

The Secretary,
An Coimisiún Pleanála,
64 Marlborough Street,
Dublin 1.

Date: 11th September 2026
Ref.: JN 24219

Re: Application for permission / approval for a proposal for the provision of a downstream underground gas transmission pipeline connection between the existing Dublin to Galway high pressure gas pipeline and the Edenderry Power Plant, and associated development

ACP REF.: ACP-324280-26

Dear Sir / Madam,

We, JSA Planning (the Agent), on behalf of Gas Networks Ireland, Gas Works Rd, Ballintemple, Cork, T12 RX96 (the Applicant, and further to correspondence received from An Coimisiún Pleanála on the 22nd of July 2026 and the 29th of July 2026 hereby submit this letter responding to the submissions received by the Commission in relation to the Strategic Infrastructure Development (SID) Gas Transmission Application under Register Reference ACP-324280-26, for the provision of a downstream underground gas transmission pipeline connection between the existing Dublin to Galway high pressure gas pipeline and the Edenderry Power Plant, and associated development.

Introduction

The development was described as follows in the public notices submitted with the application:

“The proposed development primarily comprises the provision of a new downstream underground high pressure gas pipeline, the provision of an offtake installation compound, and an above ground installation (AGI) compound and associated development, including associated access arrangements, landscaping and ancillary works.

The proposed development is located within the following townlands in County Meath: Kilwarden, Aghnagillagh, Ardnamullen, Ticroghan, Park, Ballyboggan, Ballynakill, Harristown, Castlejordan, and Clongall, and in the following townlands in County Offaly: Clonmore, Roosk, Lenamarran, Jonestown, Mountwilson, Thornwell, Monasteroris, Rathmore, Drumcooly, Rathgreedan, Shean, Ballykilleen, and Esker More.

The proposed 300mm steel underground gas transmission pipeline will cover a distance of c. 23.65km. The application site has an area of c. 243.4 hectares, including the pipeline route, temporary works areas, pipe storage / construction compounds, and the proposed offtake installation and AGI compounds. The proposed pipeline will be a strategic downstream gas pipeline.

The proposed development comprises an underground steel gas transmission pipeline extending south from the proposed offtake installation at the townland of Kilwarden. The

pipeline continues south/southwest through the following townlands in County Meath, at Kilwarden, Aghnagillagh, Ardnamullen, Ticroghan, Park, Ballyboggan, Ballynakill, Harristown, Castlejordan, Clongall. From this point, the transmission pipeline enters County Offaly and proceeds southwards through the following townlands, Clonmore, Roosk, Lenamarran, Jonestown, Mountwilson, Thornwell, Monasteroris, Rathmore, Drumcooly, Rathgreedan, Shean, Ballykilleen. The pipeline runs to the west of the River Boyne and the settlement of Edenderry, and terminates at the proposed AGI at Ballykilleen.

Five temporary construction / pipe storage compounds are proposed. Temporary construction compound 1 is located at the townland of Kilwarden, adjacent to the proposed Kilwarden Offtake Installation. Temporary construction compound 2 is located at the townland of Ardnamullan, adjacent to the linear pipeline route. Temporary construction compound 3 is located within the townland of Monasteroris, positioned to the east of the pipeline corridor. Temporary construction compound 4 is located to the west of the pipeline terminus within the townland of Esker More. Temporary construction compound 5 is located in the townland of Ballykilleen, adjacent to the proposed Ballykilleen AGI. The compounds will accommodate site offices, crane and truck parking, pipe storage, secure lock up containers, car parking, material laydown areas, welfare facilities and material storage areas during the construction stage.

The proposed AGI compound is to be located on lands at Ballykilleen (within the Edenderry Power Station site) and will include a Pressure Reducing Skid (PRS) Kiosk (with a gross floor area (GFA) of c. 49 sq.m. with a parapet height of 3.15m and vent terminations 5.4m in height.), a Packaged Boiler Unit (PBU) Kiosk (with a GFA of c. 23.4 sq.m. with a parapet height of 3.7m and boiler flues extending to 5.67m in height), a Gas Analyser Kiosk (with a GFA of c. 7 sq.m and with a parapet height of c. 2.9m. and vent terminations extending to 3.5m in height) and an E&I Kiosk (with a GFA of c. 15.75 sq.m. and with a parapet height of c. 3m.). Solar PV panels are provided on the roof of the PBU Kiosk. The AGI compound will be enclosed by a 2.4m high palisade security fence, with a 1.2m high open mesh boundary fence.

The proposed Kilwarden Offtake Installation will be accessed off a laneway from the existing R161 Regional Road. The Kilwarden Offtake Installation will accommodate the live 'hot-tap' connection to the existing 750 mm Dublin-Galway pipeline (PTTW), enabling the new 300 mm transmission pipeline to be connected without interruption to the existing network. The Installation will include a below-ground isolation valve located within an access pit, and above-ground pipework and connection points for a temporary PIG (pipeline inspection gauging) trap to facilitate future inspection and maintenance of the proposed pipeline. The compound will be enclosed by a 2.4 m high palisade security fence, with a 1.2 m stock-proof fence installed along the external boundary.

An Environmental Impact Assessment Report and a Natura Impact Statement have been prepared and will be submitted in respect of this application."

This current third-party submission response is submitted in reply to correspondence received from the Commission dated the 22nd of July 2026 and the 29th of July 2026.

The Commission's letter of the 22nd of July 2026 (a copy of which is included in Appendix 1) provided a link to the submissions received on the application. Subsequently, JSA Planning wrote to the Commission on behalf of the applicant (on the 28th of July 2026) requesting further time to respond to the submissions, in order to provide a comprehensive response. In correspondence dated the 29th of July 2026 the Commission responded and confirmed an extension of time to the **15th of September 2026** to provide a response. The Commission confirmed that a copy of their correspondence of July 29th 2026 would be added to the file, and a copy is also included within Appendix 1 to this letter for reference.

Eight submissions were made to the Commission in relation to this SID Application (six of which were made by prescribed bodies / the relevant Planning Authorities and two of which were made by third parties). The parties who made submissions were as follows:

- The Development Applications Unit of the Department of Housing, Local Government and Heritage
- The Environmental Protection Agency
- The Health Services Executive
- Uisce Eireann
- Offaly County Council
- Meath County Council
- Oisín Sheils Ryan
- Ryan Taggart

This response is submitted in advance of the deadline for responding (i.e. 5:30pm on the **15th September 2026**).

The information accompanying this letter is solely submitted in response to and is confined to the points raised in the submissions on the application, and does not entail any supplementary information or reports unconnected with the submissions. The following documentation is provided in direct response to the matters raised within the submissions:

- Appendix 2 to this cover letter comprises a coordinated response table prepared by the project environmental consultants (AWN Consulting and the EIAR Chapter Authors identified in Table 1-4 of the EIAR), the project ecologists (Altemar), the project engineers (Fingleton White), the project transport consultants (CST Group), and the Applicant.
- Appendix 3 - Aviation Safeguarding Response Document prepared by Rose Aviation (submitted in response to the submission of Ryan Taggart).
- Appendix 4 - Fingleton White Response Cover Letter along with a copy of the Kilwarden River, M4 Motorway, Yellow River, and Grand Canal Preliminary Crossing Design Reports referenced within the Appendix 2 response table.

The crossing design reports mentioned above are submitted in response to the submission of Meath County Council for information purposes, as they were prepared as background engineering design documentation which informed the submitted design drawings and EIAR, and therefore they do not alter any of the assessment, conclusions, or mitigation of the submitted EIAR or the submitted application drawings.

We trust the Commission will afford the responses set out herein due consideration in determining the application. Should you require any queries or require any further information please do not hesitate to contact the undersigned.

Yours sincerely,



JSA Planning

Enclosures:

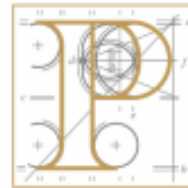
- Appendix 1 – Correspondence received from An Coimisiún Pleanála dated 10th August 2026.
- Appendix 2 - Coordinated Response Table
- Appendix 3 - Aviation Safeguarding Response Document
- Appendix 4 - Fingleton White Response Cover Letter and Preliminary Crossing Design Reports

Submission Response Details

Applicant Name	Gas Networks Ireland
Applicant Address	Gas Works Rd, Ballintemple, Cork, T12 RX96
Applicant's Agent's Name	JSA Planning
Applicant's Agent's Address	39 Fitzwilliam Place, Dublin 2, D02 ND61
Third-Party Submitters	• The Development Applications Unit of the Department of Housing, Local Government and Heritage • The Environmental Protection Agency • The Health Services Executive • Uisce Eireann • Offaly County Council • Meath County Council • Oisín Sheils Ryan • Ryan Taggart
An Coimisiún Pleanála Reference	ACP-324280-26

Appendix 1 – Correspondence received from An Coimisiún Pleanála dated 22nd of July 2026 Circulating the Submissions and 29th July 2026 Providing for an Extension of Time to Respond

Our Case Number: ACP-324280-26
Your Reference: Gas Networks Ireland



An
Coimisiún
Pleanála

JSA Planning
39 Fitzwilliam Place
Dublin 2
D02ND61

Date: 22 July 2026

Re: The proposed development of a new downstream underground high pressure gas pipeline, the provision of an offtake installation compound, and an above ground installation (AGI) compound and associated development, including associated access arrangements, landscaping and ancillary works
various townlands within County Meath and County Offaly (www.edenderrygaspipeline.ie)

Dear Sir / Madam,

I have been asked by An Coimisiún Pleanála to refer further to the above mentioned case.

8 submissions have been received by the Commission in relation to the above mentioned case. These submissions are available for inspection on the Commission's website at the following link:
<https://www.pleanala.ie/en-ie/case/324280>.

1. Ryan Taggart
2. Oisin Sheils Ryan
3. Meath County Council
4. Offaly County Council
5. Development Applications Unit
6. Uisce Eireann
7. Environmental Protection Agency
8. HSE

The Commission hereby considers it appropriate to invite you to make a submission on the observations received in relation to the application. Please be advised that any response to the Commission's invitation should not contain any additional reports or supplementary reports and should be confined to the issues raised in the observations received by the Commission. Any submission in relation to the above must be received by the Commission within 4 weeks from the date of this letter (i.e. not later than **Tuesday 18th August 2026**).

Tell
Glas Aitíúil
Láithreán Gréasáin
Ríomhphost

Tell
LoCall
Website
Email

(01) 858 8100
1800 275 175
www.pleanala.ie
communications@pleanala.ie

64 Sráid Maolbhríde
Baile Átha Cliath 1
D01 V902

64 Marlborough Street
Dublin 1
D01 V902

If you have any queries in relation to the matter please contact the undersigned officer of the Commission. Please quote the above mentioned An Coimisiún Pleanála reference number in any correspondence or telephone contact with the Commission.

Yours faithfully,



Ellen Moss
Executive Officer
Direct Line: 01-8737285

GA10

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64 Sráid Maolbhríde
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64 Marlborough Street
Dublin 1

RE: ACP-324280-26



SIDS <sids@pleanala.ie>

To ✓ Luke Wymer

↩ Reply

↩ Reply All

→ Forward



Wed 29/07/2026 11:52

 Follow up. Start by Wednesday 29 July 2026. Due by Wednesday 29 July 2026.
You replied to this message on 29/07/2026 12:42.

This message is part of a tracked conversation. [Click here](#) to find all related messages or to open the original flagged message.

Dear Sir,

I have been asked by An Coimisiún Pleanála to refer to your email dated 28th July 2026, the contents of which have been noted.

The Commission has acceded to your request for an extension of time to submit the Response to Submissions received, as requested in your email dated 28th July 2026. Your response should be received by the Commission **no later than the 15th September 2026.**

Yours faithfully,
Ellen Moss
Executive Officer

Appendix 2 – Coordinated Response Table Prepared by the Design / Environmental Team with input from the Applicant

Submitter	Point Raised	Type	Proposed Response / Input Required
Development Applications Unit	1. All mitigation measures in relation to archaeology and cultural heritage as set out in Chapter 12 of the EIAR (date April 2026) shall be implemented in full, except as may otherwise be required in order to comply with the conditions of this Order. 2. A Project Archaeologist shall be appointed to oversee and advise on all aspects of the scheme from design, through inception to completion. a. The Project Archaeologist shall liaise with the Department of Housing, Local Government and Heritage and the Planning Authority to agree in advance an overall strategy for archaeological works to be carried out both in advance of and in parallel with construction of the development. b. This shall include the scope of any Advance Archaeological Geophysical Survey, Advance Test Excavation, Advance Underwater Archaeological Impact Assessment and Archaeological Monitoring as well as any additional mitigation measures that may be required to protect archaeological heritage. 3. The Construction Environment Management Plan (CEMP) shall include the location of any and all archaeological or cultural heritage constraints relevant to the proposed development as set out in Chapter 12 of the EIAR (date April 2026) and by any subsequent archaeological investigations associated with the project. The CEMP shall clearly describe all identified likely archaeological impacts, both direct and indirect, and all mitigation measures to be employed to protect the archaeological or cultural heritage environment during all phases of site preparation and construction activity. 4. The planning authority and the Department of Housing, Local Government and Heritage shall be furnished with a final archaeological report describing the results of all archaeological monitoring and any archaeological investigative work/excavation required, following the completion of all archaeological work on site and any necessary post-excavation specialist analysis. All resulting and associated archaeological costs shall be borne by the developer.	Recommended Condition on Grant	All of the recommendations of the Department will be adhered to in full. A condition in this respect would be acceptable.

Submitter	Point Raised	Type	Proposed Response / Input Required
Environmental Protection Agency	Summary of EPA observation is as follows. The EPA notes that the proposed development is located in the vicinity of the licensed Edenderry Power Limited facility (Licence No. P0482-04). The EPA advises that: - The existing IE licence may need to be reviewed or amended to accommodate the proposed changes. - Any future licence review application would be subject to the EPA's own Environmental Impact Assessment process and statutory consultation requirements. - Documentation relating to the planning EIA may be requested by the EPA under Section 173A(4) of the Planning and Development Act 2000 (as amended). - The EPA would assess all emissions-related matters arising from any licence review application. - No Proposed Determination on a licence review application can be issued until a planning decision has been made.	Observation	The Applicant notes the observations of the EPA. As acknowledged in the EIAR, the proposed development is located in the vicinity of the Edenderry Power Limited facility, which is regulated under EPA Licence Register No. P0482-04. It is acknowledged that a separate EPA licensing regime applies to the operation of the licensed facility. It will be the responsibility of the licence holder (i.e. Edenderry Power Limited) to assess the implications of the proposed development in the context of its existing EPA licence and to engage with the EPA, as required, regarding any notification, licence review or licence amendment process. No further action is required in respect of this observation.
HSE National Environmental Health Service	3. Public Consultation and Community Engagement It is recommended that, before construction starts, it is clarified how affected residents, landowners, farmers and businesses will be kept informed as works move along the pipeline route. This should include advance notice of works in their area, road closures, traffic diversions, particularly noisy works and works close to watercourses.	Recommendation / Observation	The need for continued communication during the construction phase is acknowledged and an outlined plan for how communication will be maintained between the construction contractor and the public is set out in the outline Construction Environmental Management Plan (oCEMP) (Appendix 2.2 of the EIAR) submitted with the application – see specifically Section 5.4.1 (relating to air quality) and 5.6.5 (relating to noise and vibration) and the Outline Construction Traffic Management Plan (oTMP) (Appendix 13.2 of the EIAR). Section 5.4.1 outlines the following mitigation: <i>Develop and implement a stakeholder communications plan that includes community engagement before work commences on site.</i> <i>Display the name and contact details of person(s) accountable for air quality and dust issues on the site boundary. This may be the environment manager/engineer or the site manager.</i> <i>Display the head or regional office contact information.</i> Section 5.6.5 outlines the following mitigation: <i>A designated Community Liaison Officer (CLO) will be appointed to site during construction works. Any noise and vibration complaints will be logged and followed up in a prompt fashion by the CLO. In addition, prior to particularly noisy or vibratory construction activity the CLO will inform the nearest sensitive locations of the time and expected duration of the works.</i> With respect of road closures and traffic diversions, as per Section 10 of the Outline Construction Stage Traffic Plan: <i>Locals in the area will be informed of any upcoming traffic related matters e.g. temporary lane/road closures (if required), via letter drops and posters in public places. Information will include the contact details of the Contract Project Co-ordinator, who will be the main point of contact for all queries from the public or local authority during normal working hours. An "out of hours" emergency number will also be provided.</i> These measures provide for advance notification and ongoing engagement with residents, landowners, farmers and businesses throughout the construction phase. Where works have the potential to affect specific stakeholders appropriate communication will be undertaken by the Contractor in accordance with the oCEMP and oCTMP.

Submitter	Point Raised	Type	Proposed Response / Input Required
	4. Population and Human Health It is recommended that, before works start and secured by condition where appropriate, the final CEMP clearly sets out: - how access to homes, farms, lands and businesses will be maintained - who will be responsible on site for dealing with environmental health matters such as dust, noise, vibration, traffic disruption, waste and water protection; - how complaints will be recorded, investigated and responded to. Subject to these recommendations and the implementation of the mitigation measures in the EIAR and CEMP, no significant environmental health concern is identified in relation to Population and Human Health.	Recommendation	The matters identified by the HSE will be addressed through the final Construction Environmental Management Plan (CEMP) to be prepared by the appointed construction contractor prior to commencement of works. The Applicant has no objection to these matters being secured through the final CEMP. The submitted Outline Construction Environmental Management Plan (oCEMP) provides the framework from which the final CEMP will be developed and updated to reflect planning conditions and the contractor's detailed construction procedures. <u>Item 1 - Access to homes, farms, lands and businesses.</u> All works will be undertaken in compliance with the oCEMP and oTMP submitted with the planning application. Access to homes, farms, lands and businesses will be maintained throughout the construction phase. While temporary road closures will be required at certain crossings, as outlined in Table 1 of the oTMP, diversion routes have been identified where necessary. The closure of the L1004, will result in a maximum diversion distance of 7 km, while the closure of the R441, will result in a maximum diversion of 4.5km. All other closure will result in maximum diversions of between 600 m and 3.7 km. Where no diversion is possible for access to remain in place, local access arrangements will ensure there no homes, farms or businesses which become inaccessible, as stated in Section 9 of the oTMP <u>Item 2 - Responsibility for environmental health matters.</u> The appointed construction contractor will be responsible for implementing and maintaining compliance with the dust, noise, vibration, traffic management, waste management and water protection measures set out in the planning documentation and the final CEMP. The final CEMP will identify the personnel and management structure responsible for the implementation of these measures. All site personnel will be required to complete site-specific induction and training and will be responsible for complying with the relevant environmental, health and safety procedures. <u>Item 3 - Complaints management.</u> A designated Community Liaison Officer (CLO) will be appointed during the construction phase. The CLO will act as the primary point of contact between the project team and the local community. The final CEMP will set out the procedures for recorded, investigated and responded to complaints or concerns raised during construction.
	5. Construction Management and Community Liaison It is recommended that, before construction starts and secured by condition where appropriate, the final CEMP confirms: - a named contact person for the works; - how complaints will be logged, investigated and responded to; - that the complaints log will be made available to the planning authority if requested; - how higher-risk works, including road crossings, watercourse crossings, dewatering, concrete works and works close to homes or farms, will be managed and supervised. This would help ensure that temporary construction impacts are managed properly and that local concerns are dealt with quickly.	Recommendation	The matters identified by the HSE will be addressed through the final Construction Environmental Management Plan (CEMP) to be prepared by the appointed construction contractor prior to commencement of works. The Applicant has no objection to these matters being secured through the final CEMP. <u>Item 1 - Named contact person for the works.</u> As outlined in the oCEMP, a designated Community Liaison Officer (CLO) will be appointed during the construction phase and will act as a point of contact between the project team and local residents. The final CEMP will identify the relevant site personnel and contact details associated with the management of construction activities. <u>Items 2 and 3 - Complaints management.</u> The final CEMP will set out the procedures for receiving, managing and responding to complaints or concerns raised during construction. <u>Item 4 - Management and supervision of higher-risk works.</u> The proposed construction techniques are described in the Construction Methodology (Appendix 2.1 of the EIAR). The final CEMP will build upon the framework established by the oCEMP and provide any additional management and supervision measures to be implemented for higher-risk works.
	6. Noise and Vibration where noise screening will be used for works close to houses, particularly within 50 metres;	Recommendation	The matters identified by the HSE have been considered as part of the Noise and Vibration Assessment presented in Chapter 10 of the EIAR. The Applicant has no objection to these matters being further addressed, where required by, through the CEMP. <u>Item 1- Noise screening.</u> As set out in Section 10.6.1.3 of the Noise and Vibration chapter, localised demountable enclosures or screens will be utilised around breakers or drill bits operating near noise-sensitive locations (NSLs) where there is potential for the applicable construction noise thresholds to be exceeded. The indicative construction plant noise levels presented in Section 10.5.1.1 identify this potential at NSLs located within 50 m of the works; accordingly, noise screening will be implemented for such works where required.

Submitter	Point Raised	Type	Proposed Response / Input Required
	2. where vibration monitoring will be carried out for higher-risk works such as road breaking, trenching or works close to buildings; 3. who will be responsible for checking noise and vibration controls on site; 4. what action will be taken if agreed noise or vibration limits/controls are exceeded or not implemented; 5. that any change to higher-noise construction methods will be reviewed against the noise and vibration assessment. Subject to these recommendations and the implementation of the EIAR and CEMP mitigation measures, no significant environmental health concern is identified in relation to noise and vibration.		<u>Item 2 - Vibration monitoring.</u> As set out in the Noise and Vibration Chapter, construction vibration is not predicted to result in structural or cosmetic damage to adjacent buildings. As stated in Section 10.7.1, where proposed works have the potential to give rise to vibration levels at or above the applicable limit values, and consequently cause human discomfort, vibration monitoring is recommended at a selection of sensitive buildings to inform the implementation of any necessary mitigation measures. <u>Items 3 and 4 - Responsibility and corrective actions.</u> Section 10.7.1 of the Noise and Vibration chapter states that the appointed contractor will be responsible for undertaking noise monitoring at representative NSLs and for using the monitoring results to evaluate and inform the implementation of noise management measures. The final CEMP should identify the suitably qualified person appointed by the contractor to carry out or oversee the monitoring and to verify that the specified noise and vibration controls are implemented and maintained on site. An appointed person by the Contractor will investigate whether it may be appropriate to exercise caution and/or implement additional or enhanced mitigation measures. The final CEMP should identify specific actions to be undertaken in such circumstances. <u>Item 5 - Changes to construction methods.</u> As set out in Sections 10.5.1.1 and 10.6.1 of the Noise and Vibration Chapter, the specific construction plant, plant numbers, locations and operating durations will be subject to site conditions, work scheduling and contractor proposals. Any proposed change to a construction method or item of plant that could result in higher noise or vibration emissions will be reviewed against the applicable noise and vibration threshold values and mitigation requirements set out in the chapter. Where necessary, additional control measures will be identified and incorporated into the final CEMP before the revised method is implemented.
	7. Air Quality It is recommended that, before works start and secured by condition where appropriate, the final CEMP confirms: 1. where dust controls and monitoring will be used during higher-risk works; 2. what action will be taken if visible dust leaves the site, dust complaints are received or dust controls are not working effectively; 3. who will be responsible for recording, investigating and responding to dust complaints; 4. that dust-related complaints and actions taken will be recorded and made available to the planning authority if requested. Subject to these recommendations and full implementation of the dust mitigation measures in the EIAR and CEMP, no significant environmental health concern is identified in relation to air quality.	Recommendation	The matters identified by the HSE have been considered as part of the Air Quality Assessment presented in Chapter 9 of the EIAR. The Applicant has no objection to these matters being further addressed, where required by, through the CEMP. <u>Item 1 - Dust controls and monitoring.</u> The need for dust controls and monitoring has been considered as part of the Air Quality Assessment. Dust mitigation measures are set out within the EIAR and oCEMP and include dust suppression at source, good site management practices and dust monitoring, where required, at site boundaries and construction compounds in proximity to sensitive receptors. <u>Items 2, 3 and 4 - Dust complaints and corrective actions.</u> Responsibility for the implementation of dust mitigation measures will rest with the appointed construction contractor. The final CEMP will identify the personnel responsible for responding to dust-related issues and will set out the procedures for recording, investigating and responding to complaints or instances where dust controls are not operating effectively. The final CEMP will also address the maintenance of records relating to dust complaints and corrective actions undertaken.
	8. Water, Hydrology and Hydrogeology It is recommended that, before relevant works start and secured by condition where appropriate, the final CEMP confirms:	Recommendation	The matters identified by the HSE have been considered as part of the Hydrology and Hydrogeology Assessment presented in Chapter 5 EIAR. The Applicant has no objection to these matters being further addressed, where required by, through the CEMP. <u>Item 1 - Responsibility for water protection measures.</u> The appointed construction contractor(s) will be responsible for ensuring all mitigation measures, including water protection measures, as outline in the oCEMP and EIAR are in place during higher risk works such as open cut crossings and the installation of temporary bridges. In particular, see Sections 5.2.1.7, 5.2.2, 5.2.3 and 5.2.4 of the oCEMP for

Submitter	Point Raised	Type	Proposed Response / Input Required
	1. who will be responsible on site for checking water protection measures during higher-risk works; 2. how dewatering water, muddy water and run-off will be controlled before discharge or disposal; 3. that any required approval is in place before discharge to land, a drain, a watercourse or any other drainage route; 4. how concrete wash water, fuels, oils and chemicals will be stored and managed to prevent pollution; 5. what emergency response measures will be used if a spill, sediment release or other water pollution incident occurs. Subject to these recommendations and the implementation of the water protection measures in the EIAR, CEMP, WFD Assessment and Flood Risk Assessment, no significant environmental health concern is identified in relation to water, hydrology or hydrogeology.		both general and specific measures that are required to take place during higher risk works. These sections may be updated post planning to include any other specific conditions imposed by the planning authority. <u>Item 2 - Dewatering water, muddy water and run-off.</u> Section 5.2.1 of the oCEMP submitted with planning application outlines a Sediment Control Plan, measures for the Management of Construction Surface Water and Mitigation of Impacts from Open-cut Watercourse Crossings. This section include details about how dewatering will take place on site and describes the treatment regime that will be put in place to ensure muddy / sediment-laden water is managed prior to discharge or disposal. <u>Item 3 - Discharge approvals.</u> The requirement for regulatory approvals relating to wastewater and trade effluent discharges is acknowledged. Where required, the appointed contractor will obtain the necessary approvals, licences or consents from the relevant authority prior to any discharge being undertaken. <u>Item 4 - Concrete wash water, fuels, oils and chemicals.</u> The management of concrete wash water, fuels, oils and chemicals has been considered as part of the submitted oCEMP. Section 5.2.1.5 of the oCEMP details specific measures for the control and management of concrete washout on site. Section 5.2.1.4 of the oCEMP details specific measures for the control and management of fuels, oils and chemicals on site. These measures will be incorporated into the final CEMP and implemented during construction. <u>Item 5 - Emergency response measures.</u> Details of emergency preparedness / environmental incident plan are detailed in Section 6 of the oCEMP, this including information of planning and prevention, emergency response protocols and coordination with emergency services as required. Detailed are the requirements for spill kits on site and a requirement to train all members of staff on the fundamentals of spill containment. Please see Section 6 of the oCEMP for further details.
	9. Climate Change It is recommended that, before construction starts and secured by condition where appropriate, the final CEMP confirms: 1. how works will be managed during heavy rainfall or poor ground conditions, particularly trenching, dewatering and watercourse crossings; 2. how temporary drainage, sediment control and stockpile management will be maintained during wet weather; 3. how plant, vehicles and generators will be managed to reduce unnecessary fuel use and emissions, including no unnecessary idling;	Recommendation	The Applicant has no objection to these matters being secured through the final CEMP. <u>Item 1 - Heavy rainfall and poor ground conditions.</u> Excavation works will not be carried out during or following heavy rainfall (extreme weather events) (as noted in Section 5.2.1.1 of the oCEMP). Works to stream banks and instream works to be conducted during times of settled weather and low water flows. Working during times of heavy rainfall is to be avoided (as noted in Section 5.2.1.7 of the oCEMP). Dewatering will take place as required and discharge will be carefully controlled to prevent sediment entering watercourses in accordance with the contractor's CEMP. With respect of poor ground conditions, the construction contractor will base construction methodology on geotechnical surveys and understanding baseline soil information. Where required, sheet piling may take place in areas such as at the hot tap location where deeper excavation are taking place and where the ground conditions deem in necessary. Section 6 of the oCEMP, Emergency Preparedness/Environmental Incident Plan, notes actions on planning for extreme weather events and general site safety protocols for an extreme weather event. The final CEMP will incorporate these measures and identify any additional controls required having regard to the contractor's detailed construction procedures. <u>Item 2 - Temporary drainage, sediment control and stockpile management.</u> Section 5.2.1.1 and Section 5.2.1.2 of the oCEMP outlines a Sediment Control Plan and Management of Construction Surface Water which can be updated for the construction contractor in the contractors CEMP. This includes management measures for temporary drainage and sediment during wet weather and where rainwater is likely to impact on excavations.

Submitter	Point Raised	Type	Proposed Response / Input Required
			Management measures for stockpiles account for wet weather conditions as stockpiles will likely be in place for months at a time. Measures are detailed in Sections 5.1, 5.2 and 5.4 of the oCEMP. Measures relating to sediment control, construction surface water management and stockpile management are included within the submitted oCEMP and will be further developed within the final CEMP as required. <u>Item 3 - Fuel use and emissions from plant and vehicles.</u> Section 5.4.4 of the oCEMP details measures for operating vehicles / machinery and sustainable travel – this includes measures such as no allowance for idling vehicles and avoidance of diesel and petrol generators and use of mains electricity or battery powered equipment where practicable. See Section 5.4.4 of the oCEMP for further details. The final CEMP will incorporate these measures and any additional contractor-specific measures, as appropriate.
	10. Waste management It is recommended that, before construction starts and secured by condition where appropriate, the final CEMP or final Resource and Waste Management Plan confirms: 1. how construction waste will be segregated, stored and removed from temporary compounds and working areas; 2. that only authorised waste collectors and appropriately permitted or licensed waste facilities will be used; 3. how waste movements will be recorded and made available for inspection if requested; 4. how unexpected or potentially contaminated soil, invasive plant material, fuel/oil waste or other hazardous waste will be identified, stored and managed; 5. how litter, mud, dust or nuisance from waste storage areas will be prevented along the route. Subject to these confirmations and full implementation of the EIAR, CEMP and Resource and Waste Management Plan, no significant environmental health concern is identified in relation to waste management.	Recommendation	The matters identified by the HSE have been considered as part of the Resource and Waste Management Plan (RWMP) submitted with the planning application. The Applicant has no objection to these matters being secured through the final CEMP and/or final RWMP to be prepared by the appointed construction contractor prior to commencement of works. <u>Items 1, 2, 3 and 4 - Waste management procedures.</u> The Resource and Waste Management Plan (RWMP) (Appendix 14.1 of Chapter 14 of the EIAR) submitted with the planning application contains details and management measures that address the points raised in items 1, 2, 3 and 4. An updated RWMP will be prepared by the construction contractor to include any further mitigation and management measures outlined as a condition of planning. <u>Item 5 - Prevention of nuisance from waste storage areas.</u> Details on how waste storage areas will be managed is detailed in Section 5.10 of the oCEMP. Proper segregation of waste in designated areas of the site along with proper training to all staff with respect of waste management procedures will ensure that any potential nuisances from the waste storage area, such as those listed, are controlled effectively.
Uisce Éireann Connections and Developer Services	Based on a review of the available information, the proposed gas pipeline route crosses the route of the WSP pipeline at a road crossing point location on the R401 Regional Road, south of Edenderry (Approx ITM Coordinates X:661063 Y:727931). Given the nature and importance of both projects, it is important that the design and layout of the respective pipelines are appropriately coordinated. In particular,	Observation	The interaction between the proposed gas pipeline and the route of the proposed Uisce Éireann WSP pipeline at the R401 has been identified. The crossing arrangement will be coordinated with Uisce Éireann's WSP Design Team as the respective projects progress, to ensure that appropriate separation distances, construction methodology and requirements for future access and maintenance are incorporated. GNI will engage with Uisce Éireann in advance of construction to confirm and agree the technical requirements applicable at the crossing. Accordingly, the interactions identified by Uisce Éireann can be appropriately managed through coordination and agreement of the relevant crossing and protection requirements as the respective projects progress and in advance of construction.

