

Appendix H

Flood Risk Assessment

Wicklow County Council
**River Dargle Public
Transportation Bridge**
Flood Risk Assessment

RDPTB-ARUP-ZZZ-ZZZ-RP-FL-0001

P02 | 2 July 2021

This report takes into account the particular instructions and requirements of our client.

It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Job number 268095-00

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1 Introduction

1.1 Project Background

Wicklow County Council (WCC) as part of Project Ireland 2040, requires a new bridge with an associated link road over the River Dargle near the mouth of the river at Bray Harbour, County Wicklow. As part of the scheme, a single span bridge is required to span the river, as well as a number of support structures to tie into existing pedestrian and cycleway infrastructure. The bridge and road are to cater for public transportation, cyclists and pedestrians, as well as the potential future Luas Line B2 extension to Bray Station.

The FRA has been undertaken in accordance with ‘The Planning System and Flood Risk Management’ Guidelines for Planning Authorities published in November 2009, jointly by the Office of Public Works (OPW) and the then Department of Environment, Heritage and Local Government (DEHLG).

The purpose of the study is to identify and quantify the risk of flooding to the proposed development and identify any measures, if required, to mitigate the risk.

1.2 Scope

The scope of the FRA includes the following:

- Confirmation of the sources of flooding which may affect the site;
- A qualitative assessment of the risk of flooding to the site and to adjacent sites as a result of construction of the proposed development.
- Review of the availability and adequacy of existing information
- Identification of possible measures which could mitigate the flood risk to acceptable levels.
- Areas for further investigation (Stage 2 FRA) if required.

1.3 Summary of data used

Data regarding flood risk relevant to the proposed development and surrounding area has been obtained from the following sources;

- Wicklow County Development Plan 2016-2022 (including Strategic Flood Risk Assessment)
- Dun Laoghaire Rathdown County Council Development Plan 2016-2022
- Bray Municipal District Local Plan 2018-2024
- OPW Flood Plans and Flood Maps (www.floodinfo.ie)
- OPW National Flood Hazard Mapping Website (www.floodmaps.ie)

- Preliminary Flood Risk Assessment (PFRA) mapping produced by OPW (www.floodmaps.ie)
- Irish Coastal Protection Strategy Study maps and reports
- Topographical survey of the site and proposed development planning application drawings
- River Dargle Flood Defence Scheme, Inspectors Report (An Bord Pleanala)
- River Dargle Flood Defence Scheme, Physical Model Study (HR Wallingford, 2009)
- River Dargle Flood Defence Scheme Design Drawings (O'Connor Sutton Cronin, 2007)

All Ordnance Datum (OD) levels referred to in this report are to Malin Head Ordnance Datum, unless otherwise stated.

1.4 Site location

The River Dargle Public Transportation Bridge is proposed to cross the River Dargle close to the existing railway bridge, providing a pedestrian, cycleway and public transport link between Dublin Road and Bray DART station. Refer to Figure 1 and Figure 2 below.

Figure 1: Site Location

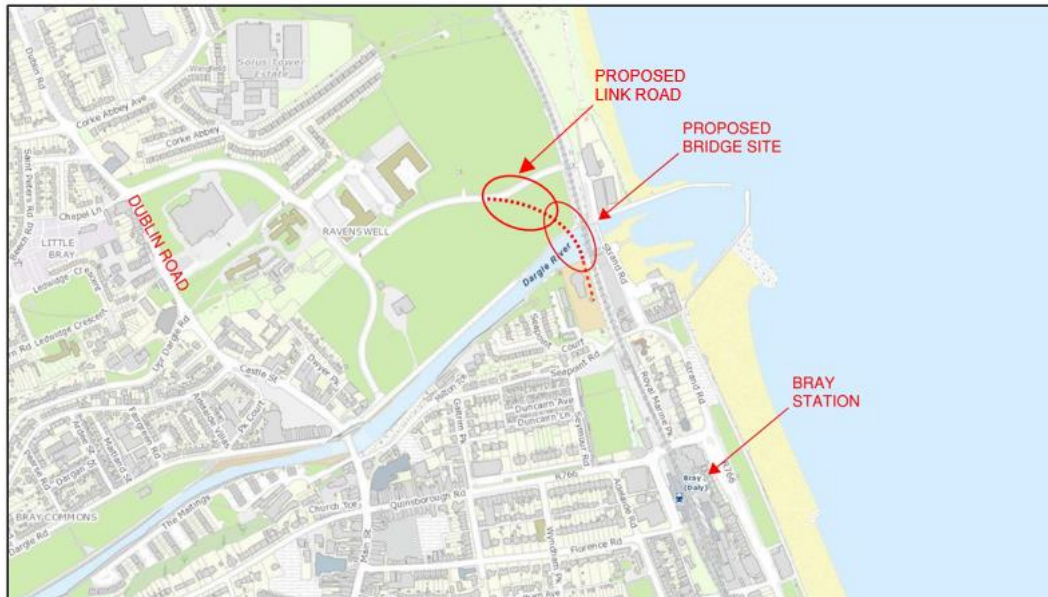
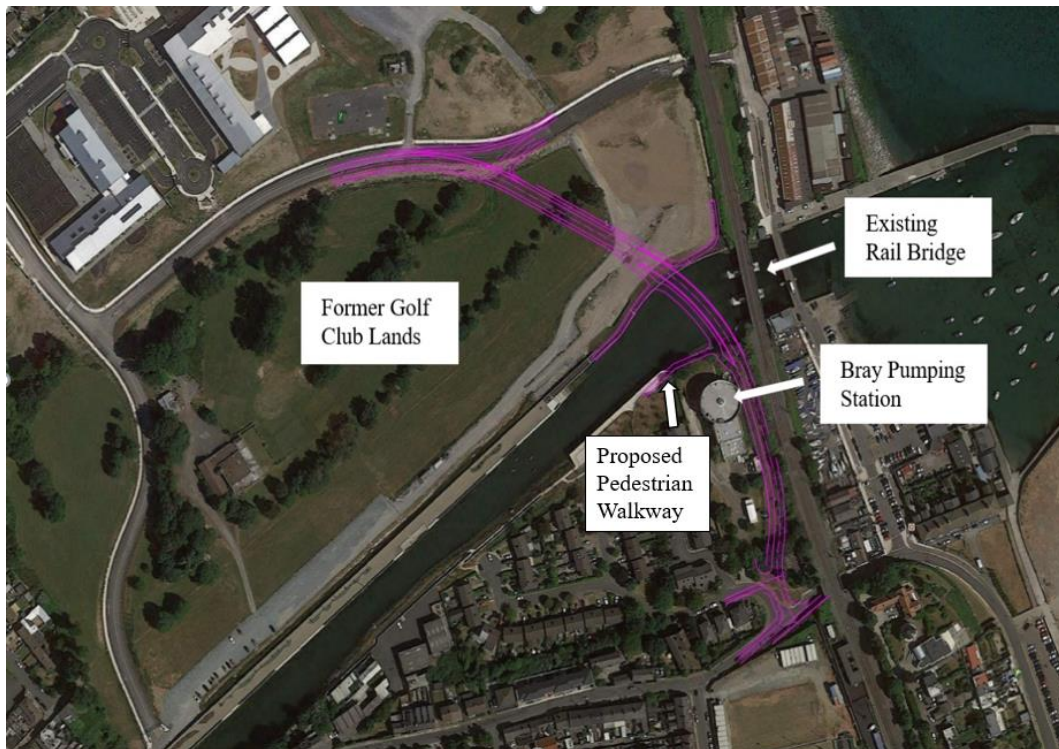


Figure 2: Proposed Bridge Site Location



1.5 Proposed development

The proposed bridge and road link will facilitate public transportation and pedestrian/cycle movement over the River Dargle and link with the existing road network. The proposed bridge, as shown in Figure 3 and Figure 4 will be a bowstring arch bridge which crosses the river with a single span of 63m.

The proposed works involves the construction of a single span bridge structure shown in Figure 4. The soffit of the bridge will be above the level of the existing flood defences and it is not proposed to place any permanent structures in the watercourse.

The carriageway will comprise two 3.25m wide bus lanes and variable width pedestrian, cyclist and shared path facilities depending on the site constraints. A new pedestrian boardwalk is proposed along the southern bank wall to link the existing walkway to the bridge crossing.

The River Dargle is approximately 57m wide at the location of the proposed bridge crossing. The river is tidal in this region and outlets into Bray Harbour to the east.

Bray Pumping Station is located to the south of the proposed bridge. Immediately to the east of this is a constrained corridor along which the southern part of the road link is proposed. The main Dublin-Bray railway line forms the eastern boundary of the proposed southern portion of the link road.

The existing rail bridge is located directly downstream (east) of the proposed bridge, with an existing road bridge running parallel immediately east of it.

The existing road bridge provides access to eth parcel of land to the north of Bray Harbour.

Figure 3: Site Location Plan

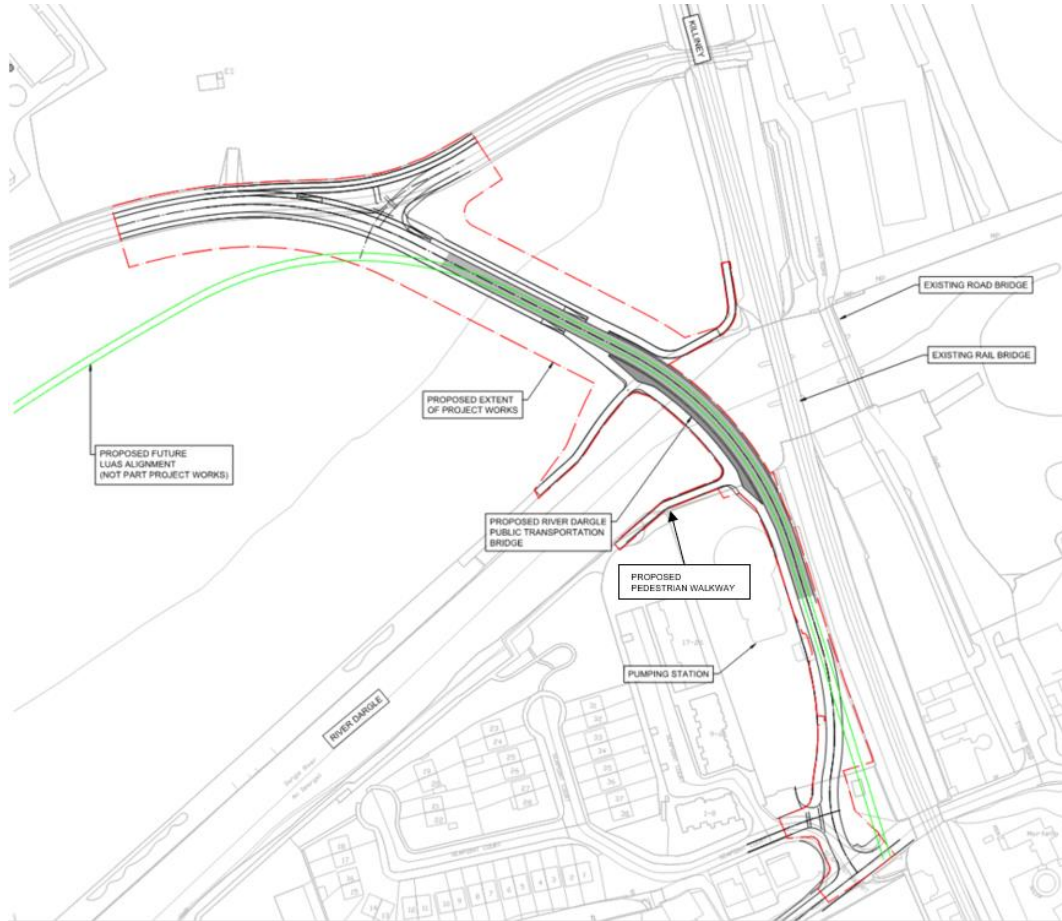
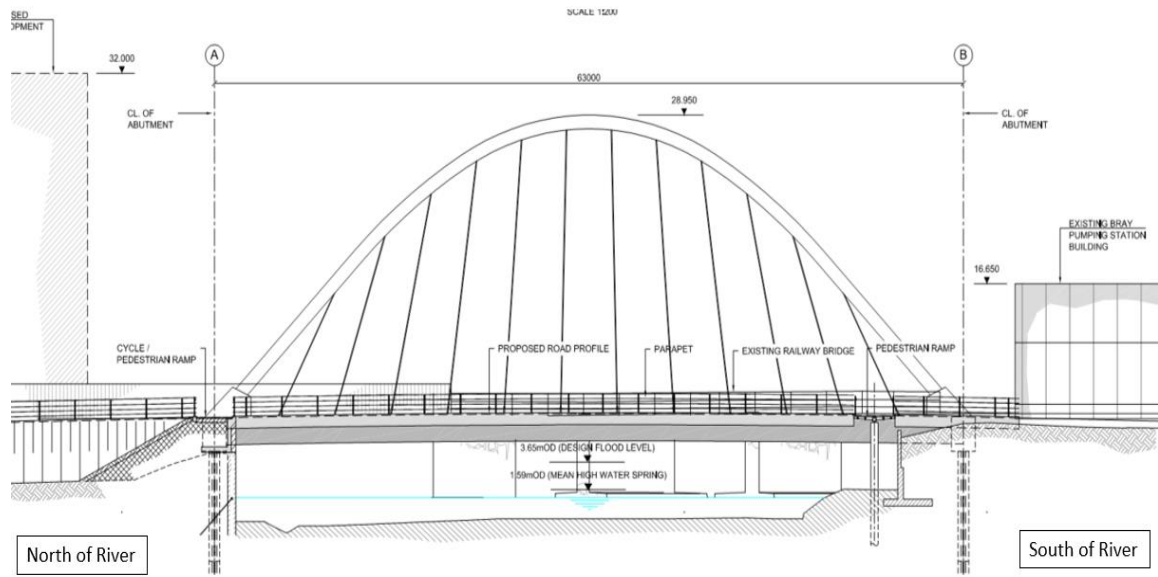


Figure 4: Elevation of Proposed Bridge



Detailed drawings for the proposed site location plan, RDPTB-ARUP-ZZZ-ZZZ-SK-CB-1000 and proposed bridge elevation, RDPTB-ARUP-ZZZ-ZZZ-SK-CB-1001 is provided in Appendix A.

