Client:

Dún Laoghaire–Rathdown County Council

Project:

Druids Glen Road - Phase 3, Cherrywood SDZ

Report:

Final Options Appraisal Report
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BARRY TRANSPORTATION

egis GROUP

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SECTION 1: INTRODUCTION

1.1 Consultant's Brief

Barry Transportation Limited (BT) has been appointed by Dún Laoghaire Rathdown County Council (DLRCC) to develop the Druids Glen Road Phase 3 project through the five project stages defined in the Capital Works Management Framework (CWMF). These stages align with the deliverables and phases outlined in the Project Appraisal Guidelines (PAG) by the National Transport Authority (NTA). DLRCC has been specified as the Development Agency for the Cherrywood SDZ by Government Order and as such, has prepared the Cherrywood Planning Scheme (CPS). The CPS requires the construction of a bridge feature on Druids Glen Road. The construction of this bridge is critical in addressing the infrastructure deficits required to open up land for development, and in particular housing.

This report has been developed to present and assess potential bridge options for the Phase 3 of project (Concept Design and Options Assessment). It provides a structured evaluation of different alternatives, considering factors such as technical, aesthetics, environmental impact, and feasibility. The findings from this report will be instrumental in shaping the final proposed development and ensuring alignment with the overarching objectives of the Cherrywood SDZ Planning Scheme. The Final Options Appraisal Report will continue to be referenced as the project progresses, and the preferred option will be further developed as necessary to reflect evolving project requirements and stakeholder input.

1.2 Project Background

Druids Glen Road Phase 3 is situated in the Cherrywood Strategic Development Zone (SDZ). The Cherrywood SDZ is situated approximately 8 km south of Dún Laoghaire Town Centre near Loughlinstown, between the N11 and the M50, approximately a kilometre north of where they fork from the M11. The CPS requires the construction of a bridge feature on Druids Glen Road to link Development Area 5 to Development Area 1, see Figure 1-1.

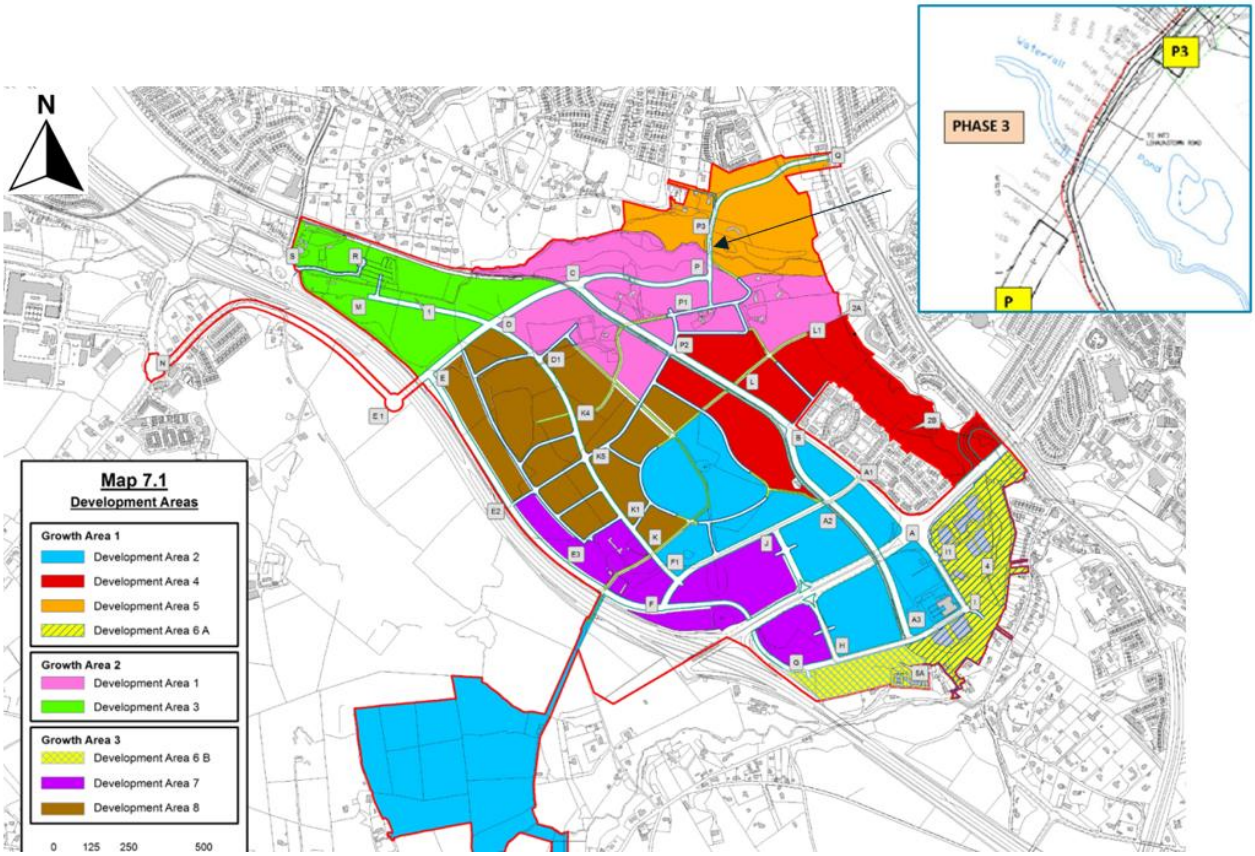

Figure 1-1: Map of Development Areas of Cherrywood SDZ and Proposed Connection between Areas 5 and 1

The Cherrywood SDZ lands have been developing for years now, with a considerable amount of infrastructure already established on other sectors of the Cherrywood SDZ lands including residential and commercial, road and public transport, and recreational and amenities for use by existing and future communities, see Figure 1-2.

Figure 1-2: Existing Cherrywood Site

As such, the road network including main tie-in points P3 and C for the Druids Glen Road scheme have already been constructed, therefore the scheme design needed to investigate the necessary road geometry to tie-in with the existing road alignment at both ends. An indicative aspiration under the Project Brief for Druids Glen Road Phase 3 includes the bridge needing to be sensitively designed to span the valley with a slender structure, one that does not dominate either the valley floor or its setting and takes due regard to the ecological corridor it crosses.

The construction of this bridge will support the ongoing development of the Cherrywood SDZ as a key residential and commercial hub.

1.3 Previous Studies

The following section is a summary of elements from the Cherrywood SDZ Planning Scheme and accompanying/subsequent studies that inform and support the Druid's Glen Phase 3 project.

- **Cherrywood Planning Scheme 2014 (updated April 2023), Chapter 4**: Physical Infrastructure details plan for all infrastructure within Cherrywood, such as the Environmental infrastructure (water and drainage), Utilities and ICT (electricity, gas and telecoms), and Energy and Waste management while drawing our attention to the Emerging Study Area. The plan also provides conclusions on the Cherrywood transport network and transportation infrastructure detailing the location of public transport corridors on Castle Street and Bishop Street and the cycling, walking networks on portions of Lehaunstown Lane for example, as well as the Luas corridor, which traverses Cherrywood with 5 Luas stops (1 inactive) before terminating within the CPS lands.
- **Cherrywood Planning Scheme 2014 (updated April 2023), Chapter 6**: Development Areas outlines the type, extent, scale and overall design ethos of the Planning Scheme. In order to do this in detail, the overall Planning Scheme area has been divided into 8 discrete Development Areas including Area 1: Lehaunstown and Area 5: Druid's Glen. Overall, it is considered important that the extent of each Development Area is based on the area's potential to supply in a logical, efficient and effective manner all infrastructure, services, facilities and amenities necessary to sustain the population of that area.
- The **Druid's Glen Feature Bridge Concept Design Report** (Published December 2020 by Arup) and Bridge Concept Drawings. Arup were commissioned to develop a concept design for a bridge crossing

of Druids Glen Valley, considering two options. The proposed road alignment adopted for the options was developed using information from previous alignment studies. The alignment uses a tie-in point to the south, based on the Atkins alignment for Phases 1, 2 and 3 (Q to P), and attempts to merge it into the proposed DBFL alignment for Phase 2 (P* to P3) to the north. Due to the level difference between these two tie-in points, the proposed bridge requires a maximum vertical grade of 5% to be used. Even with this alignment, the tie-in with the DBFL alignment occurs further back to ensure a smooth interface. The report considered Bow String Arch Bridge and a Steel/Concrete Composite Bridge. The report provided concept designs and order of magnitude cost estimates; however, no conclusions or recommendations were provided in this report.

- **Druids Glen Environmental Constraints Report** (Published by Arup, 2020) which form part of the Druid's Glen Feature Bridge Concept Design Report discussed above. This report aimed to identify various environmental constraints that require consideration for the feasibility assessment.
- Arup completed the **Technical Note 'Druids Glen Peer Review**' to review the conceptual roadway design from Point P3 to Point C as identified on the Cherrywood SDZ Planning scheme. The purpose of this study was to assess the feasibility of the proposed road connection from Point P3 to Point C, and to conceptualise an alternate vertical design for the link.
- **Alignment Options Assessment Report** was prepared by Barry Transportation to review the Arup Technical Note 'Druids Glen Peer Review' in relation to the vertical alignment of the Druids Glen Road from Point P3 to Point C. Based on this review the report was completed to evaluate the potential alignment options for the Druids Glen Road project. The purpose of this report was to finalise and agree with DLRCC the emerging preferred alignment option for Druids Glen Road Phase 3.
  The Alignment Options Assessment Report played a crucial role as a precursor to the current study, particularly in determining the vertical alignment considerations that influence the bridge design. This report assessed the feasibility of various alignment options, considering constraints such as terrain elevation changes, environmental factors, and existing infrastructure. The findings of the assessment established the context for the bridge options presented in this report, ensuring that the selected bridge alignment integrates seamlessly with the overall road network while meeting engineering and safety standards. The vertical alignment recommendations provided in the report have been instrumental in shaping the structural and functional design of the proposed bridge, ensuring optimal connectivity and minimal environmental impact.
- A **Constraints Study** was conducted by Barry Transportation to identify the constraints within the designated study area of the proposed bridge in the Druids Glen area of the Cherrywood SDZ. The constraints study identified a number of natural and environmental constraints, artificial constraints and external parameters.

Below is a list of other technical documents that were used to inform the scope of the Druid's Glen Road Phase 3 project

- Geotechnical Report (Published May 2020 by IGSL): This report provides information on geotechnical subsurface conditions.
- Cherrywood Area Wide Travel Plan (published June 2015 - updated August 2016): This report supports the projects objectives by ensuring connectivity between future developments is facilitated with a bridge over the river and sensitive environmental areas.
- Cherrywood SDZ Wayfinding & Directional Signage Guidance, 2021: This document provides guidance for wayfinding and directional signage development for Cherrywood SDZ and the surrounding areas. Reference to this document will occur during the Detailed Design Stage of JB Barry's appointment.
- The Cherrywood Biodiversity Plan formed part of the Planning Scheme Documentation. The function of this Plan was to provide a summary of the strategy behind the design of the Planning Scheme in terms of the retention, protection, and management of ecological resources. Due to the sensitive nature of the proposed bridge, this document was thoroughly scrutinized and was used extensively to identify gaps and for the compilation of the Constraints Report. A **Constraints Report** (Egis/Barry Transportation 2024) was completed and referenced as a technical document that informed the project. Additionally, it was acknowledged that this Constraints Report would be updated as the project progressed to reflect new findings and considerations

- Cherrywood Planning Scheme 2014 (updated April 2023), Appendix D – Report on the proposal for an ecological buffer zone at Druids Glen - This document sets out the rationale behind the implementation of the ecological buffer zone and the restrictions associated with same. Due to the sensitive nature of the proposed bridge, this document was scrutinised thoroughly and will be used extensively to identify gaps and for the compilation of the Constraints Report.
- Approved Part 8 Cherrywood Green Routes Network - Proposed Development (PC/CSDZ/013/2022) is a key component of the Cherrywood Planning Scheme, aimed at enhancing connectivity and promoting sustainable transport modes within the development area.

SECTION 2: SITE AND LOCATION

2.1 Study Area

The Cherrywood SDZ lands are situated approximately 8 km south of Dún Laoghaire Town Centre near Loughlinstown, between the N11 and the M50, approximately three kilometres north of where they fork from the M11. The SDZ lands, of approximately 360 hectares, are located in the administrative area of Dún Laoghaire Rathdown, approximately 16 km southeast of Dublin City Centre, 8 km south of Dún Laoghaire, 3 km from the coastline, and 4 km from the Dublin mountains. The lands have a varied landscape and topography, flanked by three valleys: Druids Glen, Brides Glen and the Cherrywood/Loughlinstown River Valley, and the historical ruins of Tully Church identifying the high point/pinnacle of the plan area. The Cherrywood SDZ lands area is shown in Figure 2-1 with the Druid's Glen Bridge scheme study area indicated by the black circle.

The proposed project is located between junction nodes P3 and P as shown in Figure 2-1. The Druid's Glen Road Phase 3 will span Carrickmines River and Druid's Glen Valley and will provide connectivity between the development areas, with particular focus on developments areas 1 and 5 within the Cherrywood Planning Scheme and the wider road network, including Lehaunstown Lane and the N11.

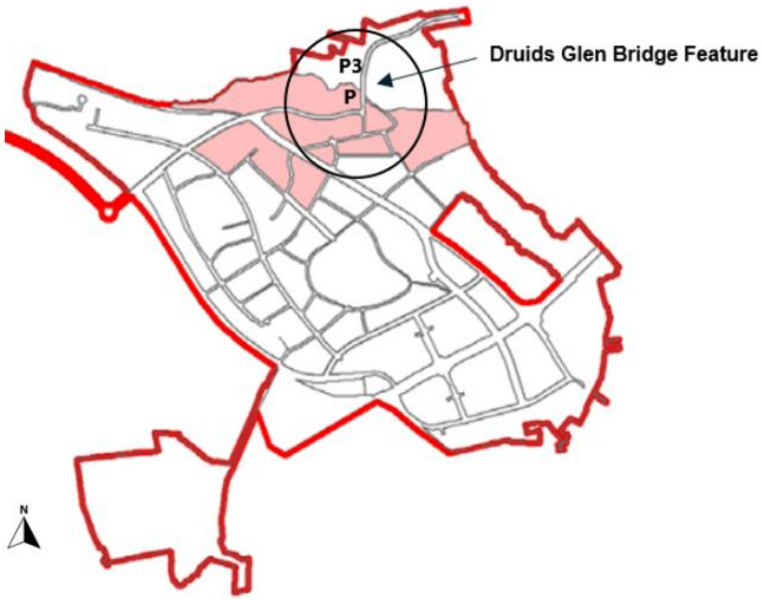

Figure 2-1: Proposed Druid's Glen Road Phase 3 Emerging Study Area

Figure 2-2 shows the extents of the Druid's Glen Road Phase 3 Project specific study area. The bridge will cross Carrickmines River and Druids Glen Valley at the location where Lehaunstown Lane currently crosses the river. It will tie into a new road (Phase 2 of the Project, already constructed), replace Lehaunstown Lane and connect the bridge to the N11, north-east of the valley as well as connect the bridge to Grand Parade, south-west of the valley.

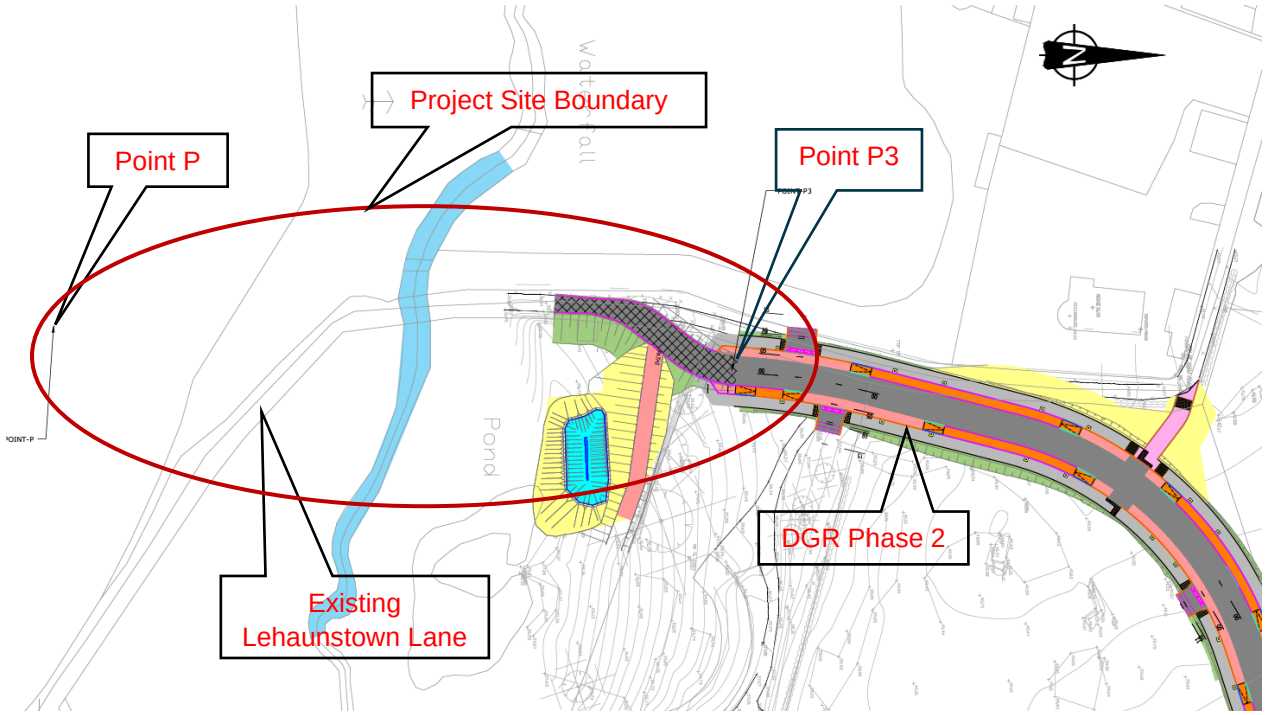

Figure 2-2: Project Site Boundary (Bridge Crossing Location)

Table 2-1 below provides co-ordinates for the proposed structure.

Table 2-1: Site Location Details

Structure Name	ITM X Coordinate	ITM Y Coordinate
Druids Glen Road Bridge	723319	724139

2.2 Geometric Parameters

The cross-section adopted for the bridge is based on the road cross section for Druids Glen Road, which can be seen in Table 2-2 and it is illustrated on Figure 2-3. A minimum cross-section of 17.5 m is required. This requirement originates from indicative street cross sections within the Cherrywood Planning Scheme (refer to Section 4.2.7 and Fig. 4.4 in CPS) as well as from overall roadway design standards and safety considerations for Druids Glen Road, ensuring adequate space for vehicular lanes, cycling paths, and pedestrian pathways. It is important to note that the actual bridge cross-section may vary depending on the chosen bridge option. Some designs may necessitate a wider bridge deck to accommodate bridge parapets, additional safety barriers, and primary structural members above deck level. Please refer to Section 4 for further details on the specific design variations and their implications on the overall bridge structure. The actual bridge cross section will be reviewed and finalized at Preliminary Design stage (refer also to Section 2.5 below).