Submitter	Point Raised	Type	Proposed Response / Input Required
	consideration will need to be given to matters such as separation distances, construction methodology and access for future maintenance. Accordingly, Uisce Éireann requests that the developer shall engage directly with Uisce Éireann's WSP Design Team at an early stage and throughout the design process to agree an appropriate design solution at the crossing point intersection of the two Projects. This will help ensure that both pieces of critical infrastructure can be delivered safely and without conflict.		The applicant would accept a condition requiring the agreement of the detailed methodology and design for the crossing of the Uisce Éireann WSP pipeline (on the R401 Regional Road, south of Edenderry (Approx ITM Coordinates X:661063 Y:727931) with Uisce Éireann, and the submission of those details to the Planning Authority for agreement prior to the construction of the crossing.
	Similarly, the proposed gas pipeline route conflicts with a number of existing Uisce Éireann infrastructure assets. Based on a review of the available information, the proposed gas pipeline route crosses the route of existing watermain at 3 no. road crossings: the L1004 (Roosk) Road Crossing; the R441 Road Crossing; and the L5007 (Monasteroris Road) Crossing. Uisce Éireann does not permit Build Over of its assets. Where the applicant proposes to build over or near to, or propose to divert, existing water or wastewater services the applicant shall have received written Confirmation of Feasibility (COF) of Separation Distance(s), Protection Measure(s), and/or Diversion(s) from Uisce Éireann (diversions@water.ie) prior to any works commencing.	Observation	The interactions with existing Uisce Éireann water infrastructure at the L1004 (Roosk) Road, R441 and L5007 (Monasteroris Road) crossings are also noted. The proposed gas pipeline crossing arrangements will provide for appropriate separation from, and protection of, the existing Uisce Éireann assets. The location and depth of existing services will be verified in advance of construction and the applicable protection and crossing requirements agreed with Uisce Éireann. There is no proposal to relocate or divert the existing Uisce Éireann assets at these locations. The gas pipeline crossing arrangements will be developed on the basis that the existing water infrastructure remains in situ, with suitable separation and protection measures incorporated as required. Where required under Uisce Éireann procedures, the GNI and their Contractor will obtain the relevant confirmation or approval in respect of separation distances and protection measures prior to works commencing at the affected locations.
Oisin Sheils Ryan	Local road network unsuitable for construction traffic and HGV use.	Observation	Overall, the assessment carried out in Chapter 13 established that roads in the receiving environment have sufficient capacity for the proposed means of carrying out the works. The primary sites within the lands serviced by HGV's will be Temporary Construction Compounds (TCC's) and Laydown Areas (Type A). The roads via which these are accessed are generally the higher category Regional Roads which were assessed as having sufficient capacity or not significant increases in overall traffic volumes. Only in one situation assessed, the Laydown Area Type A at RDX10 (L1004) is a local road utilised. Whilst this road is relatively narrow, only a short section would need to be accessed c.0.8km from the regional road (R441), and that section of road has several passing points which would afford sufficient capacity. Further, the increased traffic on the L1004 was not substantial relative to the flows already using it and it is considered to have sufficient capacity. Lower category roads will be utilised for Laydown Areas (Type B), which will be utilised primarily by light vehicles and occasional restricted larger vehicles. These roads would be considered to have sufficient capacity for the anticipated additional traffic.
	No footpaths in area and increased risk to pedestrians and cyclists.	Observation	Whilst there will be increased volumes of construction associated traffic using the roads in the area, the increased volumes were not found to be significant relative to existing use, and so the safety risk to pedestrians and cyclists using the roads would not be expected to be significantly higher. The roads are already carrying larger vehicles in the form of agricultural traffic and HGV's so they have proven ability to carry such vehicles coexisting with cyclists and pedestrians. Further there are locations along the roads, such as field accesses and house entrances which will afford passing. The impact in the immediate area of the affected local roads will be short term due to the long overall length of the pipeline works meaning works will be concentrated for only part of the overall project duration.

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	Traffic diversions may be difficult to implement safely.	Observation	Traffic diversions will be implemented strictly in accordance with DoT guidelines which are prepared in accordance with best safe practice. Requisite notification to local affected residents will be made to keep them informed regarding the timings and proposed diversion routes. Further, the diversions will be in place for as short a duration as needed to construct the relevant road crossing – normally in the order of 1-2 days which would further mitigate risk.
	Residential amenity impacts from noise, vibration, dust and construction activity.	Observation	Noise, vibration, dust, visual disturbance have been assessed thoroughly in the EIAR, with site specific mitigation contained within the respective EIAR Chapters and CEMP which were submitted with the planning application. See Section 5.4, 5.6 and 5.7 of the CEMP specifically for construction phase mitigation which will be provided with respect of these environmental factors. The impacts from the construction phase at any one location will be temporary in nature as the works continue along the pipeline route and any impacts will be mitigated appropriately. Long-term (operational) impacts have been assessed within the EIAR and give the nature of the development, all noise, vibration and dust impacts have been assessed to be imperceptible. The only remaining visual components of the development being the Kilwarden Offtake Installation, in Kilwarden, Co. Meath / Mhí, and the Ballykilleen AGI, located within the Bord na Móna site, Co.Offaly / Uíbh Fhailí, will result in a imperceptible to slight impact following all reinstatement works being complete.
	Archaeological sensitivity around Ticroghan Castle and associated monuments.	Observation	It is recognised that the Proposed Route traverses the proximity of Ticroghan Castle and environs, notably through an area believed to be the site of the Battle of Tecroghan, fought in June 1650 following the siege of the castle. Mitigation measures include geophysical survey, archaeological testing and metal detecting, and will be agreed in advance with the National Monuments Service. It is important to note that the impact of construction on the integrity of the landscape will be temporary – until the ground has re-seeded. Any archaeological features or finds encountered will be recorded in full to a methodology approved by the National Monuments Service, such that the academic knowledge gained will mitigate the potential loss of sub-surface archaeological features.
	Concerns regarding impacts on local hedgerows, biodiversity, drainage infrastructure, roadside verges and the wider rural environment during construction and reinstatement.	Observation	These matters have been assessed within the EIAR, including the Biodiversity, Water, Hydrology and Hydrogeology, Landscape and Visual, and Population and Human Health chapters. Appropriate mitigation measures have been incorporated into the project design and are set out within the EIAR and the submitted Outline CEMP. Subject to the implementation of these measures, no significant negative residual effects on biodiversity, drainage infrastructure or the wider receiving environment are predicted. Impacts on hedgerows and biodiversity have been assessed in the Biodiversity Chapter of the EIAR. While some hedgerow removal will be required during construction, the effect is not considered significant (minor adverse, medium term, not significant) due to the occurrence of similar habitat within the local area. All affected hedgerows will be replanted following completion of the works. The impact on all other key ecological receptors is deemed to have an imperceptible significance or none at all. In relation to reinstatement, disturbed areas will be reinstated following completion of the works in accordance with the project reinstatement strategy and the measures outlined within the EIAR and oCEMP.
Ryan Taggart	Taggart Airfield was not identified as a sensitive receptor, and the airfield owner/operator was not consulted.	Observation	In response to the submission, Rose Aviation Ltd., a specialist aviation consultancy, was appointed to undertake a detailed Aviation Safeguarding Assessment of the Proposed Development in relation to Taggart Airfield. The assessment considered the airfield's characteristics, runway alignment and proximity to the temporary construction works. Taggart Airfield is an unlicensed private airstrip and is not published in the Irish Aeronautical Information Publication.
	Construction Compound 02 is located close to the airfield and may interfere with aviation safety or continued airfield operations.	Observation	Construction Compound 02 would be a temporary compound used only during the construction phase. The structures, plant, equipment and stockpiles associated with Construction Compound 02 would be temporary. No permanent structures associated with Construction Compound 02 would remain following completion of the works. The Aviation Safeguarding Assessment considered the compound and its proximity to the airfield. The closest edge of the compound is approximately 273 m from the runway centreline and 33 m outside the transitional surface.

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	Temporary structures, plant, cranes, stockpiles or other physical obstacles may affect aircraft during take-off or landing.		The assessment considered the relevant Obstacle Limitation Surfaces, including the runway strip, transitional surface, Inner Horizontal Surface, conical surface, approach surfaces and take-off climb surfaces. Please see the Aviation Safeguarding Report enclosed along with the AWN Cover Letter for further details.
	Construction-related dust, debris, lighting, wildlife attraction and other activities may create aviation hazards or distractions.	Observation	These concerns relate specifically to temporary construction-phase activities, rather than the permanent operation of the Proposed Development. Standard construction controls set out in the CEMP relating to dust, lighting, waste, housekeeping and site management will apply to the works at Construction Compound 02 for the duration of its temporary use.
	The temporary nature of Construction Compound 02 does not remove the potential for aviation effects.	Observation	It is acknowledged that the temporary nature of Construction Compound 02 does not, in itself, remove the need to consider potential aviation effects. The Aviation Safeguarding Assessment has not relied on the compound's temporary duration to exclude such effects. The temporary compound, including the potential presence and storage of construction plant and equipment has been assessed against the relevant aviation safeguarding surfaces. The assessment demonstrated that the compound and associated temporary construction activities would not penetrate those surfaces, subject to the stated height restriction outlined in the Aviation Safeguarding Assessment enclosed along with the AWN Cover Letter. The compound and all associated temporary structures, plant and equipment would be removed following completion of the construction works.
	Further consultation and a detailed aviation assessment are required before the application can be determined.	Observation	A detailed Aviation Safeguarding Assessment has now been prepared by Rose Aviation Ltd. in response to the concerns raised. The assessment considered both the permanent elements of the Proposed Development and the temporary construction works, including Construction Compound 02. It concludes that no element of the Proposed Development would penetrate the applicable Obstacle Limitation Surfaces, subject to construction equipment remaining within the heights outlined in the Aviation Safeguarding assessment enclosed along with the AWN Cover Letter, and that the Proposed Development would therefore have no impact on aviation safety or operational efficiency in this regard.
Offaly County Council	7. European designations, Natural Heritage Areas, which may be affected by the proposed development (whether in or proximate to same)		
	Comment: Please apply the following conditions to any grant of permission for the proposed development; 1. In the event of a grant of permission, the mitigation measures contained in the submitted Natura Impact Statement (NIS)) shall be implemented in full. 2. Prior to commencement of development, the developer shall submit to, and agree in writing with, the Planning Authority a schedule of these mitigation measures and monitoring commitments, and details of a time schedule for implementation of these. The results of the monitoring and reports arising shall be made available to the Planning Authority, Inland Fisheries Ireland and the National Parks and Wildlife Service.	Recommended Condition on Grant	It can be confirmed that the mitigation measures and monitoring commitments identified in the NIS will be implemented as part of the proposed development. The Applicant would have no objection to these measures being secured by condition in the event of a grant of permission. No further action is required.
	8. Protected Structures, Architectural Conservation Areas etc.		

Submitter	Point Raised	Type	Proposed Response / Input Required
	Comment: Please apply the following conditions to any grant of permission for the proposed development; The developer shall comply with specific National Monuments Service requirements including: No construction or site preparation work may be carried out on the site until all archaeological requirements of the NMS are complied with, full archaeological monitoring of all groundworks, and a clear protocol for archaeological discoveries. Targeted assessment in areas of proximity to the identified SMR and NIAH assets.	Recommended Condition on Grant	A detailed and comprehensive mitigation strategy has been proposed relating to archaeological, architectural and cultural heritage in Section 12.6.1 of the EIAR, as follows: <i>The following mitigation strategy has been designed based on the principals of the Code of Practice between Bord Gáis Éireann and The Minister for Arts, Heritage, Gaeltacht and the Island (2002).</i> <i>A suitably qualified archaeological consultant will be appointed to oversee the project from design through to planning and construction phase.</i> <i>The geophysical survey of the proposed development, under license to the National Monuments Service of the Department of Culture, Heritage and the Gaeltacht, will be completed across the entire route planning corridor.</i> <i>Given the cultural significance of sacred trees in Ireland, the hawthorn tree identified in Ticroghan townland will be avoided and fenced off for the duration of the construction phase to protect it, and its root bed, from harm.</i> <i>Pre-development archaeological testing, under license to the National Monuments Service of the Department of Housing, Local Government and Heritage, will be undertaken in advance of construction, as follows:</i> <i>Trenches will largely target anomalies identified by the geophysical survey, as well as county / barony / townland boundaries. A number of trenches will also be excavated in areas where no features were highlighted (as per best practice guidelines; c. 10% of the Proposed Development corridor should be tested in total).</i> <i>Trenches will be dug by a tracked excavator equipped with a 1.8 m wide toothless ditching bucket. Each trench will be excavated to the surface of archaeological features, deposits or structures, or to the surface of the undisturbed natural soil or bedrock (typically less than 75cm). Topsoil will be removed from the test trenches in horizontal levels of not more than 0.20 m in thickness until sterile subsoil is reached.</i> <i>A suitably qualified underwater archaeology specialist will assess the following watercourses along the Proposed Development corridor (WCX02, WCX04, WCX05 and WCX19) and undertake a wade or dive survey as appropriate under license to the National Monuments Service of the Department of Housing, Local Government and Heritage.</i> <i>Should archaeological or architectural heritage features, deposits or structures be uncovered during survey will be cleaned by hand, investigated and recorded.</i> <i>Archaeological excavation of features, deposits or structured identified, will be undertaken in advance of construction, in consultation with and under license to the National Monuments Service of the Department of Housing, Local Government and Heritage.</i> <i>Applying these mitigation measures will ensure that the effect on the archaeology and architectural heritage will be permanent, neutral and imperceptible.</i> Please note that the mitigation strategy detailed here are subject to the approval of the National Monuments Service, Department of Housing, Local Government and Heritage. The proposed mitigation strategy includes provision for agreeing the final mitigation methodology with the National Monuments Service and for the targeting of areas of archaeological, architectural and cultural heritage sensitivity. As evidenced in the submission from Julie Sullivan, Development Applications Unit (above), the National Monuments Service are in agreement with the proposed mitigation strategy as outlined in Section 12.6.1 of the EIAR. While the Applicant has no objection to a condition requiring compliance with National Monuments Service requirements and the implementation of the agreed mitigation measures, the requirement for "full archaeological monitoring of all groundworks" is not considered necessary or proportionate. Such a requirement is not reflected in the mitigation strategy assessed within the EIAR and would pre-empt the detailed archaeological methodology to be agreed with the National Monuments Service. The Applicant considers that the scope and extent of archaeological monitoring should remain subject to agreement with the National Monuments Service in accordance with the mitigation strategy outlined in Section 12.6.1 of the EIAR.

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	While no direct impacts on Recorded Monuments or Protected structures are identified, mapping indicates that sections of the works will occur in proximity to the above listed heritage assets. In this context it is considered that: - the exact distances between the works and these assets are verified, and - it is clearly demonstrated that there will be no adverse impacts on their: - structural integrity - setting and curtilage - ground conditions visual appreciation, including potential impacts arising from the construction activity, vibration or temporary works	Observation raised in Internal Report (Appendix A)	All of the below listed sites are outside of the Proposed Development redline boundaries and will not be impacted, directly or indirectly by construction works. In addition to the below recorded architectural heritage sites, the Proposed Development will run under the Grand Canal by means of directional drilling. Therefore, there will be no direct or indirect impact on the Grand Canal. Please see below distances from the recorded archaeological and architectural heritage sites to the redline of the Proposed Route, and the redline of the temporary compound at Monasteroris. <i>Distances to Recorded Archaeological Sites</i> <table><tr><th>SMR No.</th><th>Townland</th><th>Classification</th><th>Distance from redline</th><th>Distance from Monasteroris temp comp</th></tr><tr><td>OF011-007--</td><td>Mountwilson,Thornwell</td><td>Burial mound</td><td>600m to W</td><td>>2km</td></tr><tr><td>OF011-010003-</td><td>Monasteroris</td><td>Dovecote</td><td>660m to NE</td><td>990m to WNW</td></tr><tr><td>OF011-024--</td><td>Ballycolgan</td><td>Enclosure</td><td>130m to W</td><td>>2km</td></tr><tr><td>OF011-025--</td><td>Rathmore</td><td>Enclosure</td><td>100m to SW</td><td>>2km</td></tr><tr><td>OF011-033--</td><td>Ballynakill</td><td>Enclosure</td><td>1200m to W</td><td>>2km</td></tr><tr><td>OF011-035001-</td><td>Ballykilleen</td><td>Ringfort - rath</td><td>120m to W</td><td>>2km</td></tr><tr><td>OF011-065--</td><td>Ballynakill</td><td>Burnt mound</td><td>1175m to W</td><td>>2km</td></tr><tr><td>OF012-002--</td><td>Monasteroris</td><td>Ringfort - rath</td><td>1030m to E</td><td>450m to SW</td></tr><tr><td>OF012-005001-</td><td>Drumcooly</td><td>Church</td><td>900m to ENE</td><td>>2km</td></tr><tr><td>OF012-005002-</td><td>Drumcooly</td><td>Graveyard</td><td>900m to ENE</td><td>>2km</td></tr><tr><td>OF012-006001-</td><td>Drumcooly</td><td>Castle - motte and bailey</td><td>1060m ENE</td><td>>2km</td></tr><tr><td>OF012-006002-</td><td>Drumcooly</td><td>Enclosure</td><td>1060m ENE</td><td>>2km</td></tr><tr><td>OF012-016--</td><td>Monasteroris</td><td>Mill - unclassified</td><td>1070m to NE</td><td>315m to NW</td></tr><tr><td>OF012-017--</td><td>Kinnafad</td><td>Earthwork</td><td>1150m to ESE</td><td>990m to NWN</td></tr><tr><td>OF019-series</td><td>Ballykilleen</td><td>Various sites in bog</td><td>250-1000m to W</td><td>>2km</td></tr></table> <i>Distances to Recorded Architectural Heritage Sites</i> <table><tr><th>NIAH No.</th><th>Townland</th><th>Description</th><th>Distance from redline</th><th>Distance from Monasteroris temp comp</th></tr><tr><td>14911006</td><td>Monasteroris</td><td>Date: 1760-1800; Originally a Country House</td><td>400m to ENE</td><td>1000m to W</td></tr><tr><td>14911013</td><td>Monasteroris</td><td>Date: 1760-1800; Originally an Icehouse</td><td>300m to ENE</td><td>1000m to WSW</td></tr></table>	SMR No.	Townland	Classification	Distance from redline	Distance from Monasteroris temp comp	OF011-007--	Mountwilson,Thornwell	Burial mound	600m to W	>2km	OF011-010003-	Monasteroris	Dovecote	660m to NE	990m to WNW	OF011-024--	Ballycolgan	Enclosure	130m to W	>2km	OF011-025--	Rathmore	Enclosure	100m to SW	>2km	OF011-033--	Ballynakill	Enclosure	1200m to W	>2km	OF011-035001-	Ballykilleen	Ringfort - rath	120m to W	>2km	OF011-065--	Ballynakill	Burnt mound	1175m to W	>2km	OF012-002--	Monasteroris	Ringfort - rath	1030m to E	450m to SW	OF012-005001-	Drumcooly	Church	900m to ENE	>2km	OF012-005002-	Drumcooly	Graveyard	900m to ENE	>2km	OF012-006001-	Drumcooly	Castle - motte and bailey	1060m ENE	>2km	OF012-006002-	Drumcooly	Enclosure	1060m ENE	>2km	OF012-016--	Monasteroris	Mill - unclassified	1070m to NE	315m to NW	OF012-017--	Kinnafad	Earthwork	1150m to ESE	990m to NWN	OF019-series	Ballykilleen	Various sites in bog	250-1000m to W	>2km	NIAH No.	Townland	Description	Distance from redline	Distance from Monasteroris temp comp	14911006	Monasteroris	Date: 1760-1800; Originally a Country House	400m to ENE	1000m to W	14911013	Monasteroris	Date: 1760-1800; Originally an Icehouse	300m to ENE	1000m to WSW
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			14911021	Edenderry	Date: 1790-1800; Originally a Bridge	130m to E	>2km	
			14911001	Jonestown	Date: 1770-1810; Originally a Country House	450m to ENE	>2km	
			14912002	Monasteroris	Date: 1710-1750; Originally a Country House	1000m to NE	525m to NW	
			14911004	Monasteroris	Date: 1790-1830; Originally a Gate Lodge	600m to NE	870m to W	
			14911005	Monasteroris	Date: 1760-1800; Originally a Gate Lodge	470m to NE	1050m to W	
			14804051	Edenderry	Date: 1880-1885; Originally a Rectory/glebe/vicarage/curate's house	1110m to ENE	430m to SW	
			14912006	Drumcooly	Date: 1820-1860; Originally a House	935m to ENE	>2km	
			14911007	Monasteroris	Date: 1790-1795; Originally a Bridge	725m to W	>2km	
			14912004	Drumcooly	Date: 1790-1800; Originally a Bridge	800m to NE	>2km	
	9. Availability and capacity of public surface water drainage facilities and any history of flooding relevant to the site							
	Comment: Please apply the following conditions to any grant of permission for the proposed development; General 1. All mitigation measures as outlined in the submitted Construction and Environmental Management Plan shall be implemented by the applicant/developer for the construction & operational phase of the development. 2. All recommendations as outlined in the submitted Flood Risk Assessment shall be implemented by the applicant/developer for the operational phase of the development. 3. All mitigation measures as outlined in the submitted Natura Impact Statement Assessment Report shall be implemented by the applicant/developer for the construction & operational phase of the development. 4. All mitigation measures as outlined in the submitted Environmental Impact Assessment Report shall be implemented by the applicant/developer for the operational & construction phase of the development.	Recommended Condition on Grant	The mitigation measures and commitments identified within the application documentation form part of the proposed development and will be implemented during the construction phase. <u>Items 1 to 5 - mitigation measures and commitments.</u> The Applicant confirms that the mitigation measures and commitments contained within the oCEMP, Flood Risk Assessment, Natura Impact Statement, EIAR and Water Framework Directive Assessment will be implemented as part of the proposed development, as applicable. <u>Item 6 - statutory consents and licences.</u> The Applicant acknowledges that all statutory consents, licences and approvals required to undertake the proposed development must be obtained prior to the commencement of the relevant works.					

Submitter	Point Raised	Type	Proposed Response / Input Required
	5. All mitigation measures as outlined in the submitted Water Framework Directive Assessment Report shall be implemented by the applicant/developer for the operational & construction phase of the development. 6. All statutory consents and licences required to commence construction Works on-site shall be obtained prior to works commencing, including but not limited to; Site notices, Construction commencement notices, Licence to connect to existing utilities (including water) and mains sewers, where required, Abstraction and / or discharge licenses, where required, Road opening / closure licences, etc.		
	Surface Water 1. The applicant shall maintain/preserve any existing riparian corridor/drain present within and/or adjacent to the site by implementing a buffer zone where no development is permitted in accordance with Offaly County Council's, Development Plan 2021-2027. - As per Chapter 4 of the Offaly County Development Plan 2021-2027, Policy BLP-20: It is Council policy to preserve riparian buffer strips free from development by reserving a minimum of 10 metres either side of all watercourses (measured from top of bank) with the full extent of the protection determined on a case by case basis by the Council, based on site specific characteristics and sensitivities. - As per Chapter 11 of the Offaly County Development Plan 2021-2027, Policy WSP-22: It is Council policy to ensure adequate surface water drainage systems are in place which meet the requirements of the Water Framework Directive and the River Basin Management Plan and to promote the use of Sustainable Drainage Systems. - As per Chapter 11 of the Offaly County Development Plan 2021-2027, Policy ENVP-03: It is Council policy to support the implementation of the Water Framework Directive, the River Basin Management Plan and the Local Authority Waters Programme in achieving and maintaining at least good	Recommended Condition on Grant	With regard to Policy BLP-20, and the recommendation condition, the applicant would have concern with the inclusion of the proposed condition as currently worded. The requirement to "<i>maintain/preserve any existing riparian corridor/drain</i>" and to implement a buffer zone "<i>where no development is permitted</i>" interpretation of this has the potential to be interpreted as prohibiting any construction activity within 10 m of a watercourse and does not reflect the nature of the proposed development or the approach assessed within the EIAR. Such an interpretation could preclude the temporary works required to facilitate assessed watercourse crossings and would effectively prevent the delivery of the proposed development. Policy BLP-20 of the Offaly County Development Plan 2021-2027 on the protection of riparian corridors is noted. However, it is considered that this policy is intended to protect riparian corridors from permanent development and should not reasonably be interpreted as prohibiting all works in proximity to watercourses. Such an interpretation would effectively prevent the delivery of any infrastructure projects where watercourse crossings are unavoidable. The proposed gas pipeline is a c. 23 km linear infrastructure project and, by its nature, must cross certain watercourses along the route, in this case 32 no. river and watercourse crossings are required. Of these, it is anticipated that 27 no. will require an open cut crossing method and therefore will require works within 10m of these watercourses. These crossings have been assessed as part of the EIAR, subject of the a construction methodology submitted with the planning application (Appendix 2.1 of the EIAR) and are subject to specific mitigation measures designed to protect water quality and aquatic habitats during construction. Importantly, the proposed development does not result in the permanent loss or occupation of riparian corridors. Following installation of the pipeline, all watercourses and their banks will be fully reinstated in line with the mitigation set out in the EIAR and CEMP, with the pipeline remaining below ground. Accordingly, the proposed development is considered consistent with the objectives of Policies BLP-20, WSP-22 and ENVP-03, as the project will not result in any unacceptable impact on the water environment and will maintain the existing function and character of affected watercourses following reinstatement. The Council's riparian buffer policy is therefore not considered to preclude the temporary and carefully managed crossing of watercourses required for the delivery of the proposed development. With regard to Policy WSP-22, it is confirmed that the proposed development has been supported by a site-specific Flood Risk Assessment and Water Framework Directive Assessment. The proposed development has been designed to ensure compliance with the requirements of the Water Framework Directive and River Basin Management Plan. Given the nature of the development, an underground gas pipeline with above ground components at each end, the only operational requirements for drainage are located at these extremities, that is at the Kilwarden Offtake Installation and the Ballykilleen AGI. As outlined in the EIAR: the Kilwarden Offtake Installation drainage system will allow for removal of surface water from areas of hardstand. A 7.2 m × 3.25 m × 1.6 m soakaway pit will be constructed in the southeastern corner of the compound to facilitate infiltration and manage surface water runoff, this soakaway overflows to an existing drainage ditch along the laneway used to access the site.

Submitter	Point Raised	Type	Proposed Response / Input Required
	environmental status for all water bodies in the county. Development proposals shall not have an unacceptable impact on the water environment, including surface waters, groundwater quality and quantity, river corridors and associated woodlands.		The proposed Ballykilleen AGI will include a concrete standing area, internal access routes, and a site drainage system connected to the existing Edenderry Renewable Energy Complex stormwater drainage network, in line with agreement between GNI and Bord na Móna. This system will drain stormwater through the existing stormwater drainage network and discharge to the Figile River. The WFD Assessment concludes that, there is no potential for adverse or minor temporary/ long-term or localised effects on the Boyne_040, Boyne_030, YELLOW (CASTLEJORDAN)_030, Boyne_020 or the Figile_030. and therefore the proposed development is considered consistent with the objectives of Policy WSP-22. With regard to Policy ENVP-03, the potential effects of the proposed development on surface water, groundwater, aquatic ecology, river corridors and associated habitats have been assessed within the EIAR and Water Framework Directive Assessment. Chapters 6 and 7 of the EIAR assessed the potential for significant impacts on Hydrology and Hydrogeology, and Biodiversity, respectively. The assessments found that once all mitigation measures outlined in these chapters and the CEMP are implemented, the proposed development will not result in unacceptable impacts on the water environment. The WFD Assessment concludes that the proposed development will not prevent achieving and maintaining at least good environmental status for all water bodies in the study area. The WFD Assessment concludes that, there is no potential for adverse or minor temporary/ long-term or localised effects on the Boyne_040, Boyne_030, YELLOW (CASTLEJORDAN)_030, Boyne_020 or the Figile_030 and therefore the proposed development is considered consistent with the objectives of Policy ENVP-03.
	Foul Sewerage 1. Prior to construction commencing on site, the developer is requested to provide details of how effluent will be collected & treated during the construction phase. 2. In the event that foul waste is to be removed regularly from site by a contractor during construction phase, the developer shall submit a signed maintenance contract with an Authorised Waste Collector and all foul waste must be transported to an Authorised Waste Facility.	Recommended Condition on Grant	No objection is raised to these matters being secured by condition in the event of a grant of permission. <u>Item 1 – Foul sewerage during construction.</u> Chapter 6 (Hydrology and Hydrogeology - Section 6.6.1.1) of the EIAR and the CEMP (Section 5.2.1.6) notes that ‘<i>Foul water from the offices and welfare facilities on the site will be contained within the portable toilets and collected by a licensed waste sewerage contractor.</i>’ Once removed from site, this will be taken to a licensed facilities for appropriate treatment. <u>Item 2 – Authorised waste contractor and facility.</u> Foul water will be regularly removed from site by a licensed waste contractor. The point raised here, will be carried out as standard construction practice
	11. Carrying capacity and safety of road network serving the proposed development		
	The Applicant shall submit details of the proposed wheel wash facilities for vehicles (HGV's) leaving the temporary compound locations and road crossing locations.	Request for further information	Measures will be implemented throughout the construction works to prevent the deposition of mud and debris on the public road network. A full-time road sweeper will be deployed for the duration of the works, with additional localised road cleaning and housekeeping measures implemented at temporary compounds and road crossing locations as required. These measures will be provided in further detail within the final CEMP prior to the construction of the development. They will also and reviewed again during construction in ongoing liaison with the relevant Local Authority and adapted where necessary having regard to site and ground conditions.
	The Applicant shall clarify the reasoning for the location of the temporary compound in Rathvilla as it is 4 km from the pipeline.	Request for further information	The location of Temporary Construction Compound 04 was selected having regard to the suitability of the site for temporary construction use and the availability of an existing developed area. The site has previously been used for a similar purpose and contains an existing hardstanding area, thereby reducing the extent of site establishment works, ground disturbance and temporary surfacing that would otherwise be required by GNI's appointed contractor. The site was also identified as being available for the duration of the works and is well connected to the surrounding road network, being located immediately off the R402. This provides suitable access for construction traffic, plant, materials and personnel associated with the pipeline works.