2 Planning context

2.1 Introduction

The following planning policy documents are relevant to the flood risk assessment of the proposed development;

- The Planning System and Flood Risk Management Guidelines for Planning Authorities
- Wicklow County Development Plan 2016-2022 (including Strategic Flood Risk Assessment)
- Bray Municipal District Local Plan 2018-2024

2.2 The Planning System and Flood Risk Management Guidelines for Planning Authorities

In November 2009, the Department of Environment, Heritage and Local Government and the Office of Public Works jointly published a Guidance Document for Planning Authorities entitled ‘The Planning System and Flood Risk Management’.

The guidelines are issued under Section 28 of the Planning and Development Act 2000; and Planning Authorities and An Bord Pleanála are therefore required to implement these Guidelines in carrying out their functions under the Planning Acts.

The aim of the guidelines is to ensure that flood risk is neither created nor increased by inappropriate development.

The guidelines require the planning system to avoid development in areas at risk of flooding, unless they can be justified on wider sustainability grounds, where the risk can be reduced or managed to an acceptable level.

They require the adoption of a Sequential Approach (to Flood Risk Management) of Avoidance, Reduction, Justification and Mitigation and they require the incorporation of Flood Risk Assessment into the process of making decisions on planning applications and planning appeals. Fundamental to the guidelines is the introduction of flood risk zoning and the classification of different types of development having regard to their vulnerability. The management of flood risk is now a key element of any development proposal in an area of potential flood risk and should therefore be addressed as early as possible in the site master planning stage.

2.2.1 Definition of flood zones

Flood zones are geographical areas within which the likelihood of flooding is in a particular range. There are three types of flood zones defined in The Guidelines as follows:

Table 1: Flood zone categories

Zone category	Description
Flood Zone A	Probability of flooding from rivers and the sea is highest (greater than 1% or 1 in 100 for river flooding or 0.5% or 1 in 200 for coastal flooding).
Flood Zone B	Probability of flooding from rivers and the sea is moderate (between 0.1% or 1 in 1000 year and 1% or 1 in 100 for river flooding and between 0.1% or 1 in 1000 year and 0.5% or 1 in 200 for coastal flooding).
Flood Zone C	Probability of flooding from rivers and the sea is low (less than 0.1% or 1 in 1000 for both river and coastal flooding). Flood Zone C covers all areas of the plan which are not in zones A or B.

2.2.2 Definition of Vulnerability Classes

The following table summarises the vulnerability classes defined in The Guidelines and provides a sample of the most common type of development applicable to each.

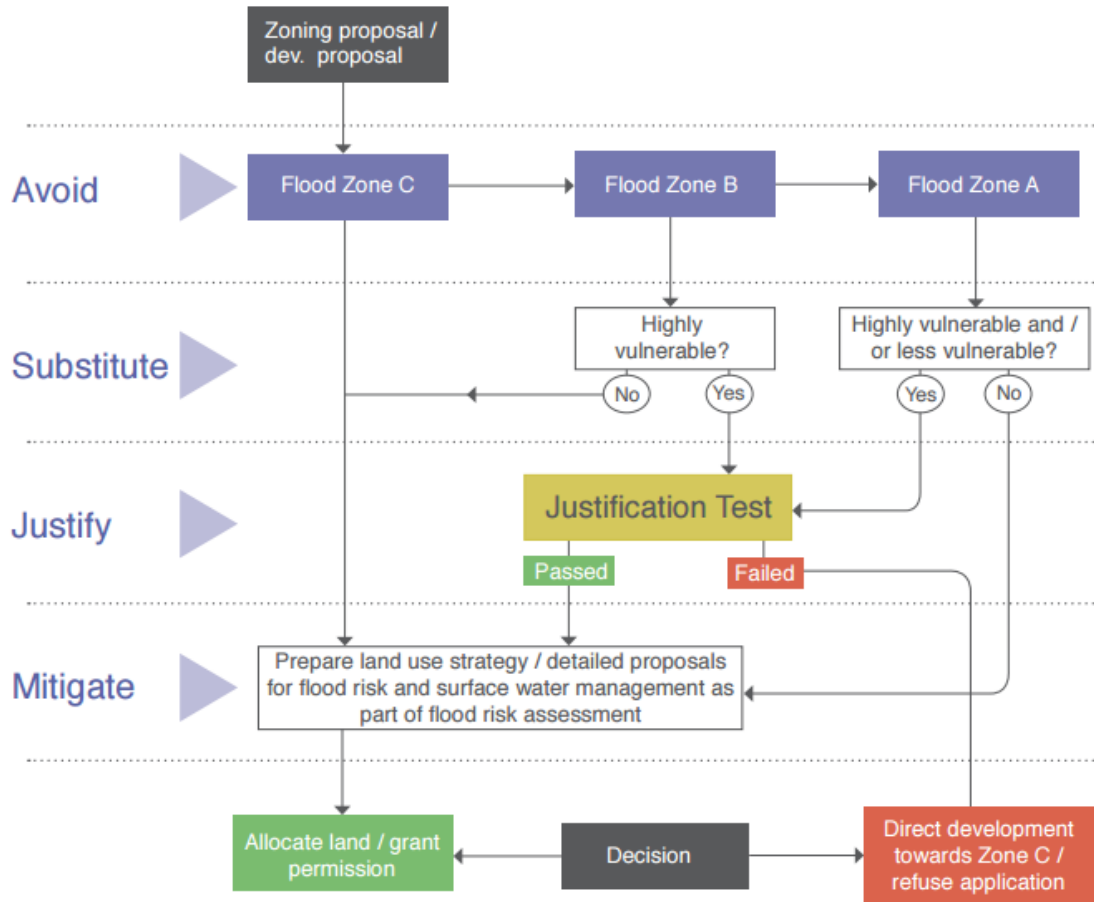
Table 2: Vulnerability classes

Vulnerability class	Land uses and types of development which include;
Highly Vulnerable Development	Includes Garda, ambulance and fire stations, hospitals, schools, residential dwellings, residential institutions, essential infrastructure, such as primary transport and utilities distribution and SEVESO and IPPC sites, etc.
Less Vulnerable Development	Includes retail, leisure, warehousing, commercial, industrial and non-residential institutions, etc.
Water Compatible Development	Includes Flood Control Infrastructure, docks, marinas, wharves, navigation facilities, water based recreation facilities, amenity open spaces and outdoor sport and recreation facilities.

2.2.3 Sequential Approach and Justification Test

The Guidelines outline the sequential approach that is to be applied to all levels of the planning process. This approach should also be used in the design and layout of a development and the broad philosophy is shown in Figure 5. In general, development in areas with a high risk of flooding should be avoided as per the sequential approach.

Figure 5: Sequential approach (reproduced from The Guidelines)



The Justification Test has been designed to rigorously assess the appropriateness, or otherwise, of developments that are being considered in areas of moderate or high flood risk. The test comprises the following two processes.

- The first is the Plan-making Justification Test and is used at the plan preparation and adoption stage where it is intended to zone or otherwise designate land which is at moderate or high risk of flooding.
- The second is the Development Management Justification Test and is used at the planning application stage where it is intended to develop land at moderate or high risk of flooding for uses or development vulnerable to flooding that would generally be inappropriate for that land.

Table 3 illustrates the different types of vulnerability class appropriate to each zone and indicates where the Justification Test is required.

Table 3: Vulnerability classes

Table with header	Flood Zone A	Flood Zone B	Flood Zone C
Highly Vulnerable	Justification Test	Justification Test	Appropriate
Less Vulnerable	Justification Test	Appropriate	Appropriate
Water Compatible	Appropriate	Appropriate	Appropriate

The Guidelines recognise that there is a need to reconcile the desire to avoid development in areas at risk of flooding while also ensuring sequential and compact urban development as several large urban centres are already located in areas that are at risk of flooding. The following section of The Guidelines is particularly relevant to the proposed development off Custom House Street;

“Notwithstanding the need for future development to avoid areas at risk of flooding, it is recognised that the existing urban structure of the country contains many well-established cities and urban centres, which will continue to be at risk of flooding. At the same time such centres may also have been targeted for growth in the National Spatial Strategy, regional planning guidelines and the various city and county development plans taking account of historical patterns of development and their national and strategic value.

In addition, development plans have identified various strategically located urban centres and particularly city and town centre areas whose continued growth and development is being encouraged in order to bring about compact and sustainable urban development and more balanced regional development.

Furthermore, development plan guidelines, issued by the Minister for the Environment, Heritage and Local Government under Section 28 of the Planning and Development Act 2000, have underlined the importance of compact and sequential development of urban areas with a focus on town and city centre locations for major retailing and higher residential densities.”

2.3 Wicklow County Development Plan 2015-2021

The Wicklow County Development Plan 2016-2022 (CDP) is consistent with higher order strategic policy documents including the ‘National Spatial Strategy 2002-2020’, the ‘Regional Planning Guidelines for the Greater Dublin Area 2010-2022’ and the National Transport Authority’s ‘Transportation Strategy for the Greater Dublin Area 2016-2035’. The policy sets out to achieve the following objectives;

Open Space

- **OS1:** No development or activity will be permitted that would directly or indirectly contribute to flood risk, coastal erosion or a reduction of water quality and safety.

Green Infrastructure

- **GI3** To minimise alterations or interference with river / stream beds, banks and channels, except for reasons of overriding public health and safety (e.g. to reduce risk of flooding); a buffer of generally 10m along watercourses should be provided (or other width, as determined by the Planning Authority) free from inappropriate development, with undeveloped riparian vegetation strips, wetlands and floodplains generally being retained in as natural a state as possible. In all cases where works are being carried out, to have regard to Regional Fisheries Board “Requirements for the protection of fisheries habitat during the construction and development works at river sites”.

New river / watercourse road crossings and / or piping shall be strongly resisted except for reasons of overriding public health and safety.

2.4 Bray Municipal District Local Plan 2018-2024

In order to properly manage flood risk, the following mitigation objectives are included in the County Development Plan 2016-2022; the Bray Municipal District LAP is a subsidiary plan to the County Development Plan, and these objectives will apply in the Bray MD area:

- **FL1:** To prepare new or update existing flood risk assessments and flood zone maps for all zoned lands within the County as part of the review process for Local Area Plans, zoning variations and Town Plans, where considered necessary.
- **FL2:** To implement the ‘Guidelines on the Planning System and Flood Risk Management’ (DoEHLG/OPW, 2009).
- **FL3:** The zoning of land that has been identified as being at a high or moderate flood risk (flood zone A or B) shall be in accordance with the requirements of the Flood Risk Guidelines and in particular the ‘justification test for development plans’ (as set out in Section 4.23 and Box 4.1 of the guidelines).
- **FL4:** Applications for new developments or significant alterations/extension to existing developments in a flood risk area shall comply with the following:
 - Follow the ‘sequential approach’ as set out in the Flood Risk Guidelines.
 - Flood risk assessments will be required with all planning applications proposed in areas identified as having a flood risk, to ensure that the development itself is not at risk of flooding and the development does not increase the flood risk in the relevant catchment (both up and down stream of the application site).
 - Where a development is proposed in an area identified as being at low or no risk of flooding, where the planning authority is of the opinion that flood risk may arise or new information has come to light that may alter the flood designation of the land, an appropriate flood risk assessment may be required to be submitted by an applicant for planning permission.
 - Restrict the types of development permitted in Flood Zone A and Flood Zone B to that are ‘appropriate’ to each flood zone, as set out in Table 3.2 of the guidelines for Flood Risk Management (DEHLG/OPW, 2009).
 - Developments that are an ‘inappropriate’ use for a flood zone area, as set out in Table 3.2 of the guidelines, will not be permitted, except where a proposal complies with the ‘Justification Test for Development Management’, as set out in Box 5.1 of the Guidelines.
 - Flood Risk Assessments shall be in accordance with the requirements set out in the Guidelines.
 - Generally, a Flood Impact Assessment will be required with all significant developments and a certificate (from a competent person stating that the development will not contribute to flooding within the relevant catchment) will be required with all small developments of areas of 1 hectare or less.

- **FL5:** To prohibit development in river flood plains or other areas known to provide natural attenuation for floodwaters except where the development can clearly be justified with the Flood Risk Guidelines 'Justification test'.
- **FL6:** To limit or break up large areas of hard surfacing in new developments and to require all surface car parks to integrate permeability measures such as permeable paving.
- **FL7:** Excessive hard surfacing shall not be permitted for new, or extensions to, residential or commercial developments and all applications will be required to show that sustainable drainage techniques have been employed in the design of the development.
- **FL8:** To require all new developments to include proposals to deal with rain and surface water collected on site and where deemed necessary, to integrate attenuation and SUDS measures.
- **FL9:** For developments adjacent to all watercourses of a significant conveyance capacity or where it is necessary to maintain the ecological or environmental quality of the watercourse, any structures (including hard landscaping) must be set back from the edge of the watercourse to allow access for channel clearing/ maintenance / vegetation. A minimum setback of up to 10m (or other width, as determined by the Council) will be required either side depending on the width of the watercourse.

2.5 River Dargle Flood Defence Scheme

The River Dargle Flood Defence Scheme, commissioned by Wicklow County Council (WCC) and the Office of Public Works (OPW), was completed in 2017.

The scheme comprised a variety of flood defences, including the construction of new sections of earth embankments, demolition and rebuilding river walls with extensive stone facing, channel excavation regrading and riverbank strengthening.

The flood defences aim to provide protection against 1-in-100-year fluvial flood and 1-in-200-year tidal flood.

The following elements were carried out in the vicinity of the proposed bridge crossing during the construction of the River Dargle Flood Relief scheme:

Soil Stabilisation and Scour Protection: Soil nails and matting were installed in the areas prone to landslides. Tonnes of local stone were placed at the toe of each soil embankment to prevent erosion of the soil during a flood.