Table 2-2: Proposed Cross-Section

Item	Width (m)
Footway	3.0
Cycleway	2.25
Carriageway	7.0
Cycleway	2.25
Footway	3.0

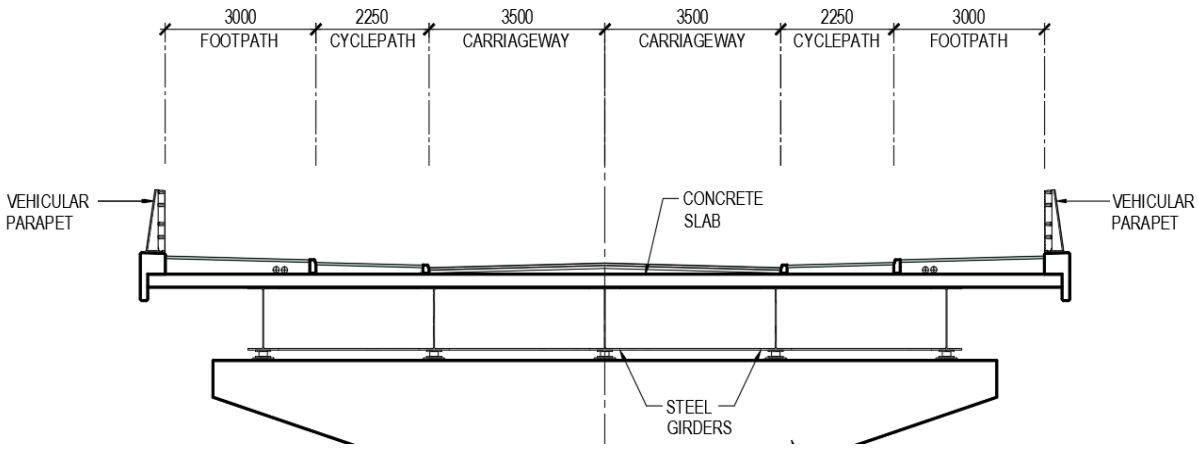

Figure 2-3: Typical Proposed Road Cross Section

2.3 Site Constraints

The Carrickmines River, together with Druids Glen Valley, creates a shallow valley at the proposed crossing location. The existing Lehaunstown Road crosses the river via a small masonry arch bridge. The northern side of the valley features a relatively gentle slope leading down to the river, whereas the southern side has a significantly steeper incline where Lehaunstown Lane is located. Additional physical constraints include differences in elevation levels, a temporary attenuation pond, dense tree cover and forestry areas, and the Druid's Glen ecological buffer zone. These factors present engineering challenges and require an elevated road crossing to ensure seamless navigation of the terrain while minimizing environmental disruption.

The proposed road alignment adopted for the options was selected as the best compromise between a larger impact on lands south of Carrickmines River and a need to relocate tie-in point P3 further north. Due to the level difference between the two tie-in points, the proposed bridge requires a maximum vertical grade of 5% to be used (refer to Alignment Options Assessment Report, in Section 1.3).

2.4 Compliance with Cherrywood Planning Scheme

The proposed development has been progressed in general accordance with the Cherrywood Planning Scheme. In particular we note compliance with specific objective DA3 which requires:

"*The high-level bridge linking Lehaunstown with the N11 will have to be sensitively designed so as to span the Druid's Glen with a visually slender structure that does not dominate either the valley floor or its setting, with due regard to the ecological corridor it crosses.*"

All four bridge options will be designed to align with this objective, with all options having a slender structure and unobtrusive presence. This design approach ensures the bridge will not dominate the landscape and will cause minimal disruption to the local environment and wildlife. The bridge will seamlessly blend into the landscape, achieving a balance between functionality and environmental sensitivity.

2.5 Active Travel Routes Interfaces

The Cherrywood Green Routes Network extends approximately 5.0 km from Brides Glen to Brennanstown comprising pedestrian and cycle connections to the N11, Wyattville Link Road, Cherrywood Avenue and Brides Glen/Cherrywood Road. The scheme received Part 8 Planning Approval in June 2022. The proposed bridge options will interface with the following 2 elements:

- An east-west greenway of c.420 m long and 3.0 m wide, from north of the Carrickmines River to Lehaunstown Lane, via a new embankment.
- An 800 m long, 1.2 m wide, pedestrian route through the Druids Glen woodland, consisting of resurfacing of existing pathways.

The Druids Glen Road cross-section between Points P3 and Q (Phase 2, now completed), aligns with Tier 1 of the NIFTI modal hierarchy by providing segregated walking and cycling facilities along the bridge. In addition, the traffic lanes provided have the lane width required for bus use thus also aligning with Tiers 2 and 3. The Phase 3 of the Project, therefore, adopts the same cross section.

Further to the indicative nature of the prescribed cross section for Druid's Glen Road P – Q (see Fig. 2-4 below), Section 4.2.7 of the Cherrywood Planning Scheme (2014, as amended) clarifies that, in general, footpaths shall be 3 m wide to allow for the planting of street trees while still maintaining an unobstructed width of 2 m for pedestrians. If no planting is required on the bridge, there may be a scope to reduce the bridge deck cross section by up to 2 metres at preliminary design stage (refer also to Section 2.2 above).

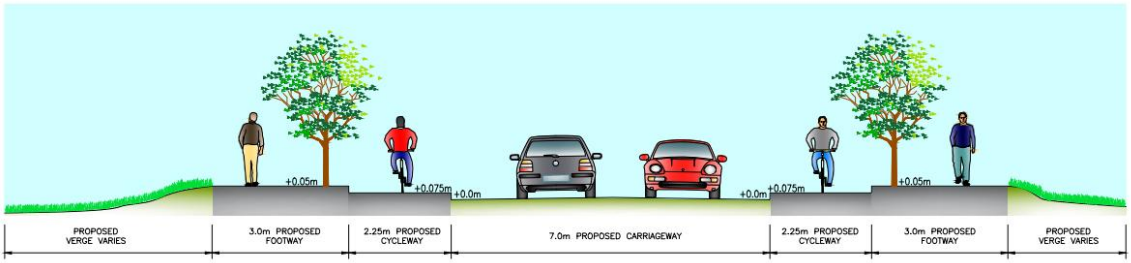

Figure 2-4: Indicative Druid's Glen Road Cross Section

SECTION 3: OPTIONS EVALUATION METHODOLOGY

3.1 Overview

The preferred option from the Alignment Options Assessment will be used to inform and develop options for the preliminary options appraisal. With reference to methodologies and Project Objectives contained in the Project Outline Document (Barry Transportation/Egis, December 2024) for the Druid's Glen Road Phase 3 project, this Final Options Appraisal Report will focus on the assessment of the bridge options to determine a preferred option using a two-step approach. The overview of evaluation steps is provided in the section below.

- Step 1: Confirming the bridge options against the project objectives. Each option is assessed against the project objectives using the assessment criteria derived from TAF Module 7. Options that do not meet any objective will be considered as not aligning with the project's goals and will not progress through Step 2.
- Step 2: A fit for purpose multicriteria analysis (MCA) will be undertaken using a range of technical criteria based on Engineering, Environment and Economy to robustly assess the bridge options and ultimately determine the preferred detailed design solution.

3.2 Step 1: Alignment with Project Objectives

The assessment criteria for the Step 1 were derived from TAF Module 7 and are listed in Table 3-1 below. Options that do not meet any objective will be considered as not aligning with the project's goals and will not progress through to the MCA assessment.

Table 3-1: Project Objectives Assessment Criteria

TAF Categories	Objectives	Assessment Criteria (as per TAF Module 7)
Transport User Benefits and Other Economic Impacts	▪ Provide infrastructure that will improve connectivity and reduce travel time within the Cherrywood development by all modes.	Travel times and enabling future development
Accessibility Impact	▪ Provide access to services such as employment, education and recreation via a high-level bridge linking Development Area 5 and 1 which forms part of a link between the M50 and N11.	Access to key services
Social Impact	▪ Provide infrastructure that can be accessed by transport users with different mobility needs.	Transport users with different mobility needs
Land Use Impacts	▪ Provide a road layout and bridge that is buildable and will tie-in to and complement the Cherrywood Road network, future road network and zoned lands.	Connection to zoned lands
Safety Impacts	▪ Provide segregated pedestrian and cycling facilities. ▪ Deliver a high-quality compliant design. ▪ Provide safer facilities for active travel through segregated pedestrian and cycling facilities.	Change in safety for users
Climate Change Impacts	▪ Provide infrastructure that will encourage mode shift and emissions reduction.	Mode shift and Emissions reduction

Local Environmental	▪ Ensure overall environmental compliance and compliance with the Cherrywood Planning Scheme including its Biodiversity Plan. ▪ Provide a sensitively designed, visually slender structure that does not dominate either the valley floor or its setting. ▪ Provide a sensitive design that will not result in significant effects on ecology that is of local importance or higher either during construction or operation.	Visual Quality

3.3 Step 2: Multicriteria Analysis

Table 3-2 shows the criteria selected to assess the bridge options. The criteria are based on the TII Publication[1] and were considered suitable by specialists as they will provide a robust assessment of the options, while considering the impacts to the surrounding environment and ultimately provide the information required to inform decision making.

Table 3-2: MCA Assessment Criteria

Categories	Criteria
Technical	Span Arrangement Structural Depth Cross Section Construction and Buildability
Economic	Construction Costs
	Whole of Life Costs
Aesthetics	Style/look of the bridge within the surroundings
Durability and Maintenance	Materials
Hydraulics	Flood Event Considerations
Health and safety	Traffic management During Construction
	Safety During Construction
	Safety in use
Local Environmental Impacts	Human Beings
	Waste
	Climate Change
	Air quality

[1] Structural Criteria based on the TII Publication - The Assessment of Road Bridges and Structures (June 2014) and TII PE-PAG 02031 – Project Appraisal Guidelines Unit 7.0 - Multi-Criteria Analysis for the Environmental Criteria

Categories	Criteria
	Noise and Vibration
	Biodiversity
	Hydrology and Hydrogeology
	Soils and Geology
	Landscape and Visual
	Cultural Heritage

The scoring for this MCA assessment will be done using a 7-point scale shown in Table 3-3. Scores for each criterion will be assessed using appropriate measures (qualitative and quantitative) such as a Carbon Assessment Report based on the TII Carbon Tool for Road and Light Rail Projects which will be used to assess the Climate Change criterion. Measures for the other are developed and reported within this report.

The following sections of this report assess each option based on the criteria above and provide a comparison of how well each option meets the criteria compared to the other options. This is then converted to an assessment scoring based on the Table 3-3 below. The assessment scoring for each criteria is then summarised in the MCA Analysis table (Table 15-2) in Section 15: Conclusions and Recommendations. This is then used to inform a decision on which option best meets the project objectives.

Table 3-3: Assessment Scoring

Scoring	Measure
	Major or highly negative compared to other options
	Moderately negative compared to other options
	Minor or slightly negative compared to other options
	Not significant or neutral
	Minor or slightly positive compared to other options
	Moderately positive compared to other options
	Major or highly positive compared to other options

3.4 Evaluation (Step 1)

Each option was evaluated against the project objectives using the assessment criteria derived from TAF Module 7. This process confirmed the alignment of the bridge options with the project objectives as outlined in Step 1 (refer also to Table 15-1 further below). Therefore, all options are brought forward to the Step 2, which involves the multicriteria analysis (MCA). The MCA will assess the technical criteria based on three key factors: Engineering, Environment, and Economy. The goal is to ultimately determine the preferred detailed design solution.

SECTION 4: DESCRIPTION OF STRUCTURE AND OPTIONS CONSIDERED

4.1 Project Elements

The Druid's Glen Road Phase 3 Project involves construction of the bridge as well as approximately 60 m of the new road at the northern end to tie into Druid's Glen Road Phase 2 (already built), approximately 60 m of the new road at the southern end, including a signalized T-junction at Point P (for the next phase), construction of a new attenuation pond between the Carrickmines Stream and the existing Lehaunstown Lane, associated retaining walls and earthworks, a ramp to provide the active travel link between the existing Lehaunstown Lane and the realigned Druid's Glen Road, construction/reinstatement of pond access tracks as well as all necessary drainage, planting and road furniture.

As the proposed bridge is the main element of the project, this section provides further details of considered bridge options. Other elements are either specifically defined or their alternatives will not have a significant impact on the overall evaluation and therefore, options on these secondary elements are not considered within this report.

4.2 Structural Form

The main structural forms commonly used in bridge design include rigid frame, girder, arch, suspension and cable stayed. For this project, the most suitable structural forms are girder, arch bridge or a modified cable stayed bridge (extradosed type) due to span constraints and the visual sensitivity of the area.

Arched bridges use a curved structure to transfers loads to the supports at either end. Extradosed bridges are a hybrid between girder and cable-stayed bridge. They use shorter towers and less cable than traditional cable-stayed bridges. Both options facilitate longer spans while maintaining a shallow structural depth. This is particularly beneficial for projects with specific height restrictions or aesthetic requirements, such as this project.

Another important consideration is the bridge articulation. Traditionally, the bridge superstructure has been separated from substructure by bearings. In more recent times, integral bridges were developed to reduce or completely eliminate bearings and join substructure with superstructure into a single frame element. The main advantage of this arrangement is reduction of number of bridge elements which need inspection, maintenance and replacement over the life span of the structure. While bridges of 100 m or even longer can be designed as integral, the exact suitability depends on number of factors. The articulation arrangement of each option is described in Section 4 with reasoning behind it provided.

4.3 Structural Detail

All bridge options will require similar structural details to ensure the integrity, durability, and functionality of the structure.

Bearings are essential components that allow for controlled movement and support the loads transferred by the bridge. They accommodate translations and rotations, ensuring the structure can respond to thermal expansion, vehicular loads, and other dynamic forces.

Expansion joints are necessary to accommodate thermal expansion and contraction of the bridge materials. They are frequently used in conjunction with bridge bearings. They prevent potential structural and pavement damage caused by temperature variations.

Effective drainage systems are required to prevent water accumulation on the bridge deck, which can lead to deterioration and reduced lifespan of the structure. Properly designed drainage systems help maintain the structural integrity and safety of the bridge by preventing water-related damage. The most commonly

used drainage system is continuous kerb drainage which facilitates collection of water from the edge of carriageway. The internal channel within the kerb then carries the water to the low end of the bridge deck where it is discharged into the road carrier drain.

Bridge parapets fulfil an essential role in maintaining the safety of both vehicular traffic as well as pedestrians and cyclists. They also play an important role in the overall aesthetic impact of the bridge. Modern parapets are designed to withstand vehicular impact, and bespoke systems can seamlessly blend with the bridge superstructure.

These elements ensure that all bridge options can withstand various environmental and load conditions while maintaining functionality and aesthetic appeal.

All options have been assessed for their ability to accommodate road drainage and other essential utilities such as water supply and telecommunications. Given the structural configuration and deck depths, sufficient space is available to integrate these services within the bridge. However, variations in bridge deck depth across different options may impact the routing and positioning of utilities, particularly where more constrained deck depths reduce available clearance. The feasibility of utility accommodation will be further assessed during the detailed design stage to ensure compliance with service requirements while maintaining structural integrity.

4.4 Span Options

The span options of the bridge are determined by present physical constraints such as the existing Lehaunstown Lane, Carrickmines stream, the approved green route network alignment and attenuation pond access. These constraints dictate the span length, with proposed main spans varying between 35 m and 65 m and overall bridge length approximately 147 m. From multiple theoretical combinations of span number and lengths, two main configurations are considered feasible: three span and four span options. These are further developed into four distinct bridge options described below.

4.5 Bridge Options – General

The following options are considered viable and will be evaluated in more detail:

- Option 1 – Three span bow string arch bridge
- Option 2 – Four span girder bridge
- Option 3 – Three span extradosed bridge
- Option 4 – Four span timber girder bridge

4.6 Option 1

Option 1 comprises a three span, low rise bow string arch with bridge deck positioned at mid arch height level, with inclined struts supporting deck end spans.

4.7 Option 2

Option 2 is four span girder bridge with a composite deck of steel girder and concrete slab.

4.8 Option 3

Option 3 is a three span extradosed bridge, featuring concrete girders and a cable stayed design with low pylons.

4.9 Option 4

Option 4 utilises cross-laminated timber (CLT) girders and a timber deck in a four-span arrangement, similar to Option 2.

4.10 Required Land Acquisition

There is minimal difference in the required land acquisition for all bridge options. Permanent land take is determined by bridge length and width. All options have a similar bridge length and width and, consequently, all options will have very similar permanent land take requirements. Temporary land take will be required to provide working space for substructure and superstructure construction, as well as tie-in road sections. The temporary land take will also be similar for all options. Proposed land acquisition is indicated on plan drawings in Appendices 1 to 4.

4.11 Indicative Drainage, SUDs and Attenuation Solution

All options require a similar drainage arrangement. Surface water flowing from the junction at Point P towards the bridge will be collected by gullies located before the bridge's south abutment. Together with the subsurface water (back-of-wall drainage at the south abutment), this water will be intercepted and treated before discharging into a proposed new attenuation pond constructed at the south bank of the Carrickmines Stream and consequently into the stream. The interception and treatment of runoff before discharge into both the existing temporary attenuation pond (incorporated as part of Phase 2 drainage) and the proposed new attenuation pond will be reviewed at the preliminary design stage to ensure compliance with drainage and environmental requirements.

Surface water collected on the bridge will naturally flow north due to the 5% longitudinal gradient of the bridge deck. To prevent flooding of the bridge deck during storm conditions, continuous kerb drainage will be utilized. The outfall of this drainage run will tie into the Phase 2 main drainage network, subject to necessary capacity checks, including a review of the capacity of the existing temporary attenuation pond to accommodate additional runoff from this project.

Sustainable Urban Drainage Systems (SUDS), such as rain gardens, are the preferred approach for water treatment. The potential use of petrol interceptors may be considered as an additional measure, subject to review of their ecological and environmental impact at the preliminary design stage.

SECTION 5: TECHNICAL EVALUATION

5.1 Option 1

Option 1 is the bow string arch bridge.

