culvert the watercourse where space allows. The section of the existing culvert under Profile Park Road will be diverted to the adjacent biodiversity area through Culvert C and opened up for 82m. The open stream will outfall straight to the existing watercourse north of the site.

1.6.2 Design Considerations for Biodiversity

Phone conversations were held with IFI during which the above proposals were discussed and advice was sought.

The IFI attended the site on 23rd April 2024 and provided additional guidance in terms of the design of the open stream. The proposed measures are based on the following recommendations, which were considered and implemented to the best extent possible.

- Design and installation techniques to be employed to ensure the un-impeded passage of fish through the culvert and minimum variance to the existing flow regime;
- Connection into the existing culverts to follow guidelines provided for fish (i.e. not perched above water, construction during dry season/low flow, ensure a short-time frame, etc);
- Culverts to be embedded below the existing stream bed level; and
- It was noted that the existing culvert connecting the on-site watercourse underneath the existing road and buildings is too small (i.e. diameter 600mm), flow appears to be too fast, and gradient is too steep. These conditions are not natural as the on-site watercourse flow is smooth, gradient is gentle, and water depth is low.

1.6.3 Design Considerations for Hydromorphology

The watercourse diversion will change the flow regime and alter the morphology of the on-site watercourse. However, there is potential for improving some attributes related to its hydromorphology as it flows through the Proposed Development site. The following design measures will be implemented to improve the overall WFD classification status of the watercourse:

- Channel form and flow types will be improved by incorporating a reduced (more natural) gradient and meandering features. Cross-sectional diversity will be created through a multi-stage channel.
- Channel vegetation will be improved through limiting dense foliage cover over the channel. Channel features such as step pools and substrate will promote channel vegetation.
- Substrate condition will be improved through introduction of substrate to the culvert and open channel, ensuring the transition from the open channel to culvert has bed protection and ensuring there are opportunities for promoting deposition of fines along the open channel. Substrate can build over time so the design will promote this. Inclusion of berms along the channel will also allow for natural accumulation of fines over time.
- Bank structure and stability will be improved through the planting of native grass species with a dense root system. The two-stage channel profile will also aid in bank stability.
- Bank vegetation will be improved through the planting of native grass species with a dense root system.

1.6.4 Design Measures

The above-mentioned design considerations were assessed under a "post-design" scenario using the RHAT scores (Table 1.5). This resulted in an overall improvement of the class of the watercourse from 'Poor' to 'Moderate' based on the improved morphology attributes.

Table 1.5: RHAT score for the on-site watercourse baseline and post-design. Source:

Attribute	Baseline RHAT Score (existing)	Design action RHAT Score (Post-design measures)
1. Channel form and flow types	The river's natural features have been significantly altered over nearly two centuries, with extensive straightening, fencing, and culverting. While some signs of recovery exist, such as substrate deposition, revegetation and habitat creation, overall, the alterations are too extensive. **RHAT Score (Existing):** **1**	Meandering features have been incorporated into the proposed stream design to the north instead of maintaining the current straight alignment. The surrounding landuse is not confined therefore placing natural gravel substrate within the channel will promote natural low flow thalweg development. Bed gradient has been designed to provide the variety of velocity and depth features expected in a LLMR. Step pools are also included in the new design to reduce water velocity and improve habitat.

Attribute	Baseline RHAT Score (existing)	Design action RHAT Score (Post-design measures)
		The development will increase both the amount of culverting and open stream areas. **RHAT Score (Post-design measures):** **1**
2. Channel vegetation	The riparian includes a mix of native and non-native species, with a dominance of bramble, thistle, and large trees like oak, ash, willow, and hawthorn. However, the dense canopy cover leads to over-shading conditions, and there is no evidence of vegetation management. Extensive invasive species, like nettles, and non-natives, such as sycamore, are present along the banks. **RHAT Score (Existing):** **2**	Due to restrictions on planting trees, which could attract birds and pose issues for the nearby airport, grasses with a dense root system are proposed, which will also help stabilise the banks. Removing dense foliage will increase the amount of light penetration and reduce the risk of invasion by non-native species. The provision of woody habitat is limited due to the risk of blockage to the downstream culverts, which would increase the risk of flooding. **RHAT Score (Post-design measures):** **3**
3. Substrate condition	The substrate presents evidence of anthropogenic changes including masonry blocks, concrete rubble, rubbish dumping, oil spillage, and trash debris. Some locations show channel bed protection with concrete. There is a high percentage of fines and silt, typical for this river type, and water cleanliness appears moderate. **RHAT Score (Existing):** **1**	Substrate condition of the on-site reach will be improved as existing masonry blocks, rubbish, and trash debris will be removed. The proposed two stage profile channel will bring in substrate made from the berm. There will also however still be channel bed protection at some locations, particularly at the transition in between culvert and open stream. **RHAT Score (Post-design measures):** **2**
4. Barriers to continuity	In-stream barriers, such as culverts, disrupt the stream's longitudinal connectivity, impacting water flow velocities, sediment, and fish migration. Overall, culverts appear inadequate for managing high flood conditions Lateral connectivity has been altered by channel straightening during agricultural development. **RHAT Score (Existing):** **1**	There is limited potential for improving longitudinal continuity due to the culverted sections in the Proposed Development, which will still pose a barrier for fish to swim upstream. Culverts have been adequately designed to handle high flood events. **RHAT Score (Post-design measures):** 1
5. Bank structure & stability L/R	The river banks have undergone extensive alterations, including embankment during the 1800's agricultural development and concreting with the industrial development of the 2000's. Sections of the banks show evidence of poaching. **RHAT Score (Existing):** **Left bank = 0.5** **Right bank = 0**	Improvement to bank structure and stability will mainly be accomplished by planting grasses with a dense root system along the banks. The new section of the stream will have a floodplain bench below the bank top, improving the overall stability of the bank. Soft erosion protection such as geotextiles will be incorporated to the banks, where necessary **RHAT Score (Post-design measures):** **Left bank = 1** **Right bank = 1**
6. Bank vegetation L/R	Both riverbanks are overrun by invasive plants like brambles and thistles, competing with native species. Evidence of invasive nettles and non-native sycamores was also noted.	Native grasses with dense root systems are proposed for the banks, with no trees. Tree planting is limited due to constraints with surrounding land use (the airport).

Attribute	Baseline RHAT Score (existing)	Design action RHAT Score (Post-design measures)
	Large trees, including oak, ash, willow, and hawthorn, are present, which contribute to excessive shading. No vegetation management is apparent. **RHAT Score (Existing):** **Left bank = 0.5** **Right bank = 0.5**	**RHAT Score (Post-design measures):** **Left bank = 1** **Right bank = 1**
7. Riparian land use L/R	The land use within the riparian area is mainly rough pasture. There is also a man-made gravel area and a private property. **RHAT Score (Existing):** **Left bank = 0.5** **Right bank = 0.5**	The potential for improving riparian land use within the site is limited. Currently, there is a man-made gravel area and rough pasture; under the Proposed Development, it will be replaced by the new building, rough pasture and native vegetation. **RHAT Score (Post-design measures):** **Left bank = 0.5** **Right bank = 0.5**
8. Floodplain connectivity L/R	The lateral connectivity between the river channel and floodplain has been disrupted with the embankment and fencing of the channel, which prevents the stream from overtopping its banks during high flows as it should. **RHAT Score (Existing):** **Left bank = 0** **Right bank = 0**	Channel lateral connectivity will be improved by having a floodplain bench below the bank top that will overflow every 1 or 2 years (a two stage channel). Although lateral connectivity is constrained by surrounding landuse allowing for a bench will promote natural accumulation of substrate which will maintain the health and functionality of the river and its surrounding ecosystem. **RHAT Score (Post-design measures):** **Left bank = 1** **Right bank = 1**
TOTAL	**7.5**	**14**

1.7 Summary

This Chapter examined the impacts of the Proposed Development on the on-site watercourse hydromorphology in accordance with the SDCC, 2023 guideline, "Development Hydromorphological Assessment Guidance". Although the site is not within a Riparian Corridor (SDCC, 2022), it is in a flood zone, necessitating a scoping assessment and due to potential variations in stream flow characteristics from the development, a detailed assessment was required. This involved a quantitative evaluation of the baseline condition of the on-site channel and proposed design measures.

The desktop assessment indicated a watercourse that has historically been modified and disconnected from the floodplain. In its natural form the watercourse would have been associated with a lowland, meandering floodplain river typology. A site assessment using the RHAT analysis indicated that the current WFD Hydromorphological Status of the watercourse is 7.5 (poor status). After implementing the proposed design measures, which considered flood risk, biodiversity, landscaping, and hydromorphology, the status is expected to improve to 14 (moderate status).