Submitter	Point Raised	Type	Proposed Response / Input Required
			Overall, the location was considered appropriate due to its existing condition, accessibility and suitability for construction use. Its use also avoids the need to establish a new temporary compound on an otherwise undeveloped site, thereby reducing additional land take, enabling works and environmental disturbance.
	The Applicant shall clarify the details of the logistics to facilitate the haulage of the 18m pipe or alternative arrangements.	Request for further information	The 18 metre long sections of line pipe will be delivered using an articulated HGV unit with an extendable flatbed trailer, via the haul routes assessed in the EIAR Chapter 13. The loads will be moved under an abnormal load permit (Garda S.I. 147 for designated routes, plus Local Authority permits for the rest of the route), with appropriate overhang marking. Additionally, an escort vehicle would be utilised if required under the conditions of the permit. The line pipe will initially be delivered to one of the Temporary Construction Compounds (TCC). From the TCC's line pipe will be delivered to the work sites via the Type A laydowns via routes set out in the EIAR Chapter 13. Routing these vehicles into work areas would be carried out in accordance with the Construction Traffic Management Plan (CTMP) including safety measures set out in the plan. The applicant requests that this constraint be effected via condition in any permission for the development.
	The Applicant shall submit details of pipeline interactions with the public road network (crossings) at each interface location (public and non-public roads). The details shall include, construction details, construction programme, traffic management designs, reinstatement details and measures to protect existing public infrastructure during development works.	Request for further information	The proposed pipeline interfaces with the public and private road network have been identified and assessed as part of the planning application. The application also sets out the proposed construction and reinstatement principles for road crossings. Concrete and asphalt/bituminous road crossings will be permanently reinstated in accordance with the applicable requirements, including I.S. 328:2021, GNI/AD/SP/007, the Guidelines for Managing Openings in Public Roads 2017 (The Purple Book) and the requirements of the relevant Local Authority and/or private landowner. A typical road crossing reinstatement detail is included in planning application drawing GNI143-GNI-PL-RD-0001-01. Final reinstatement details will be agreed prior to construction, typically through the Road Opening Licence process between the Applicant, its appointed contractor and the relevant Local Authority. The detailed construction programme and site-specific traffic management designs are construction-stage deliverables and will be developed by the appointed contractor once the final construction methodology, sequencing, plant requirements and programme are established. These details will be submitted to and agreed with the relevant Local Authority and other appropriate bodies in advance of the works. Similarly, measures to protect existing public infrastructure will be confirmed during detailed construction planning, informed by utility records, surveys and site investigations, and agreed with the relevant asset owners where required. Accordingly, the planning application provides the proposed road crossing and reinstatement principles, while the detailed construction programme, traffic management arrangements and infrastructure protection measures will be developed and agreed prior to construction. The Applicant request that this constraint be effected via condition in any permission for the development.
	The Applicant shall submit a detailed programme of haul routes/deliveries. Details to include dates and times, number of loads, weights, road closures and diversion routes and support vehicles, etc.	Request for further information	Outline information has been submitted as per the responses above. Forecast daily maximum number of loads have been set out in the EIAR Chapter 13, and road closures and diversion routes set out in the Outline CTMP. It would not be feasible to provide precise dates and times at this stage of the project - detailed information will be developed by the applicant's appointed Contractor. The applicant requests that this constraint be effected via condition in any permission for the development.
	Proposed Conditions – 1.0 Project Management 1.0 Gas Networks Ireland shall appoint a full time Public Liaison Officer and be a dedicated point of Contact for Offaly County Council and members of the public throughout the duration of the project. This contact person shall address	Recommended Condition on Grant	No objection is raised to these matters being secured by condition in the event of a grant of permission.

Submitter	Point Raised	Type	Proposed Response / Input Required
	issues raised by members of the public within 2 weeks of the date they are made aware of those issues. In any case where an issue cannot be resolved between GNI and a member of the public, Offaly County Council shall engage with both parties to achieve a successful outcome.		
	2.0 The Developer shall consult with Offaly County Council, An Garda Síochána, Emergency Services and Bus Operators in relation to each stage of the works.	Recommended Condition on Grant	No objection is raised to these matters being secured by condition in the event of a grant of permission.
	Roads Conditions 3.a) Prior to commencement of development the developer shall submit a full pavement analysis of the haul routes within Co. Offaly terminating at the access points into the site that the haul routes service. The analysis shall include PSCI, FWD, RDP, SCRIM and a video survey of road surface condition. A schedule of required works to enable the haul routes shall be submitted to Offaly County Council for agreement with Edenderry Municipal District at least 3 months prior to project commencement in Co. Offaly. Agreed works must be undertaken at the developer's expense and Edenderry Municipal District must sign off on the completed works prior to utilisation of any haul routes to service the development. NOTE: Offaly County Council are responsible for the entire area between boundaries (hedges, tree lines, boundary walls etc.) and not just the roadway surface. The analysis to be carried out shall include roadside verges, footpaths, drainage and boundaries, in addition to the road surface. Where haul routes consist of narrow roads, junctions etc. appropriate measures must be taken to ensure verges, drainage and boundaries will not be affected by the use of those haul routes.	Recommended Condition on Grant	The final haul routes for quarried materials and ready mix concrete can only be defined once the Applicants' appointed Contractor has made supplier selection. The proposed deliveries for the development will not necessitate abnormal road loadings. The only anticipated abnormal (weight) loads may be associated with movement of heavy plant, but these will be expected to be small in number. Therefore, it is considered that the adverse impact of the development on the local roads network would not be significant and that the extent of testing proposed is disproportionate with the additional traffic generated. It is requested that the condition be amended to requiring <i>'a pre-construction and post-construction road condition survey to be agreed with the planning authority'</i>
	3.b Within 12 months of the completion of the development the developer shall submit a full pavement analysis of the haul routes used within Co. Offaly terminating at the access points into the Site that the haul routes service. The analysis shall include PSCI, FWD, RDP, SCRIM and a video survey of road surface condition. A schedule of required works to repair the utilised haul routes shall be submitted to Offaly County Council for agreement with Edenderry Municipal District. Agreed works must be undertaken at the developer's expense within	Recommended Condition on Grant	

Submitter	Point Raised	Type	Proposed Response / Input Required
	6 months of agreement with Offaly County Council.		
	4.a Prior to commencement of development the developer shall submit a Structural Survey including load bearing Capacity analysis of all bridges/ culverts, or any other load bearing infrastructure along the proposed haul routes within Co. Offaly. A schedule of required works to strengthen said infrastructure (if required) shall be submitted to Offaly County Council/Edenderry Municipal District for agreement at least 9 months prior to project commencement in Co. Offaly. Agreed works must be undertaken at the developer's expense prior to utilisation of any haul routes to service the development.	Recommended Condition on Grant	The final haul routes for quarried materials and readymix concrete can only be defined once the Applicant's appointed Contractor has made supplier selection. The proposed deliveries for the development will not necessitate abnormal road loadings. The only anticipated abnormal (weight) loads may be associated with movement of heavy plant – subject to haulage configuration which addresses problematic locations. Therefore, it is considered that the adverse impact of the development on the local roads network would not be significant and that the extent of testing proposed is disproportionate with the additional traffic generated. It is requested that the condition be amended to requiring 'Prior to commencement of development the developer shall agree with the local authority routes of abnormally heavy loads and configure haulage to account for any load constraints.'
	4.b Within 12 months of the completion of the development the developer shall submit a Structural Survey including load bearing Capacity analysis of all bridges/ culverts, or any other load bearing infrastructure utilised along haul routes within Co. Offaly. A schedule of required repair works on said infrastructure (if required) shall be submitted to Offaly County Council for agreement. Agreed works must be undertaken at the developer's expense prior to utilisation of any haul routes to service the development.	Recommended Condition on Grant	
	5.0 All haul routes shall be agreed with Offaly County Council/Edenderry Municipal District prior to commencement. Any deviation from haul routes submitted under SID application is not permitted unless written agreement has been received from Offaly County Council. Unauthorised deviation from proposed haul routes submitted as part of the planning application, or otherwise agreed in writing with Offaly County Council/Edenderry Municipal District, may result in a Notice to Cease transportation of materials on unauthorised roads within Co. Offaly, until such time as an assessment of the un-authorised haulage routes has been undertaken by Offaly County Council/Edenderry Municipal District to establish defects.	Recommended Condition on Grant	The Applicant has no objection in principle to agreeing construction haul routes with Offaly County Council / Edenderry Municipal District prior to commencement of the relevant works. However, it is considered that the proposed wording is unduly restrictive, particularly where temporary route changes may be required due to road closures, traffic management requirements, emergencies or other circumstances outside the Applicant's control. It is therefore requested that the condition be amended to provide reasonable flexibility for alternative haul routes to be agreed where required, for example: <i>"Prior to commencement of the relevant construction works, the principal haul routes to be used within County Offaly shall be agreed in writing with Offaly County Council / Edenderry Municipal District. Construction traffic shall generally utilise the agreed haul routes. Any material or permanent alteration to the agreed haul routes shall be subject to prior written agreement with Offaly County Council / Edenderry Municipal District, save for temporary diversions required as a result of road closures, emergencies, traffic management measures or other circumstances outside the developer's reasonable control."</i>

Submitter	Point Raised	Type	Proposed Response / Input Required
	6.0 Prior to commencement of the development, the developer shall submit to Offaly County Council/Edenderry Municipal District details of the proposed maintenance and inspection regime for roads being utilised as haul routes through Co. Offaly to facilitate the development. The proposed inspection regime shall be at monthly intervals, shall record defects encountered, maintenance issues identified, contain geo-located photographic records, and shall propose interventions to be undertaken to rectify defects/ maintenance issues at the developer's expense and a timeframe for doing so. Such reports shall be submitted to Offaly County Council on a monthly basis for review and acceptance. The developer shall be responsible for any public liability claims that arise in connection with damage caused on haul routes by the developer or their agents.	Recommended Condition on Grant	The proposed dilapidation surveys carried out on haulage routes and at road crossing locations under road opening licences will benchmark road conditions. These actions will necessitate ongoing liaison between the Applicant's Contractor anyway. It is requested that the Condition be amended to: <i>Prior to commencement of development, the developer shall submit to Offaly County Council/Edenderry Municipal District details of the proposed inspection regime for public roads utilised as principal construction haul routes within County Offaly. The regime shall provide for periodic inspections during the principal construction phase, including photographic records where appropriate. Where deterioration or damage to the public road network is demonstrated to be attributable to construction traffic associated with the development, appropriate remedial measures shall be agreed with the Roads Authority and undertaken by the developer within an agreed timeframe.</i>
	7.0 Prior to the commencement of the development, the following shall be submitted to, and agreed in writing with, Offaly County Council: 7.0(a) A Transport Management Plan, including details of road network/ haulage routes, vehicle types to be utilised (including oversized loads), sources of materials, a programme of anticipated deliveries to sites/compounds to facilitate development, including no's of loads, arrangements for the protection of bridges, culverts and other structures to be crossed, as may be required.	Recommended Condition on Grant	Regarding condition 7.0 (a)-(l), No objection is raised to these matters being secured by condition in the event of a grant of permission. It should be noted that construction traffic management and protocols will be detailed in the contractors' Construction Traffic Management Plan rather than the CEMP
	7.0(b) A Construction Environmental Management Plan (CEMP) in respect of the proposed development. This plan shall provide details of intended construction practice for the development, including: • Details of site security fencing and hoardings. • Details of on-site car parking facilities for site workers during the course of construction. • Phasing programme (including a detailed schedule of all deliveries that run concurrently (eg. Pipe delivery, stone etc and the delivery of abnormal loads) indicating the timescale within which it is intended to use each public route to facilitate construction of the proposed	Recommended Condition on Grant	

Submitter	Point Raised	Type	Proposed Response / Input Required
	development. Developer to liaise with Edenderry Municipal District & Offaly County Council in relation to deliveries. Once all suppliers have been confirmed by the Developer/Contractor, a detailed programme of deliveries is to be submitted to OCC/Edenderry MD for review. Details to include number of movements per day, weights, etc. Developer/Contractor to liaise with OCC / Edenderry Municipal District to establish the designated delivery/haul routes. Note: Any change(s) to locations and sources of materials being hauled to the site during construction shall be notified to the planning and Roads authority, as any deviation from agreed haul routes may have an adverse impact on the road network; which may also lead to amendments to agreed schedule of works to roads as agreed with Edenderry Municipal District under designated haul routes for materials for the development. • Detailed arrangements for temporary traffic arrangements/ controls on roads. Including associated directional signage to be submitted and agreed with the Roads authority. • Traffic Signage to be compliant with Chapter 8 of Traffic Signs Manual 2019 (as amended). • Measures to prevent queuing of construction traffic on the adjoining road network. • Measures to prevent the spillage or deposit of clay, rubble or other debris on the public road network. • Details of appropriate mitigation measures for noise, dust and vibration, and monitoring of such levels. • Containment of all construction-related fuel and oil within specially constructed bunds to ensure that fuel spillages are fully contained; such bunds shall be roofed to exclude rainwater. • Off-site disposal of construction / demolition waste and details of how it is proposed to manage excavated soil. • Details of on-site re-fuelling arrangements, including use of drip trays.		

Submitter	Point Raised	Type	Proposed Response / Input Required
	- Details of how it is proposed to manage excavated soil. - Means to ensure that surface water run-off is controlled such that no deleterious levels of silt or other pollutants enter local surface water drains or watercourses.		
	7.0(c) Details of pipeline interactions with the public road network (crossings) at each interface location (public and non-public roads). The details shall include, construction details, construction programme, traffic management designs, reinstatement details and measures to protect existing public infrastructure during development works.	Recommended Condition on Grant	
	7.0(d) Details of all access points from the public roadways in Co. Offaly into the site including access road tie in details, details of site boundary security measures adjoining public roads, wheelwash facilities, measures to mitigate dust and site material being deposited onto the public roadway, measures to mitigate impacts on existing roadside drainage, measures to control vehicle movements into and off of the site, maintenance of sightlines and security provisions at access points to site. Cleaning of Roads used as haul routes shall be carried out daily and as required at the developers expense.	Recommended Condition on Grant	
	7.0(e) A phasing programme indicating the timescale within which it is intended to use each public route to facilitate construction of the proposed development.	Recommended Condition on Grant	
	7.0(f) Details of Gas Network Ireland's appointed Public Liaison Officer for Edenderry Municipal District.	Recommended Condition on Grant	
	7.0(g) Where Road Closures are required to facilitate works, details of Road Closures, including; Road No, Townland, start and end points, detour routes, traffic management plans, proposed start and end dates and times and purpose of road closure must be submitted to Offaly County Council 8 weeks prior to required closure date. NOTE: The developer shall be liable for all costs incurred by Offaly County Council relating to the advertisement of road closures. The developer shall inform Offaly County Council, An Garda Siochana, Fire and Rescue Services, Midlands Radio 3, The Midland Tribune, The Offaly Express and any other	Recommended Condition on Grant	

Submitter	Point Raised	Type	Proposed Response / Input Required
	party/body Offaly County Council require on a weekly basis of road closures relating to the project.		
	7.0(h) Detailed arrangements for temporary traffic arrangements / controls on roads.	Recommended Condition on Grant	
	7.0(i) Details of location of works within public roads in Co. Offaly, anticipated programme of such works, methods of traffic control, anticipated durations of works and MSRA for the activities. Road Opening Licences (T1 and T2 licences) will be required at each and every location of works to be carried out on public roads within Co. Offaly. The conditions, set by Offaly County Council, applied to Road Opening Licences shall be accepted by the applicant prior to granting of a licence, and prior to any works being undertaken on the public road. Conditions must be complied with in full, throughout the duration of said licences, in order to satisfy the requirements of Offaly County Council and ensure satisfactory execution and reinstatement of the works. The acceptance of a Road Opening Licence, will be an acceptance of associated costs of the licence by the applicant, set by Offaly County Council, which will include the payment of all applicable Road Opening Licence charges to Offaly County Council, as through the Road Management Offices (RMO) process for monthly billing. The Developer shall arrange a meeting with Edenderry Municipal District prior to submitting a Road Opening Licence for parts of the works.	Recommended Condition on Grant	
	7.0(j) Confirmation that abnormal load permits will be applied for as per Offaly County Councils requirements, a minimum of 6 weeks prior to anticipated load transportation to site.	Recommended Condition on Grant	
	7.0(k) Details of Gas Network Ireland's Project Management Structure for the project and points of Contact during the Management of the Project.	Recommended Condition on Grant	
	7.0(l) The developer shall submit a proposed schedule of project update meetings to be held with Edenderry Municipal District Area Engineer and Gas Network Ireland Management at agreed intervals throughout the duration of the project.	Recommended Condition on Grant	

Submitter	Point Raised	Type	Proposed Response / Input Required
	8.a Roads Shall be kept free from vehicles and obstructions throughout the duration of the development. Unloading/ loading of materials on the public roadway is not permitted at any stage of the project. Parking of vehicles along the public roadway is not permitted and the developer shall include such unloading/ loading and parking provisions within the curtilage of the development site.	Recommended Condition on Grant	Regarding condition 8 (a)-(d), No objection is raised to these matters being secured by condition in the event of a grant of permission.
	8.b Traffic Management Plans for each stage of the project where there is an interface with the public road network are required a minimum of 4 weeks prior to commencement of such works. The developer shall maintain hedges and verges for the entire extent of traffic management signage and forward sight distances for the duration of the traffic management. Where necessary, the developer shall provide a report from a suitably qualified person, outlining mitigation measures for hedge and verge maintenance between 1st March and 30th September.	Recommended Condition on Grant	
	8.c Prior to commencement Offaly County Council will require Training Records & Details of your Temporary Traffic management designer – who will be selecting the traffic management set ups and advising.	Recommended Condition on Grant	
	8.d Prior to commencement of development the developer shall submit detailed designs for the written agreement of the Planning Authority/Edenderry Municipal District showing roadside drainage details at all site entrances within Co. Offaly.	Recommended Condition on Grant	
	8.e Lines of sight at all proposed entrances to the site shall be constructed and maintained strictly in accordance with the requirements of Table 1.3: Design Speed Related Parameters of TII Rural Link Road Design DN-GEO-03031, April 2017 in the interest of traffic safety.	Recommended Condition on Grant	The proposed accesses comprise existing entrances, with no new permanent road accesses proposed as part of the development. Their use will be managed having regard to the nature, frequency and duration of construction and operational traffic. A Construction Traffic Management Plan (CTMP) will be developed prior to commencement of construction, setting out the proposed traffic management arrangements at the relevant accesses. These measures will be submitted to and agreed with the local authority in advance of the works. Accordingly, it is requested that the condition be amended to recognise the existing nature of the accesses and to require that available visibility be maintained and managed, insofar as practicable, within lands under the Applicant's control.

Submitter	Point Raised	Type	Proposed Response / Input Required
	9.0 Prior to the commencement of development, the developer shall lodge with the planning Authority a cash deposit, a bond of an insurance company, or such other security as may be acceptable to the Planning Authority, to secure the reinstatement of public roads which may be damaged by the transport of materials to and from the site, coupled with an agreement empowering the Planning Authority to apply such security or part thereof to the satisfactory reinstatement of the public road. The form and amount of the security shall be agreed between the Planning Authority and the Developer. Reason: To ensure the satisfactory reinstatement of Haulage Routes.	Recommended Condition on Grant	The applicant is not accepting this condition. The Applicant is part of the National Deposit Scheme (NDS), in which the applicant has a perpetuity bond lodged with the RMO since March 2019. Therefore, the Applicant would request this facility is used to ensure the reinstatement of any public roads if required.
	10.0 Where Offaly County Council/Edenderry Municipal District consider a proposed haul route is not in a suitable condition, the developer shall upgrade the road or junction in advance of haulage operations as agreed with Edenderry Municipal District /Roads authority.	Recommended Condition on Grant	Prior to commencement of development, the developer shall submit to Offaly County Council/Edenderry Municipal District details of the proposed inspection regime for public roads utilised as principal construction haul routes within County Offaly. The regime shall provide for periodic inspections during the principal construction phase, including photographic records where appropriate. Where deterioration or damage to the public road network is demonstrated to be attributable to construction traffic associated with the development, appropriate remedial measures shall be agreed with the Roads Authority and undertaken by the developer within an agreed timeframe.
	11.0 Any defects that appear upon the public roads/designated haul routes during the construction period of the development shall be rectified by the developer as agreed with Edenderry Municipal District /Roads authority.	Recommended Condition on Grant	
	TEMPORARY TRAFFIC MANAGEMENT (TTM) FOR CONSTRUCTION PHASE 12.0 The applicant shall ensure that specific Temporary Traffic Management Plans are designed and installed to cater for the various phases of the project. Items that may be considered along with the General Principles of Prevention, could include, but not exclusively, some of the following: • The prevailing traffic speeds and traffic volumes. Busy commuter routes. • Horizontal and vertical alignments of the road(s). Visibility. Obstacles. Undulations. • Presence of existing entrances in the vicinity / existing turning movements / existing slow-moving traffic areas. • Grass verges shall be kept in check by the developer to ensure that TTM signage is visible at all times.	Recommended Condition on Grant	No objection is raised to these matters being secured by condition in the event of a grant of permission.

Submitter	Point Raised	Type	Proposed Response / Input Required
	- Appropriate TTM Plan and risk assessments shall be in place for all activities on the public roads. - Housekeeping: All public roads affected by the development shall be kept free of loose materials, dust, mud, spillages, and debris. - For excavation works at entrances, the safety zone requirements and available residual road widths shall be considered as part of the Design Process. - The impact that (i) queuing of delivery vehicles on the road before entry to the site, and (ii) slow-moving vehicles exiting the site, could have on traffic safety. - The Provision of Variable Message Signs (VMS) for the duration of the project, or at specific phases of the project.		
	12. Environmental carrying capacity of the subject site and surrounding area, and the likely significant impact arising from the proposed development, if carried out		
	Foul Sewerage 1. Prior to construction commencing on site, the developer is requested to provide details of how effluent will be collected & treated during the construction phase. 2. In the event that foul waste is to be removed regularly from site by a contractor during construction phase, the developer shall submit a signed maintenance contract with an Authorised Waste Collector and all foul waste must be transported to an Authorised Waste Facility.	Recommended Condition on Grant	<u>Item 1 – Foul sewerage during construction.</u> Chapter 6 (Hydrology and Hydrogeology - Section 6.6.1.1) of the EIAR and the CEMP (Section 5.2.1.6) notes that ‘<i>Foul water from the offices and welfare facilities on the site will be contained within the portable toilets and collected by a licensed waste sewerage contractor.</i>’ Once removed from site, this will be taken to a licensed facilities for appropriate treatment. <u>Item 2 – Authorised waste contractor and facility.</u> Foul water will be regularly removed from site by a licensed waste contractor. The point raised here, will be carried out as standard construction practice
	Waste Management 1. All wastes arising from/at the proposed development shall be managed in accordance with the Waste Management Acts 1996 as amended. While awaiting removal, all waste materials shall be stored in designated areas protected against spillage or leachate run-off. 2. The applicant is required to obtain an Integrated Pollution Control licence from the EPA prior to any extraction/excavation of peat and any associated Works such as drainage. 3. All uncontaminated soil and stone imported onto the site shall comprise non-waste	Recommended Condition on Grant	The matters identified have been considered as part of the Resource and Waste Management Plan (RWMP) submitted with the application. No objection is raised to these matters being secured by condition in the event of a grant of permission. <u>Items 1, 3, 4 and 5 – Waste Management Procedures.</u> The RWMP includes measures relating to the management, storage and handling of waste, including arrangements for waste segregation, the use of authorised waste collectors and facilities, the management of imported soil and stone, and the maintenance of appropriate waste records. The Applicant has no objection to these matters being secured by condition, where considered necessary by the Planning Authority. <u>Item 2 – IPC Licence.</u> An Integrated Pollution Control (IPC) Licence is not required for the proposed development and, therefore, it is not considered necessary to include this condition. The relevant class of IE/IPPC Licence Activity in the First Schedule to the EPA At 1992 is <i>1.4 The extraction of peat in the course of business which involves an area exceeding 50 hectares</i>. The proposed development does not involve the extraction of peat in the course of business or the commercial extraction of peat. While peat may be excavated incidentally during construction, such excavation is undertaken solely to facilitate the proposed development. The proposed development does not involve the commercial extraction of peat.

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	byproduct, in accordance with Article 27 of the European Communities (Waste Directive) Regulations 2011, S.I. No. 126 of 2011. 4. No development shall commence prior to registration with the Environmental Protection Agency of the material to be imported onto the lands, in accordance with Article 27 of the European Communities (Waste Directive) Regulations 2011, S.I. No. 126 of 2011. 5. Prior to commencement of development, details regarding the origin/source of proposed soil & stone to be imported onto the site shall be submitted for the written agreement of the Planning authority		As set out in the EIAR, 95% of excavated clean excavated material will be reinstated as backfill provided that the soil excavated is clean and inert. It is currently estimated that 5% of the excavated material (c. 13,267 m³) will need to be removed off site for reuse, recovery, recycling or disposal. In effect, if peat is to be permanently removed off site, it will be done so at a far smaller scale than that which requires a IPC Licence. <u>Item 4 – Article 27 of the European Communities (Waste Directive) Regulations.</u> Should a condition relating to Article 27 registration be imposed, it is suggested that the wording be amended as follows: "If Article 27 is to be utilised to import material on to the site, no development shall commence prior to registration with the Environmental Protection Agency of the material to be imported onto the lands, in accordance with Article 27 of the European Communities (Waste Directive) Regulations 2011, S.I. No. 126 of 2011."
	Environmental Nuisance 1. Noise emissions at the nearest noise sensitive location (such as dwellings, schools, places of worship or areas of high amenity) shall comply with recommendations set out in chapter 11 of EIAR and/or the EPA IPC licence requirements. 2. Audible tonal or impulsive components should be minimised at any noise sensitive location; 3. The Applicant shall take reasonable measures to mitigate any environmental nuisance (noise and dust) which may arise during construction. Construction shall take place during working hours 7am to 6.30pm Monday to Friday and 8am to 1.30pm Saturday unless otherwise authorised by the Planning Authority. 4. Dust suppression shall be undertaken under dry and windy conditions to ensure that dust deposition does not exceed 350mg/m²/day. Details of a monitoring programme for the dust shall be submitted to, and agreed in writing with, the Planning authority prior to commencement of development. Details to be submitted shall include monitoring locations, the commencement date and the frequency of monitoring results.	Recommended Condition on Grant	The matters identified are consistent with the mitigation measures and operational controls set out in the Air Quality and Noise and Vibration Chapters of the EIAR. The Applicant has no objection to these matters being secured through the final CEMP. However, the reference to compliance with EPA IPC licence requirements is not applicable to the proposed development. <u>Item 1 – noise emissions.</u> The Applicant has no objection to noise limits and operational controls being secured by condition in the event of a grant of permission. There is no EPA IPC licence requirements applicable to the proposed development. <u>Items 2 and 3 - environmental nuisance (noise and dust).</u> The matters identified are consistent with the mitigation measures and operational controls set out in the Air Quality and Noise and Vibration Chapters of the EIAR. No objection is raised to these matters being secured by condition in the event of a grant of permission. <u>Item 4 – dust suppression.</u> Dust mitigation and monitoring measures are detailed in the Air Quality Chapter of the EIAR and the oCEMP. No objection is raised to the submission of a dust monitoring programme, including monitoring locations and monitoring frequency, where required by condition.