Span Arrangement

Option 1 has a total span length of 125 meters and consists of three main spans, with an overall bridge length of 147 meters. The large central span is formed by a parabolic arch with the length of 72.5 m and rise 14 m, giving it a profile which is aesthetically pleasing and structurally efficient. The bridge deck is positioned at arch mid-rise level; therefore, the arch springing points are 7 m below the deck and the arch crown rises 7 m above the deck. Arch ends are connected to short concrete columns supported by the foundations. From these springing points rise secondary inclined struts to support approach spans at both ends of the bridge. The span between the arch legs has a length of 22.5m, while the northern approach spans measures 12m and the southern approach span measures 17m.

Cross-Section

The width of the proposed bridge deck for option 1 is 21.5m.

A traffic barrier is proposed between the cycle track and footpath, to protect arch ribs and vertical hangers from potential vehicle collisions. This adds 3m in total to the width of the bridge for option 1.

Superstructure

Option 1 uses steel for the main arches, and for the primary and secondary deck girders. Reinforced concrete is used in the deck slab.

The bridge deck structural depth of this option is 1m. The arch rises to a maximum of 7 m above the deck, and the arch legs extend 7 m below deck to the supports. The arch spans 48 m above the deck, while the span between arch springing points below the deck is 72.4 m. There are also inclined struts rising from the arch springing helping to better distribute end span loads.

Substructure

The arch legs are supported by short reinforced concrete piers, on piled foundations. Deck ends are supported on reinforced concrete bankseat abutments.

Materials

The main construction materials for this option are steel and concrete.

Technical Advantages/Disadvantages

The main advantage of this option is the possibility to achieve a large open central span while maintaining shallow structural depth. Additionally, the selected form – tied arch – is structurally efficient, which leads to material savings. Using steel as the main construction material facilitates a large proportion of fabrication to be done off site, reducing construction time and associated negative impact on the surrounding environment.

As this option has only three spans, it will require construction of four supports (two abutments and two piers). This is an advantage over four span options (Option 2 and 4) requiring additional pier to be constructed in the river valley. Relatively lightweight structure will have less demand on foundations which also may be smaller in comparison with Option 3 (also 3 span bridge).

On the other hand, the site assembly of the bridge will require temporary towers to support the steelwork (deck and arch) prior to concreting the deck and stressing the support cables. A temporary working area

adjacent to the bridge will be required to place a mobile crane to allow for erection of the steelwork as well as temporary foundations for erection towers.

5.2 Option 2

Option 2 is the girder bridge.

Span Arrangement

Option 2 is a four-span bridge, with a total length of 121 m and spans 29 m, 29 m, 35 m, 28 m and an overall bridge length of 147 meters. The bridge deck is supported on three reinforced concrete piers and bank seat abutments.

Cross-Section

The width of the proposed bridge deck for option 2 is 18.5 m.

Superstructure

This option uses steel for the girders, and reinforced concrete is used in the deck slab. The structural depth of this option is 1.5 m.

Substructure

Option 2 is supported on reinforced concrete piers and bankseat abutments.

Materials

The main construction materials are steel and concrete.

Technical Advantages/Disadvantages

The steel composite girder bridge features very simple structural system and straightforward construction. Utilizing continuous steel girders increases structural efficiency and speeds up construction, as they can be erected and connected together within days, using a suitable mobile crane, thus significantly reducing need for extensive temporary works. Similarly, the concrete deck slab construction will require minimal temporary works, making this option fast and safe to build. This option does not require any increase in bridge deck width (as does Option 1 and Option 3) which also makes it more economical.

As a four-span bridge, it has an additional pier (compared to Option 1 and 3) to construct, meaning more construction time and resources required for the substructure. This is a technical disadvantage relative to three span options.

5.3 Option 3

Option 3 is the extradosed bridge.

Span Arrangement

Option 3 consists of three spans, with a total span length of 125.7 meters and an overall bridge length of 147 meters. The larger central span measures 65.5 meters, while the two outer spans each measure 30.1 meters.

Cross-Section

The width of the proposed bridge deck for option 3 is 19.5 m. The cable stayed design necessitates the addition of 1 m in total to the minimum cross section of the bridge.

Superstructure

Option 3 uses a cable stayed design, with steel cables extending from four reinforced concrete pylons, with 2 pylons on either side of the bridge. This option has a structural depth ranging between 2.1 m (midspan) and 3.0 m (support), while the pylons have an overall height of 17 m, of which 6.5 m is over the bridge deck.

Substructure

The concrete pylons are supported by foundations, and the approach spans rest on reinforced concrete bankseat abutments.

Materials

Option 3 uses concrete, and high strength steel tendons for the cables.

Technical Advantages/Disadvantages

Similar to Option 1, this is a three-span structure with a large open central span, thus the visual and physical impact on the river valley is less severe than four span options (Option 2 and 4). Using external stay cables helps the structure to carry the traffic load and maintain relatively slender bridge deck profile. Bridge pylons with cables are positioned on either side of bridge deck, therefore the deck requires only a minimum increase in width to facilitate cable connections. This is an advantage over Option 1 which requires a wider deck.

The construction complexity is slightly less demanding than Option 1. There will be temporary supports and falsework needed as well as a crane area.

Technically this option scores behind Option 2 & 4(best) and is similar to Option 1.

5.4 Option 4

Option 4 is the timber girder bridge.

Span Arrangement

Option 4 consists of four spans and has a total length of 124 m and an overall bridge length of 147 meters. The two central spans have a length of 35 m, while the outer two spans are 27 m in length.

Cross-Section

The width of the proposed bridge deck for Option 4 is 18.5 m.

Superstructure

Option 4 uses timber girders as well as timber deck, with a structural depth of 2 m.

Substructure

The substructure consists of three reinforced concrete piers, and bankseat abutments.

Materials

Option 4 uses cross laminated timber and concrete as the main construction materials.

Technical Advantages/Disadvantages

As this option uses timber as the primary construction material, it has the biggest advantage in the transport, site assembly and temporary works. Timber is very lightweight and thus require smaller cranes to lift. Part

or full span girder assemblies may be easily erected, using timber decking eliminates the need for concrete curing period and therefore, the bridge may be completed significantly faster than other options (Option 2 and 3 in particular).

Timber has its limitations though, mainly because it has a lower strength than steel or concrete. Maximum feasible span which can be achieved with timber girders is approximately 30 – 40 m, therefore this option proposes a four-span arrangement. Large number of individual timber elements will also require more connections with additional demand on precision in fabrication and assembly. The structural depth is also larger than Option 2, so the bridge cannot achieve the same slender profile.

This option has a number of technical advantages, but limitations of timber material put it behind Option 2 overall in the technical evaluation.

SECTION 6: ECONOMIC EVALUATION

6.1 Construction Costs

For the purpose of options evaluation, relative differences of the estimated construction costs were considered, based on material type and quantities as well as the construction methodology and duration. The ranking of options is presented in Table 6-1 below (1 – lowest cost, 4 – highest cost).

Table 6-1: Construction Cost Ranking

Option	Cost Ranking
1	3
2	1
3	2
4	4

NB. The above ranking include construction of the bridge as well as the road between point P (including the signalized junction at point P) and tie-in to Phase 2., drainage, SUDS, attenuation, pond access, retaining walls, pedestrian and cycle link between Lehaunstown Lane and Phase 2 road. It also covers preliminaries and contingencies, but excludes other scheme costs such as design, supervision, land acquisition, client costs, inflation, etc.

6.2 Whole Life Costs

The expected maintenance activities are described in Section 7.

The ranking of expected whole life inspection and maintenance activities is set out in Table 6-2 below (1 – lowest cost, 4 – highest cost). In terms of combined whole life cost, Option 2 is the most cost effective followed by Option 3 (2nd), Option 1 (3rd) and Option 4 (4th).

Table 6-2: Whole Life Cost Ranking

Option	Maintenance	Whole Life
1	3	3
2	2	1
3	1	2
4	4	4

SECTION 7:AESTHETIC EVALUATION

7.1 Summary of the Concept Design

The concept design was developed with two main design aims. The first design aim was to develop an “object” bridge, to create a well composed and balanced structure. The second design aim was to create a “subject” bridge that is easy, safe and comfortable to use for all traffic modes. Due to the sites secluded nature, a bridge in this location cannot be seen from afar unless elements of the bridge project far above the tree line. It was concluded that exaggerating the height of the bridge above the tree line would not have structural logic, and that any projecting elements could potentially be visually lost against a grey sky when seen from afar. Subsequently a lower and structurally sensible design is preferred.

The bridge's design, with its balanced proportions, integration with the natural landscape, and thoughtful material choices, has the potential to be both functional and visually pleasing. By considering the surrounding environment and incorporating subtle architectural details, the bridge can become a harmonious and elegant addition to the valley, appreciated for its aesthetic as well as its utility.

7.2 General

The bridge options can achieve good aesthetics via the following methods:

Proportion and Scale

- The bridge's length of 120 meters and height of 16 meters provide a balanced proportion, ensuring that it does not dominate the landscape but rather complements it.
- Both three and four-span design contributes to a rhythmic and harmonious appearance, breaking up the length into visually manageable sections.

Integration with Natural Landscape

- The presence of mature trees on south and west side creates a natural screen, allowing the bridge to blend seamlessly into the environment when viewed from that direction.
- The shallow valley setting enhances the visual appeal, as the bridge appears to gracefully span the natural depression without overwhelming it.

Material and Colour

- Choosing materials and colours that harmonize with the natural surroundings will enhance the bridge's aesthetic appeal. For example, using natural stone or weathered steel can create a rustic and timeless look.
- Pattern profile finish on any large areas of visible exposed concrete, e.g., wingwalls and abutment
- Higher quality surface finish can be specified in prominent locations, e.g., bridge deck edge beam.
- The bridge's colour should complement the hues of the valley and the surrounding vegetation, ensuring it integrates rather than contrasts sharply with the environment.

Architectural Features

- Adding subtle architectural details, such as elegant railings or decorative elements, can enhance the visual interest of the bridge without making it too ornate.
- Consistent and symmetric arrangement of parapet posts and parapet edge beam joints over the bridge
- Consider incorporating design elements that reflect the local cultural or historical context, adding a layer of meaning and connection to the place.

Lighting

- Thoughtful lighting can highlight the bridge's structure and enhance its nighttime appearance. Soft, warm lighting can create an inviting and serene atmosphere.
- Ensure that the lighting design does not cause light pollution or detract from the natural beauty of the valley.

7.3 Option 1

The arch shape provides a visually pleasing and balanced structure that integrates seamlessly with its environment. The low arch height makes the bridge a standout feature against the dark green backdrop without overwhelming the landscape. It also enhances the sense of space by introducing a landmark gateway, an entrance to Cherrywood. The height of the Arch from the bridge surface is approx. 6.7 m. This option, together with Option 3 offer higher aesthetic value than remaining two options (Option 2 & 4).

7.4 Option 2

Option 2 features a simple and understated design, blending in with the local environment. Four-span arrangement facilitates a shallow structural depth of the bridge deck resulting in a slender superstructure line, virtually hovering above the valley floor. It should be noted, though, that this option, with multiple steel plate girders, presents more 'industrial' look and especially when viewed from underneath, the overall view will be broken into number of lines and small elements. Thus, this option (as well as Option 4) scores worse compared to Option 1 & 3.

7.5 Option 3

Despite featuring cable stay towers projecting above the deck level, these are low enough (project 6.3 m above the bridge deck level). Therefore, the extradosed cable design allows the bridge to standout against the natural backdrop without overwhelming the landscape. Similarly to Option 1, Option 3 also enhances the sense of space by introducing a landmark gateway, with prominent intermediate piers and cable towers. This option is thus scored as a second most preferred from the aesthetic point of view (after Option 1).

7.6 Option 4

Option 4 displays a design, which is the closest possible match to the surrounding nature. Natural tones and textures of timber girders, gently curved at their connection to piers, highlight the heritage of the existing small arch bridge and enhance the bridge's visual appeal, making it a charming and unobtrusive feature within its setting. On the other hand, the bridge deck consists of a large number of individual elements (timber beams) and from a close up view it will look busy and cluttered. Additionally, being a four-span option, the view through the valley will be slightly more obstructed by the additional pier. Hence despite the utilization of natural material (timber), this option scores as the least preferred.

SECTION 8: EVALUATION OF DURABILITY AND MAINTENANCE REQUIREMENTS

All options can be designed to meet Eurocode design life requirements for bridges, i.e. 120 years. Main structural elements use durable materials, such as steel and concrete. Even timber – traditionally considered a low durability material, may last very long time, as confirmed by number of historic timber structures. The key to achieving a long-lasting structure is a proper maintenance as well as other factors further described below.

Some secondary bridge elements have a shorter design life though and will require replacement during the bridge lifespan: Bridge deck waterproofing systems, bridge parapets, expansion joints and bearings may have to be replace after 50 years. This is achieved by road or lane closures, planing off the existing surfacing and waterproofing, before laying new waterproofing in accordance with manufacturer instructions.

Bridge abutment galleries would be provided to enable maintenance and bearing replacement.

8.1 Option 1

The arch bridge uses structural steel for main and secondary elements. The steelwork generally requires a paint protection system to prevent corrosion. Modern paint systems can last between 10 and 20 years, so minor maintenance will be required every 10 years and major paint repairs every 20 years. Due to a higher complexity of steelwork, this option will have higher demand on maintenance compared to options 2 and 3.

Although this option includes bearings, they will be only at end supports (abutments) where it will be relatively easy to inspect them and replace when necessary. This is an advantage compared to other options which require more bearings (at abutments as well as on piers).

8.2 Option 2

Steel composite girder bridge will also require paint protection, same as Option 1. However, the steelwork of this option is less complex, and its maintenance will be less demanding.

As this is a four-span option, there are bearings at each support which will need regular inspections and replacement after 30 to 50 years.

8.3 Option 3

Extradosed bridge has a concrete deck requiring minimum maintenance, mostly ensuring that stay cables and their connections are protected against corrosion. This is its main advantage against all other options.

The bridge deck may be designed as integral at piers and thus requiring bearings only at abutments, making it comparable to Option 1 and again advantageous against Option 2 and 4.

8.4 Option 4

Timber girder bridge will be the most demanding in the regular maintenance. Timber girders will receive an initial treatment during fabrication to protect it against moisture ingress, vegetation growth and pests. These treatments have a limited durability, usually 5 to 10 years. Therefore, the bridge will require periodic inspections and renewal of surface protection within these intervals.

Girders will rest on elastomeric bearing pads which will also require regular inspections and replacement after their specified design life (max. 50 years). This option will use the largest number of bearings of all options.

SECTION 9: HYDRAULIC CONSIDERATIONS

9.1 Introduction

The proposed scheme encompasses a proposed vehicular bridge located between junction nodes P3 (construction completed prior to this scheme) and P (future signalized junction) as described in Section 1 and 2 above. The bridge will be constructed over the Carrickmines River and Druid's Glen Valley, as such any surrounding areas have the potential or likelihood to flood.

The proposed bridge options spans over the Carrickmines Stream with a significant level difference and it is unlikely that the works will affect the predicted flood levels or the available flood plain storage of the Carrickmines watercourse. It is noted that potential flooding impacts caused due to construction activity should not be ignored and the potential for flooding should be investigated. The Initial Flood Risk Assessment carried out in tandem with this Final Options Appraisal Report will be progressed further at Preliminary Design Stage.

9.1.1 Hydrological Regime

Carrickmines watercourse flows through the study area before meeting the Cabinteely St Bride's Stream to the east. Both flow from the northwest of the Druids Glen Road Phase 3 emerging study area and meet to form Loughlinstown River, North. This river flows southeast through the Druids Glen Road Phase 3 emerging study area, parallel to the N11 and crosses under the N11 towards Loughlinstown Woods. The Loughlinstown River, South flows east under the M50 and under the N11, where it meets the Loughlinstown River, North and forms Shanganagh River.

9.2 Flood Risk Review

Sources adopted during initial flood risk assessment were reviewed during initial flood risk assessment of the proposed scheme. A list of these sources is provided below:

a. Eastern CFRAM Study – by OPW issued November 2017
b. Carrickmines Shanaganagh River Flood Relief Scheme
c. DLRCC Strategic Flood Risk Assessment 2022 – 2028
d. Green Routes Network for Cherrywood FRA prepared by AECOM for DLRCC, issued February 2022

Available hydraulic model outputs compared for flood risk assessment where enclosed in Eastern CFRAM Study and Green Routes Network for Cherrywood FRA. Flood levels at node 1600M00372 were compared for both studies in which both results were similar i.e. 30.052 mAOD (CFRAM) and 30.01 mAOD (Green Route). Flood levels at this node were considered to be compatible with the uses proposed under the Green Routes Network Project.

9.2.1 Historic Flood Events

A review of the National Flood Hazard Mapping website www.floodinfo.ie shows no record of historic flooding on or adjacent to the proposed works. The past flood event summary report which identifies historic flood events, which occurred within a 2.5 km radius of the proposed development indicates that approximately 1.33 km upstream of the proposed bridge crossing flooding occurred in November 1982 along the M50 and similarly approximately 1.31 km downstream of the proposed bridge crossing flooding occurred in October 2011 along the N11.

9.2.2 Design Consideration

The design of the proposed bridge will consider the 1 in 100-year river flood extents in accordance with the Cherrywood Green Routes Project PFRA. The Stage 1 Site Specific Flood Risk Assessment, which accompanies this report, incorporates and expands upon data from the Cherrywood Green Routes Network

PFRA. Further review of the flood mapping in the area may be required at preliminary design stage to identify any updates to the flood record. Figure 9-1 overleaf indicates river flood extents modelled in 2022 under Cherrywood Green Routes Project FRA.