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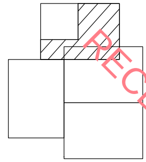
River Hydromorphology Assessment Technique (RHAT) Training Manual-Version 2. (NIEA, 2014)

Appendix A

Site topographic Survey – Land Surveys (October 2019)



Sheet 1 of 4 (A1)

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Ph: 2805212 Fax: 2302535 info@landsurveys.ie

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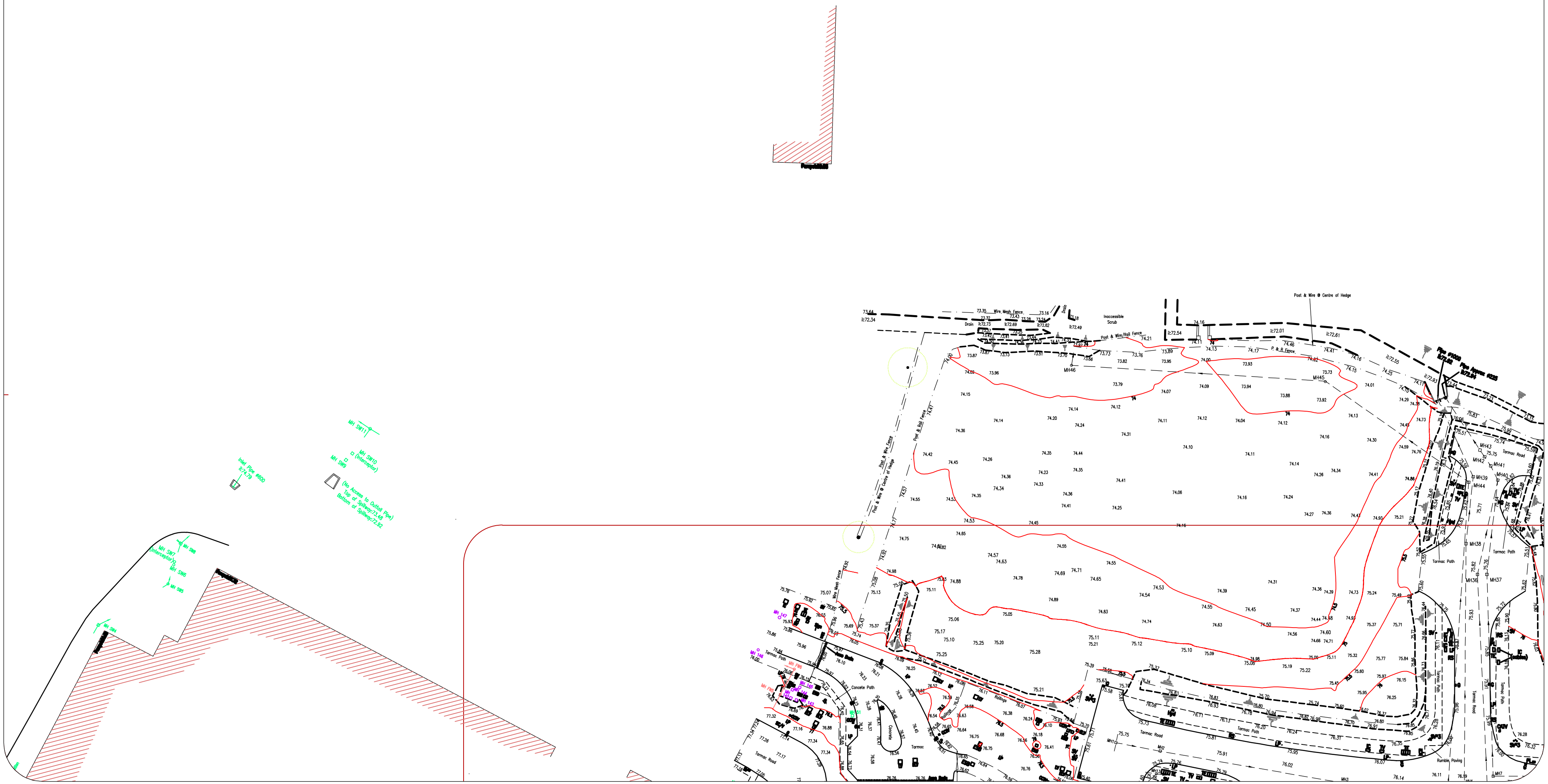
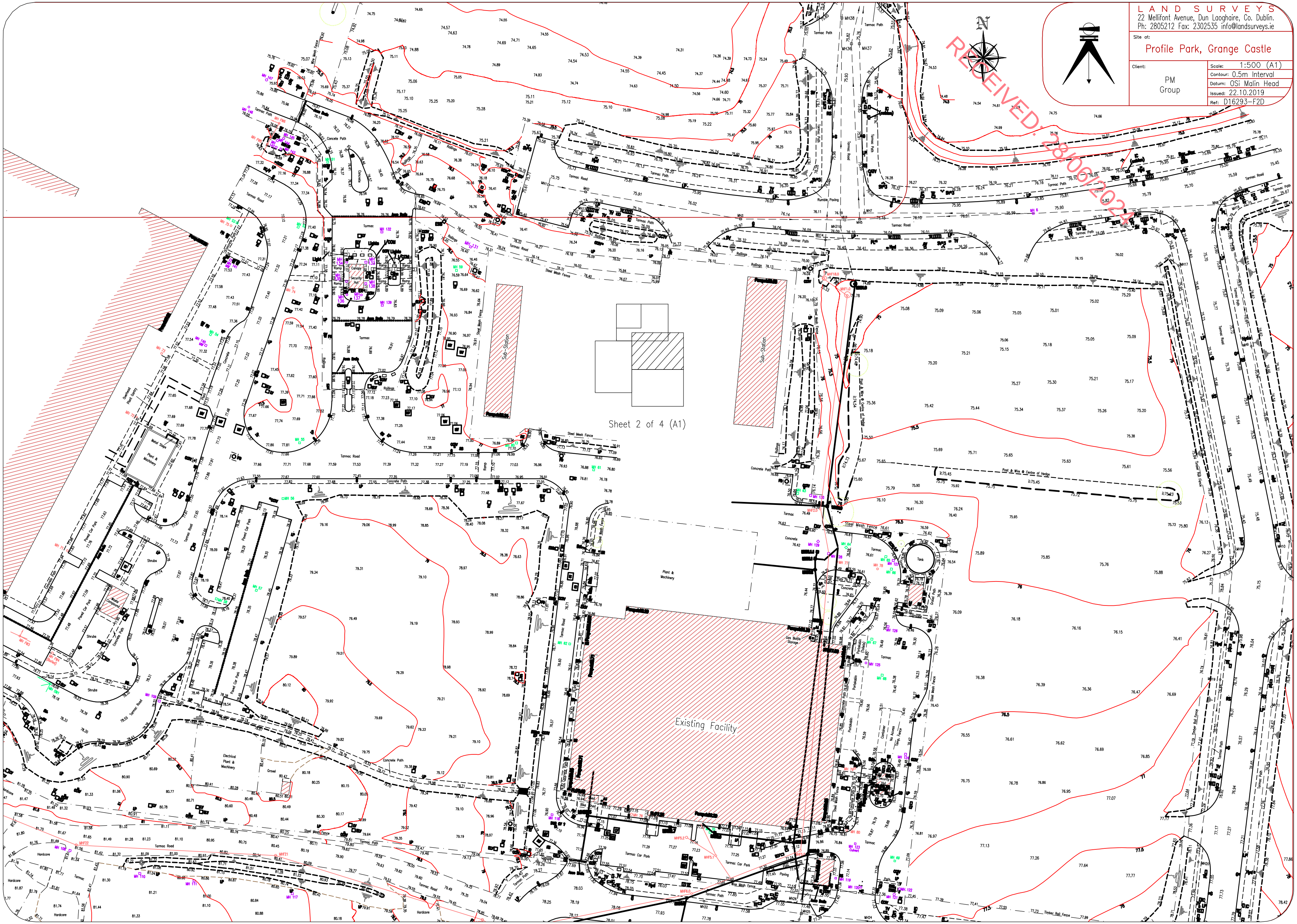
Client: PM Group

Scale: 1:500 (A1)
Contour: 0.5m Interval
Datum: OSi Malin Head
Issued: 22.10.2019
Ref: D16293-F2D