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	(Appendix Request) Biodiversity & Landscape 1. The applicant shall maintain/preserve any existing hedgerow/woodland/trees present within and/or adjacent to the site in accordance with Offaly County Council's, Development Plan 2021-2027. As per Chapter 4 of Offaly County Development Plan 2021-2027, Policy BLP-24: It is Council policy to support the protection and management of existing network of woodland, trees and hedgerows which are of amenity or biodiversity value and/or contribute to landscape character, and to strengthen local networks.	Observation	This observation was included in the Appendix of the Offaly County Councils Submission but was omitted from the main submission text. This may have been deliberately omitted, however we have provided a response below: The observation is noted. The Applicant acknowledges the objectives of Policy BLP-24 of the Offaly County Development Plan 2021-2027 relating to the protection and management of existing woodlands, trees and hedgerows which contribute to biodiversity value and landscape character. Given the nature of the proposed development as a linear infrastructure project, some hedgerow and tree removal is unavoidable to facilitate construction of the pipeline. However, the route selection and detailed design process was undertaken with input from the project arborist, ecologist, environmental specialists and engineers to minimise impacts on trees, hedgerows and other ecological features, insofar as practicable. The potential impacts on hedgerows and biodiversity have been assessed in Chapter 7 (Biodiversity) of the EIAR. While some temporary hedgerow removal will be required during construction, the effect is not considered significant given the abundance of similar habitat within the surrounding area. In addition, all disturbed hedgerows will be reinstated following completion of the works in accordance with the mitigation measures set out in the EIAR and oCEMP. This is considered to achieve compliance with the Development Plan Policy. As noted in Chapter 7 (Biodiversity) of the EIAR: <i>With the employment of the appropriate mitigation measures [set out in the Chapter 7 of the EIAR and the CEMP] regarding hedgerows [...], any residual effects of the Proposed Development on hedgerows at a local level are anticipated to be low-adverse, negative, not significant and medium-term.</i>
Meath County Council	The omission of wintering bird surveys should be supported by further evidence. In this regard it should be noted that the route avoids Farmland Bird Hotspots (BirdWatch Ireland Hotspot Mapping - BirdWatch Ireland) but further evidence should be included as even grazed agricultural land can be utilised by significant numbers of wintering waders, geese and swans.	Observation	A desktop review and review of survey records in relation to wintering birds was carried out in August 2026 to provide additional information in relation to potential impacts on wintering bird species as a result of the Proposed Development. Birdwatch Ireland's Farmland Bird and Breeding Farmland Wader map data were reviewed in addition to a more detailed assessment in relation to survey observations, distances from SPAs, and habitat suitability of the Study Area. A review of Birdwatch Ireland's Farmland Bird Hotspot and Breeding Farmland Wader Hotspot Data reveals that the Proposed Development does not overlap with known farmland bird or breeding farmland wader hotspots overall ((Figure 7-5 Farmland Bird and Breeding Farmland Wader Hotspots) submitted with the AWN Submission Response). The only overlap with the main body of the Proposed Development occurs at Bord na Móna lands where approximately 0.01 km² of predominantly dry grassland directly overlaps with Breeding Farmland Wader Hotspot 106. This area is directly adjacent to high noise levels from heavy machinery movements and other activities associated with Edenderry Power Station. Compound location Option 2 (O'Grady's) also directly overlaps with both Farmland Bird Hotspot area 198, and Breeding Farmland Bird Hotspot 106 by approximately 2 km². Considering this compound location comprises of predominantly bare ground and recolonising bare ground, that Breeding Farmland Wader Hotspot 106 comprises an area of 160 km², that Farmland Bird Hotspot 198 comprises an area of 9 km², and the nature of the Proposed Development, it is not anticipated that any Farmland Bird and Breeding Farmland Wader Hotspots, or their associated species, will be affected as a result of the Proposed Development.
	If the proposed project is at a significant distance to SPAs for which waders and wintering geese and swans are QI, then that should be included in the assessment of the report and any records of low numbers of these species assessed within the EcIA.	Observation	During surveys carried out in January 2025, a pair of whooper swans was recorded on waterlogged agricultural grassland between chainages 12,100 m and 12,300 m. Teal and mallard were relatively common in wet drainage ditches and watercourses throughout the Study Area. Snipe were recorded at a number of locations (particularly drainage ditches), and an individual woodcock was flushed from a drainage ditch on one occasion.
	Reference should also be made to the reinstatement of farmland which will ensure no significant loss of habitats for these species in the long term.	Observation	The only Qualifying interest of any SPA within 15 km of the Proposed Development is Kingfisher (<i>Alcedo atthis</i>, A229) of River Boyne and Blackwater SPA. The nearest SPA for which agricultural land within the Proposed Development area would provide suitable habitat is Lough Derravarragh SPA (22.6 km northwest), for which Whooper Swan (<i>Cygnus cygnus</i>) is a Qualifying Interest (A038). Due to the temporary nature of the development footprint, distance from SPA's, the large quantities of similar habitats in the greater area, avoidance of Farmland Bird and Breeding Farmland Wader Hotspots, minimal numbers of wintering/wading bird species noted during winter surveys, and reinstatement of existing habitats following construction, no significant effects on wintering/wading bird species are foreseen.
	The NIS states "If otters or evidence of otters is found during pre-construction surveys, an otter	Observation	Further surveys have taken place on site since the submission of the EIAR and, as per the findings of the EIAR, there are no constraints in relation to otters identified during mammal assessments. No material changes to the baseline environment in relation to otters have been

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	management plan will be developed by the appointed ecologist. No works will commence until this plan is developed and further mitigation is implemented to ensure no impacts on otters". In this regard, the otter management plan should be included in the NIS to ensure that the mitigation measures are assessed prior to consent. Whilst it is understood the plan will be site or timing specific, sample scenarios could be included.		identified since preparation of the EIAR. No changes to the Proposed Development have occurred which might alter potential effects on otters or assessment methodology. No otters or otter holts were noted during ecological surveys which took place in 2025 and 2026. A single otter print was identified 150m from the Proposed Development area. Pre-construction ecological surveys, including surveys to search for otters, will be carried out. In the unlikely event that an otter holt is found, mitigation will be required at this stage. It is not possible to produce a project-specific management plan in relation to otters at this time. No constraints have been identified for which to form the basis of an otter management plan. The potential possible permutations of what constraints may or may not be present prior to construction, which may only be defined following pre-construction assessments, cannot be ascertained at this time. Mitigation measures outlined within the NIS and EIAR, based on evidence gathered to date, satisfactorily address any potential impacts on otters directly and/or indirectly foreseen as a result of the proposed development. As addressed within referenced mitigation measures, in the event that any evidence of constraints in relation to otters are identified during pre-construction surveys, a detailed otter management plan specifically developed to address the potential risks given the evidence gathered and proposed works within zone of influence of specific works in the vicinity of any observation made will be developed by the appointed ecologist. No works will commence until this plan is developed and further mitigation is implemented to ensure no impacts on otters. A derogation license from NPWS is not required at present. In the event that a derogation license is required based on the findings of pre-construction surveys (e.g. otter holt), no works that may impact on shall commence that may impact on those specific findings until a derogation has been granted by NPWS.
	It is noted that tributaries of the Boyne are to be crossed by the pipeline. Depending on the distance from the main channel, tributaries could be considered ex-situ habitat for this species where they nest on a nearby tributary and use the main channel to feed or visa versa. To screen out potential for significant effects to Kingfisher adequately, reference should be made to the distance of the crossing locations to the Boyne SPA and the typical territory size of Kingfisher and the suitability/ unsuitability of the crossing points for nesting/ feeding purposes with reference to scientific data.	Observation	Survey effort in both 2025 and 2026 covered all habitats and species which may breed within those habitats. Survey efforts in 2025 and 2026 ensured suitable coverage of watercourses for observations and evidence of kingfisher individuals and potential nesting sites. No observations or evidence of kingfisher was noted, and no suitable nesting habitat for Kingfisher was present within the Proposed Development area at watercourse crossings. The typical territorial range of Kingfisher in Ireland can vary from 1.5 – 4 km approximately (IRD DUHALLOWLIFE+ PROJECT, 2015). Although the Proposed Development boundary is 3.3 km from the River Boyne and River Blackwater SAC, for which Kingfisher is listed as a Qualifying Interest, the Proposed Development is hydrologically 6.8km from this SAC via the shortest watercourse distance, outside the territorial range of Kingfisher populations associated with this SAC. Additionally, this particular watercourse, and other major watercourse/bodies along the Proposed Development will be crossed via HDD, with no direct impact on these waterbodies or adjacent riverbanks.
	For any HDD, a full methodology and emergency response plan, informed by geotechnical surveys and ecology surveys of the crossing points (for water depth etc.) should be presented to ensure an informed decision can be made by An Coimisiún as to the likelihood/ risk of frac out or pollution event.	Observation	<u>Engineering</u> The observation is noted. The matters raised are addressed below in proportion to the current stage of design, with the site-specific information and supporting assessments used to inform the design. It is inherent in the development of trenchless crossings that certain construction-specific parameters, including the final HDD rig configuration, drilling fluid system, tooling and detailed construction sequence, will be confirmed by the appointed specialist HDD contractor as part of the construction planning and detailed design process. Accordingly, the preliminary HDD designs have been developed using appropriate and representative design parameters, informed by site-specific survey information, recognised HDD design guidance and industry best practice. Contractor-specific deliverables, including detailed method statements, Emergency Response Plans and final drilling fluid hydrofracture/frac-out assessments, will subsequently be developed using the confirmed construction parameters and will be submitted to, or agreed with, the relevant statutory bodies where required. HDD Methodology

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			The proposed HDD construction methodology is described in section 3.2.7.1 of Appendix 2.1 - Gas to Bord na Móna, Edenderry Construction Methodology_0 included within the EIAR. This outlines the anticipated HDD construction sequence, drilling operations, drilling fluid management and the principal environmental controls to be implemented during the works. Emergency Response Planning As set out in the Appendix 2.2 - Gas to BnM Outline CEMP_Final_0 Section 6, the appointed contractor(s) will prepare a project-specific Emergency Response Plan for the construction works. This will include specific procedures for environmentally sensitive activities, including trenchless crossings, and will address the prevention, identification, containment and response measures associated with an inadvertent drilling fluid return or other pollution incident. Preliminary HDD Design and Hydrofracture Assessment Preliminary designs have been developed for each identified HDD crossing in accordance with recognised industry guidance and best practice, taking account of site-specific environmental, topographical and geotechnical constraints. Site-specific geotechnical investigations, including boreholes and associated testing, were undertaken at these crossing locations. The results, together with topographical and bathymetric survey data and relevant environmental information (Rilta suite), informed the preliminary HDD profiles, including entry and exit locations, crossing depths, clearances and anticipated drilling conditions. A Preliminary Drilling Fluid Hydrofracture Analysis was also undertaken for each of these crossings using the available geotechnical data and representative drilling parameters. The assessments compare anticipated drilling fluid pressures with the estimated resistance of the surrounding ground to hydrofracture, allowing the potential risk of inadvertent drilling fluid returns to be assessed. The assessments are presented in the following preliminary HDD design reports: • MJS-FW-GBNME-REP-002 - Kilwarden River Crossing - Preliminary Crossing Design Report • MJS-FW-GBNME-REP-004 - M4 Motorway Crossing - Preliminary Crossing Design Report • MJS-FW-GBNME-REP-006 - Yellow River Crossing - Preliminary Crossing Design Report • MJS-FW-GBNME-REP-008 - Grand Canal Crossing - Preliminary Crossing Design Report These reports should be read in conjunction with the corresponding Preliminary HDD Crossing Drawings: • MJS-FW-GBNME-DWG-001 - Kilwarden River Crossing - Preliminary Crossing Drawing • MJS-FW-GBNME-DWG-002 - M4 Motorway Crossing - Preliminary Crossing Drawing • MJS-FW-GBNME-DWG-003 - Yellow River Crossing - Preliminary Crossing Drawing • MJS-FW-GBNME-DWG-004 - Grand Canal Crossing - Preliminary Crossing Drawing <u>Environmental</u> The hydrofracture assessment for each of these crossing concluded that the risk of drilling fluid hydrofracture to the surface is considered to be low. Hydrofracture risk was a key consideration in developing the preliminary HDD profiles, with the proposed depths, alignments and clearances selected having regard to the site-specific ground conditions and the results of the hydrofracture assessments. The preliminary HDD design and supporting assessments therefore provide a site-specific and technically informed basis for consideration of the proposed crossings at planning stage. The design will be further developed by the appointed specialist contractor using the final construction parameters and any additional information available at that stage. The Applicant will continue to liaise with the relevant statutory bodies in relation to the detailed HDD design, construction methodology and associated environmental controls, where required.
	The EIAR states "The loss of Low value hedgerow will have a low, adverse, not significant and short-term effect on biodiversity. The loss of Moderate value hedgerow will have a low, adverse, not significant and short-term	Observation	Following a further review of hedgerows within the Study Area and consultation with the project arborist, it was determined that approximately 3.8 km of an estimated 7.5 km worth of hedgerow habitat crossed by the Proposed Development area are to be removed to facilitate the construction phase of the proposed development comprising of 106 hedgerow segments. The average width of hedgerow section to be

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	effect on biodiversity. The loss of High value hedgerow will have a low, adverse, not significant and short term effect on biodiversity locally". The total metres of hedgerows loss for each hedgerow type (low, moderate, high) should be advised and efforts should be made to ensure that suitable alternative hedgerows exists for fauna such as bats, to disperse by until replacement hedgerows have matured.		removed is approximately 35.6 m, with the maximum and minimum width of any section removed to be approximately 60.6 m and 13 m respectively. This is exclusive of hedgerows along the boundary of the Proposed Development Area, which will be unaffected, or hedgerows along the boundaries of fields through with the Proposed Development passes through. In this context, and the context of hedgerows of various quality and age being widespread throughout the wider landscape, the overall loss of hedgerow during the construction phase is not considered significant. All hedgerows within the Proposed Development Area were assessed for sensitive ecological receptors on multiple occasions across winter and summer surveys. All areas of hedgerow vegetation removed will be fully reinstated with an appropriate native planting.
	The mitigation measures section states "As only low vegetation and hedgerows can be planted directly above the proposed pipeline, any additional mature trees that are to be replaced will be planted in the surrounds of the offtake location. A landscape plan will be prepared by a suitably qualified landscape architect showing the location of the proposed compensatory planting around the proposed offtake location. All replacement planting will be of native stock and of local provenance for the promotion of biodiversity." The permanent loss of all mature trees within pipeline crossings is not adequately described or assessed earlier in the document. As the trees onsite will be permanently lost a thorough assessment of the number and type and quality of trees is requested.	Observation	Further review into the permanent loss of mature trees along the pipeline route was carried out in consultation with the project arborist. 255 trees of the 1,012 trees identified by Arbtech Ireland within the Proposed Development Area are anticipated for removal to facilitate the Proposed Development. The Arboricultural Report outlining details in relation to the tree survey, tree protection/removal plans, specific trees surveyed within the Proposed Development Area and mitigation measures are included in Volume III of the EIAR. Thus, the number, type, and quality of trees has been comprehensively addressed as provided in Appendix 11.2 of the EIAR, and the Biodiversity Chapter of the EIAR assesses the impact of the proposed development on habitat, including hedgerows and treelines.
	Bats avoid gaps of greater than 5 -10 m in hedgerows and treelines (Managing-Hedgerows-for-Bats.pdf). Where substantial treelines that provide good ecological corridors are crossed (such as at Chainage 800 in Kilwarden when a mature treeline links Hevey Bog to lands south of the R161), consideration should be given to trenchless techniques to avoid impacts to mature treelines.	Observation	<u>Engineering</u> The proposed pipeline route and construction methodology have been developed to minimise impacts on existing vegetation and ecological corridors where practicable. Where hedgerow or treeline crossings are required, vegetation removal will be limited to the minimum necessary and reinstatement will be undertaken following completion of the works. Trenchless construction techniques will be considered where justified having regard to site-specific environmental and engineering constraints; however, it is not considered proportionate to require trenchless techniques at all mature treeline crossings. <u>Ecology</u> Hedgerows provide important linear features for foraging and commuting by bats. A literature review and evidence-based field study on the effects of high voltage transmission lines on bats in Ireland by RPS on behalf of Eirgrid (2015) investigated the impact of hedgerow and tree removal on bat behaviour. Results from this study found no significant reduction in <i>Pipistrelle spp.</i>, <i>Myotis spp.</i>, or Leisler's bat avoiding hedgerow gaps >10m and hedgerows without gaps. Although referenced studies found sensitivity to open space in hedgerows as little as 5m by lesser horseshoe bat (<i>Rhinolophus hipposideros</i>), this species was not identified within or in the vicinity of the Proposed Development Study Area by survey effort or desktop reviews. Referenced literature in this review found common pipistrelle and soprano pipistrelle foraging and commuting across gaps in hedgerows up to 35 m in length. As Daubenton's bat forages primarily along watercourses and brown long-eared prefer woodland habitat generally, they would not likely be significantly affected by the removal of hedgerow sections. The length of hedgerow sections removed vary from approximately 13 m to 60.6 m, averaging at approximately 35.6 m. Considering 62 of the 106 hedgerows sections to be removed are 35 m or less in length and are evenly distributed along the Proposed Development area, the planned reinstatement of all removed hedgerow sections, in addition to the numerous waterbodies and road to be maintained due to HDD

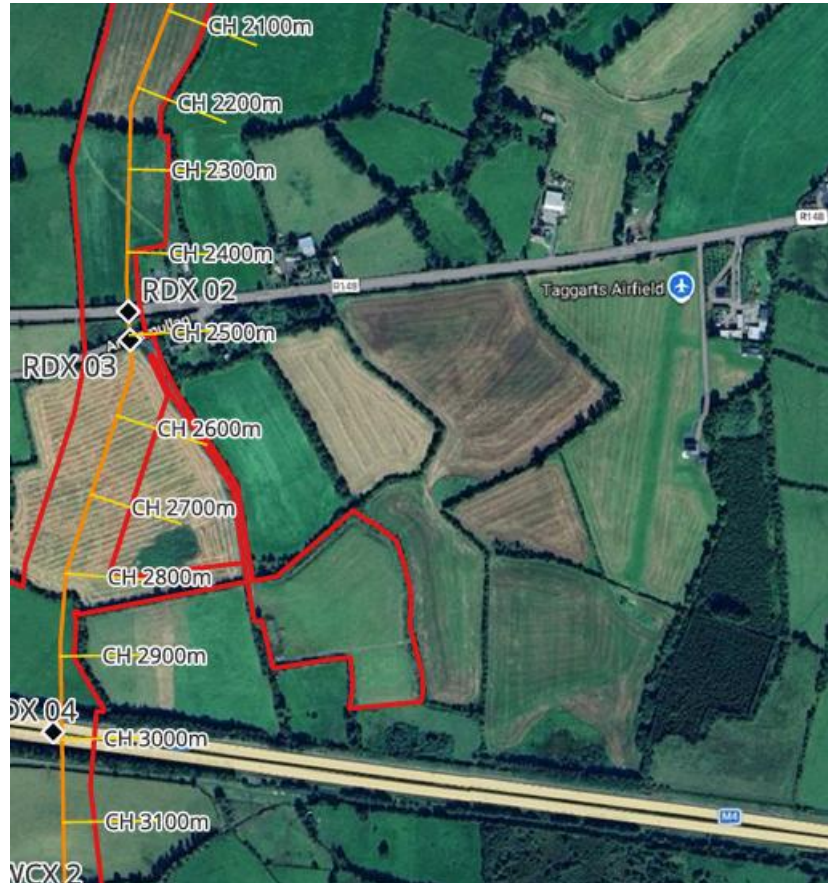
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			crossing (maintaining intact linear habitats within and immediately adjacent), even in the absence of mitigation, potential negative effects during construction on bat foraging and commuting corridors are considered <i>low, adverse, not-significant, and medium-term</i> . However with the employment of the appropriate mitigation measures regarding bats and bat habitat as outlined in Chapter 7 of the EIAR, any residual effects of the operational phase of the Proposed Development on bats at a local level are anticipated to be <i>negligible-adverse, neutral, imperceptible</i> and <i>long-term</i> .
	10 trees with confirmed bat roosts and 3 additional trees with potential for bat roosts are scheduled for removal and a further 23 bat roosts have not yet been surveyed. In accordance Guidance on the Strict Protection of Certain Animal and Plant Species under the Habitats Directive in Ireland (NPWS, 2021), ecological surveys and Application for Regulation 54 Derogation Licence is required for the removal of these roosts and this licence should be obtained prior to consent in accordance with relevant case law (EUR-Lex - 62020CJ0463 - EN - EUR-Lex).	Observation	It is not correct that 23 'bat roosts' have not been surveyed. No trees with confirmed bat roosts are going to be removed as part of the proposed development. The submitted EIAR (Appendix 7.2 Bat Impact Assessment) outlined that 23 additional trees with bat roost potential (not confirmed bat roosts) were identified within the red line boundary of the proposed development that had not yet been assessed for emergent/re-entry surveys due to only being identified in early 2026 as a result of storm damage / natural decay. Only 3 of those 23 trees are actually proposed for removal. Supplementary emergence surveys were carried out in August 2026 of the three additional trees identified as having bat roosting potential and proposed to be removed to facilitate the Proposed Development. No active bat roosts were identified in these (or any) trees of bat roosting potential scheduled for removal. A derogation license from NPWS is therefore not required at this time. Therefore, the assessment and conclusions of the submitted EIAR are unchanged in relation to bats.
	The EIAR states "A common orchid (<i>Dactylorhiza fuchsii</i>) coterie (approximately 15 specimens) was noted on within this habitat on a roadside under a mature tree line at chainage 846m" within an area of Dry Meadow and Grassy Verge. Species rich meadows and grasslands have become increasingly rare in Ireland. Section 7.6.1.2 later states "Due to the location of the common orchids within the Proposed Development site, there is the potential for this species to be lost within the works area during topsoil removal, trenching and vehicular movements."	Observation	A coterie of common orchids (<i>Dactylorhiza fuchsii</i>) was recorded adjacent to chainage 846 m in 2025, and two additional coterie of the same species identified within scrub habitat in Bord na Móna lands at chainage 23,200 m (approximately 32 specimens) and within recolonising bare ground habitat at O'Grady's Option 2 compound location (approximately 17 specimens) in 2026. This species is not protected under the Flora Protection Order (2022), is designated as 'Least Concern' in Ireland's Red List of Irish Vascular Plants (2016), and the habitats in which orchids have been identified are either managed (regularly mown roadside verge, chainage 846m) or transitional (exposed gravel, developing scrub). Taking this species into account individually as an ecological receptor, since records of this species exist throughout the island of Ireland, and that these specific coterie are considered of local importance (lower) this species is not considered to be a Key Ecological Receptor. However, due to the fact that affected individual coterie can be definitively considered of site (higher) importance, out of an abundance of caution, mitigation measures in relation to common orchid (<i>Dactylorhiza fuchsii</i>) previously outlined remain valid. Mitigation measures have been included, out of abundance of caution, due to the potential site (high) significance of these coterie. They do not meet the threshold for inclusion as a Key Ecological Receptor, and so mitigation measures are not a strict requirement under EIAR guidelines. In relation specifically to the coterie at chainage 846m, it should be specified that the risks to this coterie from the stated activities relates specifically to both dust arising from those activities, and direct impacts from the potential for person/vehicular movements outside of the working width, within which this coterie will not be included due to HDD crossing methods used. In relation to the additional coterie found in 2026, mitigation should be implemented in the form of marking (marker flags), separation (fencing, signage etc.) and avoidance where feasible, overseen by a suitably qualified botanist. The location and distribution of these specimens is likely to change over time, and so specific measures cannot be determined at this time until pre-construction surveys determine the exact extent and distribution of these species prior to construction.
	This habitat and rare species should be considered Key Ecological Receptor and their avoidance stated within key documents such as CEMP and mitigation measures of the EIAR in accordance with the CIEEM hierarchy of mitigation (2018) and in accordance with the Policies and Objectives of the Meath County Development Plan.	Observation	
	Mitigation measures for common orchid state "The following mitigation will be applied only if it does not impact on the ability to establish a function working width to facilitate the Proposed Development". It is considered that alternative mitigation measures should be outlined to be utilised if this method will be ineffective. Alternative mitigation measures may include the saving of this habitat in turves and careful	Observation	A coterie of common orchids (<i>Dactylorhiza fuchsii</i>) was recorded adjacent to chainage 846 m, within scrub habitat in Bord na Móna lands at chainage 23,200 m (approximately 32 specimens) and within recolonising bare ground habitat at O'Grady's Option 2 compound location (approximately 17 specimens). This species is not protected under the Flora Protection Order (2022) and is designated as least concern in Ireland's Red List of Irish Vascular Plants (2016). As this species is widespread throughout the island of Ireland, and that the potentially affected individuals would be considered to be of local (lower) importance, this species is not considered to be a Key Ecological Receptor. However, due to the fact that affected individuals are potentially of site (higher) importance, out of an abundance of caution, mitigation measures in relation to common orchid (<i>Dactylorhiza fuchsii</i>) were outlined and remain valid.

Submitter	Point Raised	Type	Proposed Response / Input Required
	reinstatement under the care of an ecologist post works or minor alteration of the pipe alignment to avoid rare habitat/ rare plant species.		
	Table 7-6 states of the EIAR states that the rare blue fleabane plant (previously protected in Ireland now only protected in NI) was identified within Bord na Móna grounds but did not classify either as a Key Ecological Receptor. This habitat and rare species should be considered Key Ecological Receptor and their avoidance stated within key documents such as CEMP and mitigation measures of the EIAR in accordance with the CIEEM hierarchy of mitigation (2018) and in accordance with the Policies and Objectives of the Meath County Development Plan.	Observation	In respect of Blue Fleabane, this species persists in the same location as recorded in 2025. However, it's distribution was noted to extend beyond the Proposed Development area within the Bord na Móna lands. This population of blue fleabane is therefore not considered to be fully dependant on the area of proposed works and it's immediate ZoI. A review of the status of blue fleabane in Ireland's Red List of Irish Vascular Plants (2016) and The Irish Red Data Book (1988) reveals that although the species was historically classified as 'Vulnerable' and predicted to move into the 'Endangered' category in the Republic of Ireland, its current status is considered of 'Least Concern'. Taking this species into account as an ecological receptor, considering this population of fleabane is not considered to be fully dependant on the area of proposed works at a site level, that NBDC records show this species to be present in locations across the midlands region, and that the potentially affected population can only be considered of local importance (lower) at most, this species is not considered to be a Key Ecological Receptor. However, due to the fact that affected individuals are potentially of site (higher) importance, out of an abundance of caution, mitigation measures in relation to blue fleabane were outlined and remain valid.
	Section 7.6.1.2 later states "In the absence of mitigation, it is highly likely that blue fleabane will be lost within the immediate vicinity of the works area as a result of vegetation removal, trenching and vehicular movements during the proposed works."	Observation	This statement remains valid.
	Mitigation measures for blue fleabane rely on seed saving. In this regard, the applicant could also be requested to avoid loss or transplant turves of plants that will be lost.	Observation	Depending on the determination of the competent authority and any conditions pertaining to blue fleabane. Similar habitat exists throughout the Bord na Móna lands. Any mitigation measures relating to blue fleabane will be carried out and/or directed by a suitably qualified member of the Ecological Clerk of Works.
	Similarly, Table 7-6 states drainage ditches and canal provide suitable habitat for frogs and newts but do not identify frogs and newts as a Key Ecological Receptor. Mitigation measures to avoid impacts, particularly during breeding season should be included in key documents.	Observation	No material changes to the baseline environment in relation to amphibians have been identified since preparation of the EIAR. No changes to the Proposed Development have occurred which might alter potential effects on amphibians or assessment methodology. No amphibians were recorded during field surveys carried out across 2025 and 2026. However, out of an abundance of caution and considering the availability of suitable habitat for amphibians which may be impacted by the Proposed Development via open-cut crossings and surface water run-off, amphibians have been reconsidered as an ecological receptor. Common frog (<i>Rana temporaria</i>) and smooth newt (<i>Lissotriton vulgaris</i>) are found in wet habitats across the island of Ireland, as demonstrated in NBDC database records. Drainage ditches are found throughout the Proposed Development area. It therefore cannot be ruled out that wet drainage ditches through which open-cut crossing methods will be employed in the construction phase of the Proposed Development will host frogs, and potentially newts, and their respective spawn, and potentially impacted by the proposed works. Common frog and smooth newt are protected under the Wildlife Acts (1976). Amphibian populations within the Proposed Development Area potentially impacted would be considered to be of local importance (lower value), due to the quantity of similarly suited habitat available in the wider landscape. Due to the potential for interaction with amphibians across their respective lifecycles during the construction phase of the Proposed Development through direct contact with drainage ditches and the potential for silt and pollution entering drainage ditches via surface water run-off, out of an abundance of caution, we revise the status of amphibians to a Key Ecological Receptor. In the absence of mitigation measures, potential negative effects on amphibians at a local level are assessed as being low, adverse, not significant, and short-term. However due to their protected status, mitigation measures are required.

Submitter	Point Raised	Type	Proposed Response / Input Required
			No impacts on amphibians during the operational phase of the Proposed Development are foreseen due to the planned reinstatement of baseline habitats following construction, and passive nature of the Proposed Development during operation. Additional mitigation measures relating to amphibians during the construction phase of the proposed development are as follows: • A preconstruction survey for amphibians will be carried out prior to construction activities taking place in any ditch, watercourse or water-holding feature. • Should amphibians, at any life stage (including spawn), be recorded within or immediately adjacent to the sections of waterbody where works are proposed, a derogation licence shall be sought from the National Parks and Wildlife Service (NPWS) prior to the commencement of works. No works shall proceed within the affected area until such licence has been granted. Following implementation of all previous mitigation measures outlined within the EIAR, particularly in relation to compliance with the Water Pollution Acts and in respect of aquatic biodiversity in their current form, in addition to the above mitigation measures, any residual effects of the Proposed Development on amphibians at a local level are anticipated to be negligible-adverse, neutral, not significant and short-term. A derogation license with NPWS is not required at this time.
	The applicant is requested to demonstrate sightlines from the proposed entrances of both the Kilwarden and Ardnamullen compounds of 90 metres to the nearside edge of the road from a setback of 2.4 metres, in accordance with TII document DN-GEO-03060. The nearside road edge shall be visible over the entire sight distance. Where works are required to provide unobstructed sightlines, they shall be identified in a revised site layout and included within the red line boundary. Where works are required in third party lands, written consent from the landowner shall be submitted.	Request for Information	The accesses referred to are understood to comprise the existing access serving the proposed Kilwarden Offtake Installation and Temporary Construction Compound 1 location, and the existing access serving Temporary Construction Compound 2 location at Ardnamullen. Both accesses are existing entrances, and no new permanent road access is proposed as part of the development. The proposed use of these accesses has been considered having regard to their existing nature, the anticipated frequency and duration of use, and the traffic management measures to be implemented during construction. The permanent Kilwarden Offtake Installation will be subject to very infrequent operational access following construction, anticipated to be approximately one light vehicle visit per month for inspection and maintenance purposes. This represents a very low level of traffic generation and is substantially below that typically associated with residential, agricultural or commercial accesses. Use of the accesses associated with Temporary Construction Compounds 1 and 2 will be limited to the construction period. Construction traffic movements will be managed through the Construction Traffic Management Plan (CTMP), with appropriate traffic management measures implemented having regard to the nature and frequency of construction traffic and prevailing road conditions. Such measures will include, as appropriate: • advance warning signage on the approaches to the access; • temporary traffic management signage and controls; • use of trained flagmen/banksman to manage HGV movements into and out of the compounds; • temporary stop/go arrangements or traffic signals where required; • coordination and scheduling of HGV deliveries to avoid conflicting vehicle movements; • controlled entry and exit of oversized or abnormal loads; and • maintenance of visibility at the existing accesses through appropriate management of vegetation within the applicant's control. The detailed traffic management arrangements will be developed prior to commencement of construction and agreed with Meath County Council through the CTMP and associated road permitting/traffic management processes. Having regard to the existing nature of the accesses, the very low level of permanent operational traffic associated with the Kilwarden Offtake Installation, and the temporary and actively managed nature of construction traffic associated with the compounds, it is considered that alteration of the existing entrances or acquisition of third-party lands to provide 90 m sightlines is not warranted or proportionate.

Appendix 3 - Aviation Safeguarding Response Document

Aviation Safeguarding Report



Taggart Airfield

30 Aug 2026

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Acronyms

Acronym	Title
'	feet
AIP	Aeronautical Information Publication
AMSL	Above Mean Sea Level
AS	Approach Surface
EASA	European union Aviation Safety Agency
IAA	Irish Aviation Authority
ICAO	International Civil Aviation Organisation
IFR	Instrument Flight Rules
IHS	Inner Horizontal Surface
LPA	Local Planning Authority
M	metres
OHS	Outer Horizontal Surface
OLS	Obstacle Limitation Surfaces
RA	Rose Aviation
TA	Taggart's Airfield
TOCS	Take Off Climb Surface
VFR	Visual Flight Rules

Introduction

1. The management of AWN consulting along with their client Gas Networks Ireland contracted Rose Aviation (RA) to act as their aviation consultant to carry out a safeguarding analysis concerning the impact their construction project in Ardnamullen Co Meath, will have on aviation operations at Taggarts Airfield (TA).
2. The proposed development consists of the construction, commissioning, and operation of a c. 23.65-kilometre (km), underground gas transmission pipeline (the GNI 143 Ballykilleen Pipeline). The proposed development also includes associated ancillary fibre ducting, new offtake installation comprising a hot tap tie in location (the Kilwarden Offtake Installation) located in the townland of Kilwarden, Co. Meath, and new Above Ground Installation (the Ballykilleen AGI) located in the Edenderry Renewable Energy Complex located in Kilcumber, Co. Offaly. The most relevant sections of the development are to the North and West of TA as this is the closest section of the development to TA.