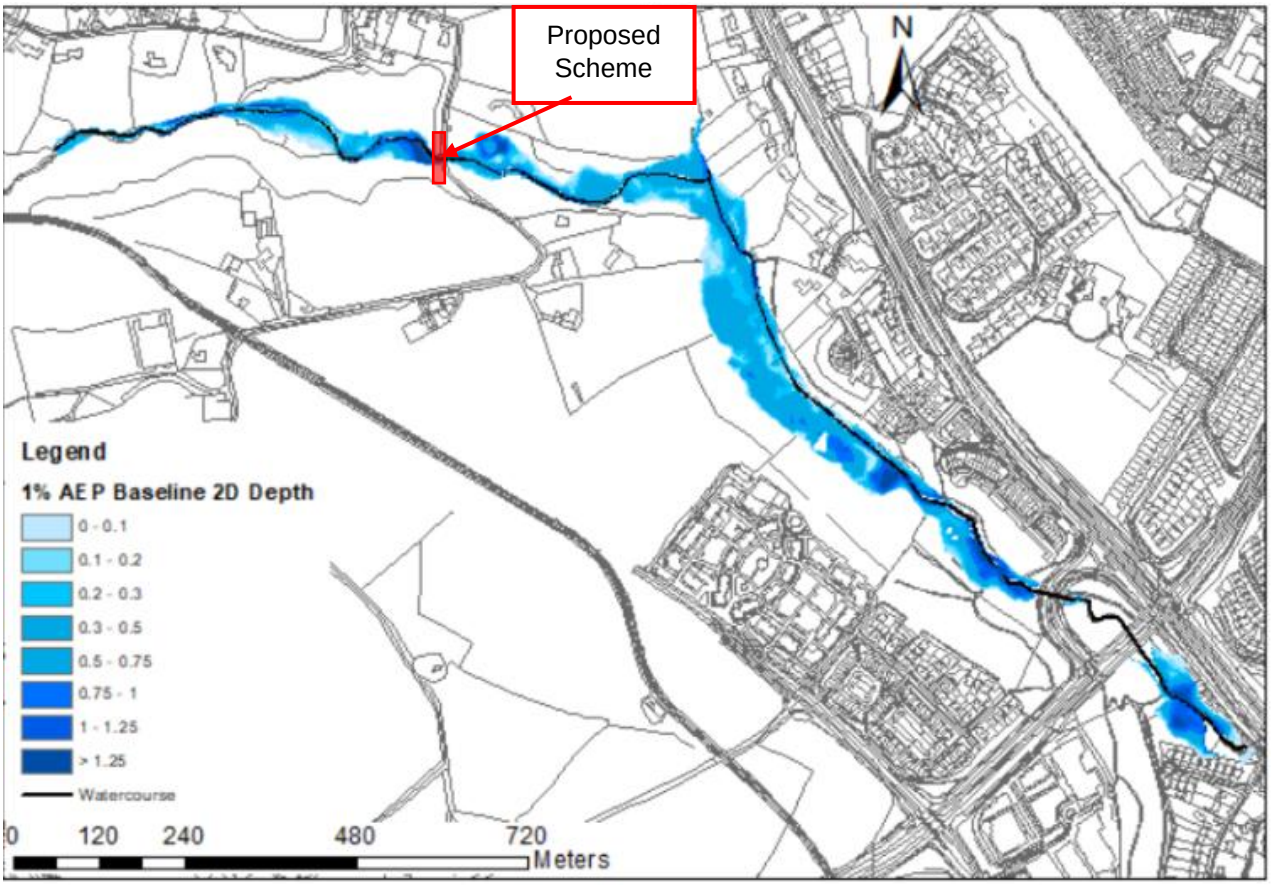

Figure 9-1: Extract of Existing 1% AEP Flood Extent for Cherrywood Green Route Project
(Source: Flood Risk Assessment Report, AECOM, 2022, annotations by Egis Engineering Ireland)

9.3 Section 50

For the proposed bridge over water consent under Section 50 of the Arterial Drainage Act from the Commissioners of Public Works (OPW) will be required to construct, replace, or alter a bridge as there is a potential to change the hydraulic characteristics of a watercourse. The Section 50 application process will need to consider the proposed bridge and the effect on the surrounding hydraulics. The application must consider the 1% AEP or 1 in 100-year fluvial flood levels. It is likely that the Section 50 application process will be straightforward due to the high vertical alignment of the bridge meaning it is unlikely to affect flooding in the area subject to confirmation upon completion of the flood risk assessment process.

SECTION 10: ENVIRONMENTAL EVALUATION

10.1 Introduction

The potential environmental effects of the proposed development must be considered as part of the design. The impacts on human health, biodiversity, the landscape, and climate are just a few of the factors to be considered. The magnitude of the environmental impacts will be related to several factors such as the location, quantity, and choice of materials, span, and structural form etc. Considering the type and location of the bridge options, Biodiversity, Landscape and Visual and Cultural Heritage are considered the most critical elements and are covered in the greatest detail.

10.2 Human Beings

A key objective of the CPS is to provide infrastructure that will improve connectivity and reduce travel time within the Cherrywood SDZ for all transport modes and provide access to services such as employment, education and recreation via a high-level bridge linking Development Area 5 and 1.

Under this criterion the assessment compared the options based on how the designs provided connectivity and accommodated all transport modes including provisions for vulnerable road users, particularly the elderly and people with disabilities. This criterion identifies the potential impact of each proposed option in facilitating a healthier lifestyle, by providing segregated pedestrian and cycling facilities and thereby enabling and encouraging greater active travel and improved opportunities for permeability and local connections.

All four bridge options provide linkage between Development Areas 5 and 1 and provide greater improvements for vulnerable road users by including new segregated footpaths and cycleways and accessible connection to the adjacent Green Routes Linear Park. Therefore, all four bridge options are comparable and scored as ‘not significant or neutral’.

10.3 Waste

Waste is defined under Section 4(1) of the Waste Management Act 1996 (as amended) as any substance or object which the holder discards or intends or is required to discard.

The TII’s ‘Project Appraisal Guidelines for National Roads, Unit 7.0- Multi Criteria Analysis’ (2024) outline the following elements be considered in the options stage 2 waste assessment:

- Offsite disposal of suitable materials;
- Offsite disposal of unsuitable materials; and
- Level contaminated/hazardous material left in situ.

For the Stage 2 assessment, the TII Project Appraisal Guidelines specify that waste is to be assessed as a standalone environmental sub-criterion. Whilst the exact types and quantities of waste are not available at this stage, alignment and bridge options have been developed to a sufficient level of detail to enable preliminary figures for each option. A further detailed consideration of impacts from waste and the potential requirement for mitigation measures will be completed during Phase 3 ‘Design and Environmental Evaluation’ of the Emerging Preferred Option.

Overall, the four bridge options will generate similar volumes of material for disposal offsite. There may be areas of unsuitable material to be disposed of in the form of soft ground surrounding watercourses and contaminated engineering fill within the study area as well as other potential sources of contamination such as construction and demolition waste.

In terms of a road construction project, most naturally occurring materials excavated as part of the works will not be considered a waste where they can be re-used within the works in embankments and other landscaping elements where feasible.

Option 4 is assessed as the best performing option in terms of unsuitable material for disposal offsite, followed by Option 3 and Option 1. Option 2 is assessed as the worst performing. A summary of each option in terms of waste appraisal is provided in Table 10-1 below.

Table 10-1 Preliminary Waste Quantities

Waste Type	Waste Route	Option 1 (tonnes)	Option 2 (tonnes)	Option 3 (tonnes)	Option 4 (tonnes)
Aggregate and Soil Exported Off-Site	Reuse off site	1916.64	2231.68	1804.00	1610.40
Concrete, Brick, Tiles and Ceramics	Reuse off site	308.08	293.72	405.62	247.83
Mixed Construction and Demolition Waste	Landfill	12.19	13.23	16.98	9.48
Mixed Metals	Recycled	8.97	7.76	3.98	1.91

10.4 Climate Change

This assessment has been prepared based on the following TII Climate guidance:

- PE-ENV-01104: Climate Guidance for National Rods, Light Rail and Rural Cycleways (offline & Greenways) – Overarching Technical Document (TII 2022a), and
- PE-ENV-01105: Climate Assessment of Proposed National Roads – Standard (TII 2022b);
- GE-ENV-01106: TII Carbon Assessment Tool for Road and Light Rail Projects and User Guidance Document (TII 2024a).

The climate assessment is split into two aspects, the Greenhouse Gas Assessment (GHGA) (i.e. the impact of the project on climate change) and the Climate Change Risk Assessment (i.e. the impact of climate change on the project) (CCRA). When considering the GHGA construction and operational phases have been considered.

10.4.1 Greenhouse Gas Assessment

With respect to the construction stage, the TII carbon tool (TII 2024a) was completed by the project design team based on information available at this early stage of design, see Table 10-2 below for outputs.

Table 10-2 Embodied Carbon Estimates

Option	Materials	Material Transport (Tonnes CO_2e)	Clearance and Demolition (Tonnes CO_2e)	Land Use Change and Vegetation Loss (Tonnes CO_2e)	Excavation (Tonnes CO_2e)	Construction Waste Disposal (Tonnes CO_2e)	Maintenance Material (Tonnes CO_2e)	Total (Tonnes CO_2e)
1	1,720.63	11.32	0.04	3.53	1.31	1.57	8.71	**1,747.11**
2	1,557.41	13.49	0.04	3.42	1.53	1.66	7.90	**1,585.44**
3	1,150.50	13.63	0.05	3.45	1.24	2.15	7.86	**1,178.88**
4	67.79	7.03	0.05	3.47	1.10	1.27	7.90	**688.61**

Option 4 results in significantly lower carbon when compared to the other options. This includes consideration of the onerous treatment regime and potential replacement of the timber elements on a 5 to 10-year maintenance cycle within the model. Option 1 (three span, low rise bow string arch bridge) is the least preferable option. This construction assessment also considers maintenance during the operational phase for key materials.

During the operational phase the change in vehicle emissions associated with all options is considered equal and therefore operational phase emissions are not a differentiating factor. All options provide the same cross sections for active travel and public transport facilitation and therefore modal shift is not a differentiating factor. Operational phase data is currently unavailable and therefore the impact of traffic emissions associated with the bridge and future associated connecting roads has not been considered.

Table 10-3: Preference Embodied Carbon

Option	Preference
1	4
2	3
3	2
4	1

10.4.2 Climate Change Risk Assessment

When considering the CCRA the sensitivity and exposure of project receptors (i.e. drainage, road surfaces, utilities etc) are considered with respect to potential climate hazards:

- Flooding (coastal, pluvial, fluvial) – including sea level rise and storm surge;
- Extreme heat (including wildfires and drought)– including extreme heat events and increasing temperatures overtime;
- Extreme cold – including frost and snow;
- Extreme wind;
- Lightning and hail;
- Landslides; and
- Fog.

When considering adaptation to climate hazards it is considered that the resilience to wind, fog, soil stability, flood risk and drought are stable across all options given that all options are within the same footprint. Wildfires risk will also be similar across most options however the risk is increased for Option 4.

The impact of material or design choice on the bridges ability to tolerate extreme temperatures must be considered. Some materials are more tolerant to extreme temperatures outside of the standard operating range. However, given the likely requirement ranges for Ireland, which is considered within the European Climate Change Risk Assessment to be in “Northern Europe” it is not expected that our required operational range requirements, even in RCP8.5 (high end future scenario for climate change), will be outside ranges that can be designed for within detailed design.

Given the fact that the footprint of all options is not geographically diverse, there are no significant differentiating factors between options that cannot be resolved at detailed design. All options will be required to assess both RCP4.5 and RCP8.5 (e.g. 30% for flood risk) to ensure the design is compatible as there is a risk of flooding at the proposed bridge location at the Carrickmines river.

10.5 Air Quality

The specific objectives of the air quality assessment at this stage are to determine the existing ambient air quality, the most sensitive receptor locations in proximity to the proposed bridge options, and the predicted

air quality impact as a result of the proposed options. This assessment has been prepared based on the following TII Air Quality guidance:

- PE-ENV-01106: Air Quality Assessment of Specified Infrastructure Projects; (TII 2022a) and
- PE-ENV-01107: Air Quality Assessment Standard for Proposed National Roads (TII 2022b).

The primary aspects of the assessment relate to the existing ambient air quality, proximity of sensitive locations and a review of the overall significance of potential changes in air quality.

Construction phase impacts relate to construction dust. Construction dust related impacts can be mitigated with best practice mitigation measures and are temporary in nature, so are not considered significant for scoring. The Institute of Air Quality Management in the UK (IAQM) guidance document '*Guidance on the Assessment of Dust from Demolition and Construction'* (2024) outlines mitigation measures and determines the level of site-specific mitigation required. Transport Infrastructure Ireland (TII) recommends the use of the IAQM guidance (2024) in the TII guidance document *Air Quality Assessment of Specified Infrastructure Projects – PE-ENV-01106* (TII, 2022a). Construction dust impacts can be mitigated with best practice and therefore their impacts are not a differentiating factor. In addition, as all options have the same footprint and therefore, number of receptors within a 250m boundary with the potential to be affected is not a differentiating factor between options.

During the operational phase the change in vehicle emissions associated with all options is considered equal and therefore operational phase emissions are not a differentiating factor. The bridge will facilitate the construction of the proposed Druids Glen Road crossing the Carrickmines river. A traffic assessment to allow an air quality modelling assessment to be completed is currently not available for the Druids Glen Road.

All options provide the same cross sections for active travel and public transport facilitation and therefore modal shift is not a differentiating factor. Operational phase data is currently unavailable and therefore the impact of traffic emissions at sensitive local receptors as a result of the bridge and future associated connecting roads has not been considered within the options assessment.

Given the nature of the proposed scheme, and based on the available data, all options are ranked equally.

10.6 Noise and Vibration

10.6.1 Operational Phase

From a noise perspective, there is a negligible difference in terms of operational traffic noise emissions between the four bridges options. All options have a similar bridge length and width and, consequently, all options will have very similar noise footprint. Traffic noise along the bridge will be governed by traffic volumes and speed. It is assumed for the purpose of this options selection assessment the same traffic volumes and design speed apply to all options. Given traffic flows will travel across the bridge via the adjoining roads, the influence of traffic noise at the closest noise sensitive locations (NSLs) will be dominated from traffic along the adjoining roads.

There is no operational vibration impacts associated with the bridge options to the surrounding environment.

10.6.2 Construction Phase

The construction phase of all four bridge options will follow a similar methodology requiring foundation excavation, construction of piers and abutments, bridge deck and surfacing, parapets and landscaping works.

Highest noise levels will be associated with foundation excavation works and piling for all bridge phases, with the exception of Option 4 which requires lighter foundations. Whilst there are variations in construction

methodologies and durations between each option, the works are at similar distances from noise sensitive properties and will result in similar, temporary negative effects.

The construction of all bridge options will be required to work within the relevant construction noise and vibration criteria from the TII 2004 and 2014 noise documents and other best practice guidance document (e.g. BS 5228-1 and BS 5228-2 2008 + A1 2014) and, hence assuming all control measures are in place to control noise and vibration at the closest NSLs, this phase of work is deemed to be comparable between each.

Each option has been scored not significant or neutral as none are deemed to result in a more negative or positive effects compared to the other options.

10.7 Biodiversity

The proposed bridge route will pass through one of the Primary Ecological Corridors within the Cherrywood SDZ and abuts woodland habitats (Mixed Broadleaved Woodland and Riparian Woodland) of County importance which include Tufa Springs (Annex I Habitat). See Figure 10-1 below.

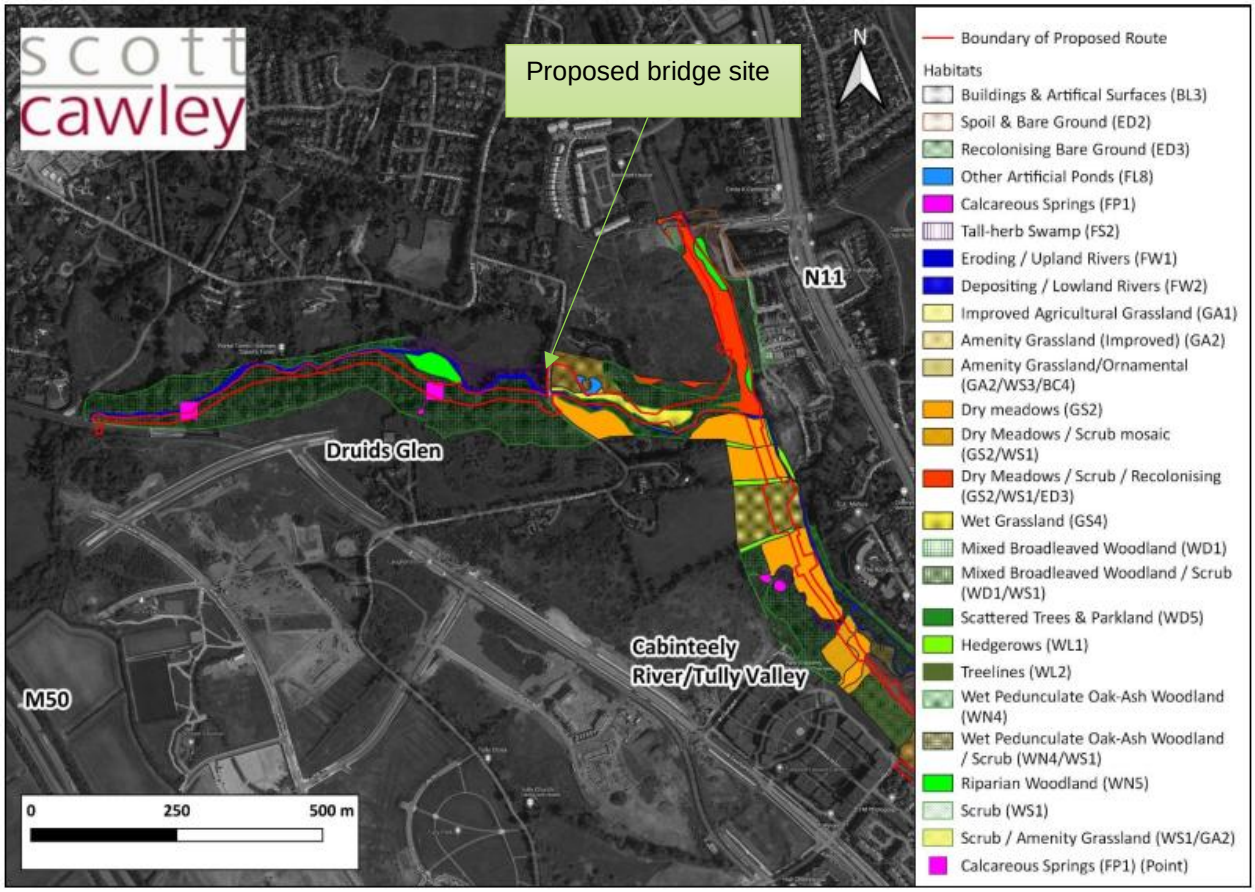

Figure 10-1 **Habitats, classified by Fossitt (2000) along the proposed Cherrywood Green Routes Project (northern section)**.
Source: Ecological Impact Assessment Cherrywood Green Routes Network, Scott Cawley 2022.

Based on the Scott Cawley 2022 Cherrywood Green Routes Project Ecological Impact Assessment (EcIA) the habitats in the vicinity of the bridge works also include Dry Meadows (GS2), Amenity Grassland Ornamental (GA2/WS3/BC4) and Wet Grassland (GS4). A review of previous studies carried out as part of other developments (Planning Files Ref DZ19A/0863, DZ18A/0208, DZ21A/1017) and DLRCC Draft Cherrywood Biodiversity Plan and Ecological Data Sets and Additional Baseline Information 2022 record that the proposed bridge is potentially sited within **a bat foraging corridor** and will cross the Carrickmines

River which is known to have populations of salmonids (trout (*Salmo trutta)*) in addition to otter (*Lutra lutra*). Bats observed in the vicinity of the bridge recorded in the Cherrywood Green Routes Project ECIA surveys included Brown Long-eared Bat, Common Pipistrelle, Soprano pipistrelle, Leisler bat. Furthermore, several trees in the vicinity of the proposed bridge site contain potential bat roost features. Based on the Cherrywood Biodiversity Plan datasets no bat roosts were located at the bridge site. However, four bat roosts were previously observed in 2012 in the vicinity of Glendruid House approximately 100m to the northwest of the bridge location, their continued presence is yet to be confirmed. Otter spraints were previously recorded at the bridge crossing location. **The woodland habitats have previously been known to contain numerous species of breeding bird and bat species**. The invasive species Giant Hogweed has also been recorded within site (Druids Glen Phase 3 Invasive Species Survey and Management Plan, Invas 2024).