RECEIVED: 28/06/2024





LAND SURVEYS
22 Mellifont Avenue, Dun Laoghaire, Co. Dublin.
Ph: 2805212 Fax: 2302535 info@landsurveys.ie
Site at:
Profile Park, Grange Castle
Client:
PM Group
Scale: 1:500 (A1)
Contour: 0.5m Interval
Datum: OSi Malin Head
Issued: 22.10.2019
Ref: D16293-F2D
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Sheet 2 of 4 (A1)
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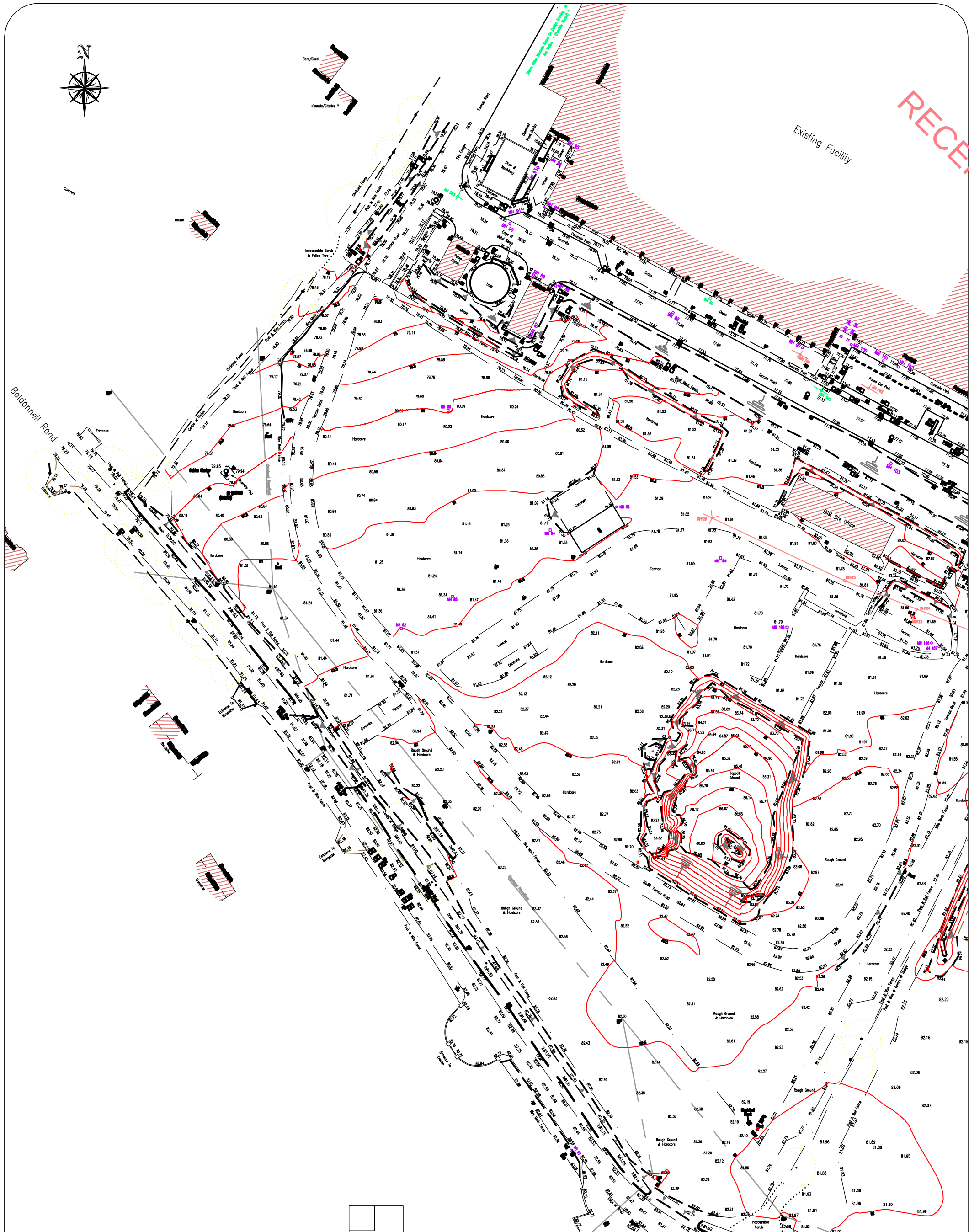
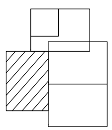
Sub-Station
Existing Facility
Plant & Machinery
Tank
RECEIVED: 28/06/2024





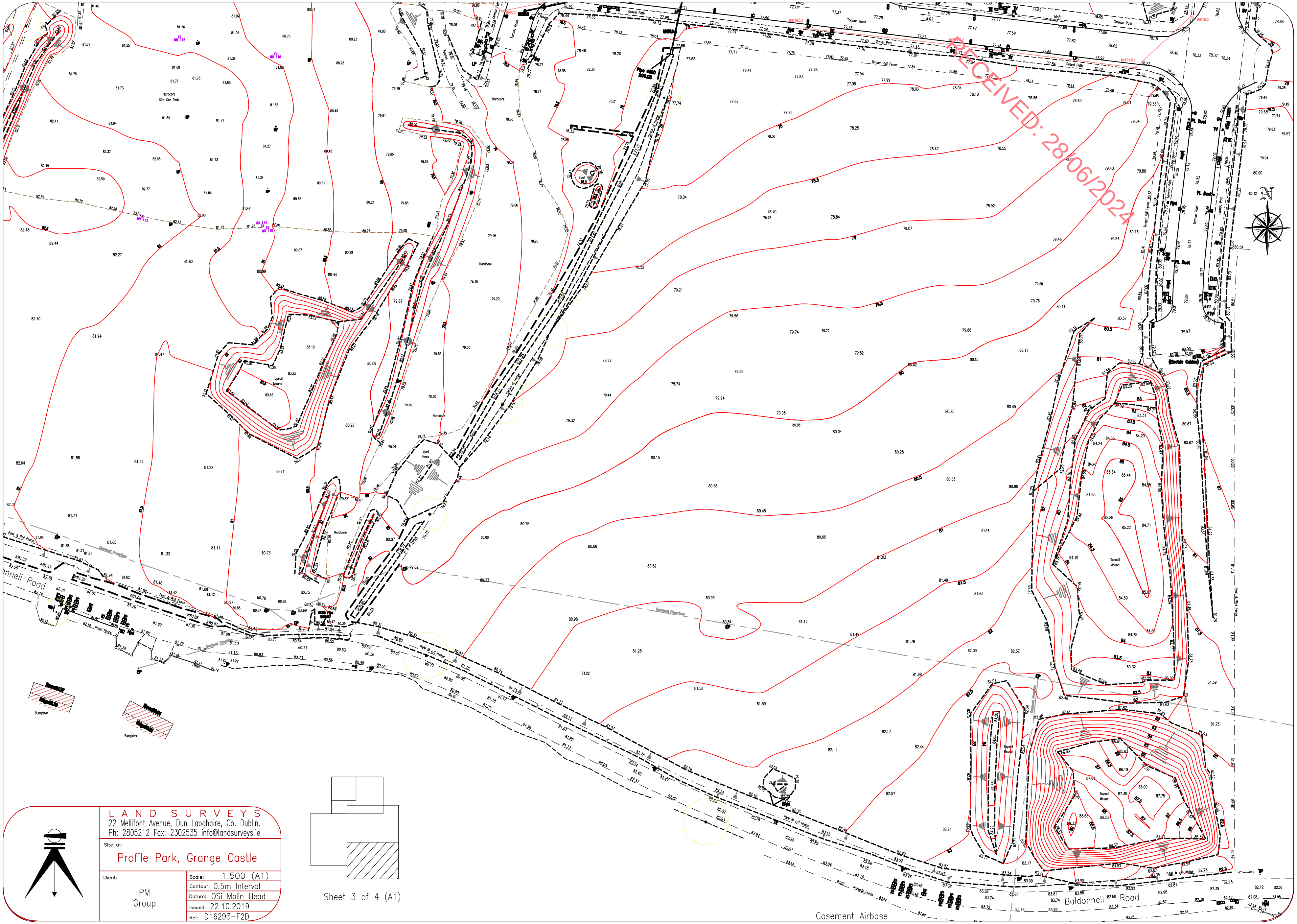
Sheet 4 of 4 (A1)

LAND SURVEYS
22 Mellifont Avenue, Dun Laoghaire, Co. Dublin.
Ph: 2805212 Fax: 2302535 info@landsurveys.ie

Site at:

Profile Park, Grange Castle

Client: PM Group	Scale: 1:500 (A1)
	Contour: 0.5m Interval
	Datum: OSi Malin Head
	Issued: 22.10.2019
	Ref: D16293-F2D