Seapoint Court: Ground floor levels in this area are 2m below the design flood level. A sheet pile wall and earth embankment were built to provide protection in a flood event.

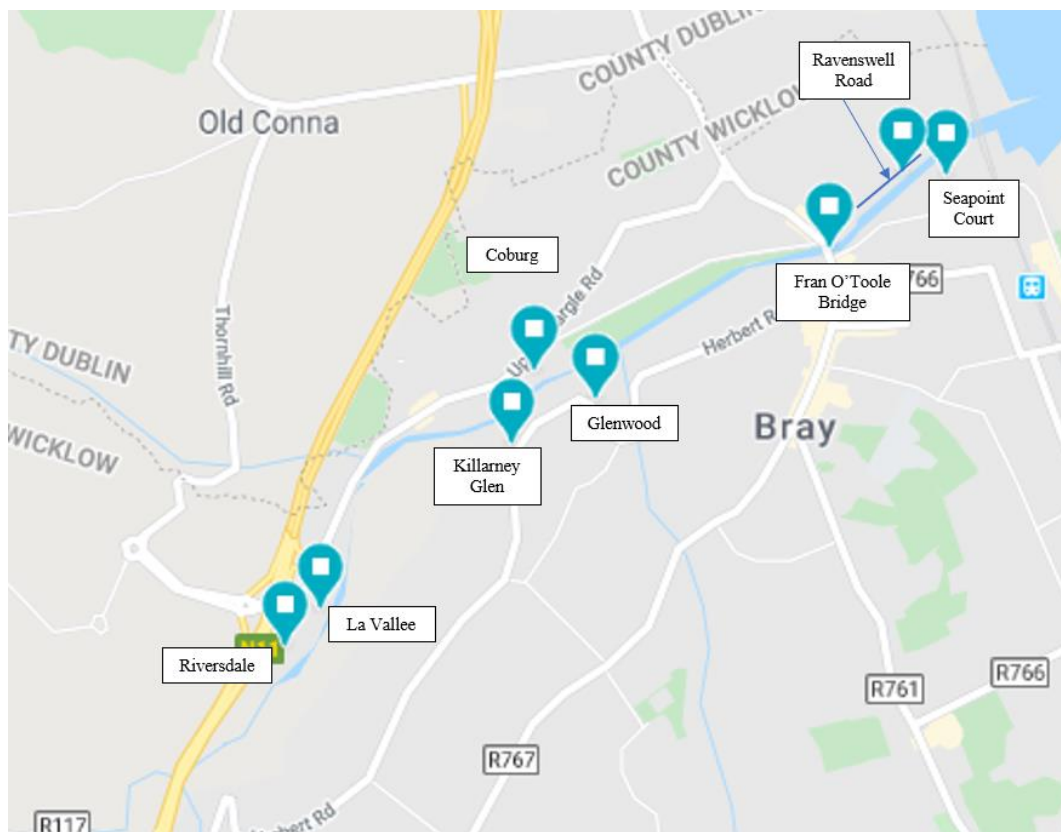
Ravenswell Road: An emergency overflow outfall was built on Ravenswell Road. A linear park was constructed including open access to the river and a cycleway and pathway.

A realignment of the channel was undertaken along the northern riverbank on the approach to the rail bridge. 6 no. culverts were constructed to allow for discharge of surface water from the little bray area and from the former golf club lands.

Fran O'Toole Bridge: The riverbed was lowered by 1m to cater for extreme floods. A new 650m wall was constructed to protect the Maltings Estate from an extreme flood event. The existing sewer network at Fran O'Toole Bridge has been realigned to remove obstruction to the river flow. Additionally, a fourth span was added to the bridge, this consists of a 14m wide x 70m long culvert under Castle Street. This allows up to 300m³/sec to flow through in an extreme flood event.

Irish Rail Dart Bridge: To prevent erosion of the Bridge Piers and abutments 15m long sheet piles were driven into the soft ground and tied together with anchors and concrete.

Figure 6: Flood Defence Scheme Location Plan



3 Flood mechanisms and historic flooding at the site

3.1 Potential flood mechanisms at the site

The following potential sources of flood risk have been assessed;

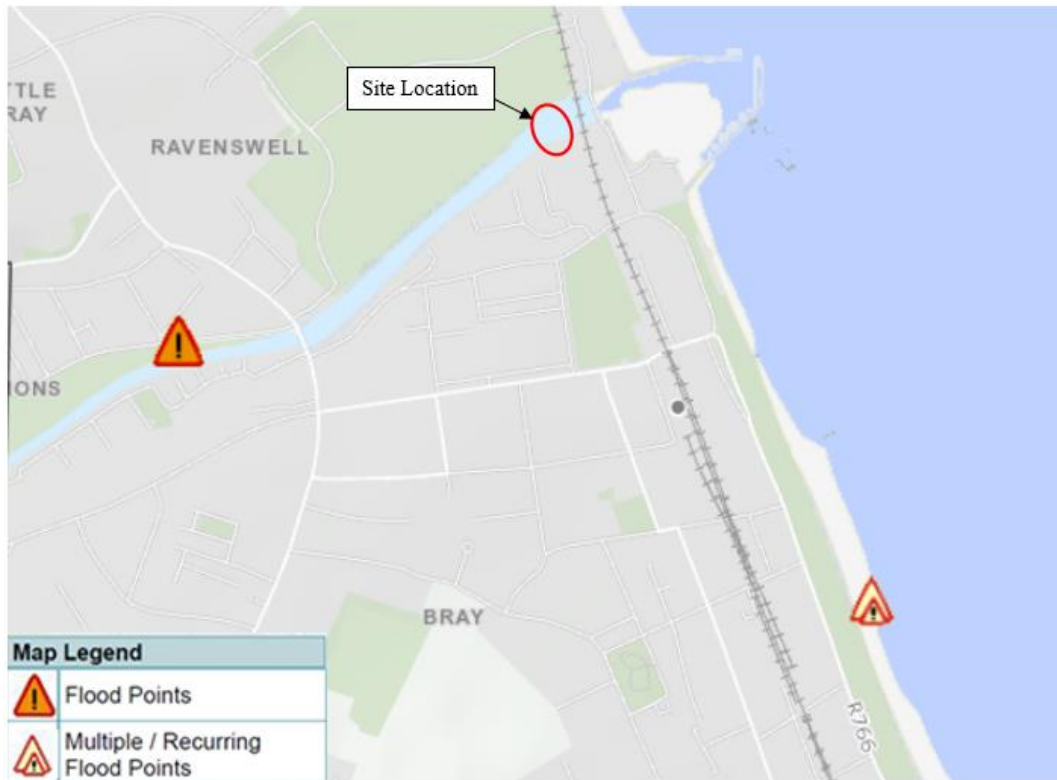
- **Fluvial (river) flooding:** flooding of watercourses occurs when the capacity a river is exceeded during periods of intense rainfall.
- **Tidal Flooding:** is the temporary inundation of low-lying areas, during exceptionally high tide events.
- **Pluvial Flooding/Urban Drainage:** pluvial flooding occurs when the capacity of the local urban drainage network is exceeded during periods of intense rainfall. At these times, water can collect at low points in the topography and cause flooding.
- **Groundwater flooding:** can occur during lengthy periods of heavy rainfall, typically during late winter/early spring when the groundwater table is already high. If the groundwater level rises above ground level, it can pond at local low points and cause periods of flooding.

3.2 Historic flood data

Records of historic fluvial and tidal floods were obtained from the OPW National Flood Hazard Mapping website (www.floodmaps.ie). While no flood events are reported in the area of the proposed scheme it is noted that the River Dargle Flood Defence Scheme was commissioned to address flooding in Bray Town. The Inspectors Report for the River Dargle Flood Defence Scheme (refer Appendix C) refers to a history of flooding in Bray and in particular the flooding resulting from Hurricane Charlie in 1986. It is assumed that there is no recent flooding as a result of the River Dargle Flood Defence Scheme.

For completeness Figure 7 presents an overview of the recorded flood events in the vicinity of the site from Floodmaps.ie.

Figure 7: Location of Historic Flooding Events



In October 2017, the River Dargle Flood Defence Scheme was constructed in the area since the installation Flood Defence Scheme there have been no recorded instances of fluvial or tidal flooding in the area.

4 Existing flood risk

4.1 Fluvial and Tidal flood risk

4.1.1 River Dargle Flood Defence Scheme

The River Dargle is a potential source of flooding to the proposed scheme and as such, the flood level in the river at the proposed crossing location is a key driver of the design soffit level. The River Dargle Flood Defence Scheme was designed to provide protection against 1-in-100-year fluvial flood and 1-in-200-year tidal flood. The scheme was designed to allow for future adaptation to accommodate rising water levels due to climate change.

The River Dargle Flood Defence Scheme Physical Model Study (HR Wallingford) determined flood levels ranging from 3.61m OD to 3.65m OD in the vicinity of the proposed bridge. These levels corresponded with a 1-year fluvial and 200-year tidal flood event which was noted in the report as the worst-case scenario.

Figure 8 below is an extract from the River Dargle Flood Defence Scheme design drawings. The proposed bridge crosses the scheme at approximately Section 038; Section 038 is reproduced in Figure 9 below. The design flood level at the proposed crossing is 3.54m OD. The design flood defence level of the River Dargle scheme at the proposed crossing is 4.30m OD. These drawings are reproduced in full in Appendix B of this report.

Figure 8: River Dargle Flood Defence Scheme (Site Layout Plan, O'Connor Sutton Cronin, 2007)

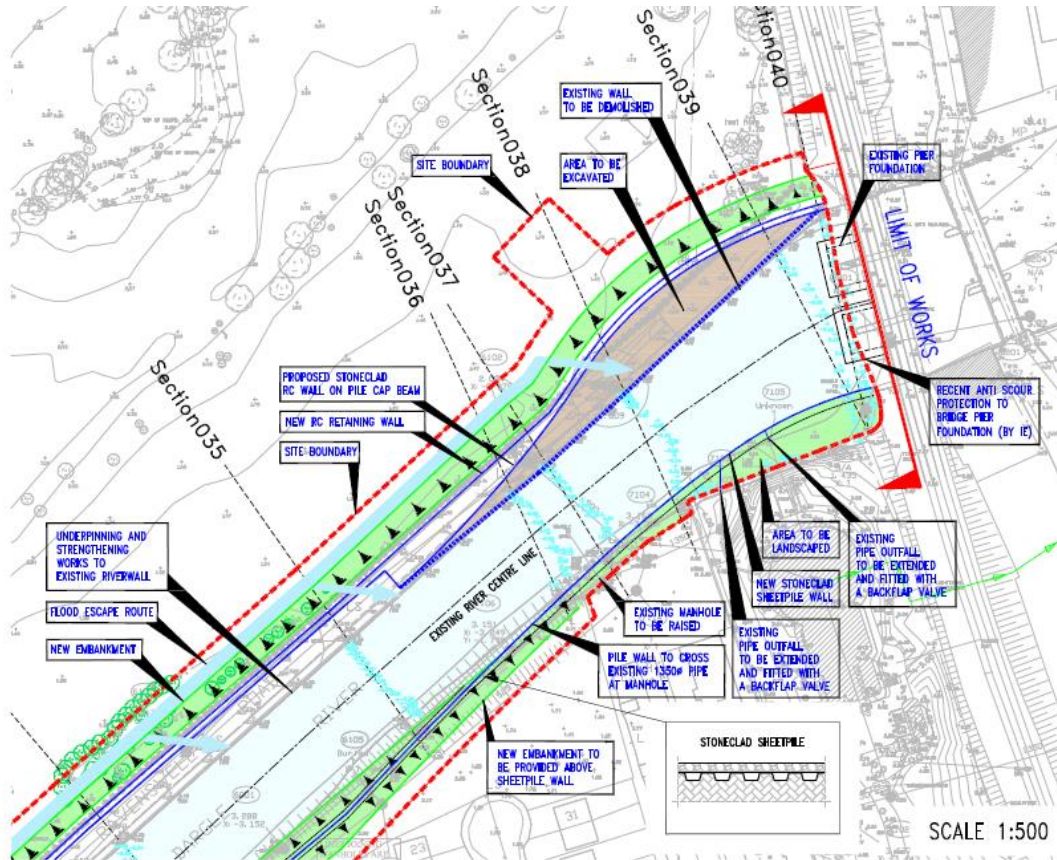
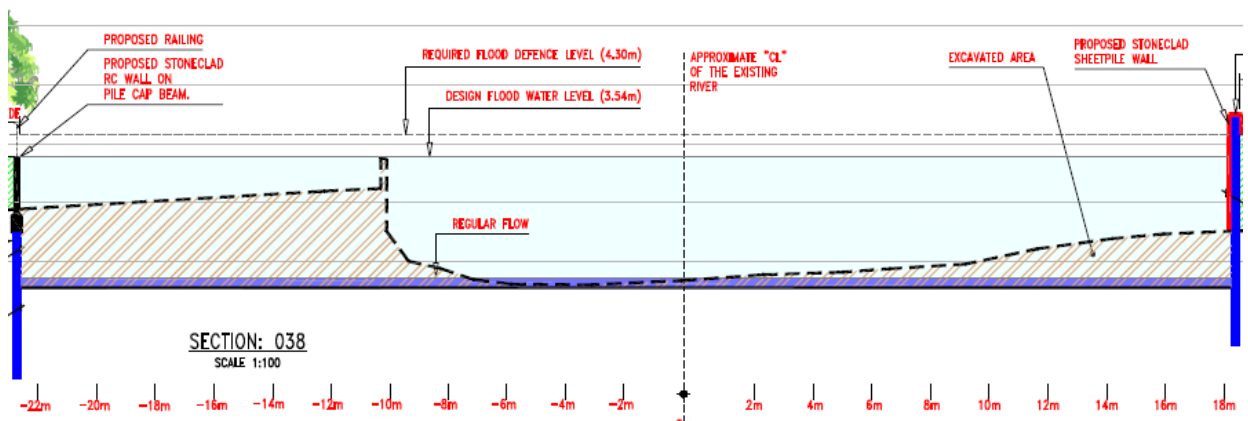
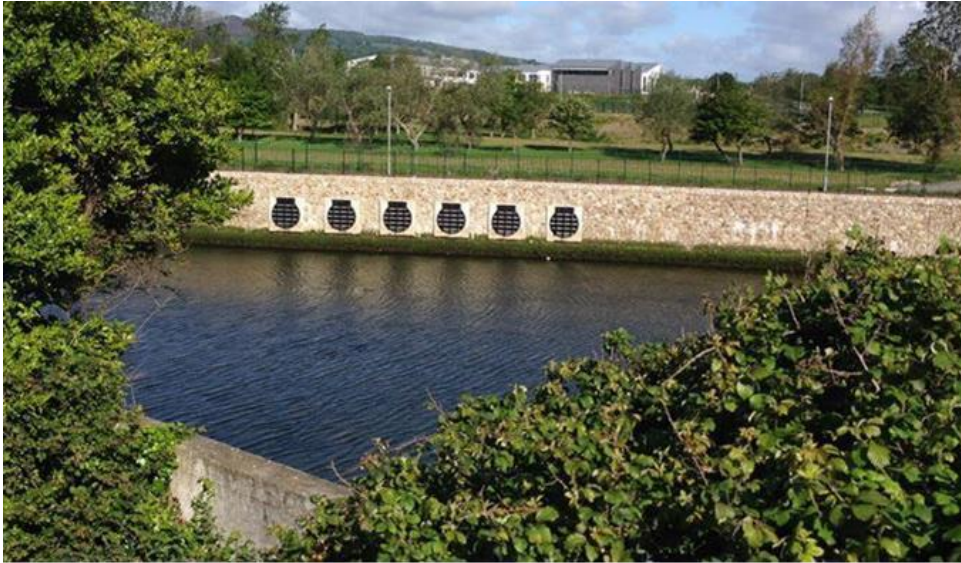