A full suite of ecological surveys will be undertaken in 2025-2026 to provide new and up to dated baseline information on the species and habitats within the area of potential influence of the proposed works.

The alignment of the bridge will be the same for all four options and only the design of each bridge option will vary. In relation to the proposed options the following should be noted:

Option 1 – Three span bow string arch bridge

The proposed bridge design for Option 1 does not involve the construction of instream support structures and the supports are set back from the watercourse. It would be expected that the proposed design would allow unhindered movement of both otter and bat species beneath the bridge in addition to unhindered movement of aquatic species during operation. During the construction phase the lack of instream supports would reduce the impacts on the Carrickmines River. The scale of the works zone needs to be detailed and the zone of influence particularly on surrounding woodland would be an important element of the design. It would be expected however that the lack of instream structures would assist on minimising the impact on the woodland during construction as potentially works could proceed from either side of the river and not impact significantly on the woodland area. In relation to lighting and the potential impact on bats, it would be the preferred option not to have the bridge and woodland area lit. However, if this is not possible low-level lighting would be preferred and not to light the structure including the arch or beneath the bridge.

Option 1 would have a reduced impact on biodiversity particularly in relation to the construction elements. However, during the operational phase this bridge option will have structures above the bridge deck which would impact on bat foraging particularly if these elements were lit. Subject to final design and surveys, it would be deemed that this option would have a minor adverse, not significant impact on biodiversity following the implementation of biodiversity-based design e.g. lighting and construction/operational mitigation measures.

Option 2 – Four span girder bridge

The proposed bridge design for Option 2 does not involve the construction of instream support structures. However, the supports are proximate to the watercourse. This option would allow unhindered movement of both otter and bat species beneath the bridge in addition to unhindered movement of aquatic species during operation. During construction the supports proximate to the watercourse would increase the negative impacts on the Carrickmines River. The scale of the works zone needs to be detailed and the zone of influence particularly on surrounding woodland would be an important element of the design. It would be expected that the presence of the additional support would increase the impact on the woodland during construction as potentially works would be required on the valley floor and heavy machinery would be required proximate to the woodland and in the riparian zone. In relation to lighting and the potential impact on bats, it would be the preferred option not to have the bridge and woodland area lit. If this is not possible low-level lighting would be preferred and not to light the structure including beneath the bridge. The lower profile would be more beneficial to bats due to the lack of structures above the deck of the bridge.

Option 2 has structures proximate to the watercourse and would be suboptimal from an ecological perspective particularly in relation to potential impacts on aquatic biodiversity. In addition, it would be expected that the construction of structures proximate to the watercourse would result in an increased footprint in the vicinity of the woodland and riparian corridor, primarily due to getting bridge elements in

place. Subject to final design and surveys, it would be deemed that this option would have a moderate adverse, not significant impact on biodiversity following the implementation of biodiversity-based design e.g. lighting and construction/operational mitigation measures.

Option 3 – Three span extradosed bridge

The proposed bridge design for Option 3 does not involve the construction of instream support structures. However, the southern support structure is proximate to the watercourse. It would be expected that the proposed design would allow unhindered movement of both otter and bat species beneath the bridge in addition to unhindered movement of aquatic species during operation. During construction the lack of instream supports would reduce the impacts on the Carrickmines River. The scale of the works zone needs to be detailed and the zone of influence particularly on surrounding woodland would be an important element of the design. It would be expected however that the lack of instream structures would assist on minimising the impact on the woodland during construction as potentially works could proceed from either side of the river and not impact significantly on the woodland or riparian area. In relation to lighting and the potential impact on bats, it would be the preferred option not to have the bridge and woodland area lit. However, if this is not possible allow level lighting would be preferred and not to light the structure including the cable structures or beneath the bridge.

Option 3 would have a reduced impact on biodiversity particularly in relation to the construction elements. However, during the operational phase this bridge option will have structures above the bridge deck which would impact on bat foraging particularly if these elements were lit. Subject to final design and surveys, it would be deemed that this option would have a minor adverse, not significant impact on biodiversity following the implementation of biodiversity-based design e.g. lighting and construction/operational mitigation measures.

Option 4 – Four span timber girder bridge

The proposed bridge design for Option 4 does not involve the construction of instream support structures. This option would allow unhindered movement of both otter and bat species beneath the bridge in addition to unhindered movement of aquatic species during operation. During construction the supports proximate to the watercourse would increase the negative impacts on the Carrickmines River. The scale of the works zone needs to be detailed and the zone of influence particularly on surrounding woodland would be an important element of the design. It would be expected that the presence of structures near the watercourse would increase the impact on the woodland during construction as potentially works would be required on the valley floor and heavy machinery would be required proximate to the woodland and in the riparian zone. In addition, the wooden structure may result in increased operational maintenance. In relation to lighting and the potential impact on bats, it would be the preferred option not to have the bridge and woodland area lit. if this is not possible allow level lighting would be preferred and not to light the structure including beneath the bridge. The lower profile would be more beneficial to bats due to the lack of structures above the deck of the bridge.

Option 4 has structures proximate to the watercourse and would be suboptimal from an ecological perspective particularly in relation to potential impacts on aquatic biodiversity during construction. In addition, it would be expected that the construction of structures proximate to the watercourse would result in an increased footprint in the vicinity of the woodland and riparian corridor, primarily due to getting bridge elements in place. Subject to final design and surveys, it would be deemed that this option would have a moderate adverse, not significant impact on biodiversity following the implementation of biodiversity-based design e.g. lighting and construction/operational mitigation measures.

Summary

The proposed bridge location is within an ecologically sensitive area of the Cherrywood SDZ. The retention of biodiversity elements in the vicinity of the bridge is an important element of compliance with the CPS as well as National and International legislation. Construction and operational impacts on ecology need to be minimised. Options 2 and 4 both have structures proximate to the watercourse and would be suboptimal from an ecological perspective particularly in relation to potential impacts on aquatic biodiversity. In addition,

it would be expected that the construction of structures proximate to the watercourse would result in an increased footprint in the vicinity of the woodland and riparian corridor, primarily due to getting bridge elements in place. Options 1 and 3 would have a reduced impact on biodiversity particularly in relation to the construction elements. However, during the operational phase these bridge options have structures above the bridge deck which would impact on bat foraging particularly if these elements were lit. It would be preferable if all options remained unlit. If lighting is required, it would be preferable not to light the structure and to keep lighting level low. The impact of the chosen option will be assessed in more detail at preliminary design stage from the perspective of impact on bat species.

10.8 Hydrology and Hydrogeology

All four bridge options are assessed based on their impact on the Surface Water features, quality, quantity and Groundwater resources, quality and quantity.

The four proposed bridge options lie within the Dargle_SC_010 WFD subcatchment. Carrickmines stream flows in easterly and south easterly direction before discharging into Shanganagh River and pNHA c.1.5 km southeast of the proposed bridge locations. The Shanganagh River flows in an easterly direction and in turn falls into the Irish sea c. 1.5km east.

The WFD River Body Quality Status 2016-2021 of Carrickmines Stream (including its distributaries i.e. Cabinteely and Loughlinstown streams) and Shanganagh River is Assigned to be of 'Good Status' (EPA, 2025).

The Rockabill to Dalkey Island SAC and Dalkey Islands SPA are located c. 4.5 km east of the proposed bridge locations (NPWS, 2025).

The four proposed bridge options lie within Wicklow Groundwater Body. The bedrock aquifer underlying all options is classified as 'Poor Aquifer - Bedrock which is Generally Unproductive except for Local Zones' (GSI, 2025).

The WFD Groundwater Body Quality Status 2016-2021 underlying the four proposed bridge options is assigned to be of 'Good Status' (EPA, 2025)

No groundwater wells, springs or drinking water protection areas are identified in the vicinity of the four proposed bridge options.

The Cherrywood Biodiversity Plan (2014) and the Cherrywood Green Routes Network Hydrogeological and Hydrological Risk Assessment (Aecom 2022) identify a number of tufa-forming springs present in the Study Area.

This habitat type was found in four locations within the SDZ lands. Due to its level of ecological importance at a County-level this habitat was subject to a specialist survey. One known Tufa Spring is located within Druid's Glen (*c.* 400m to the west of the proposed bridge); two other springs are located to the south (*c.* 400m to the south of the proposed bridge).

A summary of the location and habitat is provided below:

Upper Druid's Glen Spring: This spring within Druid's Glen was highly calcareous and marl producing. Plant cover was low in the spring, but there were scattered plants of Opposite-leaved Golden-saxifrage *Chrysosplenium oppositifolium* and the bryophytes *Palustriella commutata, Cratoneuron filicinum, Plagiomnium ellipticum* and *Pellia endiviifolia*. This flowed down the bank in several channels and fed into an area of wet woodland by the river. The calcareous spring was also of high, local conservation value but was not considered to be an example of the Annex I habitat 'Petrifying springs with tufa formation' due to the low cover of bryophytes and vascular plants. Please refer to the Druids Glen Road Phase 3 –

Cherrywood Constraints Reports for Tufa Spring locations and more information (Egis, 2024). The locations of Tufa Springs are not directly impacted by any of the 4 bridge options. Further assessment will be carried out during the preliminary design stage.

The impact assessment for hydrology is set out in Table 10-4 below.

Table 10-4 Hydrology Impact Assessment

Option	Attribute	Attribute Importance	Impact	Level of Impact
1	Dalkey Islands SAC/SPA	Extremely High	Potential temporary indirect impact to surface water quality (small proportion of attribute).	Moderate Negative
	Carrickmines Stream	Medium	Potential temporary direct impact to Carrickmines stream (small proportion of attribute).	Minor Negative
	Shanganagh River	Medium	Potential temporary indirect impact to Shanganagh River (small proportion of attribute).	Minor Negative
	Flood Plains- Fluvial Flooding	Medium	The area along the bank of the Carrickmines Stream is identified to be at risk of potential flooding (1 in 100-year event). The extent of the flood risk area varies (permanent impact on small proportion of attribute).	Minor Negative
2	Dalkey Islands SAC/SPA	Extremely High	Potential temporary indirect impact to surface water quality (small proportion of attribute).	Moderate Negative
	Carrickmines Stream	Medium	Potential temporary direct impact to Carrickmines stream (small proportion of attribute).	Minor Negative
	Shanganagh River	Medium	Potential temporary indirect impact to Shanganagh River (small proportion of attribute).	Minor Negative
	Flood Plains- Fluvial Flooding	Medium	The area along the bank of the Carrickmines Stream is identified to be at risk of potential flooding (1 in 100-year event). The extent of the flood risk area varies (permanent impact on small proportion of attribute).	Minor Negative
3	Dalkey Islands SAC/SPA	Extremely High	Potential temporary indirect impact to surface water quality (small proportion of attribute).	Moderate Negative
	Carrickmines Stream	Medium	Potential temporary direct impact to Carrickmines stream (small proportion of attribute).	Minor Negative
	Shanganagh River	Medium	Potential temporary indirect impact to Shanganagh River (small proportion of attribute).	Minor Negative
	Flood Plains- Fluvial Flooding	Medium	The area along the bank of the Carrickmines Stream is identified to be at risk of potential flooding (1 in 100-year event). The extent of the flood risk area varies (permanent impact on small proportion of attribute).	Minor Negative
4	Dalkey Islands SAC/SPA	Extremely High	Potential temporary indirect impact to surface water quality (small proportion of attribute).	Moderate Negative
	Carrickmines Stream	Medium	Potential temporary direct impact to Carrickmines stream (small proportion of attribute).	Minor Negative
	Shanganagh River	Medium	Potential temporary indirect impact to Shanganagh River (small proportion of attribute).	Minor Negative

Option	Attribute	Attribute Importance	Impact	Level of Impact
	Flood Plains- Fluvial Flooding	Medium	The area along the bank of the Carrickmines Stream is identified to be at risk of potential flooding (1 in 100-year event). The extent of the flood risk area varies (permanent impact on small proportion of attribute).	Minor Negative

The Impact Assessment for Hydrogeology is presented in the Table 10-5 below

Table 10-5 Hydrogeology Impact Assessment

Option	Attribute	Attribute Importance	Impact	Level of Impact
1	Dalkey Islands SAC/SPA	Extremely High	Potential temporary impact to surface water quality (small proportion of attribute) via. groundwater pathway.	Moderate Negative
	Poor Bedrock Aquifer	Low	Potential permanent impact to PI aquifer quality (small proportion of attribute).	Minor Negative
2	Dalkey Islands SAC/SPA	Extremely High	Potential temporary impact to surface water quality (small proportion of attribute) via. groundwater pathway.	Moderate Negative
	Poor Bedrock Aquifer	Low	Potential permanent impact to PI aquifer quality (small proportion of attribute).	Minor Negative
3	Dalkey Islands SAC/SPA	Extremely High	Potential temporary impact to surface water quality (small proportion of attribute) via. groundwater pathway.	Moderate Negative
	Poor Bedrock Aquifer	Low	Potential permanent impact to PI aquifer quality (small proportion of attribute).	Minor Negative
4	Dalkey Islands SAC/SPA	Extremely High	Potential temporary impact to surface water quality (small proportion of attribute) via. groundwater pathway.	Moderate Negative
	Poor Bedrock Aquifer	Low	Potential permanent impact to PI aquifer quality (small proportion of attribute).	Minor Negative

All four proposed bridge options are comparable based on baseline environment and potential impact on the attributes. Option 1 and Option 3 are slightly better than Option 2 and Option 4 solely based on the additional pier leading to potential impact on surface water of Carrickmines stream and groundwater quality due to extra excavation, proximity to the stream and introduction of additional concrete.

10.9 Soils and Geology

All four bridge options are assessed based on their impact on the underlying soils, subsoils and geology. The soils underlying all four proposed bridge options is described as well drained mineral soils and alluvium in the vicinity of the Carrickmines Stream (EPA, 2025) while the subsoils are identified as Tills from Limestone in the northern part of the bridge, Alluvium and Shallow Bedrock Outcrops in the central portion of the bridge around the Carrickmines Stream and Gravels from Granite in the southern section of the bridge (GSI, 2025). The Bedrock is identified as Pale, fine to coarse grained Granite beneath the proposed bridge with No identified Karst Landforms in the vicinity. The geological mapping is consistent with the historic ground investigation carried out in the surrounding area.

The Landslide Susceptibility Classification underlying the proposed bridge options ranges between ‘Low’ to ‘Moderately High’. Low susceptibility is classified for the northern and Central section of the proposed bridge while Moderately Low and Moderately High is identified in the southern section of the proposed bridge.

Groundwater Vulnerability Mapping underlying the proposed bridge options ranges between 'Extreme' and 'Rock at or near Surface or Karst' indicating shallow bedrock between 0-3 m bgl.

The impact assessment on soil and geology is summarised in Table 10-6 below:

Table 10-6: Summary of Bridge Impacts on Soil and Geology

Option	Attribute	Attribute Importance	Impact	Level of Impact
1	Well drained Soils	High	Loss of well drained and highly fertile soils along the proposed bridge	Minor Negative
	Rock/Alluvium	Medium	Rock/Alluvium requiring Excavation	Minor Negative
2	Well drained Soils	High	Loss of well drained and highly fertile soils along the proposed bridge	Minor Negative
	Rock/Alluvium	Medium	Rock/Alluvium requiring Excavation	Minor Negative
3	Well drained Soils	High	Loss of well drained and highly fertile soils along the proposed bridge	Minor Negative
	Rock/Alluvium	Medium	Rock/Alluvium requiring Excavation	Minor Negative
4	Well drained Soils	High	Loss of well drained and highly fertile soils along the proposed bridge	Minor Negative
	Rock/Alluvium	Medium	Rock/Alluvium requiring Excavation	Minor Negative

All four proposed bridge options are comparable based on baseline environment, the likely foundation solutions (shallow foundations or combination of shallow and piled foundation) and the resulting potential impact on the attributes. Option 1 and Option 3 are slightly better than Option 2 and Option 4 solely based on the additional pier leading to extra excavation, loss of well drained minerals and introduction of additional concrete.

10.10 Landscape and Visual

10.10.1 Assessment Methodology

The assessment is based on the recommendations in the guidelines from the Landscape Character Assessment (LCA) and Landscape and Visual Impact Assessment (LVIA) of Specified Infrastructure Projects - Overarching Technical Document[2] and Proposed National Roads - Standard[3] and the Guidelines for Landscape and Visual Impact Assessment (GLVIA) as published by the Landscape Institute (UK) and the Institute of Environmental Management and Assessment (3rd Edition, 2013)[4], The assessment also considers the Cherrywood Strategic Development Zone (CSDZ) objectives and landscape character assessment within the DLRCC County Development Plan 2022-2028

To evaluate potential impacts to the existing landscape and visual amenity, this stage's assessment involved:

- A desktop study of the proposed bridge options to establish the baseline conditions and with a focus on impacted landscape designations, as well as environmental and heritage designations;

[2] TII Publications, December 2020. *Landscape Character Assessment (LCA) and Landscape and Visual Impact Assessment (LVIA) of Specified Infrastructure Projects - Overarching Technical Document*, PE-ENV-01101

[3] TII Publications, December 2020. *Landscape Character Assessment (LCA) and Landscape and Visual Impact Assessment (LVIA) of Proposed National Roads - Standard*, PE-ENV-01102

4 Landscape Institute and Institute of Environmental Management & Assessment, 2013. Guidelines for Landscape and Visual Impact Assessment 3rd Edition. Routledge

- A site and photographic survey to further determine any potential effects of the proposed bridge options and the degree to which they would be visible in the landscape;
- A desktop count of the potentially impacted receptors;
- An assessment of the impact of the proposed bridge options to protected views and amenity; and
- An overall assessment and ranking of the bridge options based on these criteria and the ranking system provided for the stage.

10.10.2 Definition of Study Area

The study area for the Landscape and Visual assessment has been defined by the 500m from the red line boundary of the proposed option and is shown in each option evaluation section. The study area of the assessment included the entire character of the land take of all options. It is expected that the visual effects of the proposed development can extend outside the study area. For these receptors the effect is expected to be insignificant and have therefore been excluded from this assessment.