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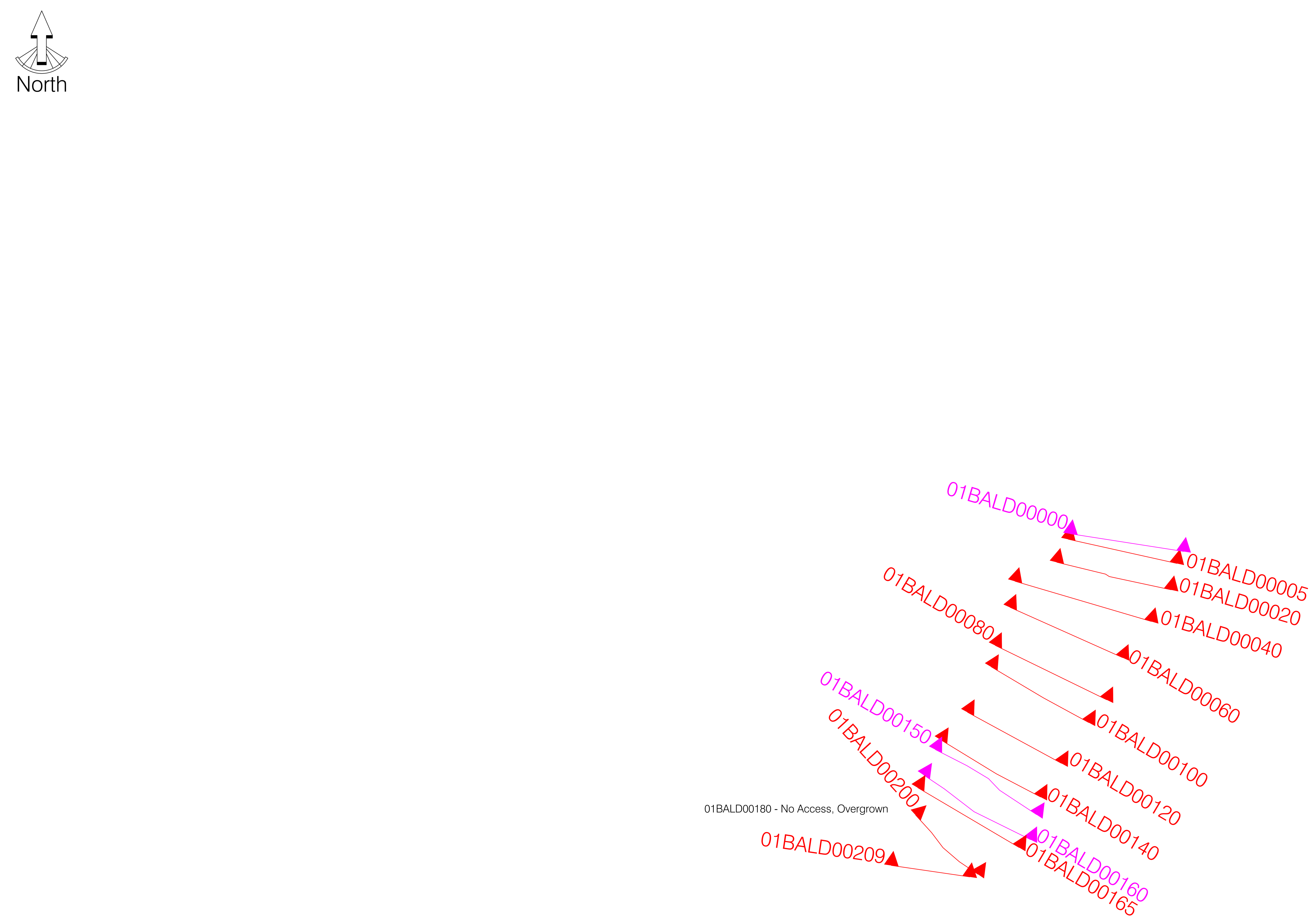
Sheet 3 of 4 (A1)

Appendix B

Stream topographic Survey – Murphy Geospatial (February 2024)



RECEIVED: 28/06/2024

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LEGEND

section plan details

- Surveyed Section Lines with References & Section Orientation (at Open channel)
- Surveyed Section Lines with References & Section Orientation (at Structures)
- Surveyed Section Lines with References & Section Orientation (at Additional items)

Surveyed by :	MGS	Date:	February 2024
Drawn by :	AK	Date:	February 2024
Checked by :	CE	Date:	16.02.2024

Revisions

No.	Date	Description
0	16.02.2024	First Drawing

Murphy GEOSPATIAL

Topographic surveys, Measured Building Surveys, Setting-Out, As-Built Surveys, Hydrographic Surveys, Legal Mapping, Pipeline Surveys, Services Location, Ground Penetrating Radar, Laser Scanning, Rectified Photography

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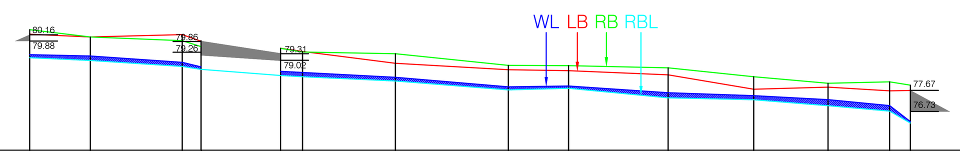
Email: info@murphygs.ie

Client :	Arup Consulting Engineers Dublin
Project :	BALDONNELL SECTIONS
Date : 16.02.2024	Scale : 1:1000
Description :	SECTIONS PLAN
Drawing Number :	BALDONNELL SECTIONS_XS_PLAN

J:\2024\Clients\Arup Consulting Engineers Dublin\57055 Baldonnell Watercourse Survey\9_HYDRO\02_C3D\03_Output\Baldonnell Watercourse Survey\DWG\ITM 15\bw_00_01bald_d_itm_mh15_00.dwg, 16/02/2024 16:00:41, AutoCAD PDF (General Documentation).pc3

River Profile
Chainage 0.000
Hz. Scale 1:1000
Vt. Scale 1:200
Datum 75.00



ISIS Chainage	212.74	199.20	178.65	174.44	156.65	151.74	130.97	105.73	92.26	69.98	50.86	34.25	20.45	15.83
MIKE Chainage	12.22	25.76	46.31	50.52	68.31	73.22	93.99	119.23	132.70	154.98	174.10	190.71	204.51	209.13
River Bed Level (MIKE 0)	79.14	79.01	78.74	78.62	78.34	78.28	78.09	77.70	77.77	77.34	77.26	76.99	76.75	76.22
Elevation Water Level	79.272 12:28:50@2024-02-14	79.211 12:57:33@2024-02-14	78.928 12:16:52@2024-02-14	78.723 11:25:32@2024-02-14	78.525 11:40:19@2024-02-14	78.476 12:45:34@2024-02-14	78.257 11:59:33@2024-02-14	77.833 10:56:11@2024-02-14	77.868 10:44:07@2024-02-14	77.567 10:33:54@2024-02-14	77.438 10:22:25@2024-02-14	77.258 10:09:29@2024-02-14	76.994 10:04:33@2024-02-14	76.278 09:55:50@2024-02-14
Elevation Left Bank	80.18	80.06	80.17	79.87	79.56	79.41	78.89	78.60	78.56	78.37	77.72	77.82	77.66	77.67
Elevation Right Bank	80.39	80.06	79.90	79.63	79.56	79.39	79.31	78.79	78.78	78.68	78.28	77.99	78.06	77.91
Section ID	01BALD00209	01BALD00200	01BALD00165	01BALD00160	01BALD00150	01BALD00140	01BALD00120	01BALD00100	01BALD00080	01BALD00060	01BALD00040	01BALD00020	01BALD00005	01BALD00000

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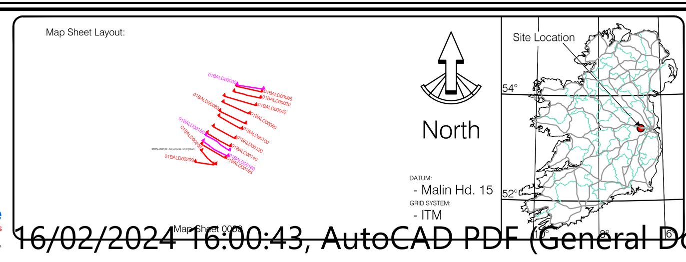
LEGEND

section plan details
- Surveyed Section Lines with References & Section Orientation (at Open channel)
- Surveyed Section Lines with References & Section Orientation (at Structures)
- Surveyed Section Lines with References & Section Orientation (at Additional items)



North

Surveyed by : MGS Date: February 2024
Drawn by : AK Date: February 2024
Checked by : CE Date: 16.02.2024

Revisions

No.	Date	Description
0	16.02.2024	First Drawing

Murphy GEOSPATIAL
Topographic surveys, Measured Building Surveys, Setting-Out, As-Built Surveys, Hydrographic Surveys, Legal Mapping, Pipeline Surveys, Services Location, Ground Penetrating Radar, Laser Scanning, Rectified Photography
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Client : Arup Consulting Engineers Dublin
Project : BALDONNELL SECTIONS
Date : 16.02.2024 **Scale :** 1:1000
Description : LONG SECTION
Drawing Number : BALDONNELL SECTIONS_LS_01

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LEGEND

Surveyed Section Lines with References & Section Orientation (at Open channel)
Surveyed Section Lines with References & Section Orientation (at Structures)
Surveyed Section Lines with References & Section Orientation (at Additional items)

North

Murphy GEOSPATIAL

Client :	Arup Consulting Engineers Dublin
Project :	BALDONNELL SECTIONS
Date :	16.02.2024
Scale :	AS SHOWN
Description :	CROSS SECTIONS
Drawing Number :	BALDONNELL SECTIONS_XS_01

J:\2024\Clients\Arup Consulting Engineers Dublin\57055 Baldonnell Watercourse Survey\9_HYDRO\02_C3D\03_Output\Baldonnell Watercourse Survey\DWG\ITM 15\bw_00_01bald_d_itm_mh15_00.dwg, 16/02/2024 16:00:45, AutoCAD PDF (General Documentation).pc3

Appendix C

Field assessment photos

Photo detail sheet Site code: On-site reach (UB1-4) River name & location: Tributary of Baldonnell Stream	
On-site watercourse 1	
	