Figure 9: River Dargle Flood Defence Scheme (Section 038, O'Connor Sutton Cronin, 2007)



Six culverts with 1.35m diameter were also built under Ravenswell Road (refer Figure 6 for road location), just upstream of the rail bridge (see figure 6). All surface flow from the former golf club lands, located on the northside of the road, that do not infiltrate to the ground, naturally flows towards Ravenswell Road and is discharged back to the river by the six culverts. These culverts also receive some flood plain from the Little Bray Area that flows this way from Castle Street and Belton Terrace towards Ravenswell Road.

Figure 10: Culverts at Ravenswell Road (view from the right bank of the river Dargle)

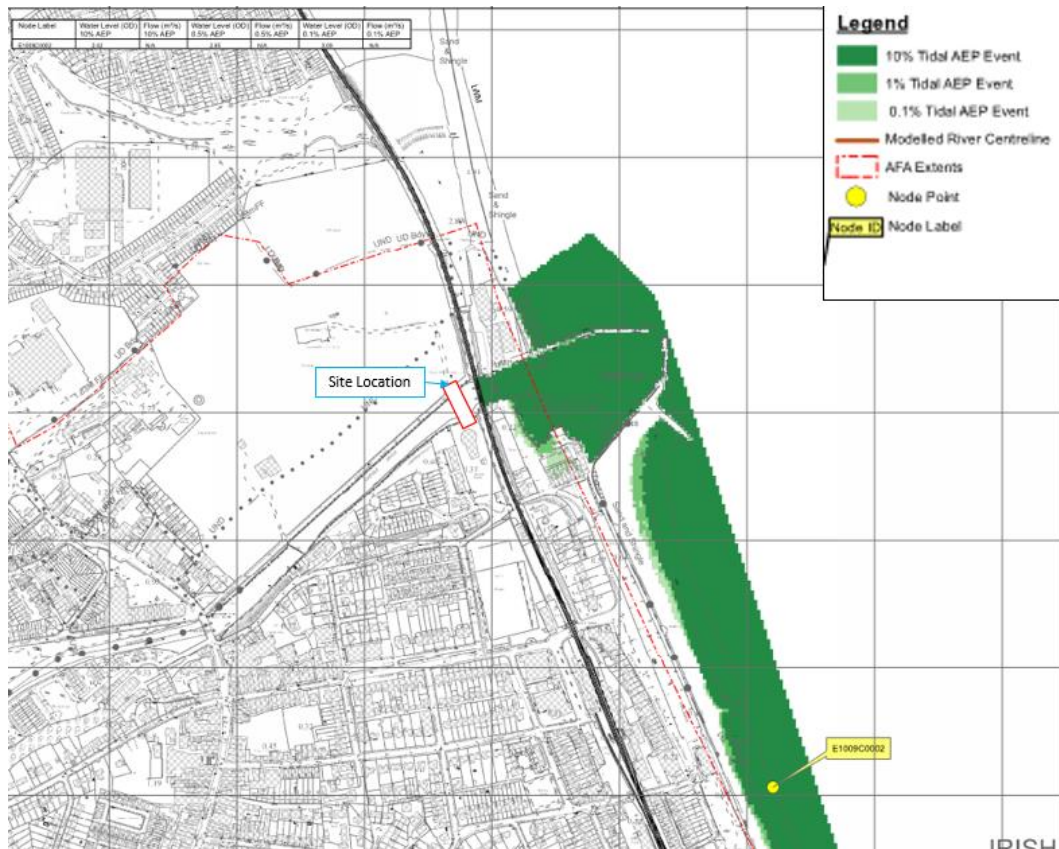


4.1.2 Eastern CFRAM Study – Tidal flooding

An extract from the Eastern CFRAMS tidal flood extent map is displayed in Figure 1110. The predicted tidal flood extents for three separate return period events are presented on the map; 1 in 10, 200- and 1000-year tidal flood extents.

The flood map indicates the area in close vicinity of the proposed site is at risk from flooding from a 10% AEP (1 in 10-year tidal flood extent) event. The predicted 200-year tidal water level at the nearest node E1009C0002 is 2.85mOD. As noted in Section 4.1 above, the River Dargle Flood Defence Scheme was designed for the 1-in-200-year tidal flood event.

Figure 11: Extract from Eastern CFRAMS tidal flood extent map



4.2 Pluvial flooding

Pluvial flooding occurs when extreme rainfall overwhelms drainage systems or soil infiltration capacity, causing excess rainwater to pond above ground at low points in the topography.

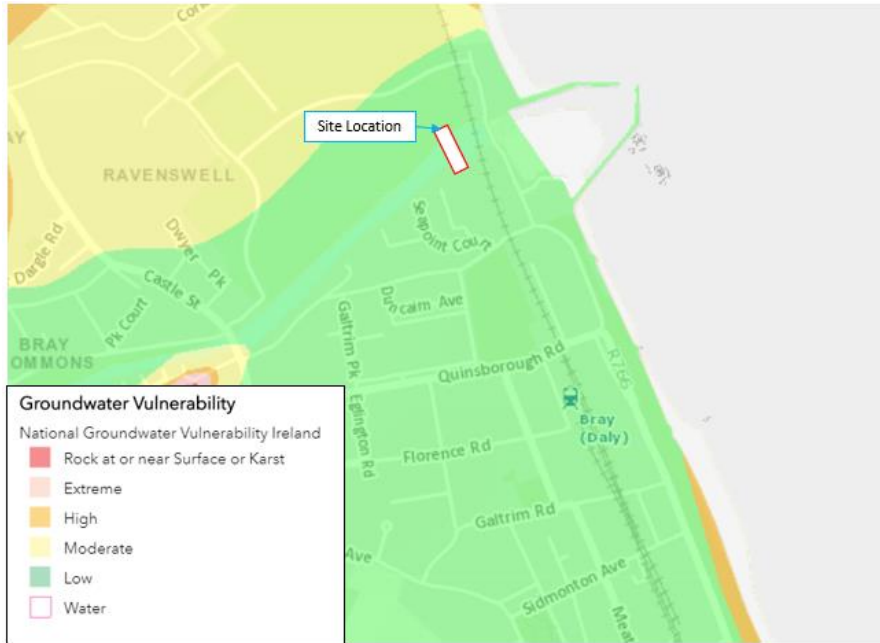
The proposed road network and bridge will be designed to allow positive drainage to the proposed drainage network. As such, pluvial flood risk is considered to be low.

4.3 Groundwater flooding

Groundwater flooding can occur during lengthy periods of heavy rainfall, typically during late winter/early spring when the groundwater table is already high. If groundwater level rises above ground level, it can pond at low points and cause periods of flooding.

The groundwater vulnerability for the proposed site is presented in Figure 11. It indicates that the proposed development falls within the “Low” groundwater vulnerability category. In order to accurately assess the site-specific risk of groundwater flooding, a geotechnical site investigation is recommended in order to confirm the findings of the below map. This should be carried out pre-construction.

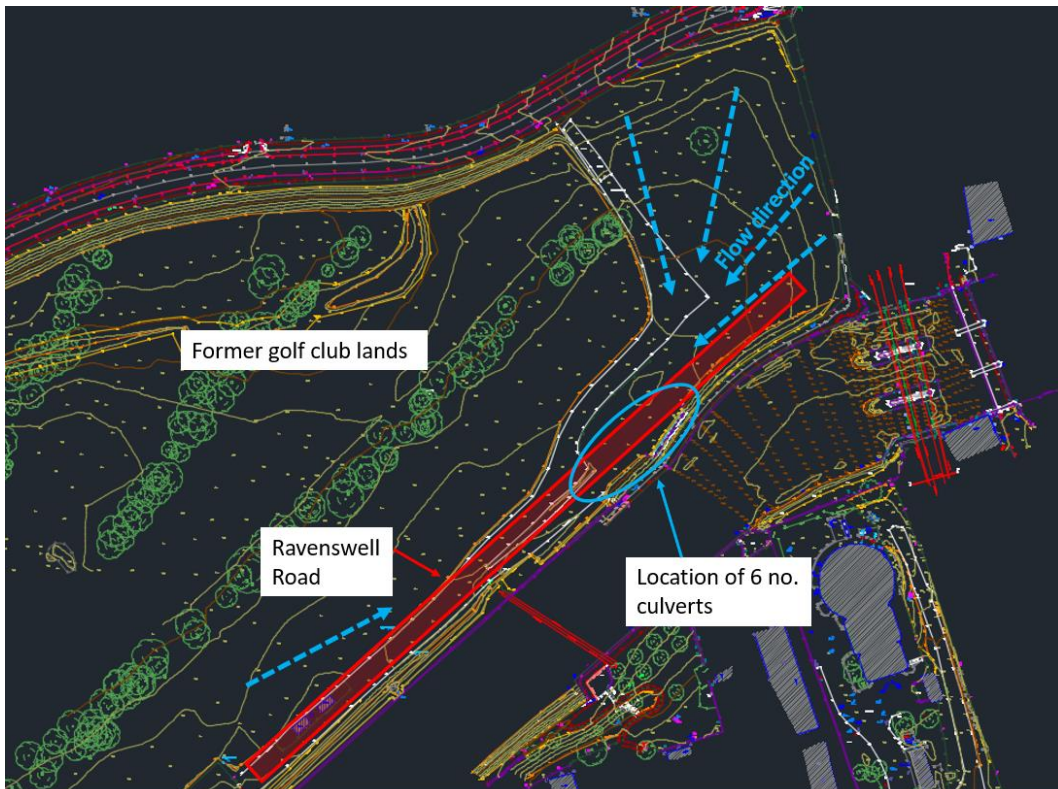
Figure 12: GSI Groundwater Vulnerability Mapping



4.4 Former golf club lands

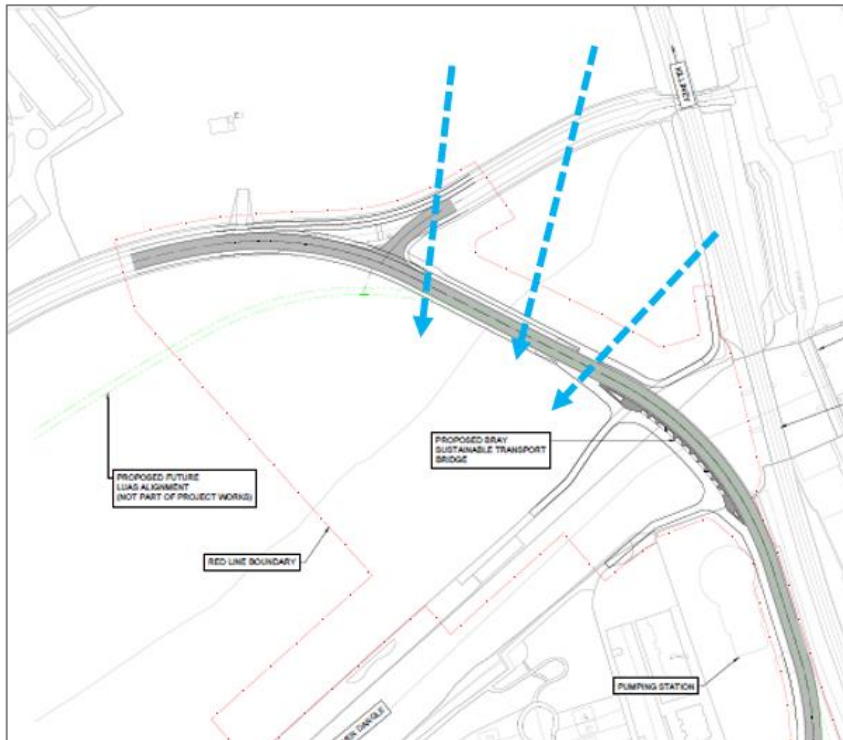
The topography on the left side bank of the River Dargle, at the former golf club lands falls towards the culverts constructed under the Dargle Flood Defence Scheme that discharge into the River Dargle.

Figure 13: Former golf club lands topography



The construction of the link road will block the area to the northside of the road where there is currently a greenfield. During lengthy periods of rainfall, the ground may not handle the constricted flow, leading to a risk of flooding as there is no additional outlets in the area where the water can drain to.