10.10.3 Impacts on Setting

This assessment evaluates a site's sensitivity to the impacts of the proposed project on the landscape and the visual amenity. The criteria for the assessment are:

Landscape Impact Assessment Criteria

When assessing the potential impacts on the landscape resulting from the proposed project, the following criteria are considered:

- Landscape character sensitivity; and
- Magnitude of likely impacts

Visual Impact Assessment Criteria

When assessing the potential impacts on the visual amenity resulting from the proposed project, the following criteria are considered:

- Visual receptor sensitivity; and
- Magnitude of likely impacts.

Limitations to and Exclusions from the Assessment

The assessment was desktop based and limited to the extent of the 500m study area surrounding the edge of the proposed bridge options. The following key characteristics specified within TII LCA and LVIA of Proposed National Roads - Standard (PE-ENV-01102, December 2020) have not been taken into consideration at this stage This outstanding information will be progressed and assessed during preliminary design stage:

- extent and scope of proposed illumination; and
- arboricultural impact assessment.

For the purposes of this assessment direct accesses or local road junctions to the proposed scheme are not considered. Also, for the purposes of this assessment it is assumed that as per the CPS any proposed lighting will be sympathetic to the ecological sensitivities of the area and therefore any proposed lighting will be low level and limited. Regarding the arboricultural impact, this assessment considers that any removed vegetation negatively impacting views will be mitigated in the immediate surrounding of the proposed option, as stated in the Druids Glen Phase 3 Tree Survey Report (Veon, 2024).

10.10.4 Existing Environment – Baseline description

TII Publication PE-ENV-01102[5] requires the provision of specific baseline with a refined description of the Landscape Character Types and Areas that the proposed development falls within as well as of the Views affected by the proposed development. The Constraints Report for Druids Glen Road (24404-BTL-EN-XX-DO-EN-00003_Constraints_Repor) details the receiving environment and protected views as stated in the Cherrywood Planning Scheme and DLRD CP 2022-2028. Additionally, to these constraints, this evaluation provides further detail on the existing public visual amenity and the impact of the proposed development to it.

Landscape Character

Dun Laoghaire Rathdown CDP 2022 – 2028

The CDP 2022-2028 sets out a number of objectives regarding landscape character including:

- GIB2: It is a Policy Objective to continue to protect, manage and plan to conserve, maintain or enhance the distinctive characteristics of the County's landscapes, townscapes and seascapes.
- GIB6: Views and Prospects - It is a Policy Objective to preserve, protect and encourage the enjoyment of views and prospects of special amenity value or special interests, and to prevent development, which would block or otherwise interfere with Views and/or Prospects.

The proposed development lies within the LCA 14. Cherrywood/Rathmichael. According to the CDP, "*this area was originally outlined in the Landscape Character Assessment Study as it was an area undergoing significant change with the introduction of the Luas B1 line and the development of the Cherrywood Science and Technology Park. This area is now subject to the Cherrywood Strategic Development Zone (SDZ) Planning Scheme which was adopted by An Bord Pleanála in April 2014"*.

The strategy for this particular area notes that development within the Cherrywood/ Rathmichael area shall take account of the features of landscape importance within the area. These include the sylvan nature of the area that enhances the protection of deciduous tree belts and having regard to the recommendations and findings of the Historic Landscape Character Assessment for Rathmichael.

Cherrywood SDZ Planning Scheme

The Cherrywood Planning Scheme (CPS) recognises existing watercourses along the boundary of the Cherrywood SDZ as significant landscape features. Existing watercourses include the Carrickmines Stream, the Loughlinstown River and the Bride's Glen River.

With regards to visual amenity, the CPS states that the CSDZ should "*ensure the incorporation of key vantage points and panoramas to create a sense of place, coherence and appreciation for the overall setting and context of Cherrywood. […] existing viewpoints in the Planning Scheme should be protected*".

Section 2.11 of the Cherrywood SDZ Planning Scheme outlines constraints regarding views and prospects. Developments must protect and enhance key views and panoramas to key local vantage points, local skylines and civic buildings in the surrounding area. This includes the protection of the important internal view from Lehaunstown Village and its environs towards Tully Church and the Druid's Glen Buffer and Tree canopy and Lehaunstown Lane and the local skyline views across the northern and southern edges

[5] TII Publications, December 2020. *Landscape Character Assessment (LCA) and Landscape and Visual Impact Assessment (LVIA) of Specified Infrastructure Projects - Overarching Technical Document*, PE-ENV-01101

of Druid's Glen and the Glenamuck Stream (northern section of the Plan Area). These constrains ensure the preservation of significant landscape features.

Glendruid is a Georgian House set on an elevated site between Brennanstown Road and Lehaunstown Lane. Its elevated position offers views to the south over Carrickmines River Valley, which are protected under the CPS. Its extensive grounds include mature woodland, trees and hedgerows. The protected structure is located within the Cherrywood SDZ Planning Scheme area and adjacent to the Proposed Development. The CPS highlights the need for the protection of the architectural and natural heritage of the site, the setting and the southern views from the house. It also states that the sitting of new development is to be informed by the topography and existing landscape character of the valley and the importance of how Glendruid (and Brennanstown House) are viewed from outside the site including from Lehaunstown Lane.

The wooded area to the south of Druid's Glen serves as ecological buffer area in compliance with the Cherrywood SDZ Biodiversity Plan. The buffer aims to prevent visual and light disturbance, to control of use of the woodland and physical protection including disturbance during the construction phase that the space provides.

Protection and retention of existing semi-mature and mature woodland and vegetation during construction works in accordance with BS 5837:2012 will be essential to retaining the local landscape and visual character along the Proposed Development. Refer to Section 3.4 for details of Woodland Habitats & Retained Habitats in Natural Greenspace.

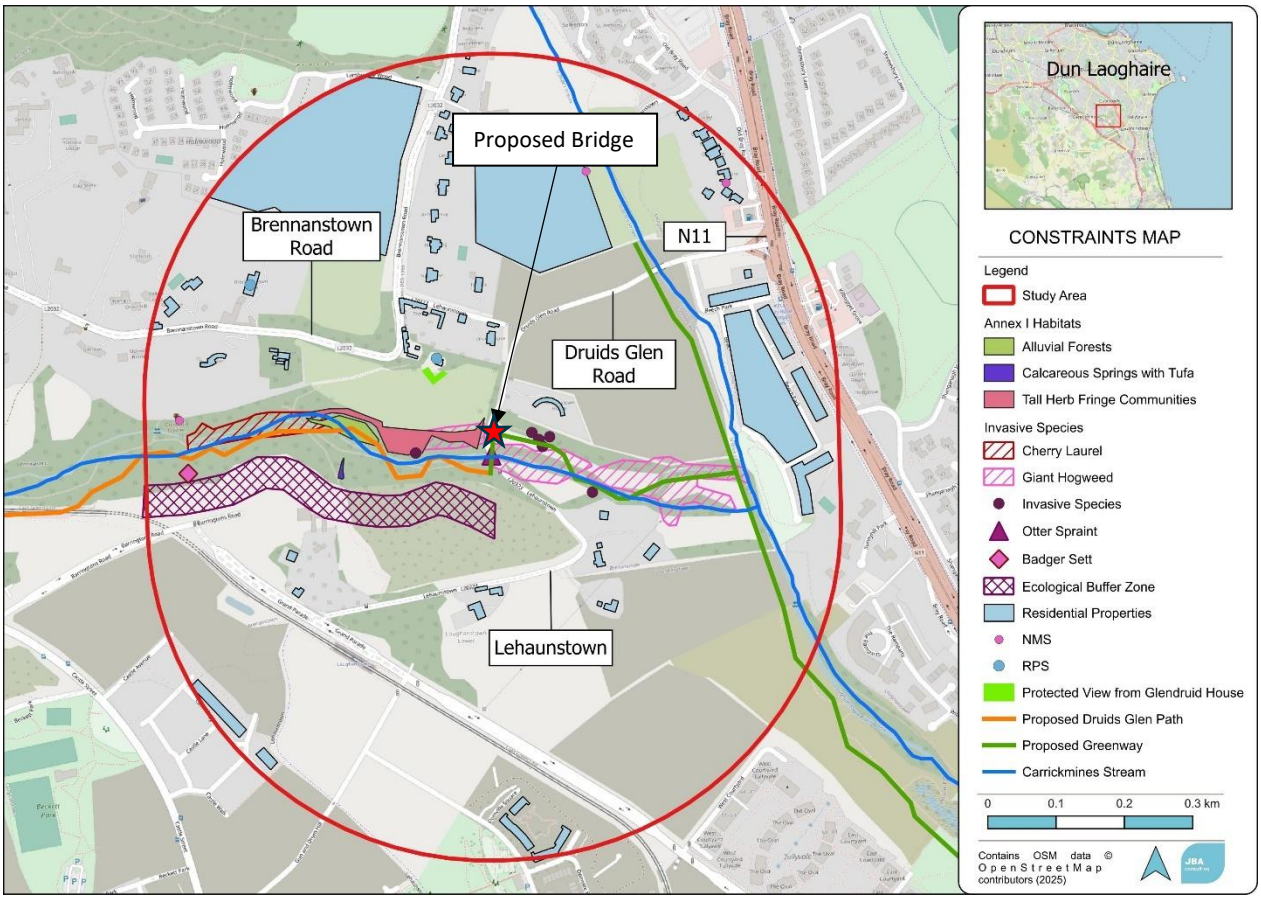

Figure 10-2: Landscape Constraints and Designated Landscape Features

Other elements influencing the Landscape Character

The TII guidelines require that important Biodiversity and Cultural Heritage elements highlighted in the respective sections inform the landscape assessment. In addition to formal designations at international, national and local level, the Guidelines for Landscape and Visual Impact Assessment (2013), recommend the use of a number of criteria which can help to assess landscape values. These include the Landscape Quality/Condition, Biodiversity, Cultural Heritage, Scenic Quality, Rarity, Perceptual aspects and Recreation Value. Biodiversity and Cultural Heritage are considered further below. Landscape Quality/Condition, Scenic Quality, Rarity, Perceptual aspects and Recreation Value are considered where appropriate within the assessment.

Biodiversity

The study area is part of the Primary Ecological Corridor P1. Carrickmines - Druid's Glen woodland – Carrickmines River Valley. Although it does not contain sites protected under international legislation, a number of nationally important Annex 1 habitats have been identified in the surrounding area. These include alluvial woodland, tufa springs and hydrophilous tall herb fringe. Existing hedgerows and treelines are to be retained as proposed in the CPS.

The presence of otters, badgers and other vertebrates increase value of the local landscape. At the same time, the presence of non-native invasive plant species poses a threat to the local biodiversity. These species include, Giant hogweed, Cherry laurel and Rhododendrons. Appropriate management has been included in the Invasive Species Management Plant prepared as part of the Cherrywood Green Route Network Project for DLRCC.

Archaeology, Architectural and Cultural Heritage

The following designations have been identified in the vicinity of the proposed development: Brennanstown Dolmen / Portal tomb (DU026-007), Standing stone (DU026-118), Fulacht Fiadh (DU026-159), Watermill (DU026-080001/2), Enclosure (DU026-006). The Brennanstown Dolmen is still accessible today and visited by local groups.

Glendruid, its entrance gates and boundary wall are of historical value. The wall and gates, which are of significant architectural and technical merit, should be considered and any proposed development should use materials that harmoniously integrate with the present ones.

10.10.5 Visual amenity

The site of the proposed development stands within a well enclosed location. The visual envelope is restricted by the Cherrywood buffer vegetation to the south and the tree lined hedgerows along Brennanstown Road and Lehaunstown Lane. The landform-built environment and existing vegetation allow limited mid-range views from Brennanstown Road to the Dublin mountains to the southwest. All other views are restricted within the local visual envelope of the valley.

The main visual receptors in the study area are the current and future residents regarding the lands around Glendruid and Lehaunstown houses that are directly to the north of the proposed development, and the residents of the properties along Lehaunstown Lane to the south. Other receptors would be the users of the dirt tracks along the valley and motorists, walkers and cyclists on the roads.

A protected view has been identified from the Glendruid house. This view is from the Georgian house looking south towards the valley and Cherrywood. Other protected views from the DLRCC DP and the CPS have been scoped out of this assessment. As stated in the methodology, visual impact arising from the proposed development outside the study area are expected to be insignificant.

10.10.6 Bridge Options

The four viable bridge options are:

- Option 1 – Three span bow string arch bridge
- Option 2 – Four span girder bridge
- Option 3 – Three span extradosed bridge
- Option 4 – Four span timber girder bridge

These are further described in more detail in Section 3 of this report.

The main differences between the Options that are relevant to the Landscape and Visual amenity are summarised in Table 10-7 below:

Table 10-7: Summary of Options

	Max height above deck (m)	Number of Piers	Width (m)	Finish
Option 1	7	2	21.5	Steel and concrete
Option 2	1.1	3	18.5	Steel and concrete
Option 3	6.5	2	19.5	Steel and concrete
Option 4	1.1	3	18.5	Timber

Options 2 and 4 are fully supported by three piers below the deck. This means that the tallest immobile elements of these two Options are the protective railings of the bridge. Options 1 and 3 have immobile structural elements extending higher than that. The steel arches of Option 1 and the pylons of Option 3 extend 7m and 6.5m above the bridge deck respectively.

Options 1 and 3 require two piers below the deck of the bridge while Options 2 and 4 require three piers.

Between Options 2 and 4 the main difference is the finish. Option 2 is concrete while Option 4 includes a number of timber features above as well as below the bridge deck.

10.10.7 Impact to Landscape Character and Visual Amenity

Common impacts across all Options

The differences between the Options are such that deriving impacts on the landscape character are expected to be varying only slightly between the Options. During construction, all options are expected to have a moderate to significant negative impact to the protected view from Glendruid House. Appropriate mitigation measures should be investigated to reduce these. Indicatively, advanced planting of semi-mature trees in the direction of the works is an effective means to reduce such impacts.

The removal of any existing vegetation along Lehaunstown Lane is expected to be mitigated with new planting. Even then, the impacts arising in the operational phase are expected to be short to mid-term.

Options with taller structural elements are expected to have reversible, mid- to potentially long-term to permanent residual impacts to close, direct views.

Motorists and other users of the roads are expected to have their amenity improved by all options. This is due to the improvement in safety and possibility to have momentary glimpses of the Glendruid house and over the valley below them.

The landscape and visual amenity offered to visitors to the Brennanstown Dolmen are not expected to be affected by any of the proposed Options. This is due to the main views being directed to the north and west, in the opposite direction of the proposed development. The retained vegetation to the east and south of the dolmen is expected to provide sufficient screening from the works and operational phase of the bridge.

All the footpaths along the valley are expected to have restricted access during construction. During the operational phase all options will provide similar access to the surrounding greenways. Therefore, the amenity offered by the landscape to this receptor group is not expected to be impacted negatively by any Option.

The visual amenity of this receptor group is expected to be very locally affected negatively. The overall impact is not expected to be significant. The option with the lesser negative impact is expected to be Option 4 due to the timber finish that is considered closer to the sylvan character of the valley.

Zone of Theoretical Visibility

The Zone of Theoretical Visibility (ZTV) represents the area over which the Options can theoretically be seen and is based on a Digital Terrain Model (DTM), overlaid on a map base.The GLVIA suggest the use of bare earth topographical datai.e., visibility of the Options in a landscape without screening structures or vegetation. This includes trees, hedgerows, buildings and small-scale landform or ground surface features. The ZTV also does not take into account the effects of weather and atmospheric conditions and therefore can be said to represent a ‘worst-case’ scenario, that is where the Options could potentially be seen given no intervening obstructions and favourable weather conditions.

In addition to the ZTV based on DTM, a visual influence map has been produced using topographic data that include existing vegetation and built environment, (Digital Surface Model – DSM). The zone of visual influence is more representative of the existing visibility, especially during the summer when deciduous vegetation is present. For the calculation of the ZTV and the visual influence map that are comparable between all Options, five points were selected:

- The first point is at the chainage of the highest point of Option 1;
- The second and third points are at the chainages of the highest points of Option 3;
- The fourth and fifth points are at the chainages of the tie in points of all Options.

The ZTV and zone of influence maps for each Option are below.