Upstream	Downstream
	
Left Bank	Right Bank

On-site watercourse 2	
	
Upstream	Downstream
	
Left Bank	Right Bank

Site UB3	
	
Upstream	Downstream

	
Left Bank	Right Bank
Site UB4	
	
Upstream	Downstream
	
Left Bank	Right Bank

Photo detail sheet

Site code: Downstream off-site reach (DB1-3)

River name & location: Tributary of Baldonnell Stream

Site DB1

Upstream

Downstream

Left Bank

Right Bank

Site DB2

Upstream

Downstream

	
Left Bank	Right Bank
Site DB3	
	
Upstream	Downstream
	
Left Bank	Right Bank

Appendix D

Field assessment results of morphological condition (RHAT Sheets)

Off-site watercourse (downstream of site) (Sheet 1)

RHAT Desktop and Field Notes

Site Identification

River Name	Baldonell Stream (Tributary)	**Site Code**	BAL02
Location	Baldonell	**Nearest WFD site**	RS09B090100
Water Body ID GBNI1N	IE_EA_09L012100 (Tributary)	**Site location: Tributary or Main channel**	Tributary
GPS First	53.315892048407, -6.4468239330958	**Reason for survey: Surv/High/Rest/Invest/other**	Rest
GPS Last	53.31611768582884, -6.447891486268916	**Start at / SPCK View: U/S or D/S**	U/S
RHAT or Spot Check *	RHAT	**Surveyed from: LB / RB / Both / In-Channel / Bridge**	Both

Desk-study notes

ASSESSMENTS MADE PRIOR TO FIELDWORK

River type	Low Lying Meandering
Estimated river widt (m)	2.5m
Estimated floodplain width (m)	445
Riparian land cover types	Industrial comercial 121 / 211 Non irrigated land
River Agency Designations: Y/N	N
Natural Heritage Designations: ASSI NNR RAMSAR SAC SPA AONB NONE	NONE
Comparison with historic map	Maps from 1888 to 1913 indicate that the stream was artificially straightened and re-sectioned, as part of agricultural development, no aerial imagery is available prior to this period. By 1995, the development of the airport disrupted the stream's longitudinal continuity, introducing a physical barrier to natural flow. Between 2012 and 2018, significant industrial development led the stream to be culverted and diverted.
Drift Geology	Alluvium
Solid Geology	Limestone and Shale
Note other relevant GIS info such as: General overall shape of river Location of weirs, impoundments, embankments etc Floodplain connectivity, Contours across or alongside river	Changes from natural meandering to straightened and re-sectioned due to human intervention. Presence of structures such as culverts. Floodplain connectivity modified due to industrial development of the area The river profile was modified, steepened to facilitate culverts crossing underneath the industrial area.

Field Notes

River Type (s) (Dominant / Secondary if	
Date	23/04/2024
Time	13:00 PM
Surveyor 1 / Code	Carles Crespo Azorin Martinez / CCAM
Surveyor 1 / Code	Louise Lodenkemper / LL
Rain in last week (mm)	2.2
Weather conditions at site	Parlty cloudy with no rain
Survey length/Visible strech (m)	10
River width (m) estimated at start of survey	2.5
River depth (m) estimated at start of survey	0.1
Overall valley form: No obvious valley sides / Shallow Vee / Concave bowl / U- shaped valley / Gorge / Deep Vee	Shallow Vee
Channel maintenance / dredging: (describe and indicate if historic or recent) Y / N / NK	N
Restoration or management activity: (describe and indicate if historic or recent) Y / N / NK	N

Off-site watercourse (downstream of site) (Sheet 2)
Field Assessment of Morphological Condition

ATTRIBUTE	SCORE[a,b]	L (Left Bank) / R (Right Bank) /	COMMENTS
1. Channel form and flow types B. substrate, flow types and modifications, F. Channel modifications, G. Re-naturalisation and K. Natural features.	1	NA	Although there has been significant straightening (eg. fencing) and culverting there is evidence of recovery such as: substrate (silt, sand and gravel as expected in a low-land meandering river type) deposition, revegetation and habitat creation.
2. Channel vegetation Sheet 1. Channel maintenance and dredging, B. Channel modifications, C. Channel vegetation present, Bank face vegetation structure, D. Bank face and bank top vegetation structure, H. Extent of trees, J. Habitat structure features, K. Marginal and bank features (tree roots), and L. Resource use Navigation	2	NA	Riparian vegetation dominated by bramble and thistle and some large trees (oak, ash, willow and hawthorn). Dense canopy cover. No evidence of vegetation management. Evidence of rabbit holes at the banks.
3. Substrate condition Sheet 1. Channel maintenance or dredging, B. Channel substrate and channel modifications, E. Channel structures, F. Channel modifications, K. Substrate and Natural Features, L. Resource Use – Rail or Navigation	1	NA	There is evidence of anthropogenic changes in the channel bed suchs as: concrete rubble, dumping of rubish, oil spillage and trash debris. High percentage of fines and silt present.
4. Barriers to continuity Sheet 1. Desk top GIS observations, B. Channel substrate artificial or silt, channel modifications, and L. Resource use Mill, Dam or HEP.	1	NA	Change to longitudinal connectivity through culverts as they increase flow velocity (the upstream culvert is approximately 300 m long, fish are unlikely to have the energy to pass through them). Evidence of historical change to lateral connectivity through channel straightening, carried out around 1800. River banks are fenced downstream not allowing the channel to meander naturally. Small bridge crossing perpendicularly with a very small culvert (~0.3m diameter) underneath to allow minimal connectivity.
5. Bank structure & stability L/R B. Bank material, modifications and height to width ratio, E. Channel structures, G. Bank modifications, K. Marginal and Bank features and L. Deflectors, jetties and road or trail.	0.5 0	L R	Evidence of historical channel embankment associated to channel straightening carried out around around the 1800. Bank stability degraded due to poaching on the right bank (~10 m). Horses from private land owner regularly come to drink from the river and without designated access points, they step on the channel banks
6. Bank vegetation L/R D. Bank top vegetation structure, bank face vegetation structure, H. Extent and variety of trees, I. Bank non natives/disturbance species, J. Habitat structure features.	0.5 0.5	L R	Evidence of bramble and thistle alien species outcompeteing native species on both banks. Overhanging branches across the channel providing organic matter. Filamentous green algae present in the channel. No evidence of vegetation management, over shading
7. Riparian land use L/R Desk top riparian land cover types, D. Bank top land use/ land cover, and L. Resource Use.	1 0	L R	Rough pasture on left bank. There is little riparian buffer zone on the right bank as a private property is close to the reach over the length of the reach. Part of the right banks serves as a dumping site for trash and home for horses to access the river for drinking water.
8. Floodplain connectivity L/R Desk top Rivers Agency designation, Field notes overall valley form, B. Bank Material and modifications, channel modifications, bankfull height: width ratio, F. Channel modifications, and G. Bank Modifications.	0 0	L R	The entire channel has been embanked and fenced as part of the stragightening works carried out around the 1800. Stream no longer overtops naturally during high flows. There is also a small bridge crossing perpendicularly with a very small culvert (~0.3m diameter) underneath to allow for connectivity, unlikely to be effective during high flows.
∑ Attribute scores	7.5		
WFD class [c]	Poor		

[a] **Attributes 1-4 scored from 0 to 4 by 1; Attributes 5-8 score LB / RB separately 0 to 2 by 0.5**

[b] **If attribute can't be scored, tick NV box and enter provisional score of 2 for attributes 1-4 or 1 for attributes 5-8**

[c] WFD Class	HM Score	∑ Att scores
High	≥0.8	≥26
Good	0.6 – <0.8	≥19.5 to <26
Moderate	0.4 – <0.6	≥13 to <19.5
Poor	0.2 – <0.4	≥6.5 to <13
Bad	< 0.2	< 6.5

HM score = ∑ Attribute scores/32

General Comments:

eg how to bring to Good hydromorphological status

Off-site watercourse (downstream of site) (Sheet 3)
Field observations at 50m stretches along survey reach