Figure 14: Link road crossing green area



4.5 Summary of Existing flood risk

The risk of flooding to the existing site from fluvial, tidal, pluvial and groundwater sources has been assessed and is summarised as follows:

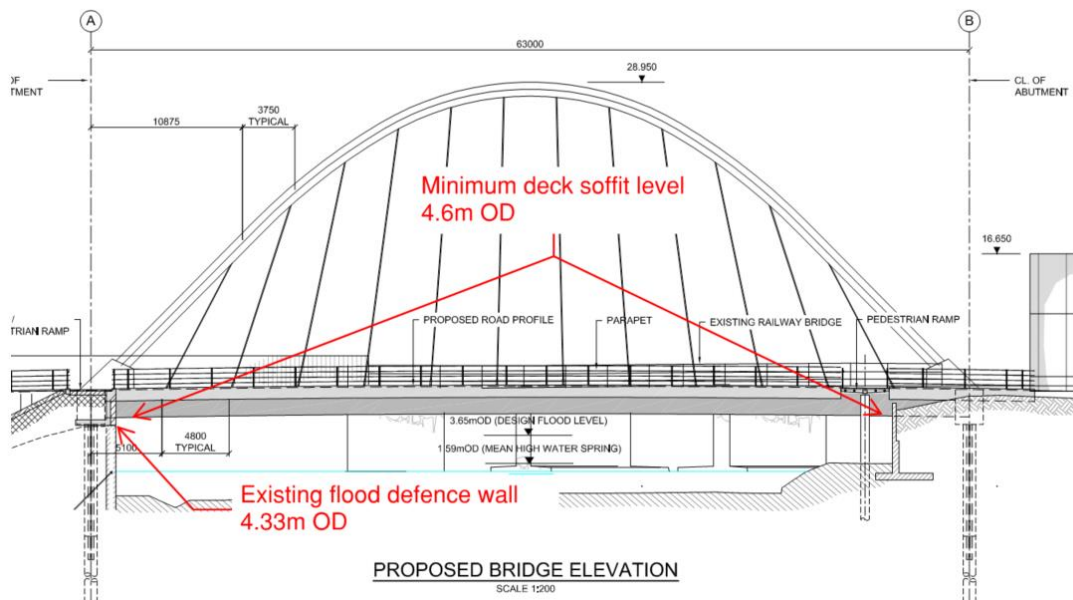
- The predicted 1 in 200-year tidal CFRAM level at node E1009C0002 is 2.85mOD.
- The River Dargle Flood Defence Scheme design flood level at the propose crossing is 3.54m OD; the corresponding design flood level is 4.30m OD. Provided the proposed bridge and pedestrian walkway do not encroach below these levels, the scheme can be considered to be outside of Flood zone A or B.
- The risk of groundwater flooding to the majority of the site is “Low” however there are areas that will require a geotechnical site investigation to determine site specific risk of groundwater flooding.
- The construction of the link road may block the natural flow and the proposed road may be in risk of flooding.

5 Proposed Scheme

5.1 Bridge Geometry

Schematics of the proposed bridge sections is presented in Figure 12. The proposed bridge is a clear-span structure with a minimum soffit level of 4.60m OD. This is 300mm above the flood defence level (4.30m OD), 0.85m above the worst-case flood level according to the Physical Model Study (HR Wallingford) and 1.06m above the design flood level applied in the construction of the River Dargle Flood Defence Scheme. The proposed bridge is therefore not at risk of flooding in the current scenario.

Figure 15: Design Flood Level and Proposed Bridge



5.2 Pedestrian Boardwalk

The proposed pedestrian boardwalk running parallel to the south bank of the River Dargle (refer drawing RDPTB-ARUP-ZZZ-BRD-DR-CH-0002, Appendix A) will be constructed on four 600mm diameter piles located in the river overbank on the south side of the river. The underside of the pedestrian boardwalk is approximately 5.23m at the lowest point in the river section. This is well above the design flood level and as such, is not considered to be at risk of flooding.

The pedestrian boardwalk support piles are 600mm diameter. These are located in the overbank of the main river channel where the channel bed is approximately 1.50-1.60m OD. The volume of the flooded cross section displaced by the piers, when considering a design flood level of 3.54m OD, is 2.25m³. As the primary source of flooding in this area is tidal this displaced volume can be considered to be relatively insignificant.

5.3 Link road

The horizontal alignment is constrained by the tie-in with Central Road to the north and the confined corridor south of the river between the railway boundary and Bray Pumping Station.

The link road has been designed to accommodate public transport, with 3.25m wide bus lanes selected in accordance with the requirements set out in DMURS.

The width of the traffic lanes over the bridge have been widened to 3.5m to space-proof the bridge structure to accommodate the potential future Luas alignment.

This includes the addition of 0.6m raised verges either side to allow for the necessary clearances adjacent to the bridge barriers.

5.4 Construction

Construction flood risk is not typically considered in the Flood Risk Assessment of permanent works however, as the construction for this project will require a platform to be constructed on the riverbed it is necessary to consider construction methodology. The site constraints, road alignment and single span arrangement requires the bridge to be constructed in parts using temporary supports, before it can support its own weight and cross the river with a single span. This requires the use of temporary towers within the waterway to support the bridge deck prior to erection of the permanent arch structure. Hence, construction of a working platform within the waterway is required. The working platform will likely comprise rock infill, laid on top of the riverbed. The working platform will be limited to either side of the river channel with a central passage maintained.

Fifteen 1.5m diameter culverts will be placed on the riverbed under the working platform. The top level of the platform will be circa 2.2m OD which will allow it to overtop in a significant flood event. A flood level of 2.2m OD will result in a driving head on the culverts which will then have a flow capacity of circa 101m³/s before the working platform is overtopped. It is noted that the Q100 river flow rate is approximately 300m³/sec (O'Connor Sutton Cronin, 2007).

6 Discussion and conclusion

This Flood Risk Assessment (FRA) has been carried out as part of the Planning Application for the proposed development across the River Dargle facilitating a public transportation link by including road infrastructure through the golf club lands in addition to the Public Transport Bridge over the Dargle as part of the planning design for the scheme.

The proposed bridge and associated pedestrian link will cross the River Dargle Flood Defence Scheme. The proposed bridge has been assessed with consideration of the River Dargle Flood Defence Scheme and corresponding flood design and flood defence levels. These levels consider both tidal and fluvial flood risk.

The proposed bridge soffit level will be 0.8m higher than the flood defence design level and 1.06m higher than the peak design flood water levels. The proposed bridge will be a single span structure and as such, will not encroach on the flood plain of the river. The proposed pedestrian link will be located on the dry side of the flood defence scheme. As a result, the proposed scheme is not at risk from tidal or fluvial flooding.

The risk of groundwater flooding at the proposed location is considered to be low, however it is recommended that groundwater levels are monitored, and the risk of groundwater flooding be considered further when such data is available. However, to accurately assess the site-specific risk of groundwater flooding, a geotechnical site investigation is recommended in order to confirm the findings of the above maps. This should be carried out pre-construction.

The construction of the proposed link road may impose a risk of flooding from blocking the natural flow of the surface water at the northern eastern area of the former golf club lands. It is recommended that a culvert through the road embankment is constructed to allow for surface water drainage, following its natural path and avoiding flooding along the roadside during long rainfall periods.

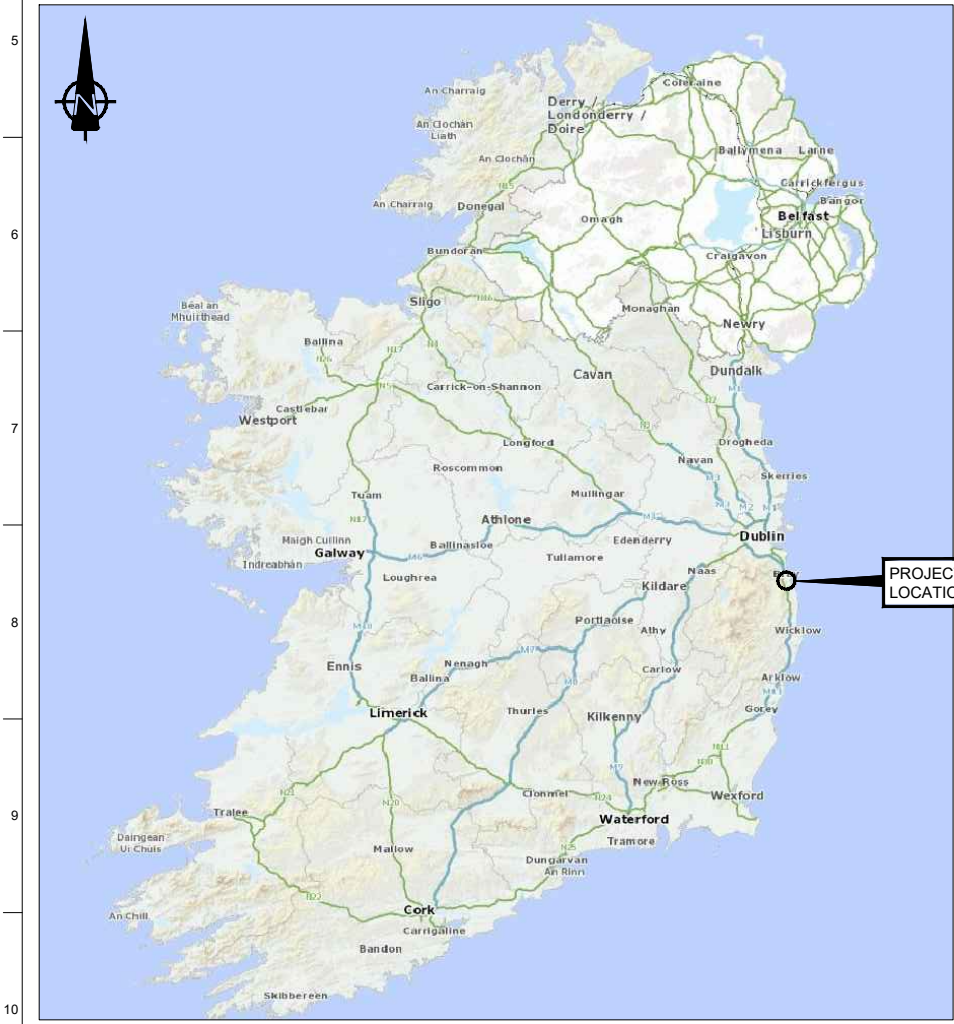
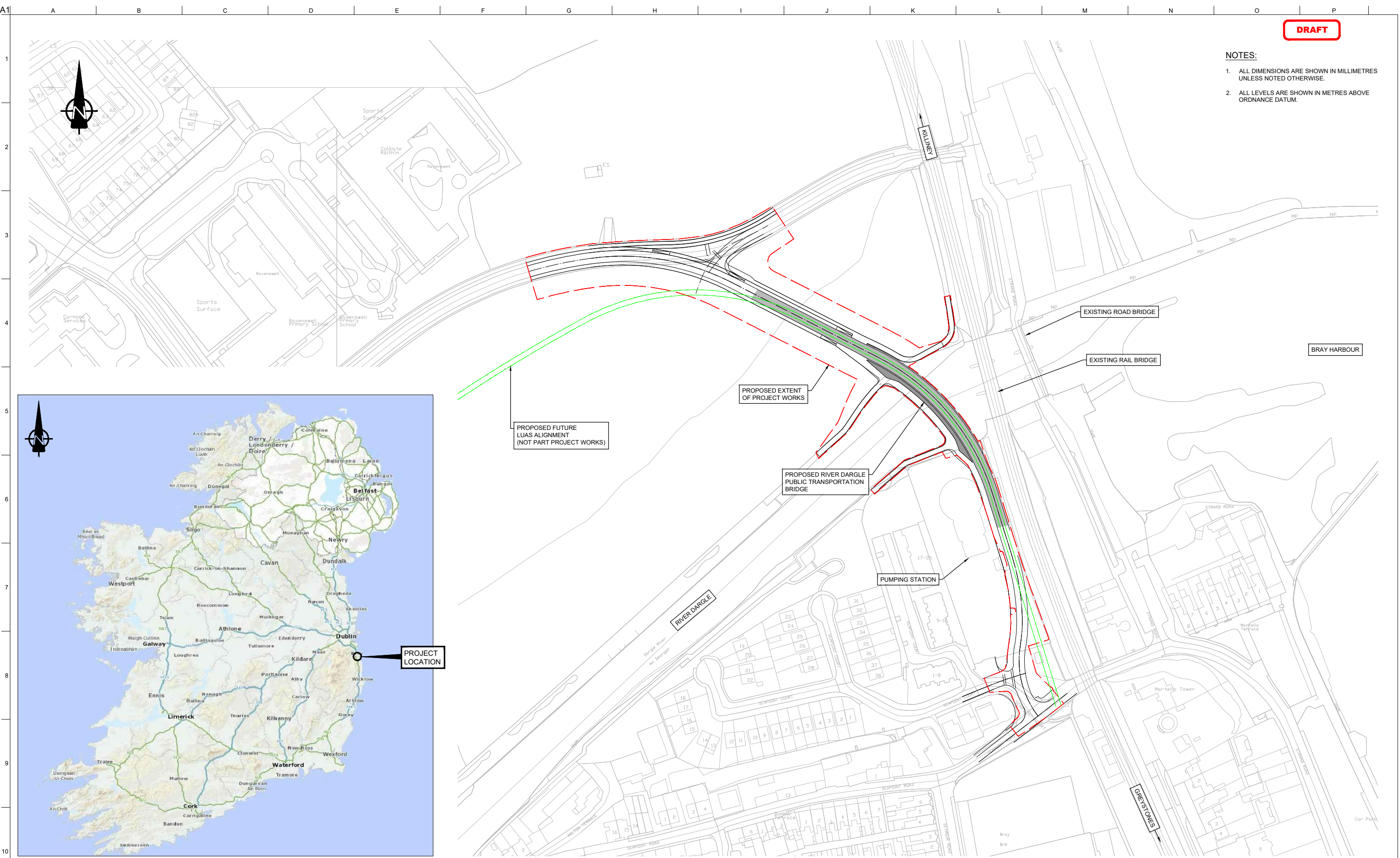
Fifteen 1.5m diameter culverts are proposed under the working platform to accommodate river flows during construction. It is recommended that emergency flood mitigation measures are demobilisation plans are devised through the Contractor Construction Environmental Management Plan.