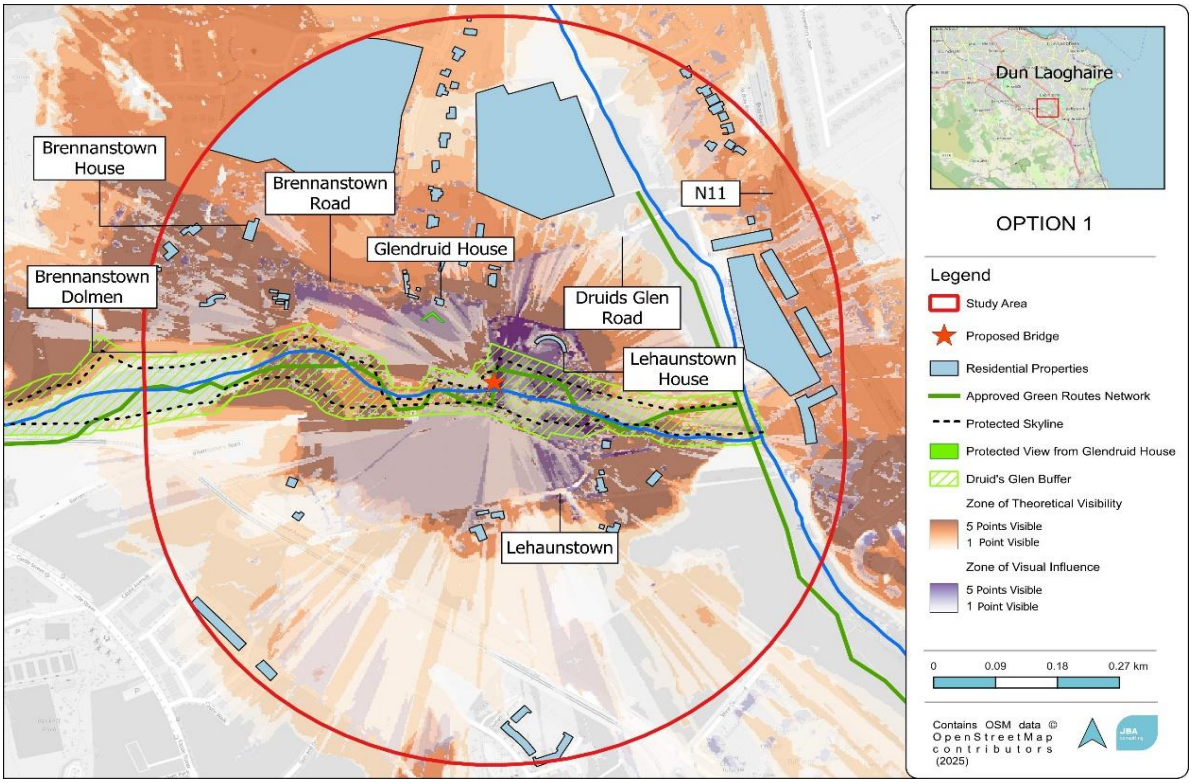

Figure 10-3: Option 1 – ZTV and zone of visual influence

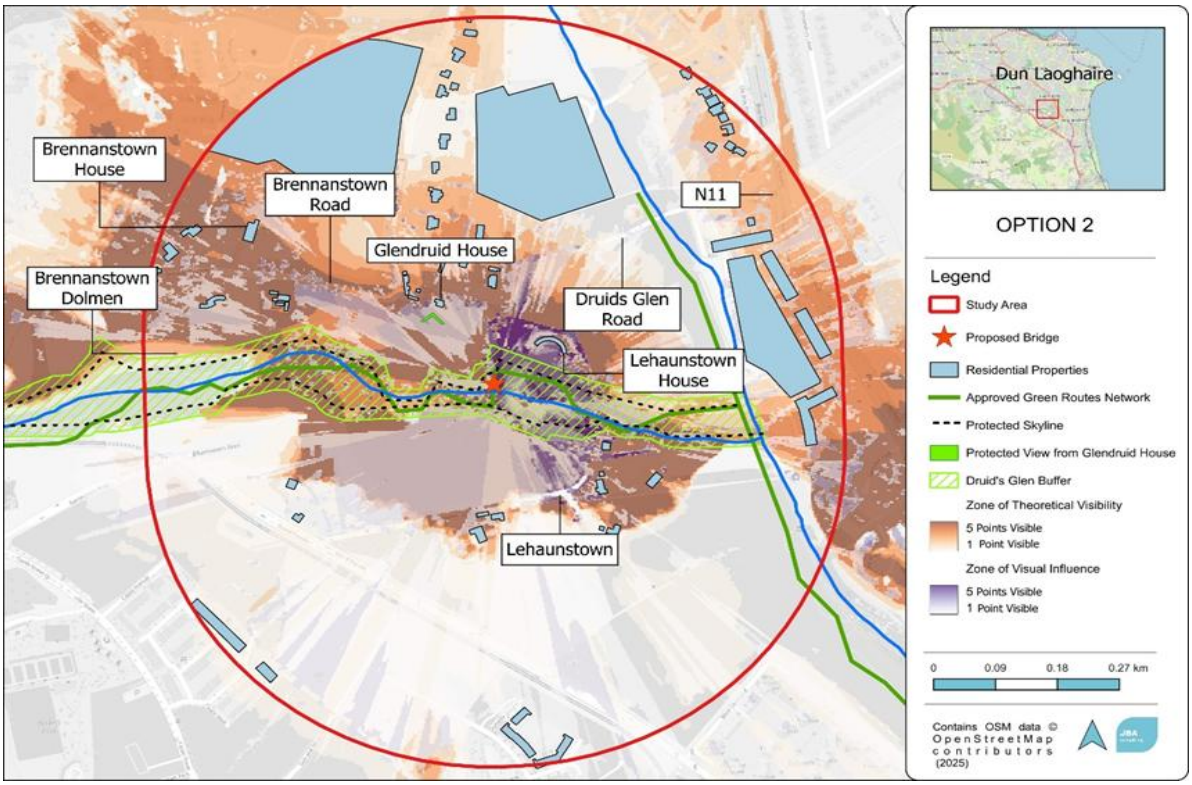

Figure 10-4: Option 2 – ZTV and zone of visual influence

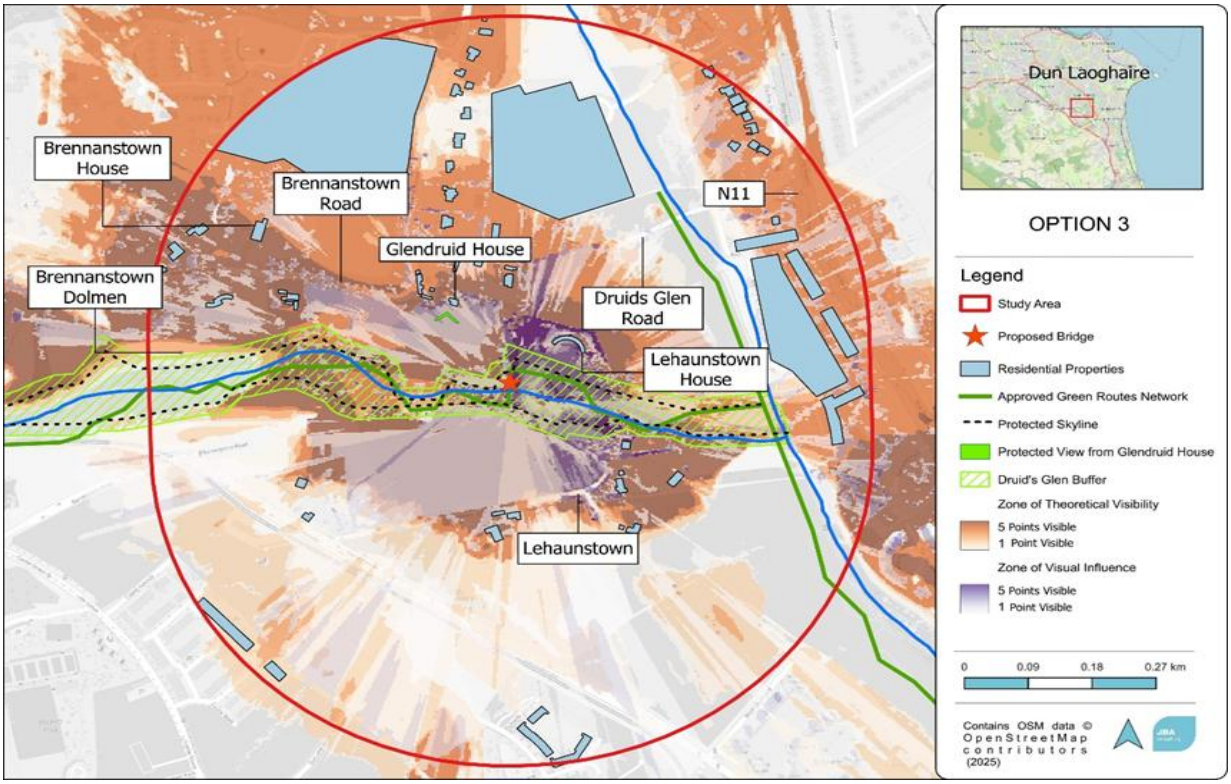

Figure 10-5: Option 3 – ZTV and zone of visual influence

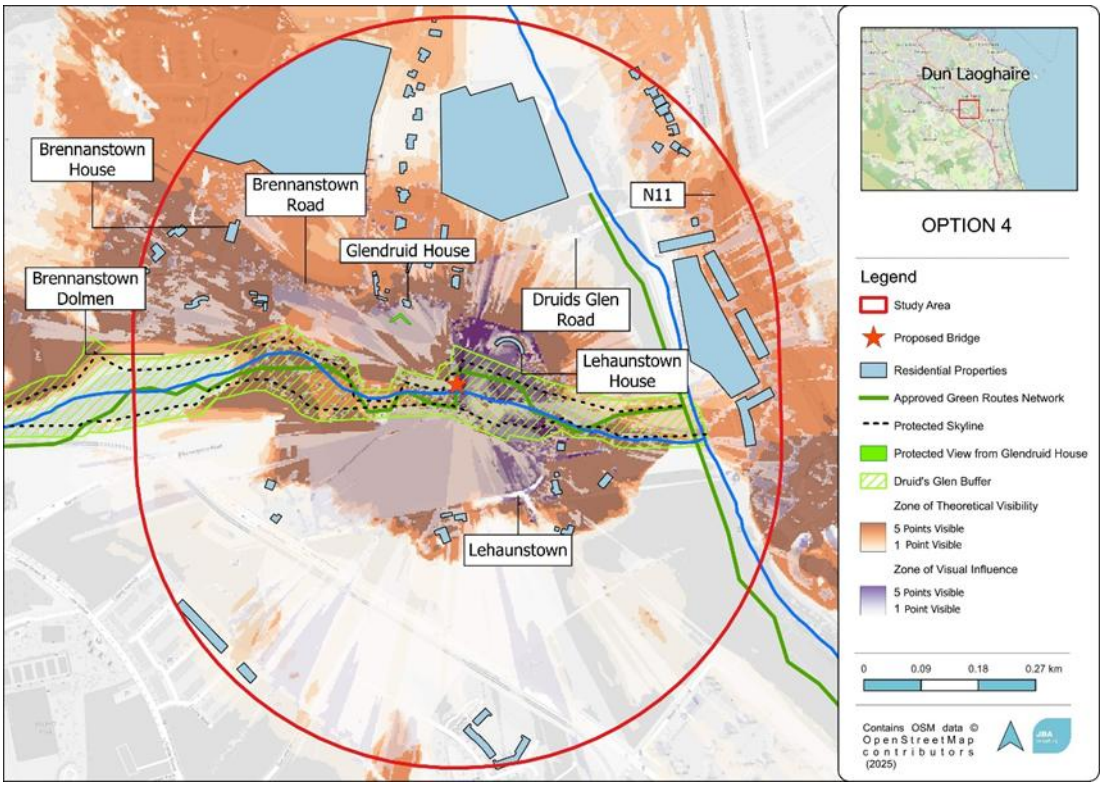

Figure 10-6: Option 4 – ZTV and zone of visual influence

The numbers indicate the visible points as described above in each location. The analysis uses a visibility grading scale from 1 to 5, where 1 equal very limited visibility meaning that it can be seen from very few points or only localised areas, and 5 equals widespread visibility meaning that it can be seen from many points across the study area. This helps to compare the relative prominence of each option based on how visible they are across the landscape.

Option 2 has the lowest potential to affect views within the study area. This is supported by the ZTV, which shows that fewer observation points would have visibility of this option. In simple terms, it is visible from fewer locations and is therefore likely to exert less influence on the surrounding landscape. In contrast, Options 1 and 3 are visible from a broader area and are therefore more likely to be noticeable within views across the study area. Option 4 sits between these extremes. It is not as widely visible as Options 1 and 3 but is seen from more locations than Option 2.

The zone of visual influence for all options appears to be largely contained within the visual envelope formed by Lehaunstown Lane and Brennanstown Road, meaning that beyond these boundaries, visibility is expected to be minimal.

10.10.8 Assessment Summary

Taking into consideration the impact each option is expected to have on the Landscape and Visual amenity, each option was scored, and the results are shown below in Table 10-8.

The preferred option is Option 4, followed by Option 2, while Options 3 and 1 are the least preferred due to their higher potential for visual impacts within the study area. Among these, Option 1 is the least favourable because it has the widest bridge deck of all options. This increased width makes it more visually prominent in the landscape, potentially creating a greater sense of intrusion when viewed from surrounding areas.

Additionally, its larger structure may lead to a more significant alteration of the existing visual character compared to the other options.

Between the two more favourable options, Option 4 and Option 2, there is a balance between visual impact and the contribution to landscape amenity. Option 4 has a slightly greater potential for visual intrusion than Option 2, as it may be visible from more locations or introduce a more noticeable structure into the existing landscape. However, Option 2, while having the lowest overall visual impact, also provides the least opportunity to enhance the recreational and aesthetic experience for users of the proposed greenway. This means that while Option 2 is the least visually intrusive, it may not integrate as well with the landscape or offer as much improvement to the setting and experience of greenway users. On the other hand, Option 4 strikes a better balance by slightly increasing visibility while also contributing more positively to the character and usability of the greenway corridor.

Table 10-8: Impact Level and impact scoring table

Option	Scoring	Measure
Option 1		Minor or slightly negative compared to other options
Option 2		Minor or slightly positive compared to other options
Option 3		Minor or slightly negative compared to other options
Option 4		Moderate positive compared to other options

The preferred option is Option 4, followed by Option 2, followed by Options 3 and 1. Options 3 and 1 are the least preferred as they have an increased potential for visual impacts. Option 1 would be the least preferred as the width of the bridge deck is the widest amongst the Options.

Between Options 2 and 4, Option 4 has a slightly higher potential for visual intrusion that Option 2. Option 2 though has the least potential to improve the amenity offered by the landscape to the users of the proposed greenway.

10.11 Cultural Heritage

All four proposed bridge options are located within the townland of Brennanstown. There are no recorded archaeological monuments located within the immediate vicinity of the options. The closest monument is the zone of archaeological potential associated with the site of an early 19th century military camp, located c. 177m to the southeast (RMP DU026-127). In the wider area, the site of an excavated Fulacht Fiadh is recorded c. 326m to the north-northeast (SMR DU026-159). Approximately 460m to the west is a recorded megalithic tomb, which is also listed as a National Monument in State Care (RMP DU026-007, Nat. Mon. 291). There is one protected structure located within c. 91m of the proposed bridge options, which comprises Glendruid, a country house located to the west-northwest (RPS 1730). A demesne landscape was established with Glendruid House, which is bordered by the current Lehaunstown Lane to the east. Although the landscape has become somewhat denuded in form a section of stone wall that separates the demesne from Lehaunstown Lane, remains extant although it is heavily overgrown. The wall will be located to the immediate west of all the bridge options but will not be directly impacted by any of the design options proposed. Indirect effects will occur, but these will not be significant and are common to all the options.

Option 1 – Three span bow string bridge

The proposed bridge option will cross the Glendruid valley which contains a small watercourse. The bridge piers will not affect the watercourse. Watercourses are recognised as possessing a general archaeological potential, due to the fact that they often formed a focus for activity throughout the prehistoric and historic

periods. The waterlogged conditions within channels can also preserve archaeological artefacts or deposits. Similarly, the greenfield areas around the valley would also possess the potential to contain previously unrecorded archaeological remains, which may be affected by the construction of this bridge option, although impacts have already arisen due to the presence of the existing Lehaunstown Lane.

Option 1 proposes the introduction of an arch, with an approximate height of 7m (above the bridge deck). It is not anticipated that the introduction of this structure would result in any indirect impacts on the settings of the recorded archaeological and cultural heritage sites within the surrounding area. This is due to the level of natural screening that is already in place along the Glendruid Valley. Views southeast from Glendruid across its demesne landscape will be affected by the presence of the bridge structure, but effects would not be considered significant as they will be partially screened by existing mature trees. The Cherrywood Planning Scheme notes that the direct south facing view from Glendruid should be protected. The view of the bridge arch will be in a southeast direction from the house and is outside of the view-shed shown in the Planning Scheme.

This option has been assessed as **Minor or slightly negative** when compared to other options.

Option 2 – Four span girder bridge

The proposed bridge option will cross the Glendruid valley which contains a small watercourse. The bridge piers will not affect the watercourse, however as set out in Section 10.7 (Biodiversity) there is potential for negative impacts to the woodland and riparian zones from heavy machinery during the construction phase. Watercourses are recognised as possessing a general archaeological potential, due to the fact that they often formed a focus for activity throughout the prehistoric and historic periods. The waterlogged conditions within channels can also preserve archaeological artefacts or deposits. The greenfield areas around the valley would also possess the potential to contain previously unrecorded archaeological remains, which may be affected by the construction of this bridge option, although impacts have already arisen due to the presence of the existing Lehaunstown Lane.

Option 2 will not include an arch, or any other upstanding elements and as such no indirect impacts on the settings of the recorded archaeological and cultural heritage sites within the surrounding are predicted. This is due to the level of natural screening that is already in place along the Glendruid Valley. Similarly, the bridge will not be visible across the demesne associated with Glendruid.

This option has been assessed as **Not significant or Neutral** when compared to other options.

Option 3 – Three span extradosed bridge

The proposed bridge option will cross the Glendruid valley which contains a small watercourse. The bridge piers will not affect the watercourse. Watercourses are recognised as possessing a general archaeological potential, due to the fact that they often formed a focus for activity throughout the prehistoric and historic periods. The waterlogged conditions within channels can also preserve archaeological artefacts or deposits. The greenfield areas around the valley would also possess the potential to contain previously unrecorded archaeological remains, which may be affected by the construction of this bridge option, although impacts have already arisen due to the presence of the existing Lehaunstown Lane.

Option 3 will not include an arch, as proposed for Option 1 but two pairs of cable towers and associated cabling are proposed with a maximum height of 6.5m above the bridge deck. It is not anticipated that the introduction of these structures would result in any indirect impacts on the settings of the recorded archaeological and cultural heritage sites within the surrounding area. This is due to the level of natural screening that is already in place along the Glendruid Valley. Views southeast from Glendruid across its demesne landscape will be affected by the presence of the cable towers and cabling, but effects would not be considered significant as they will be partially screened by existing mature trees. The Cherrywood Planning Scheme notes that the direct south facing view from Glendruid should be protected. The view of the cable towers will be in a southeast direction from the house and is outside of the view-shed shown in the Planning Scheme.

This option has been assessed as **Minor or slightly negative** when compared to other options.

Option 4 – Four span timber girder bridge

The proposed bridge option will cross the Glendruid valley which contains a small watercourse. The bridge piers will not affect the watercourse however as set out in Section 10.7 (Biodiversity) there is potential for impact to the woodland and riparian zones from heavy machinery during the construction phase. Watercourses are recognised as possessing a general archaeological potential, due to the fact that they often formed a focus for activity throughout the prehistoric and historic periods. The waterlogged conditions within channels can also preserve archaeological artefacts or deposits. The greenfield areas around the valley would also possess the potential to contain previously unrecorded archaeological remains, which may be affected by the construction of this bridge option, although impacts have already arisen due to the presence of the existing Lehaunstown Lane.

Option 4 will not include any above deck infrastructure and as such no indirect impacts on the settings of the recorded archaeological and cultural heritage sites within the surrounding are predicted. This is due to the level of natural screening that is already in place along the Glendruid Valley.

This option has been assessed as **Not significant or Neutral** when compared to other options.

Assessment Summary

Options 2 and 4 are comparable as they will have no significant impact on the settings of the recorded archaeological and cultural heritage sites within the surrounding area. Option 1 and 3 performs slightly negative when compared to the other options as the views southeast from Glendruid across its demesne landscape will be affected by the presence of the above deck infrastructure, however the effects would not be considered significant as they will be partially screened by existing mature trees. Furthermore, the direct south facing protected view from Glendruid will not be impacted as these options are outside of the view-shed shown in the CPS.

The scoring per impact level for each option is shown below in Table 10-9.

Table 10-9: Impact Level and impact scoring table

Option	Scoring	Measure
Option 1		Minor or slightly negative compared to other options
Option 2		Not significant or Neutral when compared to other options
Option 3		Minor or slightly negative compared to other options
Option 4		Not significant or Neutral when compared to other options

SECTION 11: HEALTH AND SAFETY CONSIDERATIONS

11.1 Traffic Management

Road closure on Lehaunstown Lane will be required for all options during bridge construction. A short period of Druids Glend Road closure will be necessary after the bridge construction in order to complete the north end tie-in (beyond point P3). A limited traffic management will be required to control construction site and compound access from Druids Glen Road at the north end of the scheme as well as site access from Lehaunstown Lane south of point P.