Start at / SPCK View:		*U/S*			
For spot check, use Column 1		Culvert for about 300m	5	6	7
A. Visibility along 50m stretch: C=complete (>75%); P=partial (25-75%); B=barely (<25%); S=single point; N=not visible					
River bed visibility		-	P	P	P
River bank visibility (LB/RB)		-	C	C	C
Riparian LULC visibility		-	C	C	C
B. Physical attributes along 50m stretch -IF MULTIPLE PRESENT, CIRCLE THE DOMINANT:					
Left Bank (looking D/S)					
Bank Material *(NV,BE,BI,BO,BR,CC,CL,CO, EA,FA,GA,GP,PE,RR,SP,TD,WP)*		-	EA	EA	EA
Bank Modifications *(NV,NK,NO,BM,EM,PC,PCB,RI,RIt,RS)*		-	RS	EM	RS
Bankfull height > ¼ of bankfull width (Y/N)		-	Y	Y	Y
Channel					
Channel Substrate *(NV,AR,BE,BO,CL,CO,EA,GP,PE,SA,SI)*		-	SI	SI	SI
Flow Type *(NV,BW,CF,CH,DR,FF,NP,RP,SM,UP,UW)*		-	SM	SM	NP
Channel Modifications *(NV,NK,NO,CV,DA,DR,FO,IM,NR,OD,OW,RI,RS)*		-	RS	BM	RS
Right Bank (looking D/S)					
Bank Material *(NV,BE,BI,BO,BR,CC,CL,CO, EA,FA,GA,GP,PE,RR,SP,TD,WP)*		-	EA	EA	EA
Bank Modifications *(NV,NK,NO,BM,EM,PC,PCB,RI,RIt,RS)*		-	RS	BM	RS
Bankfull height > ¼ of bankfull width (Y/N)		-	Y	Y	Y
C. Channel vegetation present along 50m stretch: √ = yes; '+' = excessive; '-' = no; '/' = NV					
NONE		-	-	-	-
Woody habitat		-	-	+	+
Marginal emergent plants		-	-	V	-
In-channel free-floating		-	-	-	-
In-channel floating-leaved, rooted		-	V	-	-
Liverworts/mosses/lichens		-	-	-	-
In-channel submerged		-	-	-	-
Filamentous green algae		-	V	-	-
Indistinguishable brown algae or fungi			-	-	-
D. Riparian land use/cover and banktop vegetation structure along 50m stretch:					
LULC - choose from NV,AW,BL,CP,IG,MH,OR,OW,PGg,PGw,RD,RP,SH,SU,TH,TL,WL - CIRCLE DOMINANT					
Left Bank					
LULC between 5 & 20 m of LEFT BANKTOP		-	RP	RP	RP
LULC between 1 & 5 m of LEFT BANKTOP		-	SH	BL	BL
LULC within 1 m of LEFT BANKTOP		-	RD	BL	BL
LEFT BANKTOP Veg Structure (B/U/S/C/NV)		-	B	S	S
LEFT BANKFACE Veg Structure (B/U/S/C/NV)		-	B	S	S
Right Bank					
RIGHT BANKFACE Veg Structure (B/U/S/C/NV)		-	B	S	S
RIGHT BANKTOP Veg Structure (B/U/S/C/NV)		-	B	S	S
LULC within 1 m of RIGHT BANKTOP		-	RD	BL	BL
LULC between 1 & 5 m of RIGHT BANKTOP		-	SH	BL	BL
LULC between 5 & 20 m RIGHT BANKTOP		-	SU	BL	BL
E. Number of Channel Structures:	*2 culverts (1 downstream ~300 m long) and one small one below a bridge at the downstream part of the reach (~2 m long)*				

Off-site watercourse (downstream of site) (Sheet 4)
Sweep-up field observations

F. Channel Modifications

Realigned NV / ABS / PRE / EXT / NK	EXT	**Narrowed NV / ABS / PRE / EXT / NK**	PRE
Over-deepened NV / ABS / PRE / EXT / NK	NV	**Impounded NV / ABS / PRE / EXT / NK**	ABS
Over-widened NV / ABS / PRE / EXT / NK	ABS	**No perceptable flow NV / ABS / PRE / EXT / NK**	PRE

G. Bank Modifications

Left Bank:		***Right Bank:***	
Resectioning NV / ABS / PRE / EXT	PRE	**Resectioning NV / ABS / PRE / EXT**	PRE
Reinforcement whole NV / ABS / PRE / EXT h or p or s	ABS	**Reinforcement whole NV / ABS / PRE / EXT h or p or s**	ABS
Reinforcement top only NV / ABS / PRE / EXT h or p or s	ABS	**Reinforcement top only NV / ABS / PRE / EXT h or p or s**	ABS
Reinforcement toe only NV / ABS / PRE / EXT h or p or s	ABS	**Reinforcement toe only NV / ABS / PRE / EXT h or p or s**	ABS
Embankment NV / ABS / PRE / EXT	EXT	**Embankment NV / ABS / PRE / EXT**	EXT
Set-back Embank NV / ABS / PRE / EXT	NV	**Set-back Embank NV / ABS / PRE / EXT**	NV
Poaching NV / ABS / PRE / EXT	ABS	**Poaching NV / ABS / PRE / EXT**	PRE
Renaturalising NV / NA / ABS / PRE / EXT	ABS	**Renaturalising NV / NA / ABS / PRE / EXT**	ABS
Fenced buffer NV / ABS / PRE / EXT VG or UV	PRE	**Fenced buffer NV / ABS / PRE / EXT VG or UV**	PRE
Buffer width (m)	5	**Buffer width (m)**	10

H. Extent of Trees along Bankface and Banktop:

Left Bank: NONE / isolated / regular / occasional / semi-continuous / continuous
Occasional

Right Bank: NONE / isolated / regular / occasional / semi-continuous / continuous
Semi-continuous

Trees NONE / oak / ash / alder / willow / birch / hazel / hawthorn / blackthorn / holly / rowan / other =
Oak, ash, willow, hawthorn

I. Bank Non-Natives // Disturbance Species (include * if extensive):

Left Bank: **NONE / Rhododendron / Him. balsam / knotweed / G. hogweed / Snowberry / Cherry laurel /** ***Gunnera /*** **Beech / Sycamore / Conifers // Butterbur / Nettles**
Nettles, sycamore

Right Bank: **NONE / Rhododendron / Him. balsam / knotweed / G. hogweed / Snowberry / Cherry laurel /** ***Gunnera /*** **Beech / Sycamore / Conifers // Butterbur / Nettles**
Nettles

J. Habitat Structure Features:

Channel shading	**NV / ABS / PRE / EXT**	PRE	***Debris dam***	**NV / ABS / PRE / EXT**	EXT
Fallen trees	**NV / ABS / PRE / EXT**	PRE	**Leafy debris**	**NV / ABS / PRE / EXT**	PRE
Lg woody habitat	**NV / ABS / PRE / EXT**	PRE	**Channel choked with veg**	**NV / ABS / PRE / EXT**	PRE

K. Bank and Channel Features (include * if extensive):

Channel biota	**NONE / NV / Lemna / Undistinguishable brown algae / Filamentous green algae / other =** Filamentous green algae
Substrate alterations	**NONE / NV/ dumping / silt on substrate / oil / placed boulders / trash debris / artifical /** Dumping / oil / placed boulders / trash debris / artificial
Nat'l Channel features	**NONE / NV/ exposed bedrock / exposed boulders / VG rock / mature island / mid-channel island /** UV silt or sand or gravel
Marginal & bank features	**NONE/ NV/ eroding cliff/ stable cliff / VG or UV point bar / VG or UV side bar / natural berm /** Exposed tree roots / overhanging boughs
Other natural features	**NONE / NV/ waterfall / cascade / reed-banks / backwater / meadow / fen / bog / oxbow / other =** None

L. Resource Use:

agriculture / coniferous or deciduous or mixed forestry / parkland /
urban / suburban / house / farm yard / paved road or trail / trash debris /
dirt road or trail / field drain / HEP / water abstraction / afforestation / deforestation /
mill / mill race / navigation / fishing / recreation / arterial drainage / other =

Urban / farm yard / paved road or trail / trash debris / dirt road or trail / field drain

M. Flow Laterally Confined:

LB: NAT or ART or NOT Naturally (NAT) or Artifically (ART) or Not (NOT)	ART
RB: NAT or ART or NOT Naturally (NAT) or Artifically (ART) or Not (NOT)	ART

Average river width 2.5 **m and river depth** 0.10 **m over the entire survey reach**

Notes and other observations (such as pathogens observed):

On-site watercourse (Sheet 1)

RHAT Desktop and Field Notes

Site Identification

River Name	Baldonell Stream (Tributary)
Location	Baldonell
Water Body ID GBNI1N	IE_EA_09L012100 (Tributary)
GPS First	53.311474785196516, -6.449142336732178
GPS Last	53.31291789530327, -6.447645634870167
RHAT or Spot Check *	RHAT

Site Code	BAL01
Nearest WFD site	RS09B090100
Site location **Tributary or Main channel**	Tributary
Reason for survey **Surv/High/Rest/Invest/other**	Rest
Start at / SPCK View **U/S or D/S**	U/S
Surveyed from **LB / RB / Both / In-Channel / Bridge**	Both

Desk-study notes

ASSESSMENTS MADE PRIOR TO FIELDWORK

River type	Low Lying Meandering
Estimated river widt (m)	2
Estimated floodplain width (m)	445
Riparian land cover types	Industrial comercial 121 / 211 Non irrigated land
River Agency Designations: Y/N	N
Natural Heritage Designations: **ASSI NNR RAMSAR SAC SPA AONB** **NONE**	NONE
Comparison with historic map	Maps from 1888 to 1913 indicate that the stream was artificially straightened and re-sectioned, as part of agricultural development, no aerial imagery is available prior to this period. By 1995, the development of the airport disrupted the stream's longitudinal continuity, introducing a physical barrier to natural flow. Between 2012 and 2018, significant industrial development led the stream to be culverted and diverted.
Drift Geology	Alluvium
Solid Geology	Limestone and Shale
Note other relevant GIS info such as: **General overall shape of river** **Location of weirs, impoundments, embankments etc Floodplain connectivity, Contours across or alongside river**	Changes from natural meandering to straightened and re-sectioned due to human intervention. Presence of structures such as culverts. Floodplain connectivity modified due to industrial development of the area The river profile was modified, steepened to facilitate culverts crossing underneath the industrial area.