The site is classified as Flood Zone C as per OPW Guidelines. A Justification Test for the development is therefore not required. It is considered that the proposal is in keeping with the principles of the Flood Risk Guidelines which seeks to locate development in appropriate locations.

Appendix A

Proposed Scheme - Design Drawings

- NOTES:**
1. ALL DIMENSIONS ARE SHOWN IN MILLIMETRES UNLESS NOTED OTHERWISE.
 2. ALL LEVELS ARE SHOWN IN METRES ABOVE ORDNANCE DATUM.



MAP OF IRELAND
SCALE N.T.S.

PLAN ON PROPOSED BRIDGE LOCATION
SCALE 1:1000

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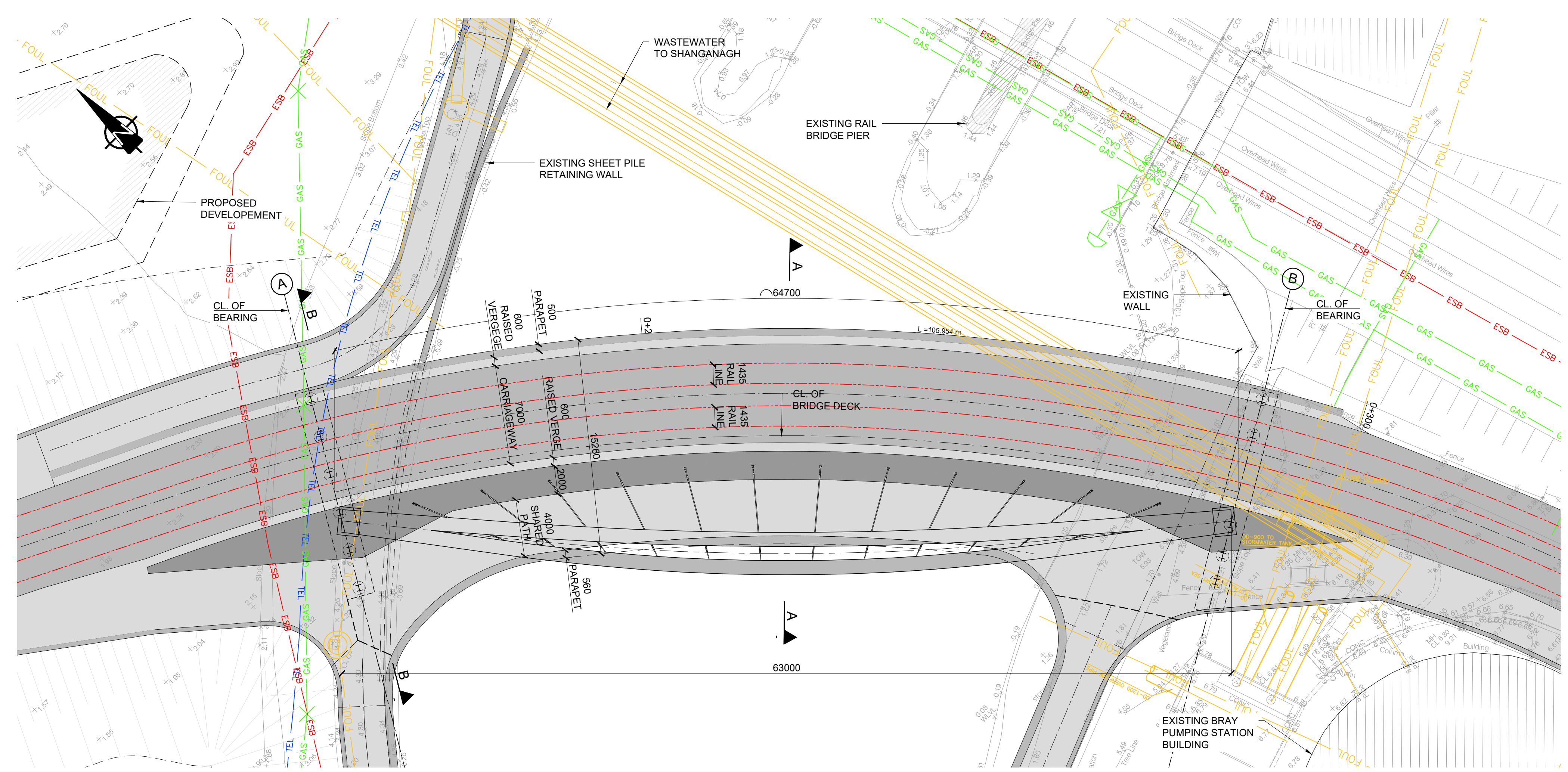
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Checked: CG	Title: BRIDGE SITE LOCATION PLAN
Approved: MS	
Date: 20.03.20	
Scale: AS SHOWN @ A1	
Status: S3	
Job No. 268095	Drg. No. RDPTB-ARUP-ZZZ-ZZZ-SK-CB-1000
	Rev. P01

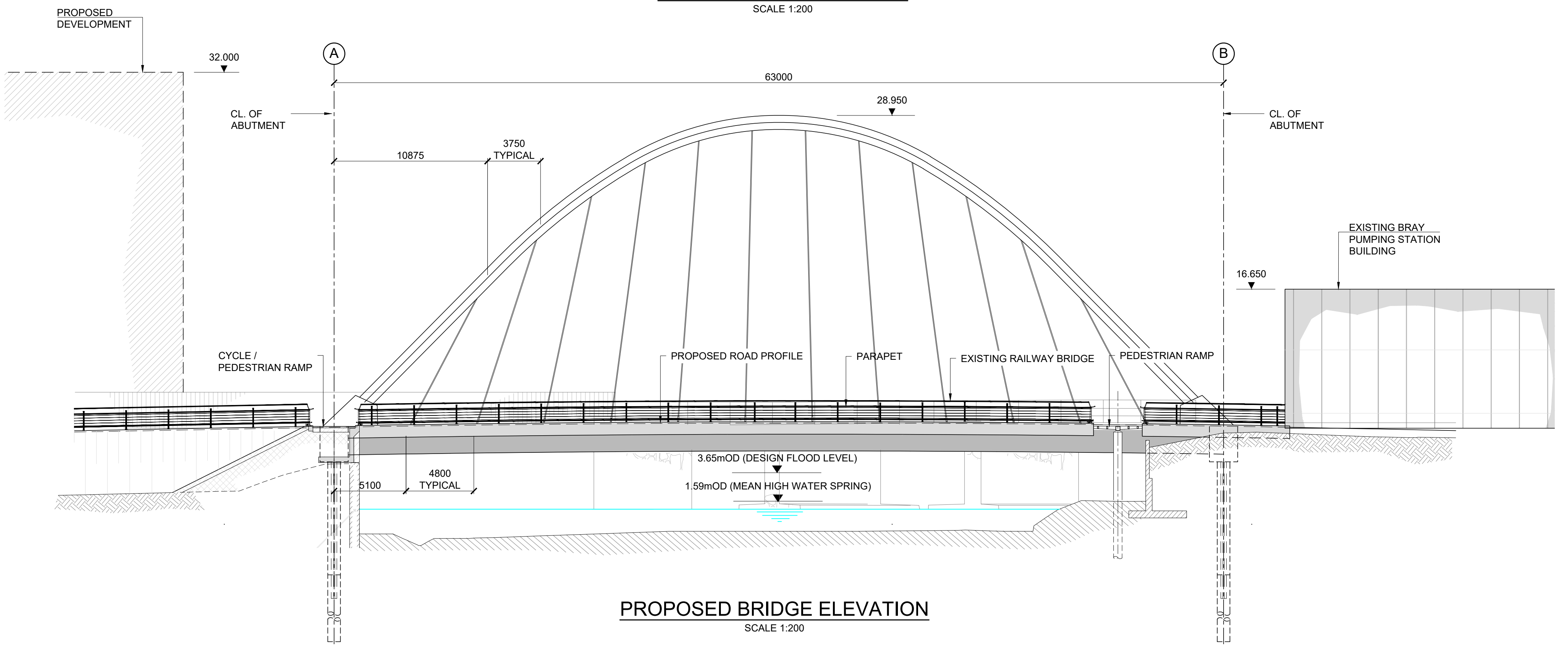
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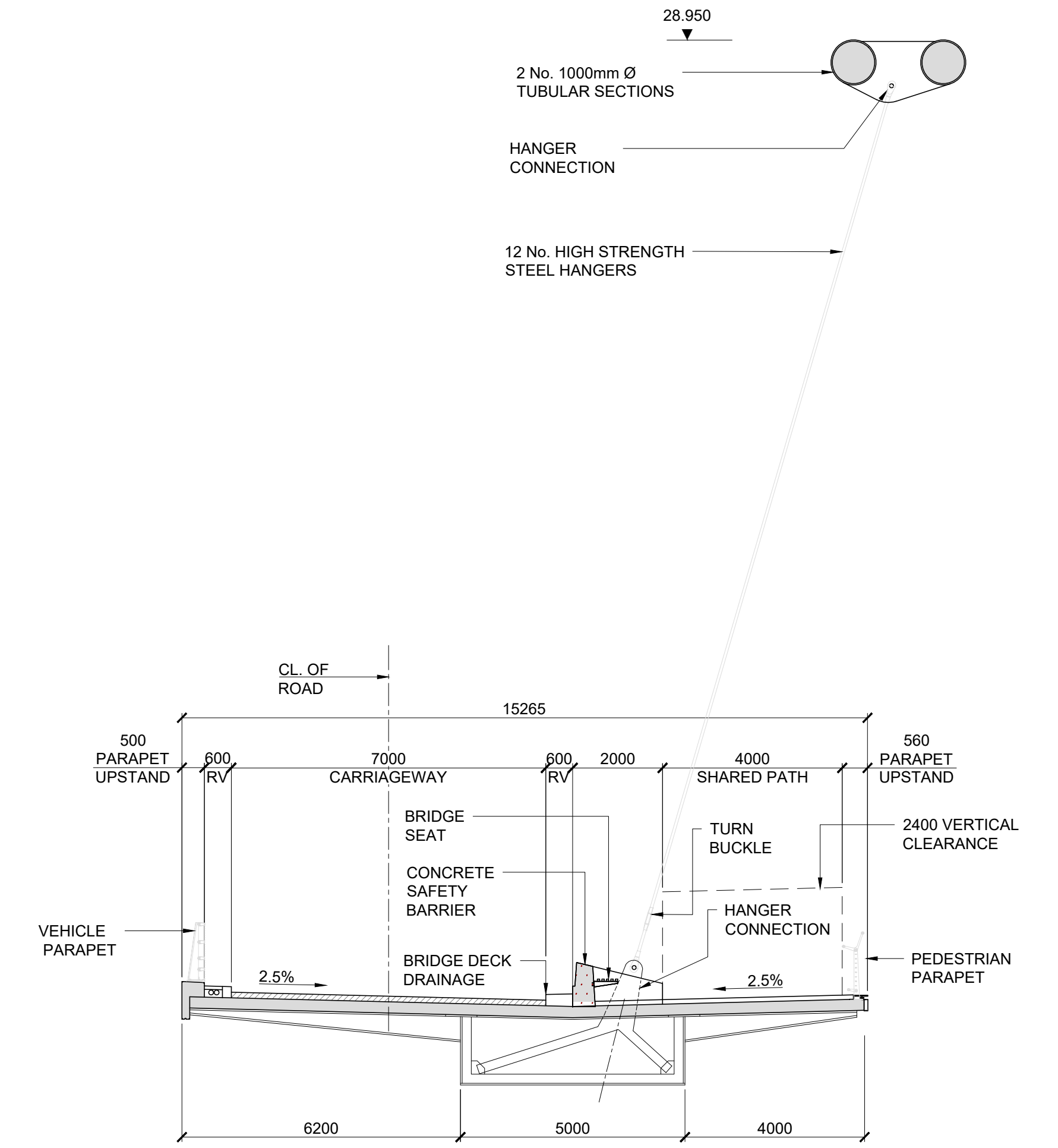
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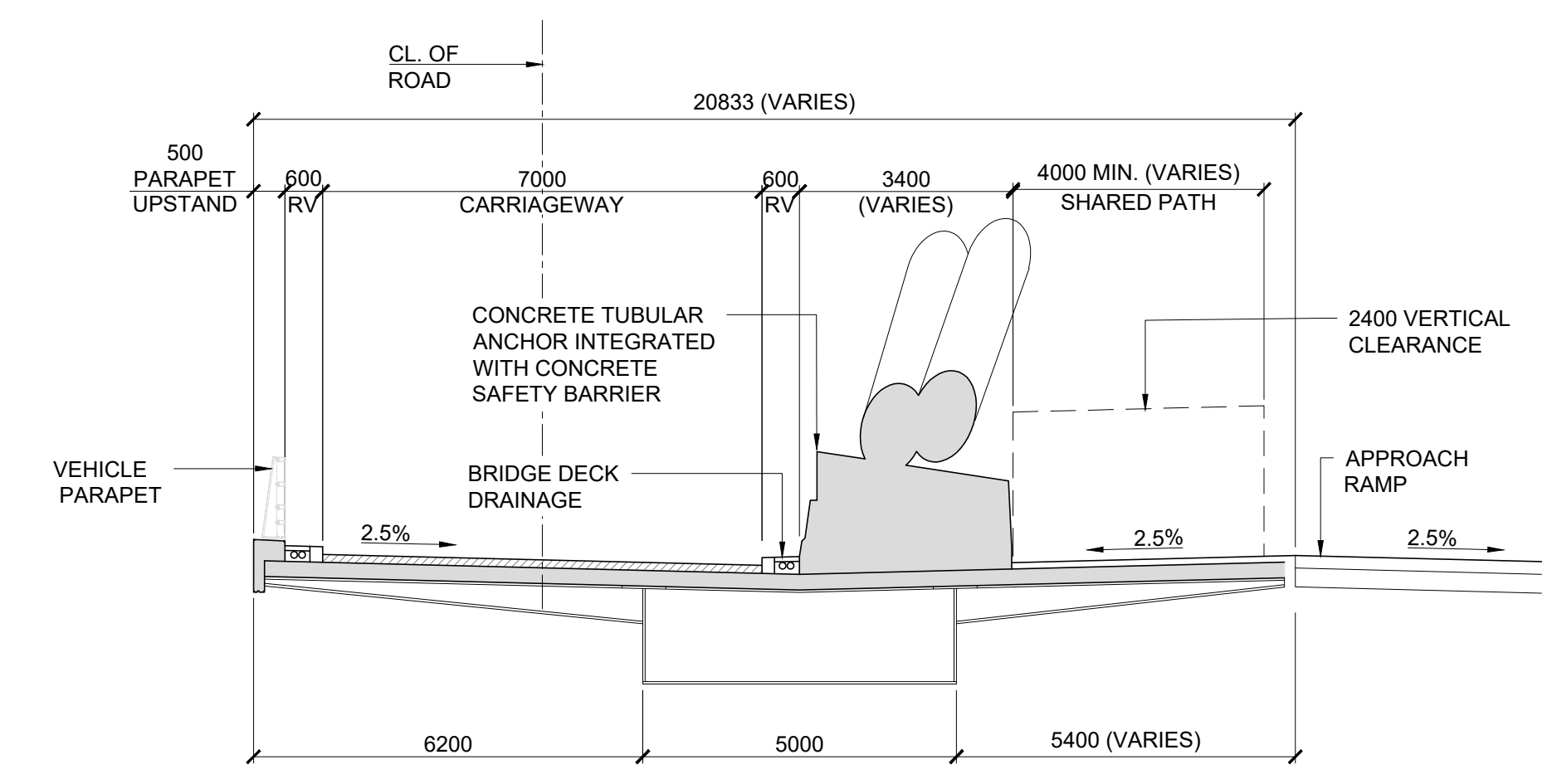
PROPOSED BRIDGE PLAN
SCALE 1:200