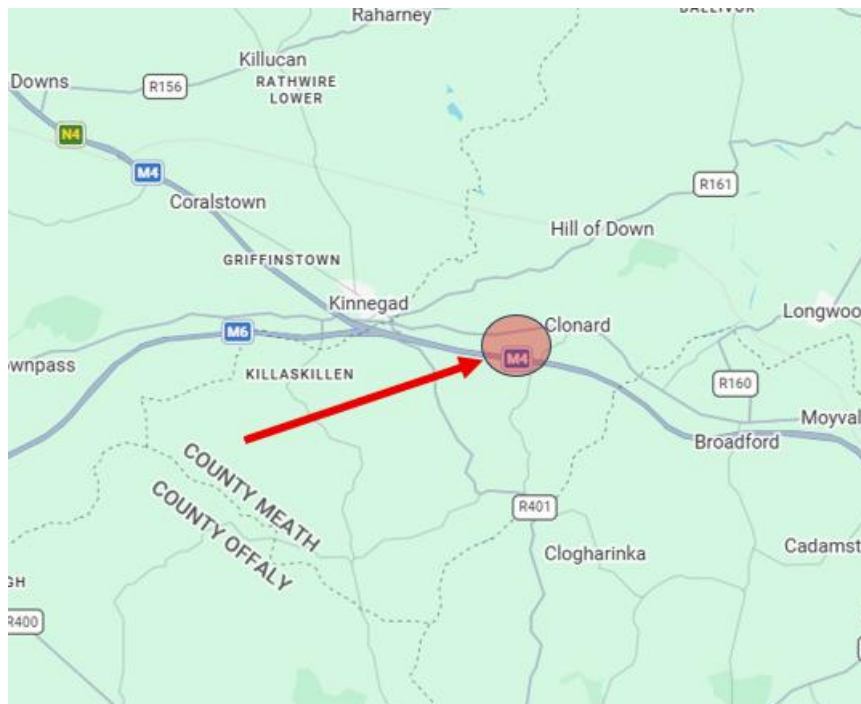


Figure 1 Location of proposed construction project and TA

3. Safeguarding is the process by which the Aerodrome Operator can protect the environment surrounding an aerodrome from developments and activities that have the potential to impact on the aerodrome's safe operation.
4. All drawings shown here are for demonstrative purposes based on explicit mathematical calculations. TA is an unlicensed private airstrip and holds no ICAO location indicator. It is not published in the Irish Aeronautical Information Publication (AIP Ireland), and accordingly no official aerodrome data, aerodrome reference point coordinates, elevation, runway dimensions or declared distances, is promulgated for the site.

5. The positional data used in this assessment have therefore been derived from third party sources such as Google Earth and LIDAR. These are deemed acceptable for Obstacle Limitation Surfaces (OLS) calculations of this nature.

6. The European union Aviation Safety Agency (EASA) under EU Regulation no 139/2014 state that:

“Member States shall ensure that consultations are conducted with regard to safety impacts of constructions proposed to be built within the limits of the obstacle limitation and protection surfaces as well as other surfaces associated with the aerodrome.”

7. They also state:

Member States shall ensure that consultations are conducted with regard to human activities and land use such as:

- any development or change in land use in the aerodrome area;
- any development which may create obstacle-induced turbulence that could be hazardous to aircraft operations;
- the use of hazardous, confusing and misleading lights;
- the use of highly reflective surfaces which may cause dazzling;
- the creation of areas that might encourage wildlife activity harmful to aircraft operations;
- sources of non-visible radiation or the presence of moving or fixed objects which may interfere with, or adversely affect, the performance of aeronautical communications, navigation and surveillance systems.

TA

8. There is one runway at TA that needs to be assessed regarding the impact of construction at the development. The true bearing of the runway is 009.73°. The magnetic declination is -1°29'. As such the runway can be said to be aligned as 01/29. RA will examine the OLS for this runway to determine if the proposed construction will penetrate these surfaces.



Figure 2 Layout of runway at TA

9. The runway is a grass surface runway with a maximum length of circa 406m(metres) long. It caters exclusively for Visual Flight Rules (VFR) aircraft traffic. There is no published VFR Chart showing the VFR reporting points for TA. There are no navigational aids at TA. The runway slopes gradually upward from North to South. The Northern threshold is at 70.63m (232ft) Above Mean Sea Level (AMSL) while the Southern is at 72.57m (238ft) AMSL. For calculations, the elevation of 232' will be used as this is more constrictive.

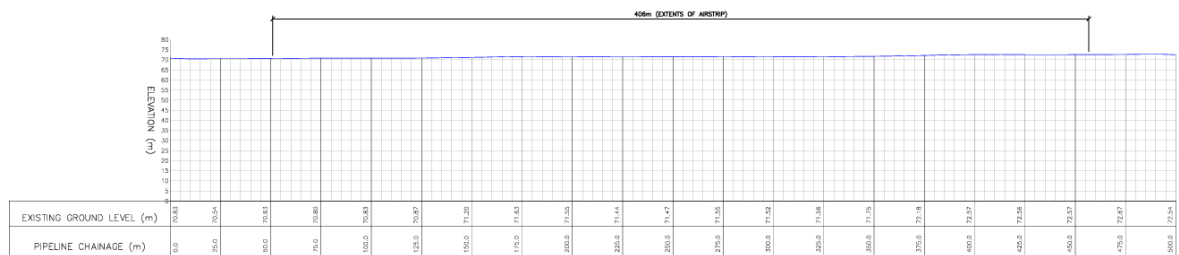


Figure 3 Ground levels at TA

10. The objectives of the specifications of ICAO Annex 14 volume 1 section 4 are to describe the airspace around aerodromes so as to permit intended aircraft operations to be conducted safely and to prevent aerodromes from becoming unusable by the growth of obstacles around them. This is achieved by establishing a series of obstacle limitation surfaces that define the limits to which objects may project into the airspace.

Obstacle Limitation Surfaces

11. There are numerous defined areas surrounding a runway that need to be kept free of obstacles. In the paragraphs below, RA have cited each of these, their explanation and the requirements for each. These are known as the OLS.

12. The closest point of the centreline of the runway to the development is the edge of the proposed temporary compound to the Southern part of the runway as shown below. This is at a distance of 273m.



Figure 4 Distance from the development to runway 22

Runway Code

13. In order to determine the OLS requirements, the first thing that must be established is the code of the runway. The TA runway is circa a maximum length of 413m which makes it a code 1 runway. The dimensions of the OLS often depend on the runway code. The runway is 12m wide.

Code number	Aeroplane reference field length
1	Less than 800 m
2	800 m up to but not including 1 200 m
3	1 200 m up to but not including 1 800 m
4	1 800 m and over

Figure 5 Runway Codes

Runway Strip

14. A runway strip is required to reduce the risk of damage to an aircraft accidentally running off the runway, to protect aircraft flying over it when taking-off or landing, and to enable safe use by rescue and firefighting (RFF) vehicles. For a code 1 runway as at TA, the strip extends 30m beyond each runway threshold and 30 m to either side from the runway centreline.
15. No fixed object, other than visual aids required for air navigation or those required for aircraft safety purposes should be permitted on a runway strip.

16. The extent of the runway strip lies entirely (laterally) within the land containing TA and as such there are no safeguarding requirement here for consideration. The image below shows the Western extent of the runway strip as well as the location of the development.



Figure 6 Location of runway strip

Transitional Surface

17. The purpose of the transitional surface is to safeguard against development between the edge of the runway, the approach surface and the Inner Horizontal Surface (IHS). No obstacles should penetrate the transitional surface.
18. The slope of the Transitional Surface is measured in the vertical plane above the horizontal, and normal to the centreline of each runway. The slope is 20% (1:5) for Code 1 and 2 non-instrument and non-precision instrument runways. For all other runways the slope is 14.3% (1:7). TA runway is a code 1 non-instrument runway and as such the 20% slope will apply here.
19. The transitional surface at TA is parallel to the runway strip and runway centreline. It runs from the edge of the strip to the bottom of the Inner Horizontal Surface (IHS) at 45m as shown in the figure below. From basic principles of trigonometry, this means the lateral distance from the edge of the strip is 225m.



Figure 7 Transitional Surface Dimensions

20. This equates to a distance of 231m from the centreline of the runway. The development does not penetrate the transitional surface as shown in the image below.



Figure 8 Transitional Surface Location from centreline

Inner Horizontal Surface (IHS)

21. The purpose of the IHS is to protect airspace for aircrafts visual manoeuvring prior to landing. The radius or outer limits of the HIS shall be measured from a reference point or points established for such purpose by using circular arcs centred on the runway ends and joined tangentially by straight lines, thus producing a racetrack pattern. The radii of the circular arcs vary with the runway code number and the type of approach and are specified in figure 8 below. For TA, the radius is 2000m as it is a code 1 non-instrument runway.

Surface and dimensions ^a (1)	Non-instrument Code number			
	1 (2)	2 (3)	3 (4)	4 (5)
CONICAL				
Slope	5%	5%	5%	5%
Height	35 m	55 m	75 m	100 m
INNER HORIZONTAL				
Height	45 m	45 m	45 m	45 m
Radius	2 000 m	2 500 m	4 000 m	4 000 m

Figure 9 Radii of IHS Threshold Arcs



Figure 10 Indicative Location of Inner Horizontal Surface

22. As can be seen from the image above showing the point abeam references of CH 2200 and 2800, the development clearly lies within the lateral extent of the IHS. To the South, the IHS extends to between CH4700 and CH4800 as shown below.



Figure 11 Southern extent of IHS

23. The height of the IHS shall be 45m (148') above the elevation datum established for that purpose. The height of the IHS is based on the lowest threshold if there is a difference between the two thresholds as is the case at TA. The agreed elevation to be used for the TA runway 232'. Therefore, the IHS shall begin at an elevation of 379ft (115.63m) AMSL. This means that any obstacle below this height will not penetrate the IHS area outside the transitional surface.
24. The various ground levels of the development are shown below. As long as no element anywhere along the project site exceeds 115.63m AMSL, then there is no penetration of the IHS. The ground levels shown below are between CH2200 and CH2800 as these are directly abeam the airfield. The highest point is at CH2400 at an altitude of 78.22m AMSL. As such as long as no element of the construction equipment exceeds 37.41m AGL, the integrity of

the IHS will be preserved. There will be no equipment above this height and as such it is evident that no section of the IHS is penetrated.

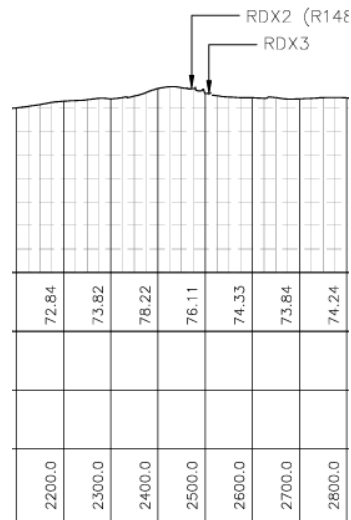


Figure 12 AMSL heights of development area close to TA

25. The closest element of the development is the proposed temporary construction compound 02 as shown below. This lies within the IHS at a closest distance of 273m (m outside the transitional surface).



Figure 13 Location of compound 02

26. This field containing the compound varies in altitude AMSL from circa 68-71m. If we take the higher value of 71 (as this is more constrictive), this will mean that the highest level of the compound will be 1.57m above the nearest threshold of the runway. However, we will take as being the same height as this is more constrictive.
27. As such, it can be seen that the proposed compound will be compliant with the IHS requirements as long as the height of any element of the compound or equipment

contained therein is less than 45m Above Ground Level (AGL). If this height is adhered to, then the development does not penetrate the IHS OLS.

28. There are also two permanent above ground locations at either end of the pipeline project; One at Kilwarden and the other at BallyKileen. The one at Ballykileen does not concern us as it is considerably lower than TA and is over 17km to the South. The one at Kilwarden is located 1950m to the North of TA.



Figure 14 Location of Kilwarden Offtake

29. At Kilwarden the ground level is at 70.13m AMSL and the security fence, which is the highest part of the Offtake development is at 72.53m AMSL. The limit of the IHS is 115.63 a height of 43.1m above the highest point of the Kilwarden Offtake. There is no conflict with the IHS.

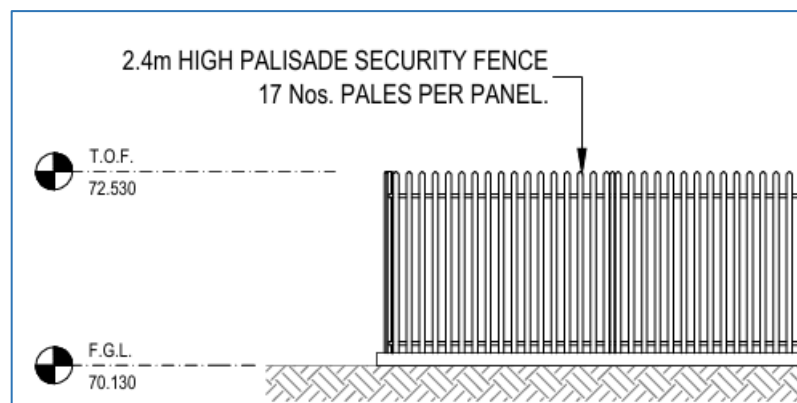


Figure 15 Altitude of Kilwarden Offtake

30. There are also 4 crossing points where the development infrastructure has to cross certain geographical features. These are:

- a. Kilwarden River Crossing (RVX01) Ground level 68.2m AMSL at CH1200 (inside IHS).
 - b. M4 Motorway Crossing (RVX04) Ground level 71.02m AMSL at CH3000 (inside IHS).
 - c. Yellow River Crossing (RVX02) Ground level 65.36m AMSL at CH11400 (5530m outside IHS).
 - d. Grand Canal Crossing (WCX23) Ground level 77.84 at CH18100 (10970m outside IHS).
31. For the Kilwarden River crossing, no element of the development permanent features or temporary features used during construction can pass above 115.63m AMSL or 47.43m AGL.
 32. For the M4 motorway crossing, no element of the development permanent features or temporary features used during construction can pass above 115.63m AMSL or 44.61m AGL.
 33. For the crossings at Yellow River and the Grand Canal, there is no height restriction as these are considerable distances outside the OLS at TA.

Conical Surface

34. The purpose of the conical surface is to facilitate safe visual manoeuvring in the vicinity of the aerodrome. The conical surface slopes upwards and outwards from the periphery of the IHS for 35m as the runway is a code 1 non- instrument runway as previously detailed.
35. The slope of the conical surface is measured in the vertical plane above the IHS, and normal to the centreline of each runway. The slope is 5% for all runways regardless of code or types of approach. Its height is 35m for the runway at TA.

Surface and dimensions ^a (1)	Non-instrument Code number			
	1 (2)	2 (3)	3 (4)	4 (5)
CONICAL				
Slope	5%	5%	5%	5%
Height	35 m	55 m	75 m	100 m

Figure 16 Conical surface dimensions

36. From basic principles of trigonometry, the lateral distance from the edge of the IHS is 700m.

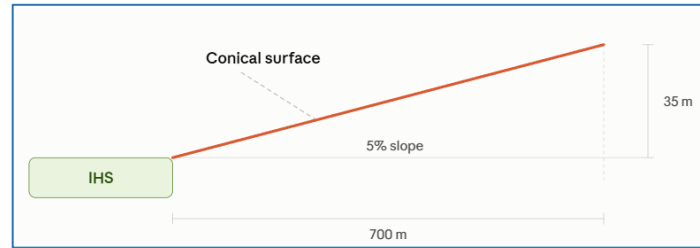


Figure 17 Dimensions of conical surface

37. The highest ground level of the entire project is at CH 5300 which is at 79.67m AMSL. This is located 2400m from the Southern end of TA and is within the lateral extent of the conical surface.



Figure 18 Location of highest ground level of the development

38. At a distance of 400m from the IHS, the conical surface rise to 20m above the level of the IHS. This is a height of 135.63m. Therefore, as long as no element of the equipment used for the development is above 55.96m (Height allowed – ground level or $135.63 - 79.67 = 55.96$ please), then the conical zone will not be penetrated at the highest section of the development area. There will be no equipment above this height and as such it is evident that no section of the conical surface is penetrated.

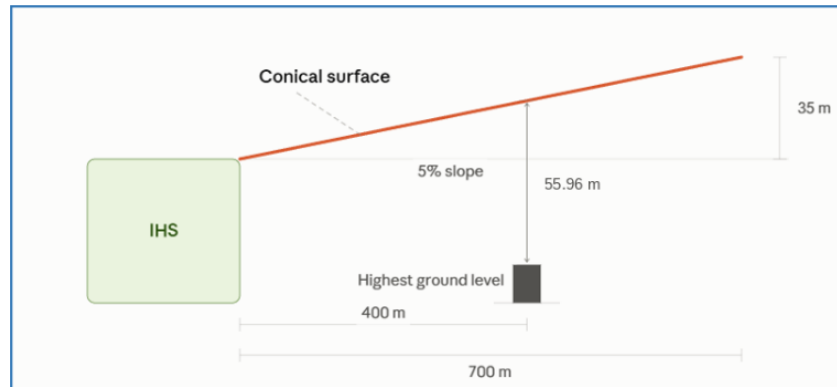


Figure 19 Clearance below conical surface

- 39. To
- 40.
- 41. efc

Outer Horizontal Surface (OHS)

- 42. The OHS extends outwards from the conical surface. This does not have to be evaluated as it is evident that the development is closer to the TA runway than the nearest element of the OHS.

Approach Surface (AS)

- 43. An approach surface is an inclined plane or combination of planes preceding the threshold and is established for each runway direction intended to be used for the landing of aircraft.

APPROACH	
Length of inner edge	60 m
Distance from threshold	30 m
Divergence (each side)	10%
First section	
Length	1 600 m
Slope	5%
Second section	
Length	—
Slope	—

Figure 20 Approach surface requirements

44. The AS consists of an inner edge. For TA this edge is perpendicular to the centreline of the runway located at a distance of 30 m before the landing threshold. The inner edge is 60m long for TA. There are two sides originating at the ends of the inner edge and diverging uniformly at a rate of 10% from a line drawn parallel to the extended centreline of the runway.
45. For larger runways there is a first and second sections of the AS. However, the AS consists of a first section only for TA. This first section slopes upward at 5% to a distance of 1600m. No obstacle can penetrate the AS. Any obstacles that are proposed within the area of the AS will need to be examined to see if they penetrate the AS.
46. The coordinates of the AS for the Southern threshold area are shown below.

Point	Latitude	Longitude
Inner edge (left)	53°26'45.90"N	007°02'54.63"W
Inner edge (right)	53°26'46.27"N	007°02'57.83"W
Outer edge (left)	53°25'54.11"N	007°03'02.66"W
Outer edge (right)	53°25'56.46"N	007°03'22.87"W

Figure 21 Coordinates of AS Southern threshold



Figure 22 AS graphic Southern runway

47. From the representation of the TA runway AS above, it is obvious that the development does not penetrate the AS for the Southern threshold.

48. The coordinates of the AS for the Northern threshold area are shown below.

Point	Latitude	Longitude
Inner edge (left)	53°27'00.72"N	007°02'53.53"W
Inner edge (right)	53°27'00.34"N	007°02'50.33"W
Outer edge (left)	53°27'52.51"N	007°02'45.49"W
Outer edge (right)	53°27'50.16"N	007°02'25.27"W

Figure 23 Coordinates of Northern AS

49. From the representation of the TA Northern runway AS below, it is obvious that the development does not penetrate the AS for the Northern threshold.



Figure 24 Approach surface Northern runway

Take Off Climb Surface (TOCS)

50. A TOCS is an inclined plane located beyond the end of the take-off run available and is established for each runway direction intended to be used for take-off.
51. The TOCS consists of a horizontal inner edge. For TA this edge is perpendicular to the centreline of the runway located at a distance of 30 m beyond the runway end in the direction of take-off. The inner edge is 60m long for TA. There are two sides originating at the ends of the inner edge and diverging uniformly at a rate of 10% from a line drawn parallel to the extended centreline of the runway.

RUNWAYS MEANT FOR TAKE-OFF			
Surface and dimensions ^a (1)	Code number		
	1 (2)	2 (3)	3 or 4 (4)
TAKE-OFF CLIMB			
Length of inner edge	60 m	80 m	180 m
Distance from runway end ^b	30 m	60 m	60 m
Divergence (each side)	10%	10%	12.5%
Final width	380 m	580 m	1 200 m 1 800 m ^c
Length	1 600 m	2 500 m	15 000 m
Slope	5%	4%	2% ^d

Figure 25 TOCS requirements

52. The diverging lines continue until a width of 380m is achieved. This width occurs at a distance of 1600m from the inner edge of the TOCS. The slope for the TOCS is 5% for a code 1 runway. No obstacle can penetrate the TOCS. Any obstacles that is proposed within the area of the TOCS will need to be examined to see if it penetrates the TOCS.
53. For TA, both ends of the runway can be used for take-off and landing. As the Approach Surface covers the same area with the same lateral criteria as the Take Off Climb Surface, there is no need to map out the dimensions of the TOCS as it is quite apparent that the development construction does not penetrate the TOCS for either threshold.

Conclusions

54. The objective of this report is to investigate the impact that the new construction project at the development, might have on aviation at Taggart's Airfield in Co Meath. Specifically, Rose Aviation were tasked with investigating whether or not any element of the proposed construction will penetrate any of the obstacle limitation surfaces associated with the runways at TA.
55. As detailed in this report, RA have explicitly demonstrated that the proposed structures will not penetrate any OLS at TA providing that no element of the construction equipment is expected to exceed the limitation surfaces as outlined in this report either during construction, when construction is completed or when stored in the temporary compounds. Should a temporary exceedance be required during construction, within the OLS as outlined in this report, the procedure outlined in Appendix 1 shall apply.
56. RA conclude that the proposed construction will have no impact on aviation safety or efficiency in this regard. This applies to the areas within the TA OLS and all areas further from TA outside these areas also.



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Appendix 1 Safety Protocol

CRANEHIGH EQUIPMENT NOTIFICATION

Taggart Airfield (TA)

1. Purpose

This procedure sets out how personnel working beside TA will warn TA if a crane or other element of their construction equipment has to temporarily penetrate any OLS for TA and the actions they must take. Its purpose is to prevent flight path restrictions for the aircraft and to keep the working area safe for workers.

2. Responsibilities

- **Works Supervisor:** If they become aware that a mobile crane must temporarily penetrate any OLS at TA, they are to contact TA immediately and provide details of the penetrating object including:
 - Date and time penetration is due to commence
 - Duration that the OLS will be penetrated
 - Location of crane
 - Height of crane
- **TA :** TA management may then warn airfield users of the obstacles presence if appropriate

3. Notification

When a temporary obstacle is in place the works supervisor must confirm same with the owners of TA.

4. Actions on notification

The owners of TA may warn users of their airfield of the location and height of the temporary obstacle.

6. Confirming the area is clear

The work supervisor will again contact the owners of TA when the temporary obstacle is no longer penetrating the OLS.

Location:	Edenderry Gas Pipeline near Taggart Airfield
Temporary obstacle location:	
Distance from runway threshold	
Commencement date/time at site	
Expected finish date at site	
LAT / LONG of Crane	
Crane or obstacle Height	
Crane or obstacle Colour	
Is there a light on top of crane	
What Colour is light	
Strobe light or permanently on	
Is crane left erected overnight or when work is not in progress	

Appendix 4 - Fingleton White Response Cover Letter and Preliminary Crossing Design Reports

8 September 2026

An Coimisiún Pleanála,
64 Marlborough Street,
Dublin 1, D01 V902

RE: Response to submission for case ACP-324280-26 – Technical Matters

Dear Sir/Madam,

We refer to the observations and submissions received by An Coimisiún Pleanála in respect of the above application Case Ref. ACP-324280-26.

On behalf of the Applicant, Fingleton White has prepared responses to the technical matters raised in the observations and submissions received. Matters outside Fingleton Whites scope are addressed separately by the Applicant and the wider project team. Where relevant, cross-references to those responses are provided.

The response document addresses these matters individually and provides clarification, supporting information and further detail, where appropriate, having regard to the documentation already submitted as part of the planning application.

The following supporting documents are also enclosed and should be read in conjunction with the Applicant's response:

- MJS-FW-GBNME-REP-002 - Kilwarden River Crossing - Preliminary Crossing Design Report
- MJS-FW-GBNME-REP-004 - M4 Motorway Crossing - Preliminary Crossing Design Report
- MJS-FW-GBNME-REP-006 - Yellow River Crossing - Preliminary Crossing Design Report
- MJS-FW-GBNME-REP-008 - Grand Canal Crossing - Preliminary Crossing Design Report
- MJS-FW-GBNME-DWG-001 - Kilwarden River Crossing - Preliminary Crossing Drawing
- MJS-FW-GBNME-DWG-002 - M4 Motorway Crossing - Preliminary Crossing Drawing
- MJS-FW-GBNME-DWG-003 - Yellow River Crossing - Preliminary Crossing Drawing
- MJS-FW-GBNME-DWG-004 - Grand Canal Crossing - Preliminary Crossing Drawing

We trust that the enclosed response and supporting documentation assist An Coimisiún Pleanála in its consideration of the application.

Yours faithfully,

A handwritten signature in black ink, appearing to read 'James'.

James Conroy
Senior Design Engineer
Fingleton White

 	Kilwarden River Crossing – Preliminary Crossing Design Report	MJS PROJECT SERVICES 
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<i>Project:</i>	Gas to Bord na Mona, Edenderry
<i>Main Client:</i>	Gas Networks Ireland
<i>MJS Client:</i>	Fingleton White
<i>Location:</i>	Ireland

<i>MJS Project No.:</i>	2525
<i>Client Project No.:</i>	1718
<i>Document Title:</i>	Kilwarden River Crossing – Preliminary Crossing Design Report
<i>Document No:</i>	MJS-FW-GBNME-REP-002
<i>Document Type:</i>	Report

Kilwarden River Crossing – Preliminary Crossing Design Report

C	26 Aug 26	Issued for Information	DM	MS	MS	-
B	03 Dec 25	Issued for Information	DM	MS	MS	-
A	21 Nov 25	Issued for Review	DM	MS	MS	-
<i>Revision</i>	<i>Date</i>	<i>Description</i>	<i>Originator</i>	<i>Review</i>	<i>Approved</i>	<i>Client</i>

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1 Introduction

1.1 Project Description

Bord na Móna (BnM) are planning to convert the existing diesel generation peaking plant at the Edenderry Power Station to run on natural gas in an effort to reduce CO₂ emissions. A new 12" Outside Diameter (OD) high pressure gas pipeline is required to be installed between the existing gas transmission network and the power station in order to supply natural gas for the gas turbines. The new GNI143 Ballykilleen Pipeline will be approximately 23km in length between the proposed hot tap location (14301 Kilwarden Offtake Installation) on the existing GNI BGE/77 Pipeline to the West (PTTW) pipeline and an Above Ground Installation (AGI) facility within the BnM Renewable Energy Complex at Edenderry.

A number of special crossings of existing infrastructure and natural features will be required on the new pipeline route. The 4 No. main crossings identified are:

1. Kilwarden River (RVX1)
2. M4 Motorway (RDX4)
3. Yellow River (RVX2)
4. Grand Canal (WCX23)

1.2 Summary of Scope and Document Purpose

Fingleton White (FW) have been engaged by GNI to produce the design for the new gas supply pipeline between the existing high pressure gas transmission network and the AGI facility at Edenderry power station. MJS Project Services (MJS) have been engaged by Fingleton White to produce preliminary crossing designs for several trenchless crossings of existing infrastructure and natural features on the new pipeline route.

The purpose of this document is to provide a narrative to support the preliminary design of a HDD crossing of the Kilwarden River (RVX1) and to provide a summary of the associated design checks that have been performed. The Kilwarden River Crossing is currently in the planning phase. Therefore, the proposed crossing design should be considered as preliminary and potentially subject to change and further development during the detailed design and construction phases. The preliminary HDD crossing design is based on current HDD industry guidelines and best practices (Section 1.3) and takes into consideration site-specific conditions and constraints.

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1.3 References

Ref:	Document Number	Document Title
1	MJS-FW-GBNME-DWG-001	Kilwarden River Crossing – Preliminary Crossing Drawing
2	25882 – Gas to Bord na Móna, Edenderry – Phase 1 GI – HCC3 – Geotechnical Interpretive Report – Rev 2 (IGSL)	
3	DNV-ST-F121	Pipeline Installation Using Horizontal Directional Drilling (DNV)
4	NASTT's Horizontal Directional Drilling (HDD) Good Practice Guidelines (NASTT)	
5	Information and Recommendations for the Planning, Construction and Documentation of HDD Projects – DCA Technical Guidelines (DCA)	
6	Settlement above Tunnels in the United Kingdom – Their Magnitude and Prediction (O'Reilly and New)	

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1.4 Abbreviations / Acronyms

Term	Meaning
3LPE	3-Layer Polyethylene
3LPP	3-Layer Polypropylene
AGI	Above Ground Installation
AOD	Above Ordnance Datum
BGL	Below Ground Level
BH	Borehole
BnM	Bord na Móna
CO ₂	Carbon Dioxide
DCA	Drilling Contractors Association
DN	Diameter Nominal
DNV	Det Norske Veritas
FW	Fingleton White
GIR	Geotechnical Interpretive Report
GNI	Gas Networks Ireland
GSI	Geological Survey Ireland
HDD	Horizontal Directional Drilling
ID	Internal Diameter
IFI	Inland Fisheries Ireland
LCM	Loss Control Measures
MJS	MJS Project Services
NASTT	North American Society for Trenchless Technology
OD	Outside Diameter
PLSI	Point Load Strength Index
PTTW	Pipeline to the West
RC	Rotary Core
RVX	River Crossing
SPT	Standard Penetration Test
TWA	Temporary Working Area
WT	Wall Thickness

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2 Pipeline Details

Details of the proposed route of the new gas pipeline (GNI143 Ballykilleen Pipeline) between the proposed offtake location (14301 Kilwarden Offtake Installation) on the existing GNI BGE/77 Pipeline to the West (PTTW) pipeline and an Above Ground Installation (AGI) facility within the BnM Renewable Energy Complex at Edenderry have been provided for the purpose of preliminary crossing design. The Kilwarden River Crossing is located between Ch1100.0 and Ch1400.0 (Approx.) on the proposed pipeline route.

The new gas pipeline will be a 12" (323.9mm) OD (DN300) carbon steel pipeline. Material grade of the pipeline will be L415 (X60), and the wall thickness (WT) of the pipeline will be 12.7mm at special crossing locations. The pipeline external coating thickness will be 2.5mm where 3-Layer Polyethylene (3LPE) is used and 10mm where 3-Layer Polypropylene (3LPP) is used. Pipeline field joint coating material and thickness is subject to confirmation.

The minimum depth of cover for the pipeline is 1.2m at Road Crossings (RDX), 1.6m at River Crossings (RVX), and 3.0m at the Grand Canal. The minimum depth of cover for the pipeline at the Kilwarden River Crossing is therefore assumed to be 1.6m to the riverbed, and 1.6m to bed level of any drainage channels present in the crossing extents.

In addition to the pipeline to be installed at the crossing of Kilwarden River, 2 No. 32/24mm diameter cable ducts are to be installed at the crossing. It is anticipated that the cable ducts will be attached to the outside of the pipeline and installed inside the same HDD bore during the pipeline installation operation. Alternatively, a parallel HDD bore can be drilled for the cable ducts at a spacing of 5-10m from the main HDD bore for the new pipeline. The preliminary analyses contained in this document are based on the installation of the pipeline only as this is the most onerous condition.