Field Notes

River Type (s) (Dominant / Secondary if	
Date	23/04/2024
Time	10:00 AM
Surveyor 1 / Code	Carles Crespo Azorin Martinez / CCAM
Surveyor 1 / Code	Louise Lodenkemper / LL
Rain in last week (mm)	2.2
Weather conditions at site	Parlty cloudy with no rain
Survey length/Visible strech (m)	5
River width (m) estimated at start of survey	2
River depth (m) estimated at start of survey	0.08
Overall valley form: **No obvious valley sides / Shallow Vee / Concave bowl / U- shaped valley / Gorge / Deep Vee**	Shallow Vee
Channel maintenance / dredging **(describe and indicate if historic or recent)** **Y / N / NK**	N
Restoration or management activity **(describe and indicate if historic or recent)** **Y / N / NK**	N

On-site watercourse (Sheet 2)
Field Assessment of Morphological Condition

ATTRIBUTE	SCORE[a,b]	L (Left Bank) / R (Right Bank) /	COMMENTS
1. Channel form and flow types B. substrate, flow types and modifications, F. Channel modifications, G. Re-naturalisation and K. Natural features.	1	NA	Although there has been significant straightening and culverting in both ends there is evidence of recovery such as: substrate (silt, sand and gravel as expected in a low-land meandering river type) deposition, revegetation and habitat creation.
2. Channel vegetation Sheet 1. Channel maintenance and dredging, B. Channel modifications, C. Channel vegetation present, Bank face vegetation structure, D. Bank face and bank top vegetation structure, H. Extent of trees, J. Habitat structure features, K. Marginal and bank features (tree roots), and L. Resource use Navigation	2	NA	Riparian vegetation dominated by bramble and thistle and some large trees (oak, ash, willow and hawthorn). Dense canopy cover. No evidence of vegetation management. Section of the bank face concreted at the entrance of the downstream convert (~5m)
3. Substrate condition Sheet 1. Channel maintenance or dredging, B. Channel substrate and channel modifications, E. Channel structures, F. Channel modifications, K. Substrate and Natural Features, L. Resource Use – Rail or Navigation	1	NA	There is evidence of anthropogenic changes in the channel bed suchs as: Masonry blocks present at the outlet of the upstream culvert, channel bed concreted at the entrance of the downstream culvert, high percentage of fines and silt present
4. Barriers to continuity Sheet 1. Desk top GIS observations, B. Channel substrate artificial or silt, channel modifications, and L. Resource use Mill, Dam or HEP.	1	NA	Change to longitudinal connectivity through culverts as they increase flow velocity (the downstream culvert is approximately 300 m long, fish are unlikely to have the energy to pass through them) Evidence of historical change to lateral connectivity through channel straightening, carried out around 1800.
5. Bank structure & stability L/R B. Bank material, modifications and height to width ratio, E. Channel structures, G. Bank modifications, K. Marginal and Bank features and L. Deflectors, jetties and road or trail.	0.5	L	Evidence of historical channel embankment associated to channel straightening carried out around around the 1800. Section of the channel banks concreted at the entrance of the downstream culvert (~5m)
	0.5	R	
6. Bank vegetation L/R D. Bank top vegetation structure, bank face vegetation structure, H. Extent and variety of trees, I. Bank non natives/disturbance species, J. Habitat structure features.	0.5	L	Evidence of bramble and thistle alien species outcompeteing native species on both banks. Overhanging branches across the channel providing organic matter. No evidence of vegetation management, over shading
	0.5	R	
7. Riparian land use L/R Desk top riparian land cover types, D. Bank top land use/ land cover, and L. Resource Use.	0	L	
	1	R	
8. Floodplain connectivity L/R Desk top Rivers Agency designation, Field notes overall valley form, B. Bank Material and modifications, channel modifications, bankfull height: width ratio, F. Channel modifications, and G. Bank Modifications.	0	L	The entire channel has been embanked as part of the stragightening works carried out around the 1800. Stream no longer overtops naturally during high flows. The small size of the downstream culvert has an impact on floodplain connectivity.
	0	R	
∑ Attribute scores	8		
WFD class [c]	Poor		

[a] Attributes 1-4 scored from 0 to 4 by 1; Attributes 5-8 score LB / RB separately 0 to 2 by 0.5

[b] If attribute can't be scored, tick NV box and enter provisional score of 2 for attributes 1-4 or 1 for attributes 5-8

[c] WFD Class	HM Score	∑ Att scores
High	**≥0.8**	**≥26**
Good	**0.6 – <0.8**	**≥19.5 to <26**
Moderate	**0.4 – <0.6**	**≥13 to <19.5**
Poor	**0.2 – <0.4**	**≥6.5 to <13**
Bad	**< 0.2**	**< 6.5**

HM score = ∑ Attribute scores/32

General Comments:

eg how to bring to Good hydromorphological status

On-site watercourse (Sheet 3)
Field observations at 50m stretches along survey reach

Start at / SPCK View:		*U/S*				
For spot check, use Column 1		1	2	3	4	Culvert for about 300m
A. Visibility along 50m stretch: C=complete (>75%); P=partial (25-75%); B=barely (<25%); S=single point;						
River bed visibility		C	C	C	C	-
River bank visibility (LB/RB)		B	P	P	P	-
Riparian LULC visibility		P	P	P	P	-
B. Physical attributes along 50m stretch -IF MULTIPLE PRESENT, CIRCLE THE DOMINANT:						
Left Bank (looking D/S)						
Bank Material *(NV,BE,BI,BO,BR,CC,CL,CO, EA,FA,GA,GP,PE,RR,SP,TD,WP)*		BR	EA	EA	CC	-
Bank Modifications *(NV,NK,NO,BM,EM,PC,PCB,RI,RIt,RS)*		EM	EM	EM	EM	-
Bankfull height > ¼ of bankfull width (Y/N)		Y	Y	Y	Y	-
Channel						
Channel Substrate *(NV,AR,BE,BO,CL,CO,EA,GP,PE,SA,SI)*		SI	SI	SI	SI	-
Flow Type *(NV,BW,CF,CH,DR,FF,NP,RP,SM,UP,UW)*		SM	SM	RP	CH	-
Channel Modifications *(NV,NK,NO,CV,DA,DR,FO,IM,NR,OD,OW,RI,RS)*		EM	EM	CM	EM	-
Right Bank (looking D/S)						
Bank Material *(NV,BE,BI,BO,BR,CC,CL,CO, EA,FA,GA,GP,PE,RR,SP,TD,WP)*		CL	EA	EA	CC	-
Bank Modifications *(NV,NK,NO,BM,EM,PC,PCB,RI,RIt,RS)*		EM	EM	CM	EM	-
Bankfull height > ¼ of bankfull width (Y/N)		Y	Y	Y	Y	-
C. Channel vegetation present along 50m stretch: √ = yes; '+' = excessive; '-' = no; '/' = NV						
NONE		-	-	-	-	-
Woody habitat		+	+	+	V	-
Marginal emergent plants		-	-	-	-	-
In-channel free-floating		-	-	-	-	-
In-channel floating-leaved, rooted		-	-	-	-	-
Liverworts/mosses/lichens		-	-	-	V	-
In-channel submerged		-	-	-	-	-
Filamentous green algae		-	-	-	V	-
Indistinguishable brown algae or fungi		-	-	-	-	
D. Riparian land use/cover and banktop vegetation structure along 50m stretch:						
LULC - choose from NV,AW,BL,CP,IG,MH,OR,OW,PGg,PGw,RD,RP,SH,SU,TH,TL,WL - CIRCLE DOMINANT						
Left Bank						
LULC between 5 & 20 m of LEFT BANKTOP		SH	SU	SU	SU	-
LULC between 1 & 5 m of LEFT BANKTOP		SH	SH	SH	SH	-
LULC within 1 m of LEFT BANKTOP		BL	BL	BL	BL	-
LEFT BANKTOP Veg Structure (B/U/S/C/NV)		C	C	C	C	-
LEFT BANKFACE Veg Structure (B/U/S/C/NV)		C	C	C	C	-
Left Bank						
RIGHT BANKFACE Veg Structure (B/U/S/C/NV)		C	C	C	C	-
RIGHT BANKTOP Veg Structure (B/U/S/C/NV)		C	C	C	C	-
LULC within 1 m of RIGHT BANKTOP		BL	BL	BL	BL	-
LULC between 1 & 5 m of RIGHT BANKTOP		SH	SH	SH	SH	-
LULC between 5 & 20 m RIGHT BANKTOP		RD	RD	RD	RD	-
E. Number of Channel Structures:	*2 culverts (1 downstream ~300 m long) and one upstream to cross the road (length unknown). Possibly another one in the middle of the reach*					