PROPOSED BRIDGE ELEVATION
SCALE 1:200



SECTION A-A
SCALE 1:100



SECTION B-B
SCALE 1:100

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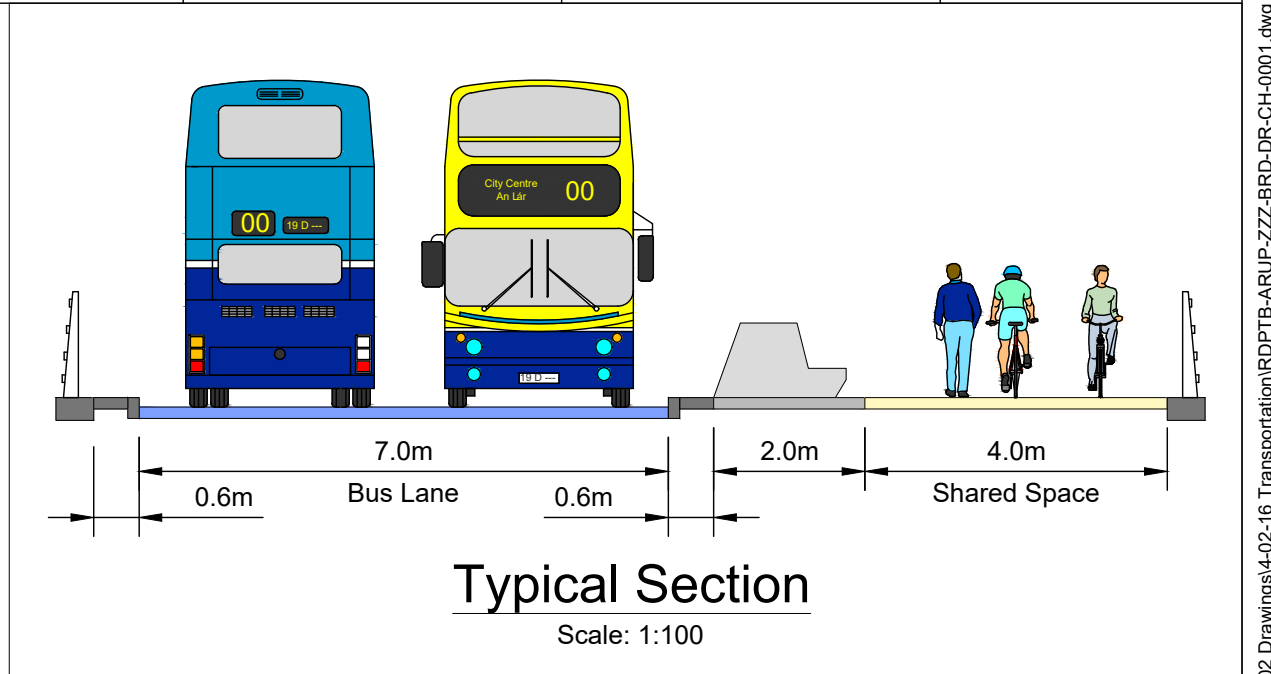
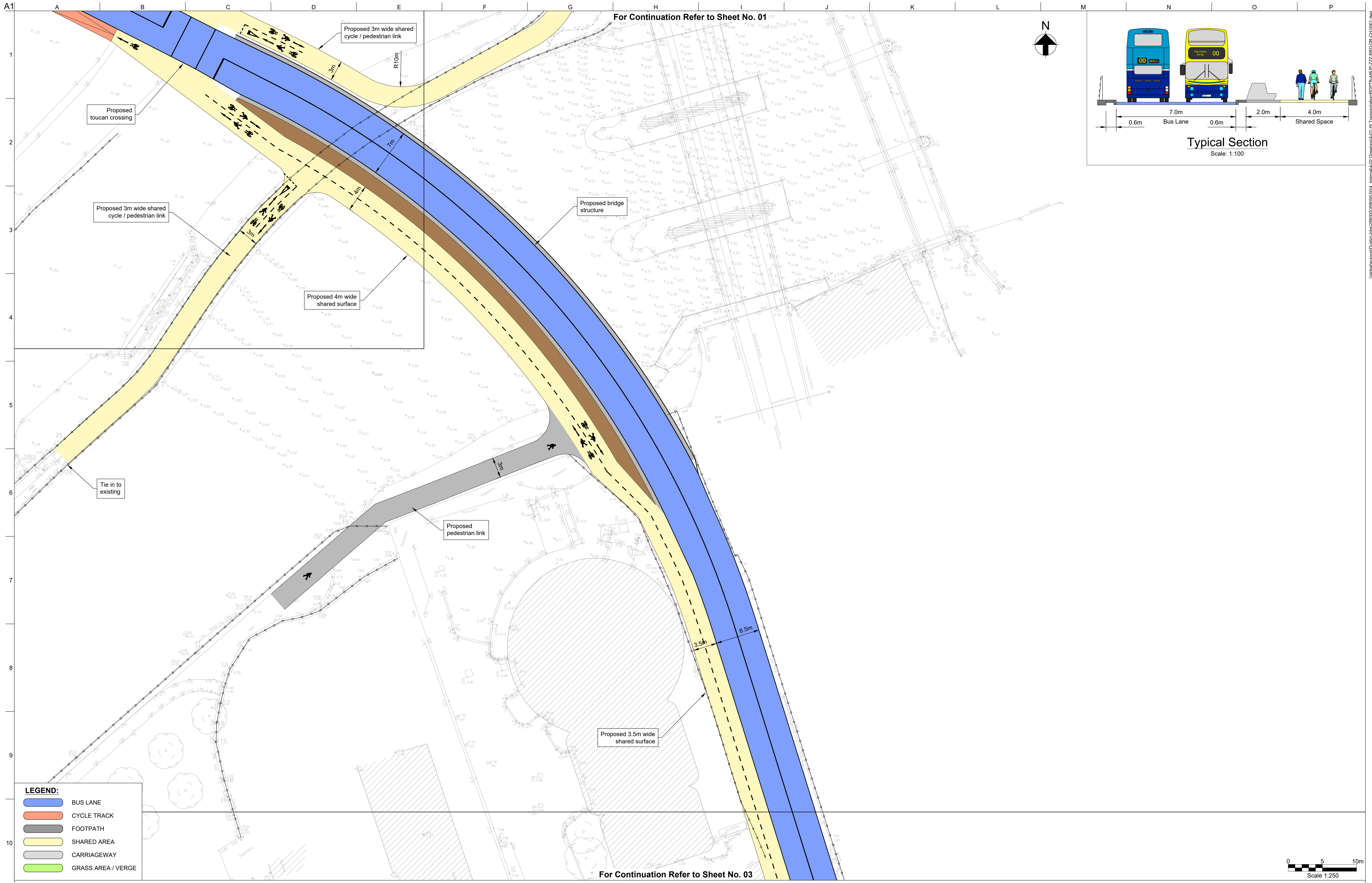


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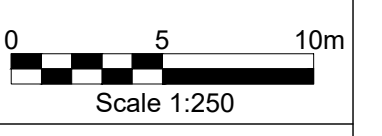
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LEGEND:

- BUS LANE
- CYCLE TRACK
- FOOTPATH
- SHARED AREA
- CARRIAGEWAY
- GRASS AREA / VERGE

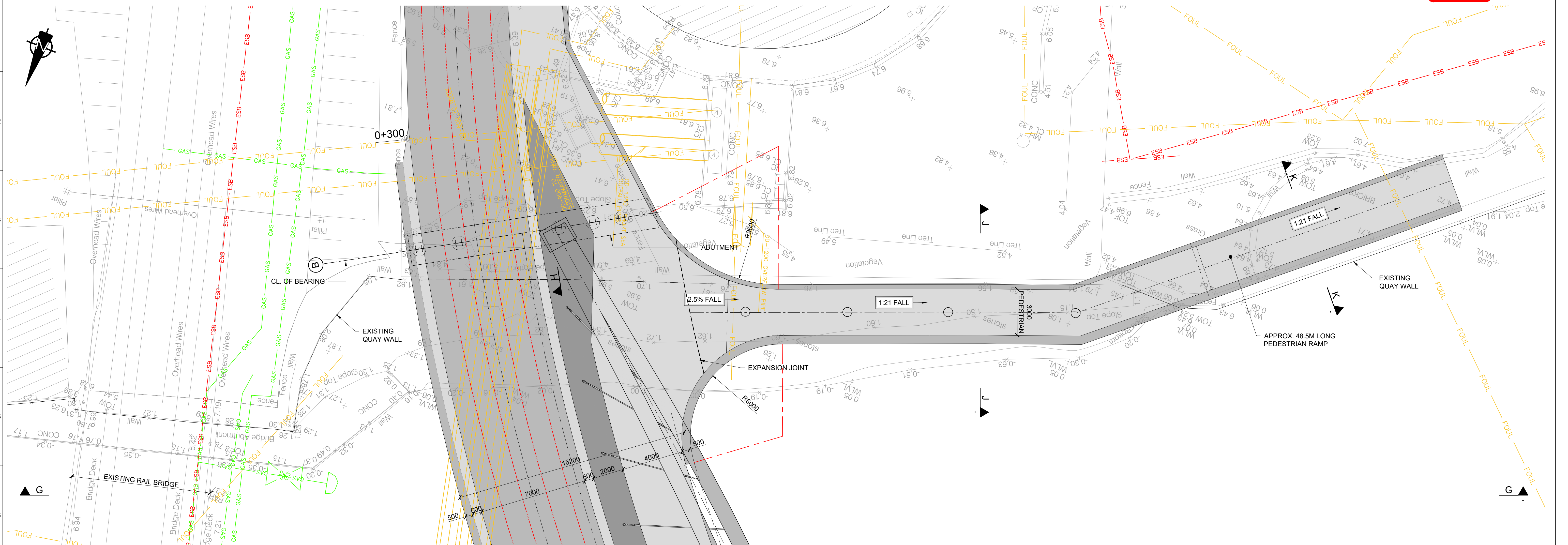


For Continuation Refer to Sheet No. 01

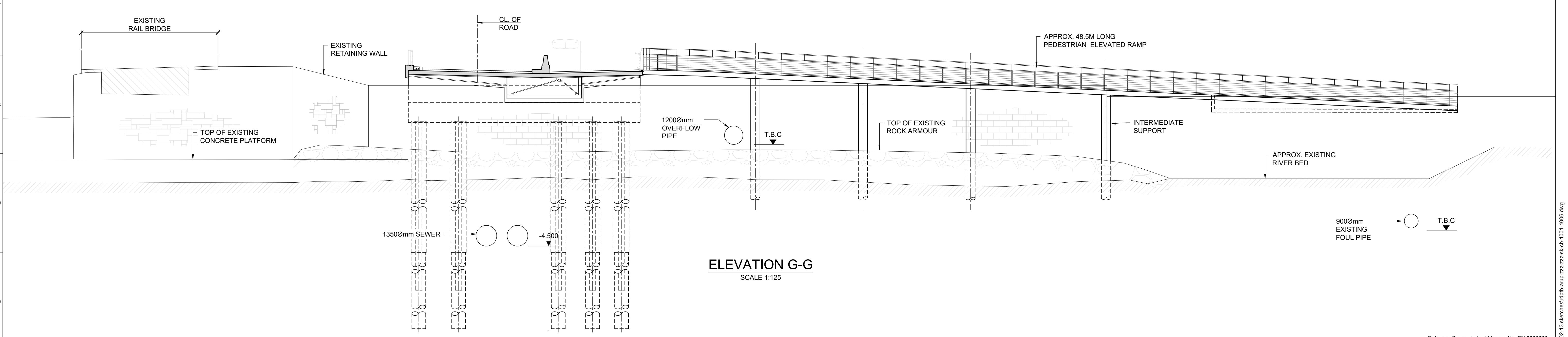
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PLAN ON SOUTHERN ABUTMENT APPROACH WORKS
SCALE 1:125