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3 Crossing Overview

3.1 Crossing Location Description

The Kilwarden River Crossing (RVX1) is located between Chainage 1100.0 and Chainage 1400.0 (Approx.) on the current route of the new GNI143 Ballykilleen Pipeline. The crossing location (Figure 3-1) is in agricultural land between Kilwarden and Aghnagilla townlands, Co. Meath, close to the border with Co. Westmeath, and approximately 2km east of Kinnegad, Co. Westmeath. The nearest residential property is approximately 300m from the point where the current pipeline route crosses the Kilwarden River.



Figure 3-1: Kilwarden River (RVX1) Crossing Location

Land on the north side of the crossing (Figure 3-2) is flat agricultural pasture land with grass fields bounded by established trees, hedgerows, and shallow land drains.

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Figure 3-2: View from watercourse of North Side of Kilwarden River Crossing

The Kilwarden River watercourse (Figure 3-3) is approximately 10m wide bank to bank at the crossing location with vegetation-covered shallow banks sloping down to the river channel. Water depth is assumed as being less than 1m deep at the crossing location. Vegetation is also present within the water channel potentially indicating a generally slow-moving body of water.



Figure 3-3: View of Kilwarden River close to proposed Crossing Location

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Land on the south side of the crossing (Figure 3-4) is flat agricultural pasture land with grass fields bounded by established trees, hedgerows, and shallow land drains.



Figure 3-4: View from watercourse of South Side of Kilwarden River Crossing

3.2 Local Constraints

3.2.1 Existing Infrastructure

There are no major items of above ground or below ground infrastructure present along the pipeline route at the crossing location that would create major obstacles to pipeline/crossing construction at present.

3.2.2 Natural Features

The main natural feature present along the pipeline route at the crossing location is the Kilwarden River watercourse, including the watercourse banks, which crosses the pipeline route at Chainage 1230.0 (Approx). It is assumed for the purpose of the assessment that trenchless construction methods are required at the crossing of the Kilwarden River in order to minimise disturbance to the watercourse. Large trees are also present along field boundaries but are not considered to be a major constraint for crossing construction. Minimum depth of cover for the pipeline at the watercourse crossing is 1.6m below lowest bed level.

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It is mentioned in the GIR for the crossing (Ref. 2) that the land drain on the north side of the crossing (Ch 1135.0) may have been the original course for the Kilwarden River. Due to the proximity between the watercourses (~100.0m), it may be beneficial to combine the crossing of the land drain with the crossing of the Kilwarden River Crossing if this land drain is environmentally sensitive.

The main environmental constraint present along the pipeline route at the crossing location is understood to be the Kilwarden River watercourse. A minimum setback distance of 20.0m is to be maintained between the crossing construction site boundaries on both sides of the watercourse. The same setback distance is assumed to apply for the land drain on the north side of the Kilwarden River.

The preliminary HDD profile will be designed so that the potential for negative impacts to the Kilwarden River watercourse is minimised. Specified minimum allowable depth of cover between the pipeline and bed level of the Kilwarden River is 1.6m. Ground settlement is not considered to be a concern for the Kilwarden River where bed levels may fluctuate seasonally. The main objective of the preliminary HDD profile design will be to maximise depth of cover below the riverbed in order to minimise the potential for drilling fluid Inadvertent Returns (IR) to the river during drilling.

A depth of cover between the HDD profile and bed level of the Kilwarden River of 14.5m (Approx.) is currently proposed. A ground settlement check for the riverbed is provided in Section 5.3 of this document to ensure that estimated ground settlement for the river bed is not above unacceptable levels. No specific ground settlement limit for the river bed is anticipated. A preliminary drilling fluid hydrofracture assessment is provided in Section 5.4 of this document to show that the risk of drilling fluid IR to the surface is within acceptable limits for the preliminary HDD profile.

3.2.3 Working Areas

The constraints present on the north side of the Kilwarden River Crossing for establishment of working areas for pipeline and crossing construction activities are assumed to be the land drain/drainage ditch and the existing field boundaries where established trees and hedgerows are present. The preliminary crossing working area boundary will be planned to be a minimum of 20m (Approx.) from the land drain/drainage ditch. Due to the proposed distance between the current pipeline route and the existing field boundaries, the field boundaries are not considered to be a major obstacle to pipeline/crossing construction.

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The constraints present on the south side of the Kilwarden River Crossing for establishment of working areas for pipeline and crossing construction activities are assumed to be a smaller land drain/drainage ditch and the existing field boundaries where established trees and hedgerows are present. The preliminary crossing working area boundary will be planned to be a minimum of 20m (Approx.) from the smaller land drain/drainage ditch. Due to the proposed distance between the current pipeline route and the existing field boundaries, the field boundaries are not considered to be a major obstacle to pipeline/crossing construction.

An initial assessment of working area requirements and existing constraints indicates that sufficient space is available for construction of an HDD crossing on both sides of the Kilwarden River Crossing. HDD Entry and Exit Point sites can be located within the proposed pipeline construction working width (assumed as 30m width) on both sides of the crossing assuming a preliminary site working area requirement of 1000m² for both the HDD Entry Point and HDD Exit Point sites. Additional working area could be taken within the proposed pipeline construction working width by extending the area footprint along the pipeline route centreline, if required. Due to the proximity between the Kilwarden River and the existing land drain/drainage ditches on the north and south sides of the crossing, it is recommended that the HDD crossing is extended both north and south beyond the existing land drain/drainage ditches to include the land drain/drainage ditches in the HDD crossing. Sufficient space is considered to be available to incorporate this recommendation.

The proposed pipeline route on both sides of the crossing includes alignment changes close to the HDD crossing extents. The alignment changes on the south side of the crossing are less severe and, therefore, it is considered more appropriate to have the HDD pipe string fabrication corridor on this side of the crossing. The HDD pipe string can be fabricated within the proposed pipeline construction working width on the south side of the crossing, but the HDD pipe string will have to be curved in order to do so. Alternatively, depending on appropriate permits and consents being granted, a temporary false pipeline construction working width could be established outside of the current project order limits to provide a straighter alignment for the HDD pipe string.

No other significant constraints are understood to be present for crossing construction. Temporary Working Area (TWA) requirements are expected to be subject to agreement with landowners and Inland Fisheries Ireland (IFI).

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4 Ground Conditions Assessment

A Geotechnical Interpretive Report (GIR) for the Kilwarden River Crossing (Ref. 2) has been provided for information. The GIR contains a geotechnical desk study and a summary of the site investigation work that has been undertaken by the project.

4.1 Geotechnical Desk Study

The geotechnical desk study provided as part of the GIR (Ref. 2) is based on information available in the public domain for local geological conditions.

The Quarternary soils plot for the general area of the Kilwarden River Crossing (Figure 4-1) reveals a varied picture of subsurface alluvium and lacustrine sediments with more widespread till. Alluvium deposition tends to follow the course of the river. There are also instances of ‘cut over raised peat’ to the north of the river. The presence of over-consolidated clay and gravel till was proven largely at depth during the investigations. Soft consistency soils were also noted in the boreholes to appreciable depths. The softening may be attributable to deep-seated water ingress combined with the presence of silt-dominant soils. Such soils are susceptible to water-softening when disturbed.

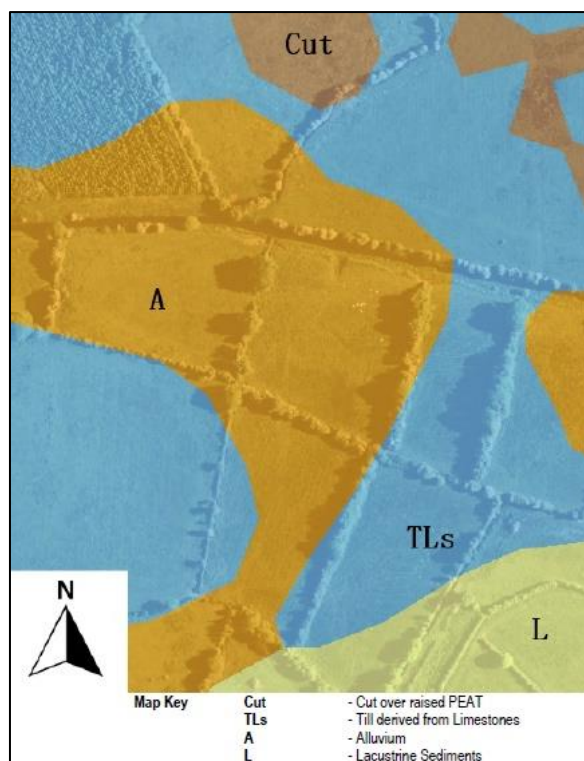


Figure 4-1: Quarternary Soils Plot for Kilwarden River Crossing Site Location (GSI)

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The bedrock geology plot for the general area of the Kilwarden River Crossing (Figure 4-2) shows that the site is underlain by Lower Carboniferous, Waulsortian Limestone and Edenderry Oolite Member of the Allenwood Formation. The Waulsortian Limestone largely consists of calcareous mudstones, wackestones, and packstones, many of them containing original cavities (including stromactis) filled with internal sediments and fibrous and blocky sparry cements. The very fine-grained carbonate lithology typical of the Waulsortian Limestones is also relatively pure and, in the right circumstances, amenable to dissolution and karst development. Blake et al (2015) suggest the Waulsortian limestone deposits within the Dublin Basin are massive and unbedded and are typically less prone to karstification. Waulsortian Limestone is also susceptible to Magnesium replacement and dolomitisation, which can further enhance permeability. McConnell & Philcox (1994) note the texture of the Waulsortian Limestone when dolomitized can make it almost indistinguishable from dolomitised Allenwood Formation limestones.

The Edenderry Oolite Member is described in McConnell, Philcox & Geraghty (1994) as a “partly skeletal calcarenite (bio-oosparite)”. A bio-oosparite is a bioclastic limestone that contains both biological fragments (bioclasts) and ooids, with a sparry calcite cement.

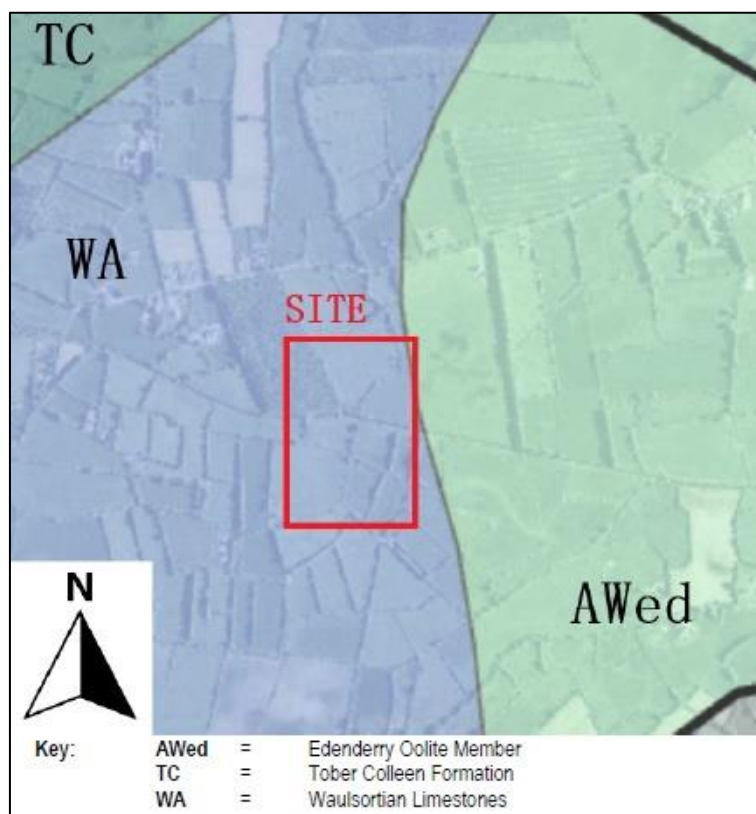


Figure 4-2: Bedrock Geology Plot for Kilwarden River Crossing Site Location (GSI)

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4.2 Review of Site Investigation Data

Site investigations have been completed for the Kilwarden River Crossing location. Details of the exploratory holes completed at the Kilwarden River Crossing location are summarised in Table 4-1.

Table 4-1: Exploratory Hole Details for RVX1

Borehole No.	Borehole Type	Borehole Coordinates	Borehole Level	Borehole Depth	Groundwater Level
BH07	Cable Percussion	662902.19 E 745937.07 N	+67.85m AOD	8.1m	6.5m BGL
BH08	Cable Percussion	662944.10 E 745939.24 N	+68.15m AOD	10.5m	3.0m BGL
BH09	Cable Percussion	662972.66 E 745911.12 N	+68.08m AOD	9.2m	6.0m BGL
BH10	Cable Percussion	662960.27 E 745883.38 N	+68.00m AOD	8.5m	2.0m BGL
BH11	Cable Percussion	662927.00 E 745873.78 N	+67.78m AOD	8.0m	3.0m BGL
BH12	Cable Percussion	662894.94 E 745902.21 N	+68.21m AOD	9.0m	5.0m BGL
BH46	Cable Percussion	662974.18 E 746029.73 N	+67.55m AOD	8.3m	No Water Strike
BH48	Cable Percussion	662904.25 E 745787.26 N	+69.13m AOD	9.0m	2.5m BGL
BH49	Cable Percussion	662887.72 E 745694.32 N	+69.47m AOD	1.0m	No Water Strike
BH49A	Cable Percussion	662887.42 E 745694.00 N	+69.50m AOD	8.3m	3.0m BGL
RC07	Rotary Core (Symmetrix)	662902.19 E 745937.07 N	+67.85m AOD	20.0m	9.0m BGL
RC08	Rotary Core (Symmetrix)	662944.10 E 745939.24 N	+68.15m AOD	20.0m	11.0m BGL
RC09	Rotary Core (Symmetrix)	662972.66 E 745911.12 N	+68.08m AOD	20.0m	6.0m BGL
RC10	Rotary Core (Symmetrix)	662960.27 E 745883.38 N	+68.00m AOD	19.5m	No Water Strike
RC11	Rotary Core (Symmetrix)	662927.00 E 745873.78 N	+67.78m AOD	17.0m	No Water Strike
RC12	Rotary Core (Symmetrix)	662894.94 E 745902.21 N	+68.21m AOD	15.1m	No Water Strike
RC46	Rotary Core (Symmetrix)	662974.18 E 746029.73 N	+67.55m AOD	20.6m	10.0m BGL
RC48	Rotary Core (Symmetrix)	662904.25 E 745787.26 N	+69.13m AOD	17.4m	9.0m BGL
RC49A	Rotary Core (Symmetrix)	662887.42 E 745694.00 N	+69.50m AOD	17.2m	8.3m BGL

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The following descriptions (Majority of text descriptions taken directly from Ref. 2) summarise the ground conditions encountered across the site as identified by the exploratory investigations. The geological cross-section included in Ref. 2 is provided in Annex A of this report for information.

4.2.1 Topsoil

Topsoil was generally found to be between 0.2-0.3m thick in the boreholes. At borehole location BH08, topsoil was measured to a depth of 0.1m. A soft brown sandy SILT was found immediately beneath the topsoil to a depth of 0.3m BGL.

4.2.2 Superficial Deposits – North of River

Borehole BH46, located 130m (Approx.) north of the northern riverbank revealed a mixed uppermost stratigraphy. Initially, a soft grey brown sandy SILT/CLAY was logged, found to become firmer with depth. At 2.2m depth BGL, a thin layer of fine sandy coarse GRAVEL persisted to 3.0m BGL. Once more a firm grey sandy gravelly SILT re-entered the stratigraphy before a loose to medium dense slightly silty very sandy GRAVEL continued to 6.8m BGL. The cable percussion borehole was terminated at 8.3m BGL (+59.25m AOD) in a very stiff grey SILT/CLAY with cobbles and boulders. Rotary drilling pushed on through the grey sandy gravelly CLAY from 8.3m BGL to eventual rockhead at 10.5m BGL (+57.05m AOD). Blowing sands were reported at both 7.0m and 9.2m BGL indicative of the piezometric pressures at depth.

The remaining three boreholes north of the Kilwarden River were located between 30.0m and 12.0m from the riverbank. As with BH46, there were stiff to very stiff CLAY and dense GRAVEL deposits unearthed at depth. These were found from 3.3m BGL / +64.55m AOD in BH07, from 7.0m BGL / +61.15m AOD in BH08 and from 7.1m BGL / +60.98m AOD in BH09. Blowing sands were again a feature in the openhole drill record, being noted at 9.0m BGL in RC09. These were reported shy of a dense dark grey sandy GRAVEL from 9.2m BGL. Rockhead was proven in RC09 at a depth of 12.0m BGL / +56.08m AOD.

Water strikes were recorded in BH08 at 4.7m BGL, in BH09 at 6.50m BGL and in BH07 at 7.2m BGL.

The stratigraphy in BH07 exhibited an incrementally stiffer consistency with depth. This finding was based on in situ SPT testing. The soils were reported as firm from 1.3m BGL, becoming stiff from 3.3m BGL and very stiff from 6.4m BGL. The borehole was ended in dense grey GRAVEL at 8.1m BGL / +58.75m AOD. A water strike was intercepted at a depth of 7.2m BGL / +60.65m AOD. This suggests that a water body lies confined in the buried GRAVEL layer at 7.2m BGL. The strike was recorded as 'moderate' in intensity, rising to 6.5m BGL after 20 minutes. Later rotary drilling proved the GRAVEL

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layer to continue from 8.1-10.5m BGL where rockhead was intercepted, proven from 11.5m BGL to a hole end depth of 20.0m BGL (+47.85m AOD).

Both BH08 and BH09 logs reported soft soils at depth. BH09 appears to have soft soils along its length from 2.0m-7.1m BGL where SPT N-values varied between 5 and 7. At 7.1m BGL, a stiff to very stiff grey sandy gravelly CLAY was intercepted, the hole ending in this material at 9.2m BGL / +58.88m AOD.

In BH08, beneath initially firm soils, from 5.0m BGL a soft sandy SILT/CLAY soil was logged. It may be the case that the deposit is silt-dominant and therefore non-plastic. Coincident with its appearance in the stratigraphy, a water strike was reported at 4.7m BGL. The resultant SPT tests carried out both at 5.0m BGL and 6.0m BGL saw SPT N-values of 4 and 8 registered. Given the overlying soils are firm and stiff in consistency, it is very likely that the soils from 5.0m BGL are liquefying somewhat due to soil disturbance / water entry. Stiff CLAY soils were encountered from 7.0m BGL / +61.15m AOD and continue to eventual cable percussion borehole termination at 10.5m BGL / +57.65m AOD. Rotary drilling at RC07 proved a further 1.5m of GRAVEL shy of eventual rockhead from 12.0m BGL / +56.15m AOD.

4.2.3 Superficial Deposits – South of River

Corresponding to the stratigraphy in BH07, directly across the river on the south bank, borehole BH12 met only firm and stiff soils to an eventual end depth of 9.0m BGL / +59.21m AOD. In fact, from 3.2m BGL, a stiff and very stiff very gravelly cobbly CLAY was logged. Later coring proved LIMESTONE rock at the base of the cable percussion borehole at 9.0m BGL.

BH10, and to a lesser extent BH11, encountered soft or low strength soils. The prevalence of silt-dominant soils in the bores, combined with water ingress, may suggest soil disturbance being the main factor in producing lower than anticipated SPT N-Values at depth - a similar trait to that witnessed in both BH08 and BH09 on the north bank. In any case, soft soils persisted to 5.80m BGL in BH10, and a layer of soft soil was logged from 4.0m-5.7m BGL in BH11. A water strike was intercepted at 3.5m BGL which remained unsealed. This may have resulted in the low SPT values of 3 and 8 at 4.0m and 5.0m depth BGL in BH11.

Based on SPT testing, BH48 is devoid of soft soils with N-Values noted to increase markedly along the length of the borehole, inferring firm and stiff and very stiff / dense soils to an eventual end depth of 9.0m BGL / +60.13m AOD. Rock was later proven at 9.4m BGL.

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Approximately 215.0m south of the riverbank, BH49A met initially soft soils to 3.4m BGL with stiff and very stiff sandy gravelly CLAY till soils from 3.4m BGL. At 7.0m BGL, PSD analysis notes a transition to a silty sandy GRAVEL to a borehole end depth of 8.3m BGL / +61.2m AOD. Rock was proven at 8.8m BGL, cored from 9.2m BGL.

Overall, the boreholes on the southern side of the river reveal stiff and very stiff CLAY or basal dense GRAVEL shy of rockhead. Rock was cored in each of the five holes from depths ranging 8.6-10.2m BGL.

SPT N-Values recorded in boreholes suggest an often soft mantle of indigenous CLAY/SILT extending to depths of up to 6.0m depth BGL in some cases. It may be the case that disturbance caused by boring coupled with water ingress diminished the in-situ strength of the upper SILT soils which thereby delivered lower than expected or unrepresentative SPT results. The incidence of groundwater between 3.3 BGL and 8.0m BGL could have artificially softened the uppermost SILT soils.

4.2.4 Bedrock

Rotary drilling was conducted at nine locations at RVX1, positioned both north and south of the Kilwarden River. In the case of RC46, north of the river, there were reported a number of CLAY layers within the rock mass from 16.7m BGL / +50.85m AOD. Open holing was required to clear the hole from 17.5-18.5m BGL such was the fragmented nature of the bedrock. A loss of flush was reported in the attempted core run from 18.5-20.6m BGL.

Drilling successfully proved rock at each of the nine locations, at depths ranging 8.0-13.0m BGL. These depths corresponded to elevations of +59.78m AOD and +55.08m AOD.

Drilling showed that cable percussion pre-bores terminated just shy of rockhead in most cases, ending on rock at both locations BH11 and BH12. The mantle of glacial till soils comprised a mixture of soft, frequently silt-dominant soils together with deeper seated stiff and very stiff sandy gravelly CLAY till and dense / very dense GRAVEL deposits.

The recovered cores consist of fresh to slightly weathered, weak to strong, generally medium strong to strong, light to dark blue/black fine-grained massively bedded LIMESTONE. The bedrock is further classified as consisting of predominantly calci-siltite layers with subordinate argillaceous limestone, being locally fossiliferous.

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Discontinuity spacings in the rotary cores generally ranged from closely (60 to 200mm) to widely spaced (600 to 2000mm). The discontinuity surfaces were typically smooth and locally rough, planar to irregular. Apertures were tight to open, locally exhibiting clay smearing with some calcite veinfill. Dips were generally sub-horizontal, locally 30-45° and irregular.

The point load strength index (PLSI) test data produced $Is(50)$ values ranging from 0.5-6.0 MPa with a mean value of 2.79 MPa. The PLSI strengths are suggestive of the presence of weak, predominantly medium strong and strong rock.

Using a correlation factor (K) of 22 to assess compressive strength, this suggests a characteristic strength envelope in the order of 11.0-132.0 MPa and categorizes the bedrock as weak (5 to 25MPa) to very strong (100 to 250MPa).

4.2.5 Groundwater

Water ingress was recorded in both cable percussion boreholes and rotary drillholes. Often two separate water strikes were observed in cable percussion boreholes, the second deeper strike occurring in both stiff and very stiff CLAY strata as well as in the dense confined gravels (BH10 and BH11). The cable percussion boreholes intercepted groundwater at its shallowest at 3.3m BGL (BH10) and at its deepest at 8.0m BGL (BH08, BH09, BH12 & BH49A). Follow-on rotary drilling at two drillhole locations proved groundwater lying at rockhead level (RC48 & RC49A). During their construction, the rotary drillholes were often remarked as dry.

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4.3 Suitability of Ground Conditions for HDD

Boreholes were completed in fields both immediately to the north and south of the Kilwarden River, and to the north and south of the existing land drains/drainage ditches. They encountered thick upper sequences of CLAY/SILT (stiffening with depth) with occasionally underlying deeper-seated, apparently water-bearing GRAVEL (BH07, RC08, BH10 & BH11). Rotary coring proved LIMESTONE bedrock from 8.0m (Approx.) BGL (RC11) to 13.0m BGL (RC08). There may be a gravel channel cut into the bedrock at RC09 where the bedrock apparently falls to its lowest level (13.0m BGL / +55.08m AOD). There is some variation in the uppermost cover of superficial deposits whereby a soft CLAY/SILT was remarked initially in a number of holes to 5.0m BGL & 6.0m BGL (Approx.). The possible presence of soft ground would warrant further investigation (According to Ref. 2). Additionally, the potential for a buried river channel to exist along the former Kilwarden / Aghnagillagh townland boundary, most especially at its western extent near the proposed crossing, will also warrant closer examination (According to Ref. 2).

An HDD crossing of the Kilwarden River is anticipated to be mainly within the limestone bedrock layer for the majority of the crossing length, and mixed layers of silts, clays, and gravels in the shallow sections of the HDD profile above the bedrock layer at the crossing extents. Potential for encountering cobbles and boulders is considered to be low, where cobbles/boulders could be encountered every 20-50m. Cobbles and boulders are expected to be derived from the limestone bedrock and can be drilled through if the HDD equipment used is suitable.

The HDD bore is expected to be self-supporting in the bedrock and superficial deposits layers and the risk of bore collapse in the bedrock and superficial deposits layers is considered to be very low and low respectively.

Routing the HDD profile deeper below ground level potentially reduces the risk of drilling fluid IR to formation or to the surface. A preliminary drilling fluid hydrofracture assessment is provided as part of this preliminary crossing design exercise (Section 5.4). However, this does not take into consideration the potential for natural leak paths to the surface to be present. The potential for natural leak paths to be present is considered to be low based on the ground conditions assessment. Karst features in the limestone bedrock layer have not been mapped at the crossing location in public domain mapping.

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The presence of gravel, cobbles, and boulders can potentially cause issues for the HDD method, especially where loose gravel/cobble layers may exist, or where the majority of the crossing length is through a soil matrix containing a high percentage of gravel/cobbles with a low cohesive clay/silt material content. The gravel layers present at the crossing location contain cohesive materials (clay and silt) with sand also present within the soil matrix. Due to the anticipated small size of the HDD bore required for the 12" OD pipeline, the risk of bore collapse in the gravel layer is considered to be low.

The potential presence of artesian groundwater in the gravel layers will have to be taken into consideration by the construction contractor. Artesian groundwater can contribute to HDD bore instability, but the risk can be minimised by an optimised design. Typically, contractors will design the HDD profile to avoid areas where artesian groundwater may impact bore stability. Artesian groundwater conditions can normally be balanced by the heavier drilling fluid in the HDD bore.

An HDD solution appears to be feasible based on the anticipated ground conditions, the average length of HDD bore required, and the small diameter of HDD bore required. The preliminary HDD crossing design will consider the local constraints and ground conditions with the additional objectives of minimising risk of drilling fluid IR to the surface. The HDD profile design and crossing construction methodology are expected to be developed further by the construction contractor and are expected to include further assessment of local ground conditions and associated risks.

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5 HDD Crossing Preliminary Design

5.1 Preliminary HDD Profile Design

The preliminary HDD profile design is generally based on the following objectives:

- Achieve a trenchless crossing of the Kilwarden River;
- Plan the HDD crossing alignment within the project order limits;
- Minimise HDD crossing length;
- Minimise complexity of pipeline tie-ins on both sides of the crossing;
- Cross the Kilwarden River at perpendicular, or close to perpendicular, angles;
- Maintain appropriate clearance (>10m) between construction working areas and land boundaries;
- Maintain appropriate clearance (>20m) between construction working areas and watercourse banks;
- Maintain a minimum required depth of cover to the pipeline of 1.6m at the Kilwarden River;
- Maintain a minimum required depth of cover to the pipeline of 1.6m at drainage ditches;
- Plan the HDD profile within stable soils over the majority of the profile length;
- Plan the HDD profile maximum depth within the coverage of the site investigations;
- Achieve an HDD profile depth which minimises risk of ground settlement at existing infrastructure locations;
- Achieve an HDD profile depth which minimises risk of drilling fluid IR to the surface;
- Achieve an HDD profile length which allows the pipe string to be fabricated in a single length; and
- Provide a feasible HDD profile geometry for crossing construction and pipeline operation.

The proposed HDD crossing alignment and profile achieves all of the objectives listed above and includes a crossing of the Kilwarden River and crossings of the land drains/drainage ditches to the north and south of the Kilwarden River.

The pipe string fabrication corridor is located on the south side of the crossing due to the better alignment of the pipeline construction working width on this side of the crossing. Curvature of the pipe string is required in order to be able to accommodate a single pipe string length within the current pipeline construction working width boundary. The space available is considered to be appropriate for fabrication of a single pipe string.

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Curvature of the pipe string during fabrication can be a complex operation, particularly for larger diameter, heavier wall, steel pipelines. Curvature of a small diameter pipeline is a less complex operation. The contractor may choose to introduce straight sections in the pipe string to reduce overall complexity and temporary works requirements during fabrication, testing, and installation.

Standard practice is to use straight alignments in plan for HDD crossings in order to minimise the complexity of the pilot hole drilling operation. A straight alignment in plan is used for the preliminary HDD crossing alignment in order to provide a conservative approach. HDD crossings can be curved in plan when necessary. However, complexity of crossing construction may increase where short radius curves (approaching the operational limits of the drill pipe), or combined horizontal and vertical curves, are proposed.

The preliminary HDD crossing alignment crosses the Kilwarden River at a perpendicular angle (Figure 5-1). An entry angle of 14° and an exit angle of 12° have been used for preliminary design purposes. A minimum radius of curvature of 360m for the HDD profile has been assumed based on typical values used for HDD crossings of this size in similar ground conditions. The proposed radius of curvature ensures that installation and operation stresses on the pipeline should remain within allowable limits, and a greater depth of cover is achieved at the Kilwarden River. This results in a preliminary HDD crossing 2D length of approximately 275m in plan.

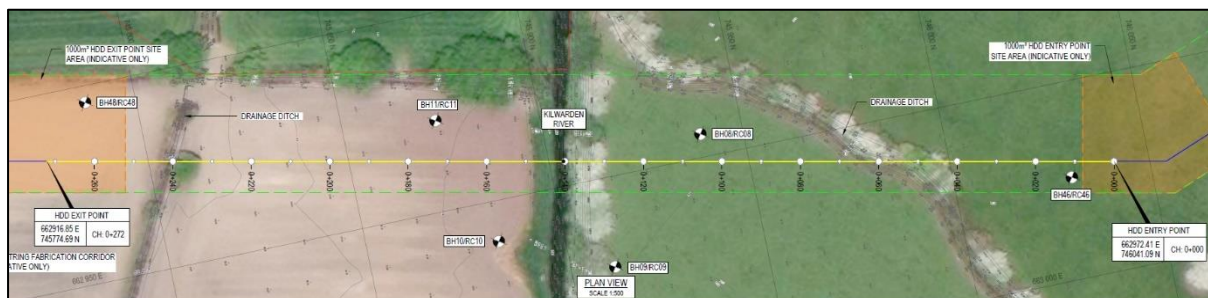


Figure 5-1: Preliminary HDD Crossing Plan Alignment

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The crossing has been extended beyond the land drains/drainage ditches on the north and south sides of the crossing as this is considered to be beneficial in terms of minimising the potential for disruption to the existing land drains/drainage ditches. The overall length of the crossing may be subject to change during the detailed design of the HDD crossing by the construction contractor. However, the overall length is not expected to change significantly. The crossing location and alignment of the pipeline in relation to the Kilwarden River is not expected to change. The final crossing extents and site area boundaries may be subject to change prior to construction during the detailed design of the crossing. However, the minimum allowable proximity distance to land boundaries, the Kilwarden River, and existing land drains/drainage ditches must be observed.