There are no significant differences between options in overall traffic management requirements. It should be noted, however, that Option 1 and Option 2 which use steel elements delivered on site may require short term traffic restrictions to facilitate passing of abnormal load on Druids Glen Road.

Option 3, due to the length of its construction programme, will require the longest traffic restrictions. On the other hand, Option 4 may need only a few short periods of restrictions. Thus, they are scored as moderately negative and major positive respectively. The impact of the construction of Option 1 and Option 2 will be less significant (in terms of time period necessary for traffic management to be in operation), but Option 1 still has a larger impact, and it is scored as minor negative, while Option 2 as a minor positive. The proposed scoring helps to identify subtle differences between options.

Traffic management during the works period will be in accordance with Chapter 8 of the Traffic Signs Manual.

11.2 Safety During Construction

All proposed options are tried and tested methods of construction and should not pose any significant or unusual hazards during construction.

All options will require some temporary works which will be the responsibility of the Contractor/PSCS. Option 1 and Option 3 will require larger extent of temporary works, specifically construction of temporary support towers for the arch erection of Option 1 and falsework construction/crawler crane installation for the concrete deck of Option 3.

In addition to the general obligations and duties under the Safety, Health and Welfare at Work Act 2005, the consultant carrying out the detailed design of the proposed crossing will also undertake the duties of Project Supervisor Design Process (PSDP) and prepare a Preliminary Safety & Health Plan for the works. The works will also be designed taking account of the principles of prevention.

It is envisaged that the appointed contractor will be experienced in bridge construction and will be appointed Project Supervisor Construction Stage (PSCS) for the duration of the works.

11.3 Safety in Use

The bridge design would be compliant with design standards and therefore safety of the public using the structure would be ensured as far as reasonably possible.

The safety of workers conducting inspection and maintenance would be ensured as far as reasonably possible with various best practise measures.

Option 1 has arches projecting above the deck level. These will require an additional safety barrier to protect road users as well as main structural elements from damage. Since the safety barrier may become a hazard on its own, this option is scored slightly negative in the respective criteria in the MCA.

SECTION 12: CONSTRUCTION AND BUILDABILITY

12.1 General

All options considered are readily constructible by a contractor suitably experienced in bridge construction of this scale and form. No issues have been identified that would not be inherent in comparable bridge schemes completed elsewhere in Ireland or the UK.

Prior to the start of the bridge construction, it will be necessary to set up a site compound, complete site clearance from trees and other vegetation and construct site access points (from Druids Glen Road near point P3, from Lehaunstown Lane south of the existing bridge to the east and west and from Lehaunstown Lane south of point P to the north towards point P.

Construction methodology of each bridge option is described in more detail below.

After the bridge construction, Phase 3 Project will be completed by constructing tie-in road sections: on the north side, behind bridge north abutment, it involves regrading of approximately 60 m of road built as part of Phase 2. On the south side, construction of approximately 60 m of new road to the future junction at Point P (junction inclusive). Both road sections will be constructed in the same cross section as on the bridge and to the longitudinal profile facilitating tie-in to the existing/future road.

12.2 Temporary Land take/Possible Site Compound Locations

Figure 12-1 illustrates the temporary land take that will be required in construction of the Druids Glen bridge and indicates potential site compound locations. All options will require similar temporary working space for the access and construction machinery.

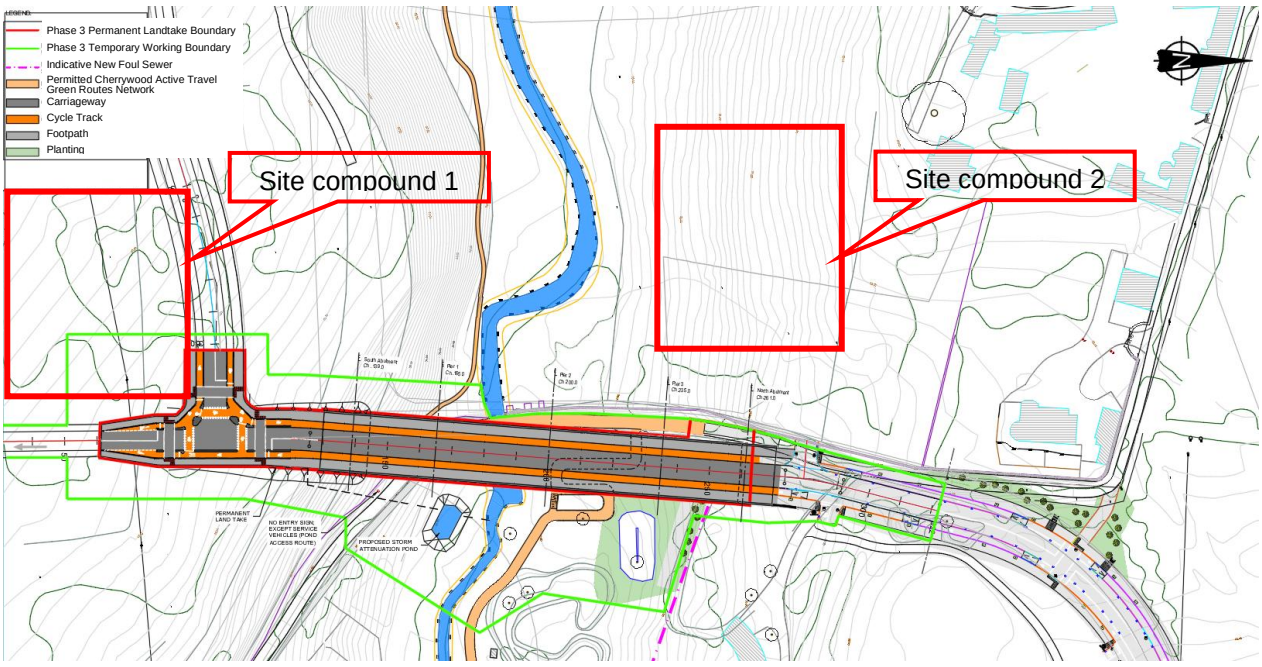

Figure 12-1: Temporary Landtake and Possible Site Compound Locations

12.3 Option 1

12.3.1 Construction Methodology

After the necessary site clearance and construction access tracks are completed, the bridge construction may commence with the foundation works: excavation at abutment locations, piling platforms and piling at pier locations, temporary tower foundations. Then the substructure (abutments and piers) will follow. Next step will be the erection of temporary steelwork towers. In the meantime, the bridge steelwork will be fabricated off site and delivered to the designated site assembly area. Larger preassembled units will be erected by mobile crane to complete the main arches with the deck grillage, followed by approach spans steelwork. Deck permanent formwork panels will be then installed on the finished deck steelwork, reinforcement fixed, and concrete deck poured. Final steps will be the application of deck waterproofing membrane, surfacing, installation of barriers and parapets, final tensioning of vertical arch hangers and landscaping works.

Compared to other options, Option 1 has the most complex construction methodology and therefore, it is scored as a moderate negative in this respect.

12.4 Option 2

12.4.1 Construction Methodology

As with Option 1, the construction will start with foundation excavation, building up spread foundations at abutments and spread/piled foundations at piers. As Option 2 has three piers, this construction stage will take longer than three span options (Option 1 and 3). The composite girder bridge has full height piers which will be constructed together with abutments. Similar as Option 1, the bridge steelwork will be fabricated off site and delivered to the designated site assembly area. Girder sub-assemblies (usually pair of girders spanning between two piers) will be then erected by crane and connected together to form a full bridge length. The following stage will be the composite concrete deck slab construction: placing permanent formwork, preparing deck reinforcement and pouring deck slab concrete in stages. The bridge construction will conclude with the finishing works: application of the deck waterproofing, road and cycle/footpath surfacing, installation of parapets and final landscaping works.

While Option 2 utilizes steelwork construction (similar to Option 1), the construction is much simpler due to less extensive temporary works and less impact on the existing infrastructure. It is scored as moderately positive in the final MCA.

12.5 Option 3

12.5.1 Construction Methodology

Extradosed bridge will require slightly different construction methodology than previous two options. Foundation and substructure construction will follow similar pattern as with Option 1, although pier foundations will have to be larger to take heavier load from the concrete superstructure. Bridge deck will be constructed by a balanced cantilever method, adding concrete segments symmetrically from each pier and then installing stay cables. Individual segments may be either precast (and thus erected by crane) or in-situ, using temporary falsework support system in end spans, traveller formwork in the main span. Following the completion of bridge deck, finishes work will conclude the bridge construction: waterproofing, surfacing, parapet installation and landscaping works.

Option 3 requires also a complex construction methodology, although to a smaller degree than Option 1. It is therefore scored as minor negative.

12.6 Option 4

12.6.1 Construction Methodology

The timber bridge option will follow similar construction sequence as Option 2: First, foundation excavation and construction, then building up piers and abutments. As the timber deck is much lighter, the bridge foundations may be also smaller and lighter. The bridge superstructure construction will progress span by span, utilizing a mobile crane to erect timber girder assemblies and connect them to form the full bridge length. After the girder completion, timber decking will be installed on top, followed by a waterproofing membrane, edge beam details and surfacing, parapets and final landscaping works concluding the bridge construction.

This option has a similar span arrangement as Option 2. Additionally, the use of lightweight (compared to steel) timber beams greatly reduces required temporary works and speeds up the construction. For these reasons, Option 4 is scored as major positive relative to other options.

SECTION 13: GROUND CONDITIONS

Historic ground investigation undertaken in the area indicate the typical subsurface conditions comprise of firm to stiff cohesive glacial till overlying granite bedrock. Alluvial deposits are likely to be present in the area immediately adjacent to the Carrickmines Stream.

Detailed geotechnical interpretation will be undertaken based on the full ground investigations that will be carried out prior to detailed design. A geotechnical Form C and Geotechnical Design Report (GDR) will be prepared for the structure in conjunction with the Preliminary Design Report and Technical Acceptance Reports.

SECTION 14: CONSULTATION WITH RELEVANT AUTHORITIES

There are several stakeholders in the scheme, including Dún Laoghaire-Rathdown County Council (DLRCC) and Landowners. To date, informal consultations have been held with DLRCC in-house departments.

It is envisaged that consultation with other stakeholders including landowners, local interest groups, state and semi-state agencies, utility providers etc. will be held during the next stage, based on this report and the identification of a preferred concept design.

The scheme will be subject to the planning permission process which includes a statutory consultation process that will include referral to prescribed bodies. This will act as the primary medium for formal consultation with most of the relevant authorities. The remainder will be consulted with during the preliminary design stage.

SECTION 15: CONCLUSIONS AND RECOMMENDATIONS

The emerging preferred option for the proposed bridge was selected following an extensive evaluation of potential physical and environmental constraints. Bridge alignments were first analysed through early screening processes (Alignment Options Assessment) to before proceeding to bridge options selection.

The process of choosing the preferred bridge option was first a check if proposed options meet all required project objectives (Step 1), then a fit for purpose multicriteria analysis (MCA) which was undertaken using a range of technical criteria based on Engineering, Environment and Economy to robustly assess the bridge options and ultimately determine the preferred detailed design solution (Step 2). The process focused on minimising impacts on stakeholders and the environment and refining the design in order to achieve the best performing option.

15.1 Options Alignment Assessment against Project Objectives (Step 1)

Several feasible options were developed that best meets the project objectives within the given constraints, see Table 15-1 below.

Table 15-1: Project Objectives Comparison

TAF Categories		Assessment Criteria	Option 1	Option 2	Option 3	Option 4
1	Transport User Benefits and Other Economic Impacts	Travel times and enabling future development	ALIGN	ALIGN	ALIGN	ALIGN
2	Accessibility Impact	Access to key services	ALIGN	ALIGN	ALIGN	ALIGN
3	Social Impact	Transport users with different mobility needs	ALIGN	ALIGN	ALIGN	ALIGN
4	Land Use Impacts	Connection to zoned lands	ALIGN	ALIGN	ALIGN	ALIGN
5	Safety Impacts	Change in safety for users	ALIGN	ALIGN	ALIGN	ALIGN
6	Climate Change Impacts	Mode shift and Emissions reduction	ALIGN	ALIGN	ALIGN	ALIGN
7	Local Environmental	Visual Quality	ALIGN	ALIGN	ALIGN	ALIGN

Overall, all options align with Project Objectives 1, 2, 3, 4, 5, 6, and 7. All options will improve travel times and provide essential access into the north-east area of Cherrywood while promoting use of the N11 and opening up a multimodal connection between Development Areas 5 and the remaining Development Areas in Cherrywood. The improved connectivity will also enable future development of zoned lands within Cherrywood including within Development Area 1. All options would be capable of accommodating traffic lanes, segregated cycle lanes and footpaths and will therefore align with the Social, Safety and Climate Change objectives. Similarly, all options align with the visual quality objectives.

All 4 options are therefore brought forward for Multi-Criteria Analysis (MCA) to evaluate the options from technical, environmental, and economic perspectives.

15.2 MCA Results (Step 2)

A Multi Criteria Analysis (MCA) was used to determine, compare and contrast the relative advantages and disadvantages of each bridge option in relation to the others, as opposed to against a set of universal or general criteria. Where no relative advantage or disadvantage has been identified between bridge options for a particular criterion, each have been given a 'not significant or neutral' rating.

For each of the criteria, a qualitative and quantitative approach was adopted to assign the relative rankings of each.

The MCA analysis is summarised in Table 15-2. The legend for colour coding is as follows:

7	Major or highly positive compared to other options
6	Moderately positive compared to other options
5	Minor or slightly positive compared to other options
4	Not significant or neutral
3	Minor or slightly negative compared to other options
2	Moderately negative compared to other options
1	Major or highly negative compared to other options

Table 15-2: MCA Analysis

Assessment Criteria	Sub-Criteria		Option 1	Option 2	Option 3	Option 4
Technical	1	Span Arrangement				
	2	Structural Depth				
	3	Cross Section				
	4	Construction and Buildability				
Economic	1	Construction Costs				
	2	Whole of Life Costs				
Aesthetics	1	Style/look of the bridge within the surroundings				
Durability and Maintenance	1	Materials				
Hydraulics	1	Flood Event Considerations				
Health and safety	1	Traffic management During Construction				
	2	Safety During Construction				
	3	Safety in use				
Local Environmental	1	Human Beings				

Assessment Criteria	Sub-Criteria		Option 1	Option 2	Option 3	Option 4
Impacts	**2**	Waste				
	3	Climate Change				
	4	Air quality				
	5	Noise and Vibration				
	6	Biodiversity				
	7	Hydrology and Hydrogeology				
	8	Soils and Geology				
	9	Landscape and Visual				
	10	Cultural Heritage				

15.3 Recommendation

Finally, through further optimisation and mitigation/avoidance of impacts, the preferred bridge option was determined.

The preferred bridge option is **Option 3**.

The four options presented above have undergone a multi-criteria analysis (MCA) to determine the preferred bridge option. The summary of results of the MCA for each option is presented in the Table 15-3 below.

Table 15-3: MCA Summary Table

Assessment Criteria	Option 1 3 Span Bow String	Option 2 4 Span Steel Girder	Option 3 3 Span Extradosed	Option 4 4 Span Timber Girder
Technical				
Economic				
Aesthetics				
Durability & Maintenance				
Hydraulics				
Environmental				
Health & Safety				

In summary, the following key assessment and considerations are noted:

- Technical – From a technical point of view, Option 2 has the most advantages – including a shallow structural depth, cross section, speed and simplicity of construction. The second preferred option is Option 4 due to its simple cross section as well as fast and simple construction. Options 1 and 3 are scoring slightly behind Option 4 due to their construction methodology, which is more complex, and an increased cross section (necessary to accommodate arches and cables).

- Economic – Option 2 is the most economical option presented in terms of both Construction and Whole Life Costs. Option 1 and 3 are considered median options. Option 4 is the least favourable due to the substantially higher construction costs and Whole Life Cycle costs due to the onerous maintenance requirements of timber structure.

- Aesthetics – Option 1 and 4 are considered the best from an aesthetic point of view. The open form and gentle curvature of an arch and the natural look and appearance of timber are their main advantages. Option 3 is the second preferred one as it brings a unique structural form and maintains the open view through the structure. Option 2 is considered least preferred due to its slightly bland appearance.

- Durability & Maintenance – Option 3 will be the easiest of the four options to inspect and maintain due to its structural form when compared to the other options. Option 4 is the least preferred option by comparison as it will require a more onerous maintenance regime throughout its design life requiring specialist inspection teams. Also, Option 4 will use the largest number of bearings of all options.

- Hydraulics – Options 1 and 3 are the preferred options as they perform slightly better than Option 2 and Option 4 solely based on the additional pier leading to potential impact on surface water of Carrickmines stream and groundwater quality due to extra excavation, proximity to the stream and the requirements for additional concrete works.

- Environmental – Option 4 is considered the most favourable as it has the lowest construction stage GHG emissions and waste quantities and creates a lower visual effect on adjacent protected structures and archaeological monuments. All four options are outside the field of the protected southern view from Glendruid. Options 1 and 3 scored similarly regarding biodiversity. Overall Options 1 and 2 are the least preferable options with regard to climate, waste and landscape and visual considerations.

- Health & Safety – Option 4 followed by Option 2 are the most preferred options on traffic management and temporary works considerations. All options will require road closures on Lehaunstown Lane during bridge construction, with a short closure of Druids Glen Road needed afterward for tie-in works. Limited traffic management will control site access. All options use established construction methods with no unusual hazards. Temporary works will be required, with Options 1 and 3 needing more extensive structures, such as temporary support towers and falsework.

Overall, options considered in this report are ranked as follows (1 being the most preferred and 4 being least preferred):

1. Option 3
2. Option 2
3. Option 1
4. Option 4

It is evident from the results of the MCA that **Option 3 Extrados** is the most favourable option presented within this Bridge Options Report.

Main factors contributing to the selection of this option as the preferred one are cost (construction and whole life cost), better durability and less maintenance requirements than Options 1 and 4, while still providing a good aesthetic quality, and meeting the environmental requirements of the project.

Option 3 is therefore proposed for selection as the emerging preferred bridge option to be carried forward to the next stages of project development namely, Stage (ib) Consultation followed by Stage (ic) Preliminary Design and Stage (id) Statutory Processes. As part of these phases the bridge design for the proposed option should be developed further with a full preliminary design prepared to confirm member sizes and determine structural requirements.

EIA and AA Screening will, in parallel with preliminary design, be carried out to determine if an Appropriate Assessment and EIAR is required and what process should be followed with regard to Planning Consent.