ELEVATION G-G
SCALE 1:125

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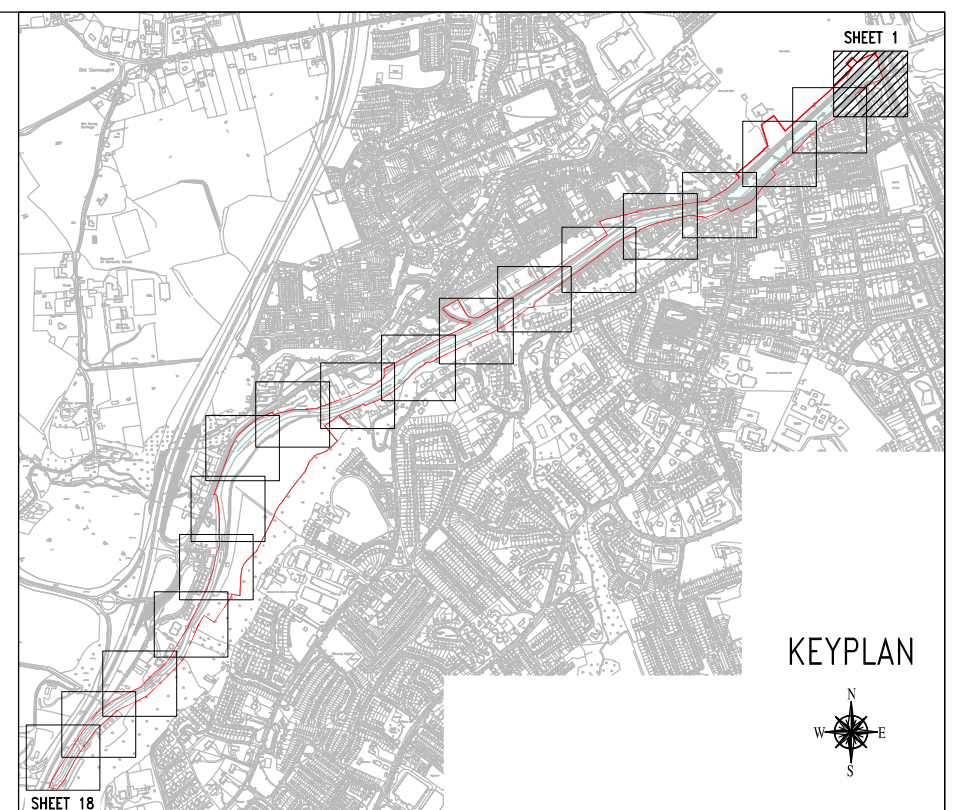
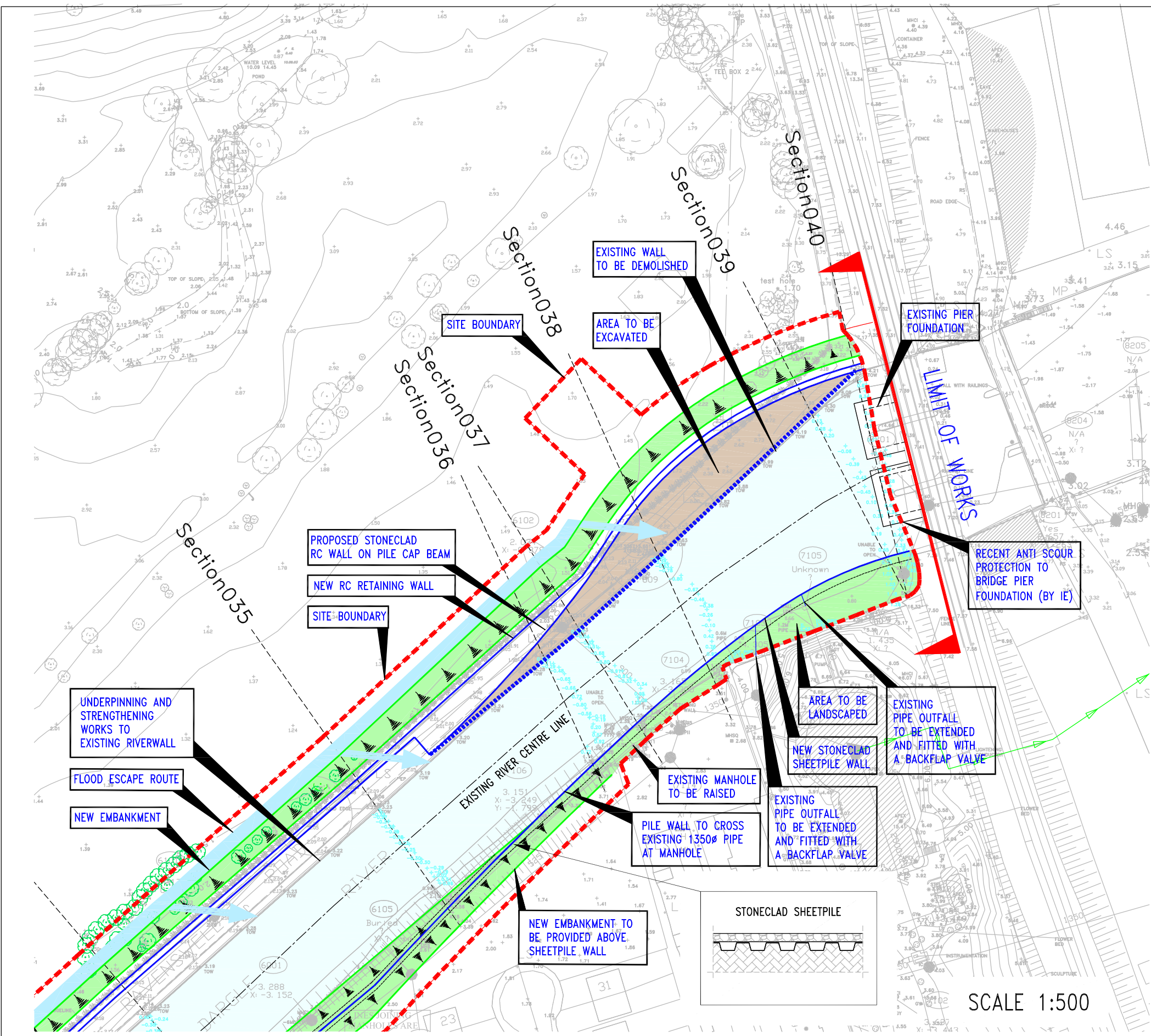
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Drg. No.	RDPTB-ARUP-ZZZ-ZZZ-SK-CB-1004
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Appendix B

Extract from River Dargle Flood
Defence Scheme



FOR SHEETS 1 to 18
REFER TO Dwg's.
B237-111 to B237-128.

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LEGEND :

	- RIVER REGRAIDING		- SITE BOUNDARY
	- AREA TO BE EXCAVATED		- SHEETPILE WALL
	- EARTHEN EMBANKMENT		- RC RETAINING WALL

LEGEND :

	- STONECLAD SHEETPILE		- EXISTING TREES
	- TIMBERCLAD SHEETPILE		NOTE: REFER TO LANDSCAPE ARCHITECT DRAWING FOR TREES TO BE REMOVED
	- STONECLAD SECANT PILE WALL		

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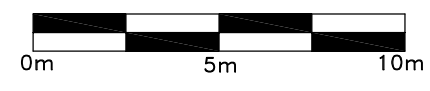
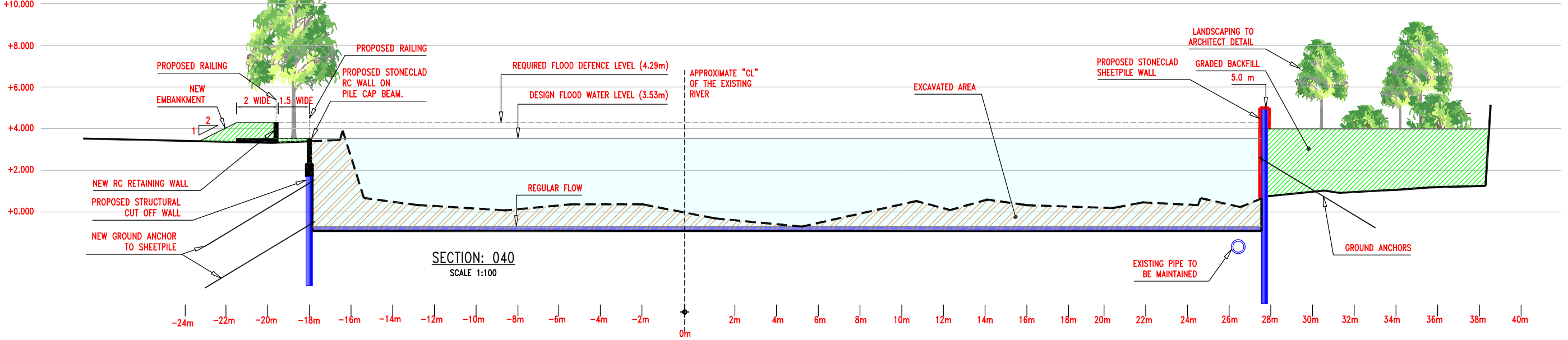
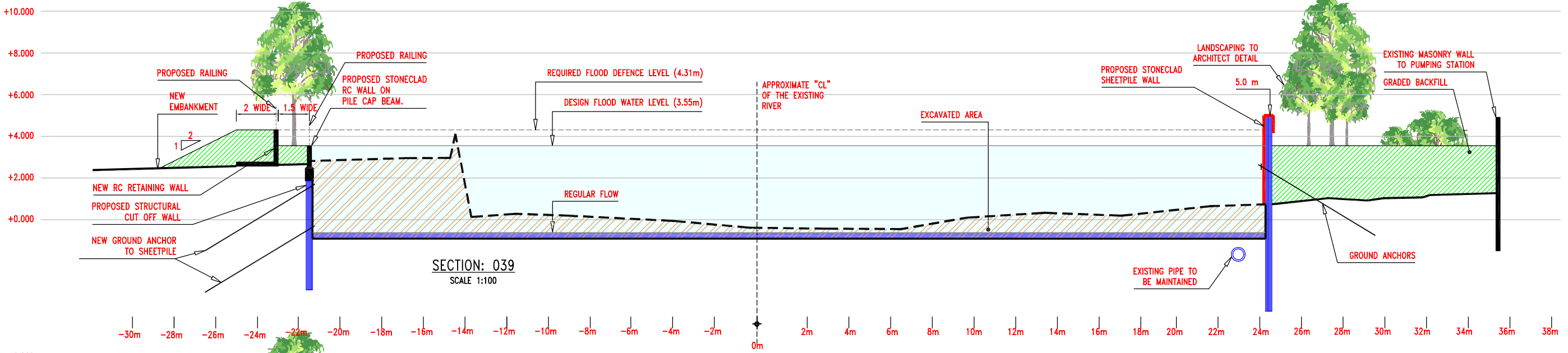
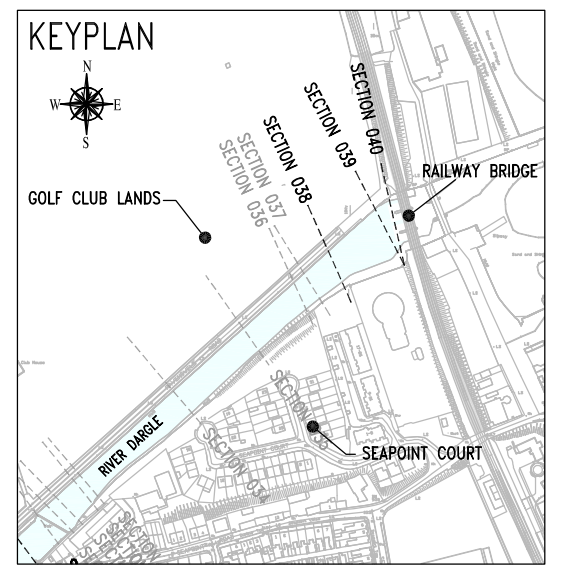
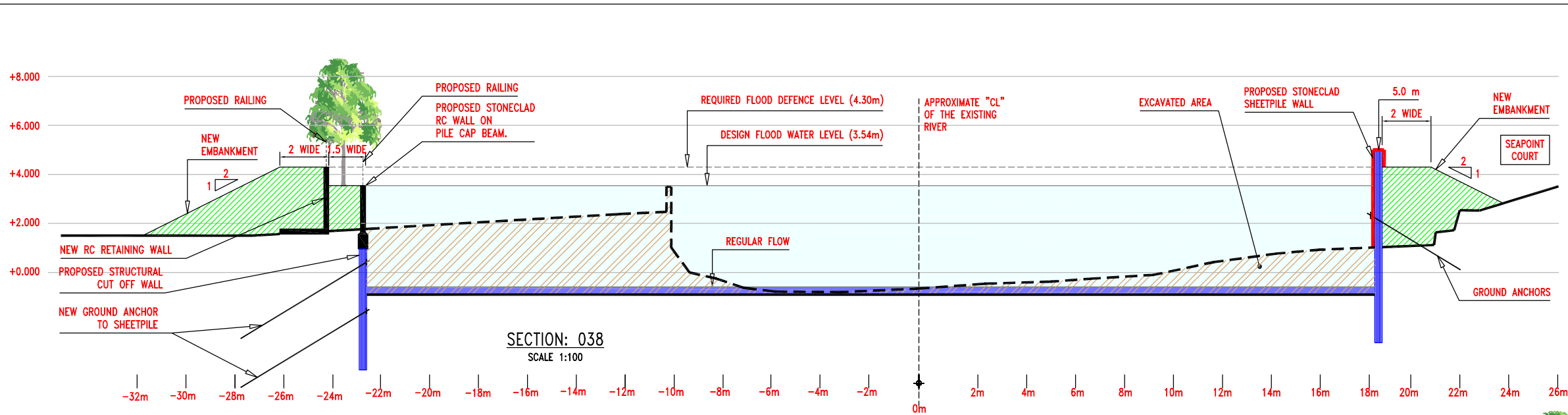
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Title				SITE LAYOUT PLAN SHEET 1 OF 18			
Dwg. No.	Scale	Rev.	Appr. by	Rev.	Appr. by	Rev.	Appr. by
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Date:	12/04/07	Dwg. No.	B237-111	Rev.		Rev.	

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