The vertical alignment of the preliminary HDD profile (Figure 5-2) is anticipated to pass through the following soil layers (HDD equipment should be selected accordingly):

- Limestone bedrock for the majority of the crossing length;
- Mixed superficial deposits including clayey/silty/sandy gravel with occasional cobbles and boulders, sandy/gravelly clay with occasional cobbles and boulders, and sandy/gravelly silt/clay with occasional cobbles and boulders in the shallow sections of the profile at each end of the crossing.

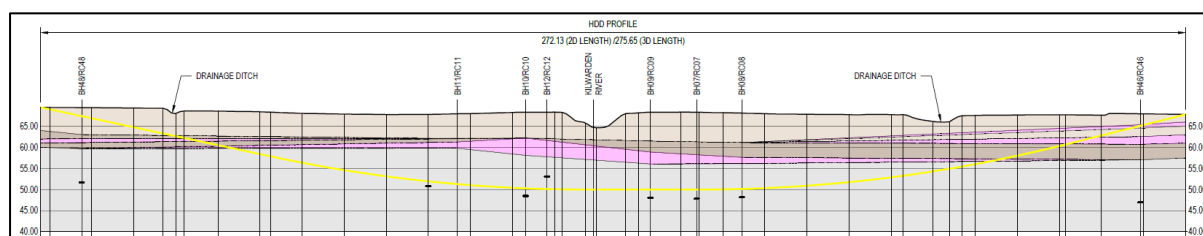


Figure 5-2: Preliminary HDD Crossing Profile Alignment

The minimum clearance distance between the preliminary HDD profile and the Kilwarden River is approximately 14.5m. The resultant minimum depth of cover to the pipeline at the Kilwarden River and existing land drains/drainage ditches is therefore expected to be greater than the minimum allowable figure of 1.6m. The preliminary HDD profile is anticipated to be within the limestone bedrock layer where the profile passes below the Kilwarden River. The minimum clearance distance between the HDD profile and the Kilwarden River may be subject to change prior to construction during the detailed design of the crossing.

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5.2 Preliminary Pipeline Stress Check

5.2.1 Pipeline Installation Pull Force Check

A pipe installation pull force check has been performed for the preliminary crossing alignment. Proprietary HDD design software D-Geo Pipeline has been used to calculate the pipeline installation pull forces for the proposed pipeline. The anticipated pull force is provided in Table 5-1.

Table 5-1: Pipe Installation Pull Force Summary

Pipe OD (mm)	Pipe WT (mm)	Pipe Weight Downhole Empty (kg/m)	Friction Value Pipe Downhole	Estimated Maximum Pull Force (Tonnes)
323.9	12.7	-6.12	0.3	11.7

The pipe installation pull force is considered to be within the allowable limits for the pipeline (subject to confirmation). The estimated maximum pull force can be used as a guide to ensure that a suitable capacity HDD drilling rig is proposed for the pipeline installation operation.

5.2.2 Temporary Installation Stresses

A check on temporary installation stresses on the pipe has been performed for the preliminary crossing alignment. Proprietary HDD design software D-Geo Pipeline has been used to check temporary pipeline installation stresses for the proposed pipeline. The maximum temporary installation stresses on the pipeline are provided in Table 5-2.

The analysis of temporary installation stresses on the pipe includes installation forces, radius of curvature of the HDD bore, and depth of the HDD bore (drilling fluid hydrostatic pressure on pipe) for the start and end of the installation operation. A maximum allowable stress value of 377.27 N/mm² has been assumed for the temporary installation case. The analysis also assumes a single full pipe string length for the start of the pullback operation.

Table 5-2: Temporary Installation Stresses Summary

Maximum Stress on Pipe (Start of Pull) (N/mm ²)	Maximum Stress on Pipe (End of Pull) (N/mm ²)	Allowable Maximum Stress on Pipe during Installation (N/mm ²)	Status
237	150	377.27	OK

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5.3 Preliminary Ground Settlement Check

A preliminary ground settlement check for the Kilwarden River has been performed based on the minimum clearance distance between the preliminary HDD bore alignment and the riverbed. The settlement check has been performed using recognised ground settlement theory provided in Ref. 6. A conservative ground volume loss of 50% has been assumed for the purpose of analysis. This figure is typically 20% for HDD applications and can be as low as 0% in strong bedrock. A conservative trough width parameter of 0.4 has been selected based on the presence of cohesive clay and granular materials above the limestone bedrock layer. The figure selected for the trough width parameter ignores the presence of stable bedrock at the level of the HDD bore. The result of the ground settlement check for the Kilwarden River is provided in Table 5-3.

Table 5-3: Kilwarden River Ground Settlement Check Summary

Minimum Clearance Distance (m)	Assumed HDD Bore Diameter (mm)	Trough Width Parameter (K)	Assumed Volume Loss	Maximum Settlement at Riverbed (mm)	Status
14.5	508.0	0.4	50%	4.4	OK

The result of the ground settlement check for the Kilwarden River indicates that the estimated ground settlement value is not unacceptable and likely to be within assumed allowable limits using conservative assumptions for the purpose of analysis. It is assumed that there will not be a settlement limit in place for the riverbed due to the likelihood that riverbed level fluctuates seasonally. The HDD bore will be within the limestone bedrock layer where it passes below the Kilwarden River and, therefore, ground settlement risk is considered to be low.

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5.4 Preliminary Drilling Fluid Hydrofracture Analysis

Hydrofracture, or frac-out, in HDD occurs when drilling fluid pressure exceeds the ability of the soil above the HDD bore to contain the drilling fluid, causing the drilling fluid to fracture the surrounding ground and potentially reach the surface. Risk of drilling fluid IR to the surface typically increases where depth of cover to the HDD bore is lowest, such as in the shallow sections at both ends of the HDD profile, and where the HDD profile passes below low points in the local terrain such as watercourses or natural/man-made depressions. Drilling fluid can also reach the surface through natural leak paths. This is not considered in a hydrofracture analysis.

Contractors typically install steel casing pipe in the shallow section of a HDD bore at the HDD Entry Point in order to stabilise the shallow soil layers. This casing pipe can also minimise the risk of drilling fluid IR to the surface in this section of the HDD bore. Casing pipe can be used as a temporary contingency measure to stabilise soils and minimise risk of drilling fluid IR to the surface. However, the current pipeline design does not allow for casing pipe to be left in-situ permanently.

A preliminary drilling fluid hydrofracture analysis has been performed based on the preliminary HDD crossing profile and soils profile. Proprietary HDD design software D-Geo Pipeline has been used to perform the drilling fluid hydrofracture analysis.

Typical values for soil parameters required for design have been assumed for the purpose of analysis. Values should be assumed as preliminary and subject to confirmation during detailed design. It should be noted that a drilling fluid hydrofracture analysis is typically only performed for HDD bores being drilled in non-rock soils and is not usually performed for bedrock conditions. Dense gravel conditions have been assumed instead of bedrock for the purpose of analysis in order to mimic the potential voids present in the limestone bedrock.

Typical values for drilling fluid parameters required for design have been assumed for the purpose of analysis. These values are dependent on the construction methodology being proposed by the construction contractor and are potentially subject to change.

The analysis is performed for the three main stages of the HDD operation:

- Pilot Hole Drilling
- Bore Reaming/Hole Opening
- Pipeline Installation

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The drilling fluid hydrofracture analysis provides a baseline minimum required drilling fluid downhole pressure to ensure drilling fluid flow back to the surface, and maximum allowable drilling fluid pressures related to (1) deformation of the HDD bore and (2) soil cover. The maximum allowable drilling fluid pressure related to soil cover is considered to be the worst case in relation to risk of drilling fluid reaching the surface. Where there is a large working window for downhole pressure (large difference between minimum required and maximum allowable drilling fluid downhole pressure), risk of drilling fluid hydrofracture to the surface is considered to be low. Conversely, where there is a small working window for downhole pressure (small difference between minimum required and maximum allowable drilling fluid downhole pressure), risk of drilling hydrofracture to the surface is considered to be high. The results for the hydrofracture analysis are provided in graphical form.

Co-ordinate 0.0m on the graphs in this section relates to the north (HDD Entry Point) side of the crossing and Co-ordinate 272.0m relates to the south (HDD Exit Point) side of the crossing.

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The results of the hydrofracture analysis for the pilot hole drilling operation are summarised in Figure 5-3. The graph shows a large working window for drilling fluid pressure over the majority of the crossing length, meaning risk of drilling fluid hydrofracture to the surface is potentially very low. The working window for drilling fluid pressure is smaller at the entry and exit sections where cover to the HDD bore is lower. However, conservative soil and drilling fluid parameters have been used for the purpose of analysis and hydrofracture risk is expected to be low in these areas. The shallow sections on HDD profiles are known areas of increased hydrofracture risk due to the reduced depth of cover to the HDD profile. Mitigation measures, such as reducing the drilling fluid pumping rate and downhole pressure in these sections, are typically employed by the contractor to reduce the potential for drilling fluid IR to the surface in shallow sections. In addition, continuous monitoring of drilling fluid volumes, and continuous monitoring of the surface for drilling fluid IR, are performed during construction. Contingency measures are expected to be in place in the event of drilling fluid IR to the surface.

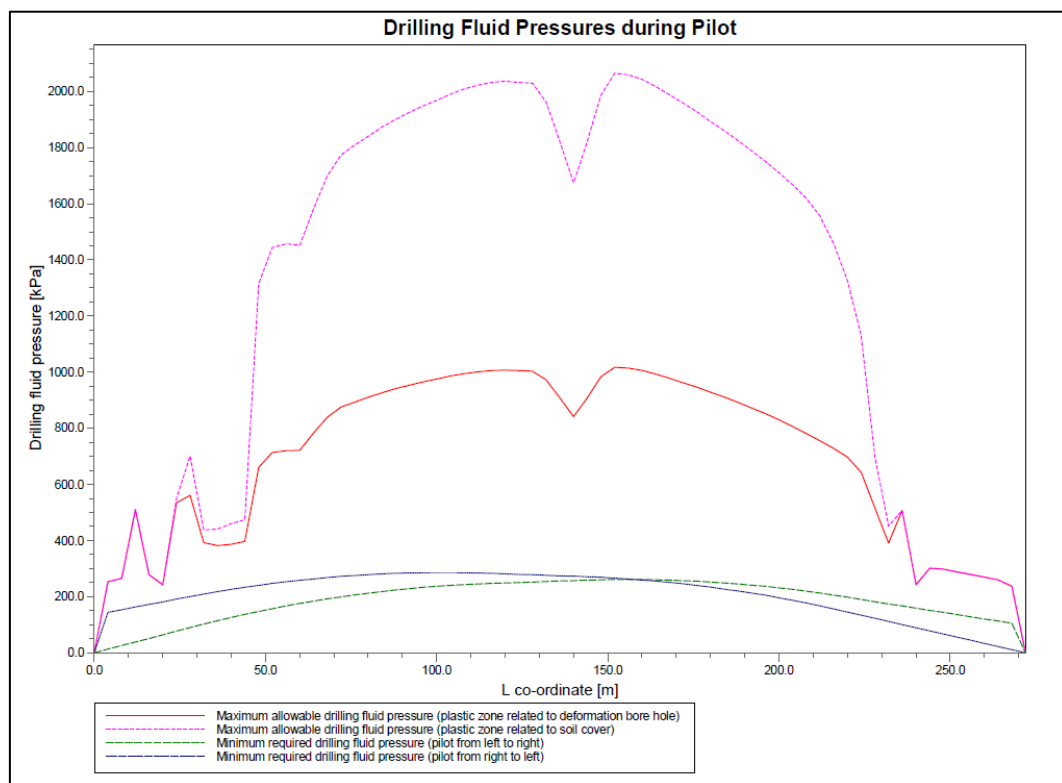


Figure 5-3: Drilling Fluid Hydrofracture Analysis Results (Pilot Hole)

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The results of the hydrofracture analysis for the bore reaming/hole-opening operation are summarised in Figure 5-4. The graph shows a large working window for drilling fluid pressure over the majority of the crossing length, meaning risk of drilling fluid hydrofracture to the surface is potentially very low. The working window for drilling fluid pressure is smaller at the entry and exit sections where cover to the HDD bore is lower. However, conservative soil and drilling fluid parameters have been used for the purpose of analysis and hydrofracture risk is expected to be low in these areas.

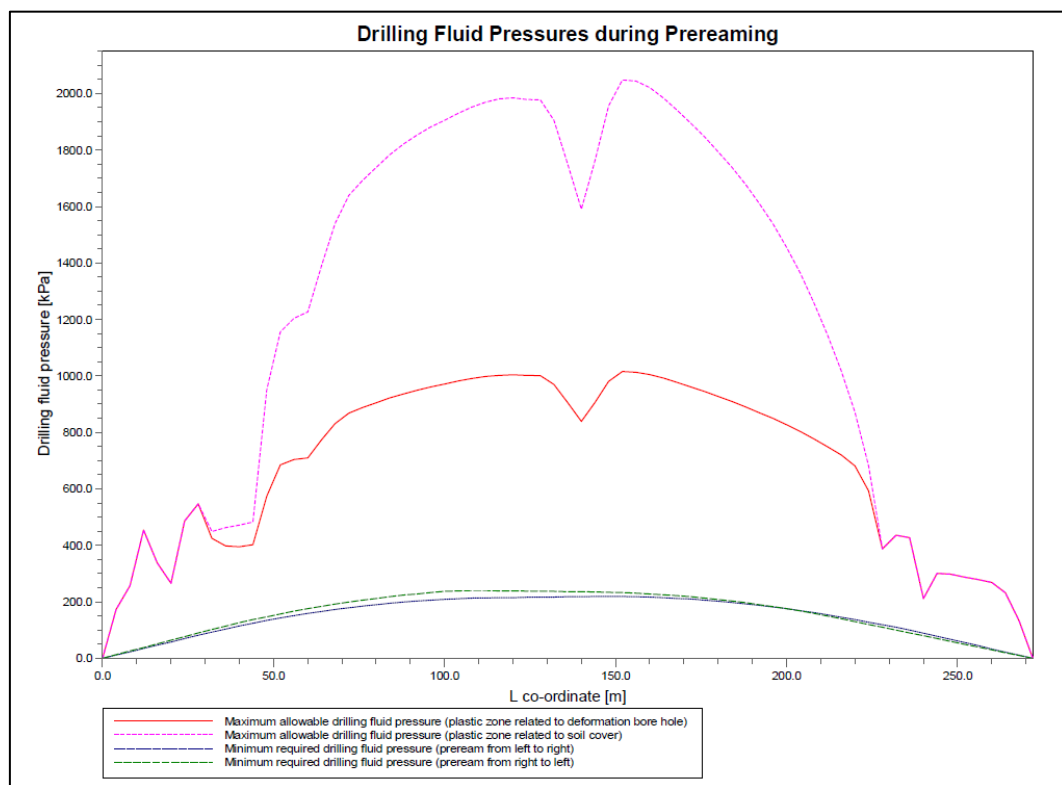


Figure 5-4: Drilling Fluid Hydrofracture Analysis Results (Bore Reaming/Hole-Opening)

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The results of the hydrofracture analysis for the pipeline installation operation are summarised in Figure 5-5. The graph shows a large working window for drilling fluid pressure over the majority of the crossing length, meaning risk of drilling fluid hydrofracture to the surface is potentially very low. The working window for drilling fluid pressure is smaller at the entry and exit sections where cover to the HDD bore is lower. However, conservative soil and drilling fluid parameters have been used for the purpose of analysis and hydrofracture risk is expected to be low in these areas.

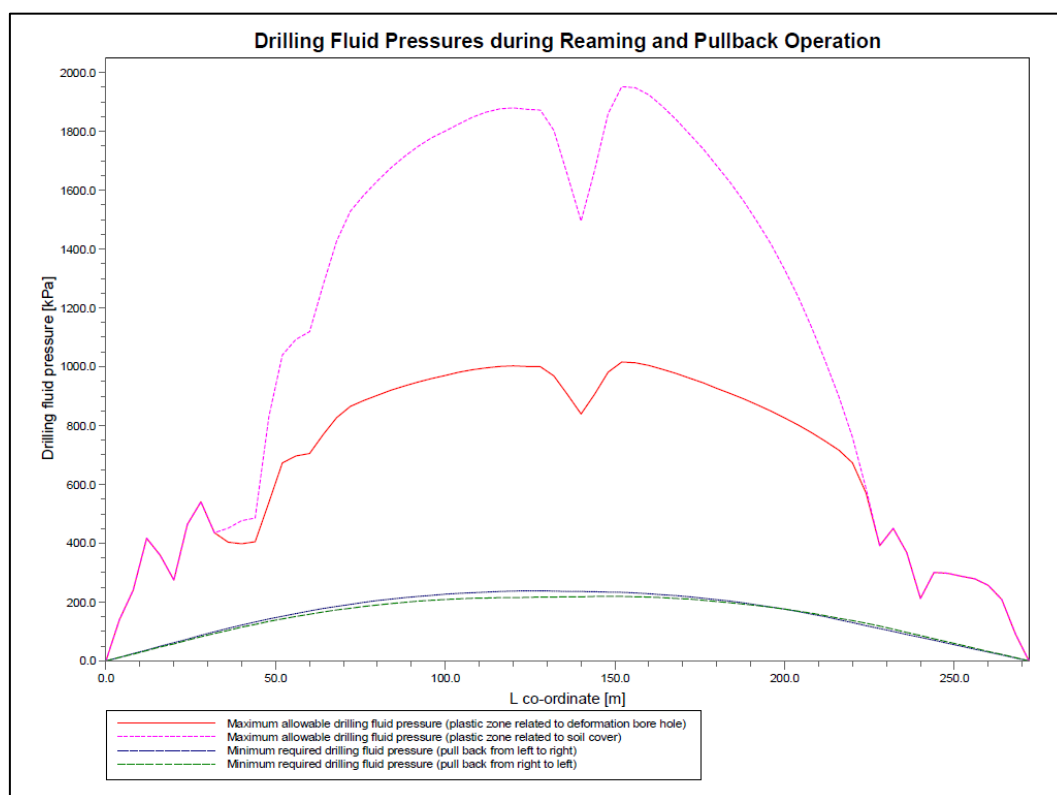


Figure 5-5: Drilling Fluid Hydrofracture Analysis Results (Pipeline Installation)

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Overall, the risk of drilling fluid hydrofracture to the surface is considered to be low for this crossing.

The north side of the crossing is at co-ordinate 0.0m on the graphs and the south side of the crossing is at co-ordinate 272.0m. The Kilwarden River is at co-ordinate 140.0m (Approx.) on the graphs above. The working window is interpreted as being appropriate for the proposed operations and risk of drilling fluid hydrofracture to the watercourse is considered to be low.

Contractors can implement contingency measures in the event of excessive drilling fluid losses to formation or drilling fluid IR to the surface. Contingency measures include the addition of Loss Control Measures (LCM) to the drilling fluid or controlled grouting of the HDD bore in areas of concern. Contractors will implement an emergency response procedure in the event of drilling fluid IR to the surface. This typically involves installing a soil bund around the drilling fluid that has come to the surface to prevent further spreading, pumping the drilling fluid back to the HDD site working area, and then reinstating the affected land.

Results presented in this document are considered to be preliminary. Conservative assumptions for various soil parameters and drilling parameters have been made for the purpose of analysis. Further assessment of drilling hydrofracture risk is expected to be performed during the detailed design phase of the works as the HDD crossing design and methodology is developed. The performance of a drilling fluid hydrofracture risk assessment during detailed design is typically a requirement of the controlling specification for the HDD works.

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6 Design Risk Assessment

A design risk assessment for the preliminary design of the HDD crossing is provided in Table 6-1 below. Residual risks are considered to be high-level risks that are relevant to future design and construction activities and provided for information only.

A geophysical survey is recommended for the crossing to help to provide further definition for bedrock level. Planning the HDD profile to pass through bedrock, where possible, may reduce overall risk for the crossing in terms of HDD bore stability. A geophysical survey can provide additional information on local bedrock level.

Table 6-1: Design Risk Assessment for Preliminary Crossing Design

Potential Hazard	Design Action	Residual Risk
Unexpected Ground Conditions	Review of project-specific site investigation data supplemented with information available in public domain for crossing location. Preliminary HDD profile designed to pass through most stable ground conditions.	Ground conditions between site investigation locations differs from assumptions made in review. Residual risk remains if HDD contractor does not interpret soils information correctly and does not plan works accordingly.
Insufficient clearance to existing infrastructure/natural features potentially resulting in breach of allowable settlement limits.	Location and approximate level of existing infrastructure/natural features have been established during site surveys. Minimum clearance of 14.5m (Approx.) between preliminary HDD profile and Kilwarden River watercourse proposed in design. Preliminary ground settlement checks performed in design using conservative assumptions and soil parameters.	HDD contractor will perform settlement checks for existing infrastructure/natural features prior to construction and design HDD profile to suit. Residual risk remains if HDD contractor does not maintain recommended clearance between HDD profile and existing infrastructure/natural features.
High installation loads on pipeline causing damage to pipeline.	Design checks performed for anticipated installation loads on pipeline.	HDD contractor will perform installation stress checks for proposed pipeline and HDD profile alignment prior to construction. Residual risk remains if HDD contractor does not monitor installation loads and does not maintain installation loads within recommended limits.

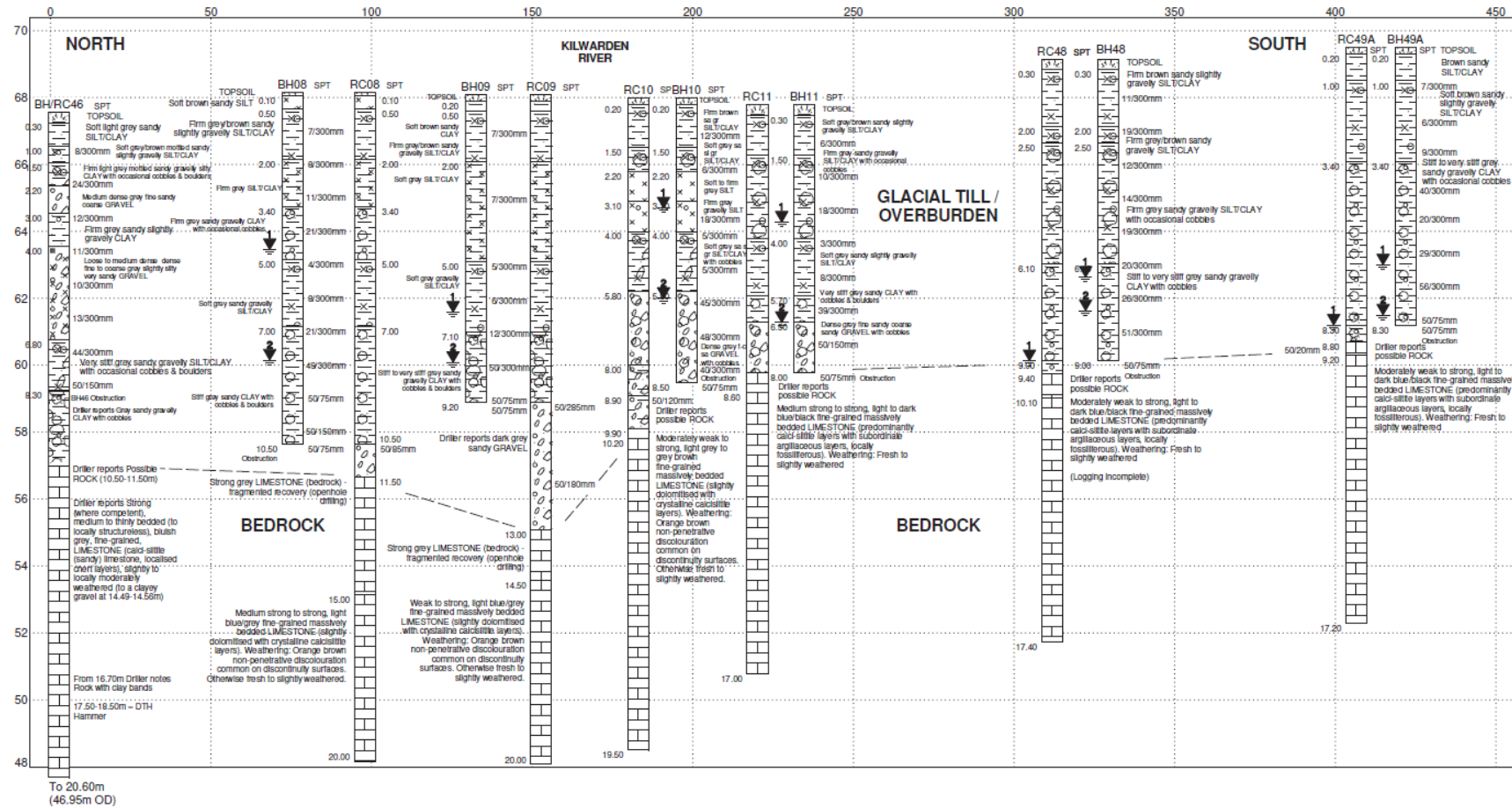
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Potential Hazard	Design Action	Residual Risk
Drilling fluid inadvertent returns to surface during drilling.	Ground levels and preliminary soil profile for crossing location established during site surveys and crossing assessment work. High-level assessment of drilling fluid hydrofracture risk performed based on assumed ground conditions and drilling parameters. Hydrofracture risk is considered to be low based on the assumed ground conditions, the preliminary crossing length and depth, and the maximum expected HDD bore diameter.	Site-specific hydrofracture analysis will be performed by HDD contractor prior to construction. HDD contractor will perform surface monitoring during drilling and will have drilling fluid containment and clean-up measures on site for the duration of the works. Residual risk remains if HDD contractor does not maintain downhole pressure within working envelope as recommended by hydrofracture analysis.

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Annex A – Geological Cross-Section for Kilwarden River Crossing



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<i>Project:</i>	Gas to Bord na Mona, Edenderry
<i>Main Client:</i>	Gas Networks Ireland
<i>MJS Client:</i>	Fingleton White
<i>Location:</i>	Ireland

<i>MJS Project No.:</i>	2525
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M4 Motorway Crossing – Preliminary Crossing Design Report

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1 Introduction

1.1 Project Description

Bord na Móna (BnM) are planning to convert the existing diesel generation peaking plant at the Edenderry Power Station to run on natural gas in an effort to reduce CO₂ emissions. A new 12" Outside Diameter (OD) high pressure gas pipeline is required to be installed between the existing gas transmission network and the power station in order to supply natural gas for the gas turbines. The new GNI143 Ballykilleen Pipeline will be approximately 23km in length between the proposed hot tap location (14301 Kilwarden Offtake Installation) on the existing GNI BGE/77 Pipeline to the West (PTTW) pipeline and an Above Ground Installation (AGI) facility within the BnM Renewable Energy Complex at Edenderry.

A number of special crossings of existing infrastructure and natural features will be required on the new pipeline route. The 4 No. main crossings identified are:

1. Kilwarden River (RVX1)
2. M4 Motorway (RDX4)
3. Yellow River (RVX2)
4. Grand Canal (WCX23)

1.2 Summary of Scope and Document Purpose

Fingleton White (FW) have been engaged by GNI to produce the design for the new gas supply pipeline between the existing high pressure gas transmission network and the AGI facility at Edenderry power station. MJS Project Services (MJS) have been engaged by Fingleton White to produce crossing construction method assessments and preliminary crossing designs for several trenchless crossings of existing infrastructure and natural features on the new pipeline route.

The purpose of this document is to provide a narrative to support the preliminary design of a HDD crossing of the M4 Motorway (RDX4) and to provide a summary of the associated design checks that have been performed. The M4 Motorway Crossing is currently in the planning phase. Therefore, the proposed crossing design should be considered as preliminary and potentially subject to change and further development during the detailed design and construction phases. The preliminary HDD crossing design is based on current HDD industry guidelines and best practices (Section 1.3) and takes into consideration site-specific conditions and constraints.

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1.3 References

Ref:	Document Number	Document Title
1	MJS-FW-GBNME-DWG-002	M4 Motorway Crossing – Preliminary Crossing Drawing
2	25882 – Gas to Bord na Móna, Edenderry – Phase 1 GI – HCC1 – Geotechnical Interpretive Report – Rev 0 (IGSL)	
3	CC-PAV-04007	Requirements for the Reinstatement of Openings in National Roads (TII)
4	DNV-ST-F121	Pipeline Installation Using Horizontal Directional Drilling (DNV)
5	NASTT's Horizontal Directional Drilling (HDD) Good Practice Guidelines (NASTT)	
6	Information and Recommendations for the Planning, Construction and Documentation of HDD Projects – DCA Technical Guidelines (DCA)	
7	Settlement above Tunnels in the United Kingdom – Their Magnitude and Prediction (O'Reilly and New)	

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1.4 Abbreviations / Acronyms

Term	Meaning
3LPE	3-Layer Polyethylene
3LPP	3-Layer Polypropylene
AGI	Above Ground Installation
AOD	Above Ordnance Datum
BGL	Below Ground Level
BH	Borehole
BnM	Bord na Móna
CO ₂	Carbon Dioxide
DCA	Drilling Contractors Association
DN	Diameter Nominal
DNV	Det Norske Veritas
FW	Fingleton White
GIR	Geotechnical Interpretive Report
GNI	Gas Networks Ireland
GSI	Geological Survey Ireland
HDD	Horizontal Directional Drilling
ID	Internal Diameter
LCM	Loss Control Measures
MJS	MJS Project Services
NASTT	North American Society for Trenchless Technology
OD	Outside Diameter
PLSI	Point Load Strength Index
PTTW	Pipeline to the West
RC	Rotary Core
RDX	Road Crossing
SPT	Standard Penetration Test
TII	Transport Infrastructure Ireland
WT	Wall Thickness

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2 Pipeline Details

Details of the proposed route of the new gas pipeline (GNI143 Ballykilleen Pipeline) between the proposed offtake location (14301 Kilwarden Offtake Installation) on the existing GNI BGE/77 Pipeline to the West (PTTW) pipeline and an Above Ground Installation (AGI) facility within the BnM Renewable Energy Complex at Edenderry have been provided for the purpose of preliminary crossing design. The M4 Motorway Crossing is located between Ch2900.00 and Ch3100.00 (Approx.) on the proposed pipeline route.

The new gas pipeline will be a 12" (323.9mm) OD (DN300) carbon steel pipeline. Material grade of the pipeline will be L415 (X60), and the wall thickness (WT) of the pipeline will be 12.7mm at special crossing locations. The pipeline external coating thickness will be 2.5mm where 3-Layer Polyethylene (3LPE) is used and 10mm where 3-Layer Polypropylene (3LPP) is used. Pipeline field joint coating material and thickness is subject to confirmation.

The minimum depth of cover for the pipeline is 1.2m at Road Crossings (RDX), 1.6m at River Crossings (RVX), and 3.0m at the Grand Canal. The minimum depth of cover for the pipeline at the M4 Motorway Crossing is therefore assumed to be 1.2m to the road surface, and 1.6m to the bed level of any road drainage channels within the motorway land boundary.