On-site watercourse (Sheet 4)
Sweep-up field observations

F. Channel Modifications

Realigned NV / ABS / PRE / EXT / NK	PRE	**Narrowed NV / ABS / PRE / EXT / NK**	PRE
Over-deepened NV / ABS / PRE / EXT / NK	ABS	**Impounded NV / ABS / PRE / EXT / NK**	ABS
Over-widened NV / ABS / PRE / EXT / NK	ABS	**No perceptable flow NV / ABS / PRE / EXT / NK**	ABS

G. Bank Modifications

Left Bank:		***Right Bank:***	
Resectioning NV / ABS / PRE / EXT	ABS	**Resectioning NV / ABS / PRE / EXT**	ABS
Reinforcement whole NV / ABS / PRE / EXT h or p or s	ABS	**Reinforcement whole NV / ABS / PRE / EXT h or p or s**	ABS
Reinforcement top only NV / ABS / PRE / EXT h or p or s	ABS	**Reinforcement top only NV / ABS / PRE / EXT h or p or s**	ABS
Reinforcement toe only NV / ABS / PRE / EXT h or p or s	ABS	**Reinforcement toe only NV / ABS / PRE / EXT h or p or s**	ABS
Embankment NV / ABS / PRE / EXT	PRE	**Embankment NV / ABS / PRE / EXT**	PRE
Set-back Embank NV / ABS / PRE / EXT	ABS	**Set-back Embank NV / ABS / PRE / EXT**	ABS
Poaching NV / ABS / PRE / EXT	ABS	**Poaching NV / ABS / PRE / EXT**	ABS
Renaturalising NV / NA / ABS / PRE / EXT	PRE	**Renaturalising NV / NA / ABS / PRE / EXT**	PRE
Fenced buffer NV / ABS / PRE / EXT VG or UV	ABS	**Fenced buffer NV / ABS / PRE / EXT VG or UV**	ABS
Buffer width (m)	5	**Buffer width (m)**	5

H. Extent of Trees along Bankface and Banktop:

Left Bank: NONE / isolated / regular / occasional / semi-continuous / continuous
Semicontinuous

Right Bank: NONE / isolated / regular / occasional / semi-continuous / continuous
Continuous

Trees NONE / oak / ash / alder / willow / birch / hazel / hawthorn / blackthorn / holly / rowan / other =
Oak, ash, willow, hawthorn

I. Bank Non-Natives // Disturbance Species (include * if extensive):

Left Bank: **NONE / Rhododendron / Him. balsam / knotweed / G. hogweed / Snowberry / Cherry laurel / *Gunnera* / Beech / Sycamore / Conifers // Butterbur / Nettles**
Nettles, sycamore

Right Bank: **NONE / Rhododendron / Him. balsam / knotweed / G. hogweed / Snowberry / Cherry laurel / *Gunnera* / Beech / Sycamore / Conifers // Butterbur / Nettles**
Nettles

J. Habitat Structure Features:

Channel shading	**NV / ABS / PRE / EXT**	EXT	***Debris dam***	**NV / ABS / PRE / EXT**	PRE
Fallen trees	**NV / ABS / PRE / EXT**	PRE	**Leafy debris**	**NV / ABS / PRE / EXT**	PRE
Lg woody habitat	**NV / ABS / PRE / EXT**	PRE	**Channel choked with veg**	**NV / ABS / PRE / EXT**	PRE

K. Bank and Channel Features (include * if extensive):

Channel biota **NONE / NV / Lemna / Undistinguishable brown algae / Filamentous green algae / other =**
NV

Substrate alterations **NONE / NV/ dumping / silt on substrate / oil / placed boulders / trash debris / artifical /**
Dumping/ trash debris

Nat'l Channel features **NONE / NV/ exposed bedrock / exposed boulders / VG rock / mature island / mid-channel island /**
UV silt or sand or gravel

Marginal & bank features **NONE/ NV/ eroding cliff/ stable cliff / VG or UV point bar / VG or UV side bar / natural berm /**
Exposed tree roots / overhanging boughs

Other natural features **NONE / NV/ waterfall / cascade / reed-banks / backwater / meadow / fen / bog / oxbow / other =**
None

L. Resource Use:

agriculture / coniferous or deciduous or mixed forestry / parkland /
urban / suburban / house / farm yard / paved road or trail / trash debris /
dirt road or trail / field drain / HEP / water abstraction / afforestation / deforestation /
mill / mill race / navigation / fishing / recreation / arterial drainage / other =

Urban/dirt road or trail / field drain

M. Flow Laterally Confined:

LB: NAT or ART or NOT Naturally (NAT) or Artifically (ART) or Not (NOT)	ART
RB: NAT or ART or NOT Naturally (NAT) or Artifically (ART) or Not (NOT)	ART

Average river width __2______**m and river depth** ______0.08______**m over the entire survey reach**

Notes and other observations (such as pathogens observed):

Post-mitigation, average (Sheet 2)
Field Assessment of Morphological Condition

ATTRIBUTE	SCORE[a,b]	L (Left Bank) / R (Right Bank) /	COMMENTS
1. Channel form and flow types B. substrate, flow types and modifications, F. Channel modifications, G. Re-naturalisation and K. Natural features.	1	NA	Although there has been significant straightening (eg. fencing) and culverting there is evidence of recovery such as: substrate (silt, sand and gravel as expected in a low-land meandering river type) deposition, revegetation and habitat creation.
2. Channel vegetation Sheet 1. Channel maintenance and dredging, B. Channel modifications, C. Channel vegetation present, Bank face vegetation structure, D. Bank face and bank top vegetation structure, H. Extent of trees, J. Habitat structure features, K. Marginal and bank features (tree roots), and L. Resource use Navigation	3	NA	Riparian vegetation dominated by bramble and thistle and some large trees (oak, ash, willow and hawthorn). Dense canopy cover. No evidence of vegetation management. Evidence of rabbit holes at the banks.
3. Substrate condition Sheet 1. Channel maintenance or dredging, B. Channel substrate and channel modifications, E. Channel structures, F. Channel modifications, K. Substrate and Natural Features, L. Resource Use – Rail or Navigation	2	NA	There is evidence of anthropogenic changes in the channel bed suchs as: concrete rubble, dumping of rubish, oil spillage and trash debris. High percentage of fines and silt present.
4. Barriers to continuity Sheet 1. Desk top GIS observations, B. Channel substrate artificial or silt, channel modifications, and L. Resource use Mill, Dam or HEP.	1	NA	Change to longitudinal connectivity through culverts as they increase flow velocity (the upstream culvert is approximately 300 m long, fish are unlikely to have the energy to pass through them). Evidence of historical change to lateral connectivity through channel straightening, carried out around 1800. River banks are fenced downstream not allowing the channel to meander naturally. Small bridge crossing perpendicularly with a very small culvert (~0.3m diameter) underneath to allow minimal connectivity.
5. Bank structure & stability L/R B. Bank material, modifications and height to width ratio, E. Channel structures, G. Bank modifications, K. Marginal and Bank features and L. Deflectors, jetties and road or trail.	1	L	Evidence of historical channel embankment associated to channel straightening carried out around around the 1800. Bank stability degraded due to poaching on the right bank (~10 m). Horses from private land owner regularly come to drink from the river and without designated access points, they step on the channel banks
	1	R	
6. Bank vegetation L/R D. Bank top vegetation structure, bank face vegetation structure, H. Extent and variety of trees, I. Bank non natives/disturbance species, J. Habitat structure features.	1	L	Evidence of bramble and thistle alien species outcompeteing native species on both banks. Overhanging branches across the channel providing organic matter. Filamentous green algae present in the channel. No evidence of vegetation management, over shading
	1	R	
7. Riparian land use L/R Desk top riparian land cover types, D. Bank top land use/ land cover, and L. Resource Use.	0.5	L	Rough pasture on left bank. There is little riparian buffer zone on the right bank as a private property is close to the reach over the length of the reach. Part of the right banks serves as a dumping site for trash and home for horses to access the river for drinking water.
	0.5	R	
8. Floodplain connectivity L/R Desk top Rivers Agency designation, Field notes overall valley form, B. Bank Material and modifications, channel modifications, bankfull height: width ratio, F. Channel modifications, and G. Bank Modifications.	1	L	The entire channel has been embanked and fenced as part of the stragightening works carried out around the 1800. Stream no longer overtops naturally during high flows. There is also a small bridge crossing perpendicularly with a very small culvert (~0.3m diameter) underneath to allow for connectivity, unlikely to be effective during high flows.
	1	R	
∑ Attribute scores	14		
WFD class [c]	Poor		

[a] Attributes 1-4 scored from 0 to 4 by 1; Attributes 5-8 score LB / RB separately 0 to 2 by 0.5
[b] If attribute can't be scored, tick NV box and enter provisional score of 2 for attributes 1-4 or 1 for attributes 5-8

[c] WFD Class	HM Score	∑ Att scores
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General Comments:
eg how to bring to Good hydromorphological status