In addition to the pipeline to be installed at the crossing of the M4 motorway, 2 No. 32/24mm diameter cable ducts are to be installed at the crossing. It is anticipated that the cable ducts will be attached to the outside of the pipeline and installed inside the same HDD bore during the pipeline installation operation. Alternatively, a parallel HDD bore can be drilled for the cable ducts at a spacing of 5-10m from the main HDD bore for the new pipeline. The preliminary analyses contained in this document are based on the installation of the pipeline only as this is the most onerous condition.

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3 Crossing Overview

3.1 Crossing Location Description

The M4 Motorway Crossing (RDX4) is located between Chainage 2900 and Chainage 3100 (Approx.) on the current route of the new GNI143 Ballykilleen Pipeline. The crossing location (Figure 3-1) is in agricultural land near Ardnamullan, Co. Meath, close to the border with Co. Westmeath and approximately 1km east of Kinnegad, Co. Westmeath. The nearest residential property is approximately 400m from the point where the current pipeline route crosses the M4 Motorway.

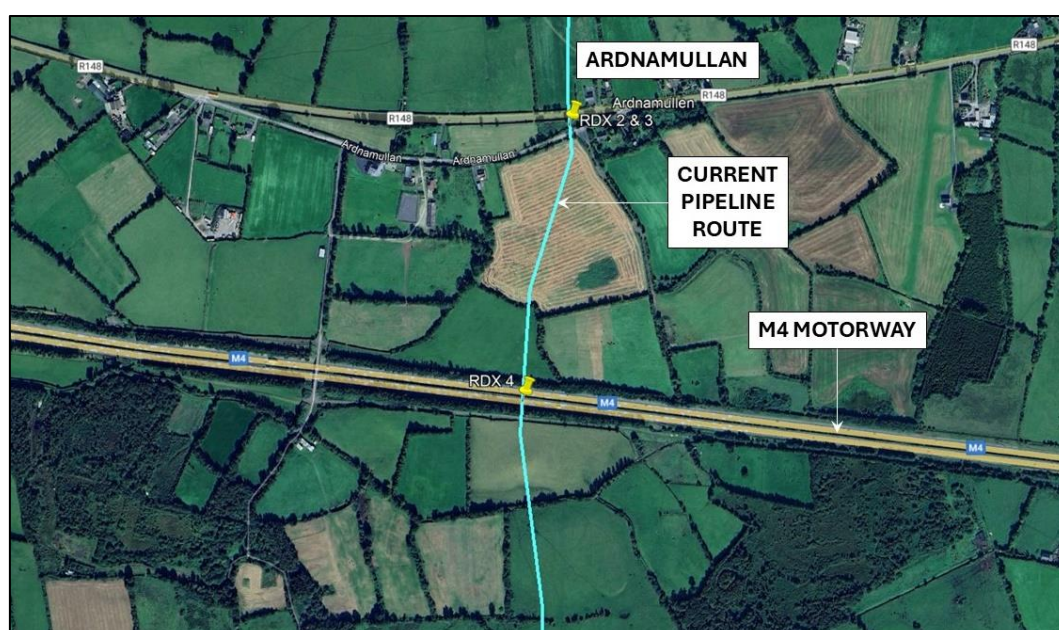


Figure 3-1: M4 Motorway (RDX4) Crossing Location

Land on the north side of the crossing is flat agricultural pasture land with grass fields bounded by established trees. The 4-lane M4 Motorway (Figure 3-2) carriageway is in a 50m wide (Approx.) cutting at the crossing location with vegetation-covered slopes back up to ground level in adjacent fields on both sides of the carriageway. Land on both sides of the crossing is agricultural pasture land with grass fields bounded by established trees and hedgerows. A minor watercourse follows the southern boundary of the first field adjacent to the southern boundary of the motorway. The minor watercourse is approximately 150m from the southern boundary of the motorway. Ground level on the south side of the crossing slopes upwards from the motorway boundary for approximately 100m before reaching the top of a large mound in the first field adjacent to the southern boundary of the motorway. Ground level at the top of the mound is approximately 10m higher than the motorway surface elevation. Ground level on the south side of the mound (Figure 3-3) returns to similar elevation in surrounding fields.

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Figure 3-2: View of Carriageway from Bridge Structure at M4 Motorway Crossing



Figure 3-3: South Side of M4 Motorway Crossing from Top of Mound on South Side of Crossing

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3.2 Local Constraints

3.2.1 Existing Infrastructure

The main infrastructure present along the pipeline route at the crossing location is the M4 Motorway 4-lane carriageway, related infrastructure, and associated land. No other major items of above ground or below ground infrastructure that would create major obstacles to pipeline/crossing construction are present.

The preliminary HDD profile will be designed so that the potential for negative impacts to existing M4 Motorway infrastructure is minimised. Specified minimum allowable depth of cover between the pipeline and the M4 Motorway road surface is 1.2m. Ground settlement limits at road surface level are expected to be subject to agreement with the motorway asset owner/operator. An objective of the preliminary HDD profile design will be to maximise depth of cover below the motorway in order to minimise the potential for ground settlement at the road surface and to minimise the potential for drilling fluid Inadvertent Returns (IR) to motorway land during drilling. A depth of cover between the HDD profile and the M4 motorway surface of 18.0m (Approx.) is currently proposed. A ground settlement check for the motorway surface is provided in Section 5.3 of this document to show that the preliminary HDD profile design satisfies initial assumptions on ground settlement limits for the motorway surface. A ground settlement limit of 5mm is assumed for preliminary design purposes in accordance with Ref. 3. A preliminary drilling fluid hydrofracture assessment is provided in Section 5.4 of this document to show that the risk of drilling fluid IR to the motorway surface is within acceptable limits for the preliminary HDD profile.

3.2.2 Natural Features

No significant natural features or major environmental constraints are understood to be present along the pipeline route at the proposed M4 Motorway Crossing location. A small watercourse is present approximately 150m south of the M4 Motorway southern boundary. Large trees are present within the embankments adjacent to the M4 Motorway carriageway (assumed to be within TII land boundary) and along field boundaries (assumed to be private land ownership) on both sides of the crossing. The crossing will be designed to avoid all woodland areas and to ensure that no crossing construction activities will take place within the TII land boundary.

3.2.3 Working Areas

The only constraint present on the north side of the M4 Motorway Crossing for establishment of working areas for pipeline and crossing construction activities are assumed to be the field boundaries where established trees and hedgerows are present. Due to the proposed distance between the current

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pipeline route and the existing field boundaries this is not considered to be a major obstacle to pipeline/crossing construction.

The only constraints present on the south side of the M4 Motorway Crossing for establishment of working areas for pipeline and crossing construction activities are assumed to be the field boundaries where established trees and hedgerows are present, and the steep terrain in the field immediately south of the M4 Motorway land boundary. Due to the proposed distance between the current pipeline route and the existing field boundaries this is not considered to be a major obstacle to pipeline/crossing construction. However, the steep terrain in the field immediately south of the M4 Motorway land boundary is considered to be an obstacle to crossing construction and it is recommended that the crossing is extended beyond this area to more level terrain to the south.

An initial assessment of working area requirements and existing constraints indicates that sufficient space is available for construction of an HDD crossing on both sides of the M4 Motorway Crossing. HDD Entry and Exit Point sites can be located within the proposed pipeline construction working width (assumed as 30m width) on both sides of the crossing assuming a preliminary site working area requirement of 1000m² for both the HDD Entry Point and HDD Exit Point sites. Additional working area could be taken within the proposed pipeline construction working width by extending the area footprint along the pipeline route centreline, if required. Due to the relatively straight alignment of the proposed pipeline route on the south side of the crossing, it is considered more appropriate to have the HDD pipe string fabrication corridor on this side of the crossing where it should be possible to fabricate the HDD pipe string within the proposed pipeline construction working width.

It is not considered possible to complete an HDD crossing of the M4 Motorway based on the current pipeline route alignment and a more suitable alignment will be proposed as part of this preliminary crossing design exercise. As a result, the proposed pipeline route centreline and construction working width will need to be adjusted to suit. Working area requirements for an HDD crossing of the M4 Motorway should not be affected. The detailed design pipeline route shall include the required centreline realignment in order to conform with the proposed crossing alignment.

No significant constraints are understood to be present for crossing construction. Temporary Working Area (TWA) requirements are expected to be subject to agreement with landowners and Transport Infrastructure Ireland (TII).

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4 Ground Conditions Assessment

A Geotechnical Interpretive Report (GIR) for the M4 Motorway Crossing (Ref. 2) has been provided for information. The GIR contains a geotechnical desk study and a summary of the site investigation work that has been undertaken by the project.

4.1 Geotechnical Desk Study

The geotechnical desk study provided as part of the GIR (Ref. 2) is based on information available in the public domain for local geological conditions.

The geotechnical desk study only discusses the bedrock geology at the crossing location and does not discuss the Quarternary soils. Consultation of the GSI online database shows that the Quarternary soils present (Figure 4-1) potentially include widespread alluvium blanketing of till derived from limestone, gravel derived from limestone and cut over peat. The extent of any cut and replace operations for motorway construction is not known.

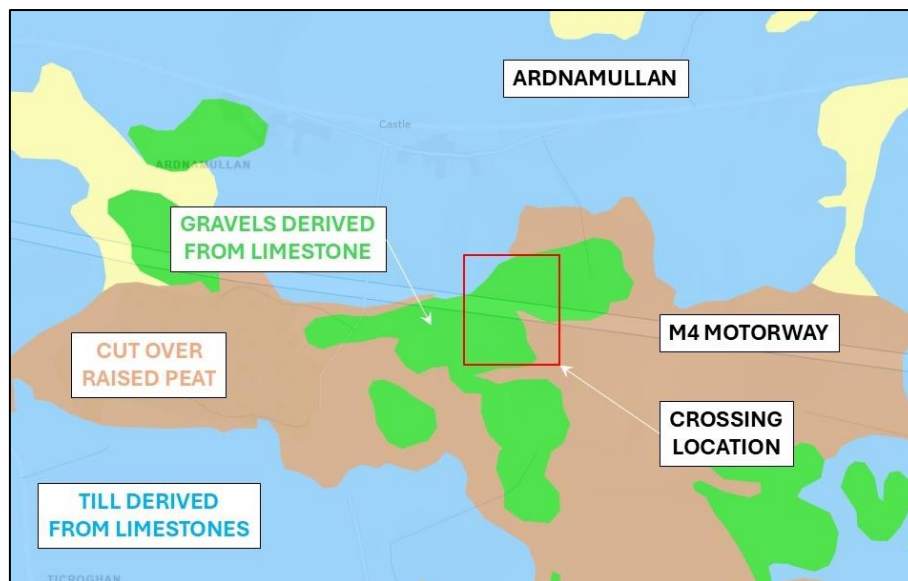


Figure 4-1: Quarternary Soils Plot for M4 Motorway Crossing Site Location (GSI)

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The geotechnical desk study includes a summary of local bedrock geology. A bedrock geology plot for the general area of the M4 Motorway Crossing (Figure 4-2) shows that the site is underlain by the Lower Carboniferous, Waulsortian Limestone (WA in Figure 4-2). The Waulsortian Limestone largely consists of calcareous mudstones, wackestones, and packstones, many of them containing original cavities (including stromactis) filled with internal sediments and fibrous and blocky sparry cements.

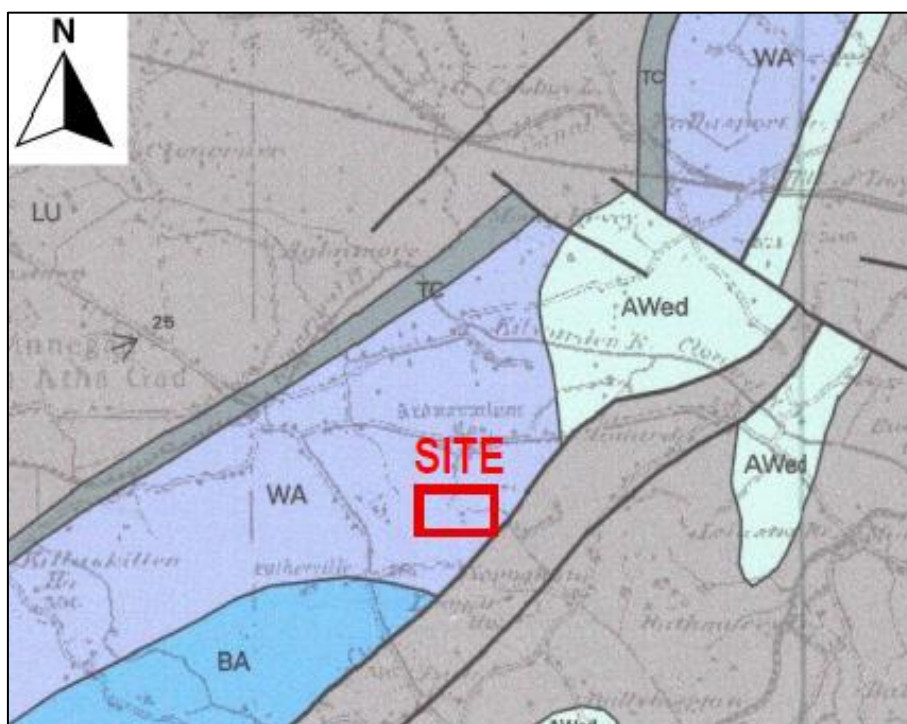


Figure 4-2: Bedrock Geology Plot for M4 Motorway Crossing Site Location (GSI)

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4.2 Review of Site Investigation Data

Site investigations have been completed for the M4 Motorway Crossing location. Details of the exploratory holes completed at the M4 Motorway Crossing location are summarised in Table 4-1.

Table 4-1: Exploratory Hole Details for RDX4

Borehole No.	Borehole Type	Borehole Coordinates	Borehole Level	Borehole Depth	Groundwater Level
BH16	Cable Percussion	662475.07 E 744340.60 N	+73.73m AOD	1.0m	No Water Strike
BH16A	Cable Percussion	662476.50 E 744338.87 N	+73.73m AOD	6.5m	No Water Strike
BH17	Cable Percussion	662499.41 E 744312.61 N	+74.52m AOD	7.5m	1.7m BGL
BH18	Cable Percussion	662462.68 E 744221.94 N	+74.69m AOD	6.0m	4.0m BGL
BH19	Cable Percussion	662489.12 E 744203.29 N	+75.51m AOD	8.5m	3.3m BGL
BH50	Cable Percussion	662483.88 E 744417.75 N	+72.68m AOD	5.8m	3.0m BGL
BH51	Cable Percussion	662511.02 E 744093.63 N	+70.71m AOD	3.0m	No Water Strike
BH51A	Cable Percussion	662510.06 E 744092.51 N	+70.57m AOD	13.0m	2.0m BGL
RC16A	Rotary Core (Symmetrix)	662476.50 E 744338.87 N	+73.73m AOD	20.2m	No Water Strike
RC17	Rotary Core (Symmetrix)	662499.41 E 744312.61 N	+74.52m AOD	20.8m	13.7m BGL
RC18	Rotary Core (Symmetrix)	662462.68 E 744221.94 N	+74.69m AOD	20.25m	12.5m BGL
RC19	Rotary Core (Symmetrix)	662489.12 E 744203.29 N	+75.51m AOD	20.5m	17.4m BGL
RC50	Rotary Core (Symmetrix)	662483.88 E 744417.75 N	+72.68m AOD	20.7m	12.1m BGL
RC51A	Rotary Core (Symmetrix)	662510.06 E 744092.51 N	+70.57m AOD	20.5m	No Water Strike

The following descriptions (Majority of text descriptions taken directly from Ref. 2) summarise the ground conditions encountered across the site as identified by the exploratory locations. The geological cross-section provided in Ref. 2 is provided in Annex A of this report for information.

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4.2.1 Topsoil

Topsoil was generally found to be between 0.2-0.3m thick in the boreholes. The southernmost borehole, location 51, was flagged as having a “peaty TOPSOIL” to a depth of 0.5m. This borehole was located approximately 5m topographically lower than the nearest other borehole location (BH19).

4.2.2 Superficial Deposits – Glacial Till

BH50 was located furthest north of all holes at HCC1 (RDX4). A firm becoming stiff grey sandy gravelly CLAY was encountered beneath the Topsoil to an eventual end depth of 5.8m BGL (+66.88m AOD). An obstruction at this depth saw an end to cable percussion boring at BH50. Rotary drilling extended the exploratory hole to a depth of 13.8m BGL before intercepting rockhead. From 5.8m BGL, RC50 reported a continuation of stiff and very stiff grey brown gravelly sandy CLAY with cobbles and boulders to 10.4m BGL (+62.28m AOD). Minus obvious cobble and boulder content, the grey brown gravelly sandy CLAY continued to 12.1m BGL before passing to a grey brown sandy clayey GRAVEL to eventual rockhead at 13.8m BGL (+58.88m AOD). Limestone rock was cored at RC50 from 14.8m BGL (+57.88m AOD) to 20.7m BGL (+51.98m AOD).

Both boreholes BH16A (BH16 was terminated on a shallow obstruction at 1.0m BGL) and BH17 found a “soft” brown sandy gravelly SILT and SILT/CLAY initially from 0.2m / 0.3m BGL to a depth of 2.2m / 2.4m BGL. This “soft” consistency was proven by in situ SPT testing. A uniformly stiff and very stiff grey slightly sandy slightly gravelly CLAY completed the cable percussion boreholes 16A and 17 from 2.2m BGL (Approx.) to depths of 6.5m and 7.5m BGL. Rotary drilling demonstrated the continuation of the stiff CLAY to a depth of 12.6m BGL (RC16A) and 12.4m BGL (RC17). A basal layer of silty/clayey sandy GRAVEL was then intercepted in both RC16A and RC17 prior to meeting rockhead at 14.5m BGL (+59.23m AOD) and 15.4m BGL (+59.12m AOD). A thin layer of CLAY was found within the Gravel in RC16A. Limestone rock was cored at RC16A and RC17 from 14.8m BGL (+58.93m AOD) and 16.10m BGL (+58.42m AOD) respectively. This proves a consistent rockhead depth north of the M4 as depicted by the cross section featured in Annex A.

South of the M4 motorway, the three cable percussion boreholes suggest the presence of soft to firm and firm surficial soils initially. These are made up of fine-grained CLAY and SILT soils. Once again, SPT testing suggests a stiffening with depth with SPT N-values increasing in both BH18 and BH51A indicative of stiff soils from ca. 3.50m depth BGL. Both cable percussion holes BH18 and BH19 ended on obstruction at 6.0m and 8.50m BGL. H51A found dark brown clayey/silty very sandy and sandy GRAVEL from 9.30m BGL (+61.27m AOD) to its eventual end depth of 13.0m BGL (+57.57m AOD).

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The presence of a deep-seated GRAVEL was proven by rotary open hole drilling in both RC18 and in RC19. As with holes north of the M4, a sizeable Gravel-dominant layer was logged beneath the very stiff CLAY in RC18 to eventual rockhead. The Gravel here was logged from ca. 10.10m BGL (+64.59m AOD) to just shy of rockhead at 15.40m BGL (+59.29m AOD). Contrasting to RC18, although a Gravel layer was encountered, it was not recorded until a depth of 17.40m BGL (+58.11m AOD). It continued to a hole end depth of 20.50m BGL (+55.01m AOD). No rock was cored in RC19.

As with RC19, at RC51A no rock was recorded to a hole end depth of 20.5m BGL (+50.07m AOD). The Gravel logged in BH51A to 13.0m BGL was found to continue to 16.8m BGL (+53.77m AOD). A very stiff grey black gravelly CLAY took the hole to 20.5m BGL.

SPT N-values recorded in boreholes suggest a soft to firm and firm mantle of indigenous CLAY/SILT extending to 3.0m BGL in some cases. It may be the case that disturbance caused by boring coupled with water ingress diminished the in situ strength of the upper SILT soils which thereby delivered lower than expected or unrepresentative SPT results. The incidence of groundwater between 2m and 4m BGL could have artificially softened the uppermost SILT soils.

4.2.3 Bedrock

Rotary drilling was conducted at six locations at HCC1 (RDX4), both north and south of the M4 motorway. Drilling successfully proved rock at four of the six locations – the four northernmost holes. Drilling showed that cable percussion pre-bores terminated shy of rockhead in all cases. The mantle of glacial till soils comprised chiefly firm and stiff fine-grained CLAY/SILT overlying deeper GRAVEL deposits. Coring of the underlying bedrock commenced at depths ranging 14.8m BGL (RC50 & RC16A) to 16.3m BGL (RC18). These depths corresponded to elevations of +57.88m / +58.93m AOD and +58.39m AOD.

The recovered cores consist of fresh to slightly weathered, medium strong to strong, often massively bedded, pale grey, fine-grained slightly dolomitised crystalline calcisiltite LIMESTONE. Discontinuity spacings in the rotary cores generally ranged from very closely (20 to 60mm) to widely spaced (600mm to 2000mm) predominantly closely to medium spaced. The discontinuity surfaces were typically smooth and locally rough, planar to irregular. Apertures were tight to partly open, locally exhibiting clay smearing with some calcite veinfill. Dips were generally subhorizontal to 10°, locally 30-45°, rarely up to 75°.

The Point Load Strength Index (PLSI) test data produced $I_s(50)$ values ranging from 0.99 to 3.38 MPa with a mean value of 2.73 MPa. The PLSI strengths are suggestive of the presence of upperbound weak, predominantly medium strong and strong rock.

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Using a correlation factor (K) of 22 to assess compressive strength, this suggests a characteristic strength envelope in the order of 22 to 82 MPa and categorizes the bedrock as weak (5 to 25MPa) to strong (50 to 100MPa).

4.2.4 Groundwater

Water ingress was recorded in both cable percussion boreholes and rotary drillholes. The cable percussion boreholes intercepted groundwater at its shallowest at 2.0m BGL (BH17) and at its deepest, 10.0m BGL (BH51A). Multiple deep-seated strikes were observed in BH51A where gravels were intercepted. The most forceful water strike was hosted in the gravel-dominant sequence at 10.0m BGL in BH51A. Water rose rapidly upon intercepting the strike. Follow-on rotary openhole drilling at four of the six locations proved groundwater in the deeply buried gravelly strata between 12.1m and 17.4m BGL.

4.3 Suitability of Ground Conditions for HDD

Boreholes were completed in fields immediately north and south of the M4 motorway. They each encountered thick upper sequences of CLAY/SILT (stiffening with depth) with underlying deeper-seated, apparently water-bearing GRAVEL. Subsequent rotary coring at four of the six locations proved LIMESTONE bedrock from ca. 14.0m / 15.0m BGL. South of the motorway, bedrock fell away beyond 20.0m BGL (RC end depth) and was subsequently not proven in either RC19 or RC51A. There is some variation in the uppermost cover of superficial deposits whereby a soft to firm and soft SILT was remarked initially in a number of holes to 2.0m / 2.50m BGL (Approx.).

An HDD crossing of the M4 motorway is anticipated to be within limestone bedrock, gravel, and stiff clay layers over the majority of the crossing length. Potential for encountering cobbles and boulders in the soils above bedrock layer is considered to be medium, where cobbles/boulders could be encountered every 10-20m. A geophysical survey is recommended for the proposed crossing alignment to establish bedrock level, particularly on the south side of the crossing where bedrock level was not encountered in boreholes BH51/BH51A/RC51A. This would provide more confidence in bedrock levels for the crossing.

Cobbles and boulders are expected to be derived from the limestone bedrock and can be drilled through if the HDD equipment used is suitable for rock drilling. The HDD bore is expected to be self-supporting in the bedrock layer and the risk of bore collapse in the bedrock layer is considered to be very low. Routing the HDD profile in the bedrock layer where the bore passes below the M4 motorway will reduce the risk of ground settlement of the motorway surface. A preliminary ground settlement check for the M4 motorway road surface is provided as part of this preliminary crossing design exercise (Section 5.3).

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Potential karstification of the limestone bedrock may increase risk of drilling fluid IR to the formation, or to the surface. Routing the HDD profile deep into the bedrock layer could reduce the risk of drilling fluid IR to formation or to the surface. A preliminary drilling fluid hydrofracture assessment is provided as part of this preliminary crossing design exercise (Section 5.4). However, this does not take into consideration the potential for natural leak paths to the surface to be present. The potential for natural leak paths to be present is considered to be low based on the ground conditions assessment. Karst features have not been mapped at the crossing location in public domain mapping.

The potential presence of compacted made ground (assumed as Class 2 Fill) below the motorway is expected to reduce the risk of ground settlement at the crossing of the M4 motorway. A preliminary ground settlement check for the road surface is provided as part of this preliminary crossing design exercise (Section 5.3). Class 2 Fill is expected to be present at this location. However, as the extent and depth of the Class 2 Fill material is unconfirmed, conservative soil parameters are used in the preliminary ground settlement check.

The presence of gravel can cause issues for the HDD method, especially where loose gravel layers may exist, or where the majority of the crossing length is through a soil matrix containing a high percentage of gravels with a low clay/silt content. The gravel layer present at the crossing location contains cohesive materials (clay and silt) with sand also present within the soil matrix. Due to the anticipated small size of the HDD bore required for the 12" OD pipeline, the risk of bore collapse in the gravel layer is considered to be low. Cobble and boulder content within the gravel layer is classified as occasional and is therefore not considered to be a major risk to drilling operations in the gravel layer. The potential presence of artesian groundwater in the gravel layers will have to be taken into consideration by the construction contractor. Artesian groundwater can contribute to HDD bore instability, but the risk can be minimised by an optimised design. Typically, contractors will design the HDD profile to avoid areas where artesian groundwater may impact bore stability. Artesian groundwater conditions can normally be balanced by the heavier drilling fluid in the HDD bore.

An HDD solution appears to be feasible based on the anticipated ground conditions, short length of HDD bore required, and small diameter of HDD bore required. The preliminary HDD crossing design will consider the local constraints and ground conditions with the additional objectives of minimising risk of ground settlement at the motorway, and the objective of minimising the risk of drilling fluid IR to the surface. The HDD profile design and crossing construction methodology are expected to be developed further by the construction contractor and are expected to include further assessment of local ground conditions and associated risks.

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5 HDD Crossing Preliminary Design

5.1 Preliminary HDD Profile Design

The preliminary HDD profile design is generally based on the following objectives:

- Achieve a combined crossing of the motorway and field immediately south of the motorway;
- Plan the HDD crossing alignment within the project order limits;
- Minimise HDD crossing length;
- Minimise complexity of pipeline tie-ins on both sides of the crossing;
- Cross the motorway at perpendicular, or close to perpendicular, angles;
- Maintain appropriate clearance (>10m) between construction working areas and motorway land boundaries;
- Maintain appropriate clearance (>20m) between construction working areas and the existing watercourse on the south side of the crossing;
- Maintain a minimum required depth of cover to the pipeline of 1.6m at drainage ditches;
- Maintain a minimum required depth of cover to the pipeline of 1.2m at the motorway;
- Plan the HDD profile within stable soils over the majority of the profile length;
- Plan the HDD profile maximum depth within the coverage of the site investigations;
- Achieve an HDD profile depth which minimises risk of ground settlement at existing infrastructure locations;
- Achieve an HDD profile depth which minimises risk of drilling fluid IR to the surface;
- Achieve an HDD profile length which allows the pipe string to be fabricated in a single length; and
- Provide a feasible HDD profile geometry for crossing construction and pipeline operation.

The proposed HDD crossing alignment and profile achieves all of the objectives listed above and includes a crossing of the M4 Motorway and a crossing of the existing watercourse to the south of the M4 Motorway. However, due to the current alignment of the pipeline route being unsuitable for the HDD crossing length being proposed, a new pipeline route alignment will be required to incorporate the proposed HDD crossing alignment which is required to ensure a straight HDD crossing alignment in plan. The detailed design pipeline route shall include the required centreline realignment in order to conform with the proposed crossing alignment.

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The pipe string fabrication corridor is located on the south side of the crossing due to the better alignment of the pipeline construction working width on this side of the crossing. No curvature of the pipe string is anticipated. However, some minor curvature of the pipe string can be accommodated in the space available.

Standard practice is to use straight alignments in plan for HDD crossings in order to minimise the complexity of the pilot hole drilling operation. A straight alignment in plan is used for the preliminary HDD crossing alignment in order to provide a conservative approach. HDD crossings can be curved in plan when necessary. However, complexity of crossing construction may increase where short radius curves (approaching the operational limits of the drill pipe), or combined horizontal and vertical curves, are proposed.

The preliminary HDD crossing alignment crosses the motorway and existing watercourse close to a perpendicular alignment (Figure 5-1). An entry angle of 14° and an exit angle of 12° have been used. A minimum radius of curvature of 360m for the HDD profile has been assumed based on typical values used for HDD crossings of this size in similar ground conditions. The proposed radius of curvature ensures that installation and operation stresses on the pipeline should remain within allowable limits, and a greater depth of cover is achieved at the motorway. This results in a preliminary HDD crossing 2D length of approximately 350m in plan.

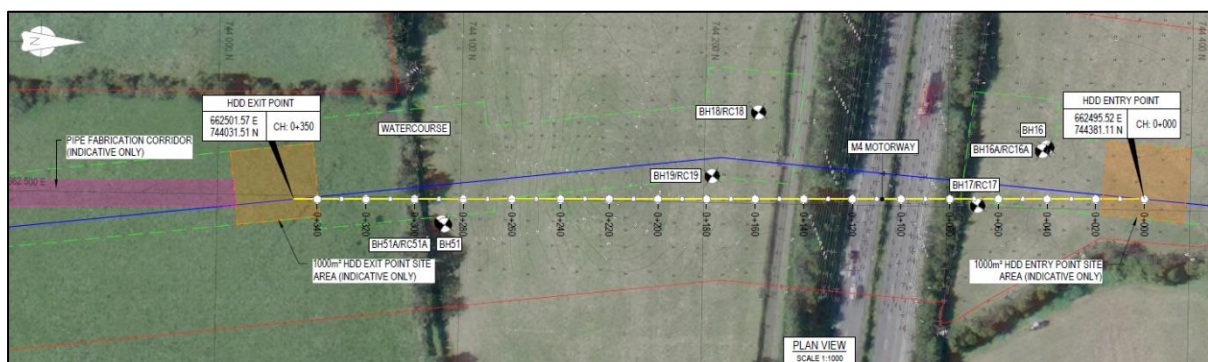


Figure 5-1: Preliminary HDD Crossing Plan Alignment

The overall length of the crossing may be subject to change during the detailed design of the HDD crossing by the construction contractor. However, the overall length is not expected to change significantly. The crossing location and alignment of the pipeline in relation to the motorway and the watercourse is not expected to change. The final crossing extents and site area boundaries may be subject to change prior to construction during the detailed design of the crossing. However, the

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minimum allowable proximity distance to land boundaries, the M4 motorway, and the watercourse must be observed.

The vertical alignment of the preliminary HDD profile (Figure 5-2) is expected to pass through the following soil layers (HDD equipment should be selected accordingly):

- Limestone bedrock for the majority of the crossing length;
- Clayey/silty/sandy gravel with occasional cobbles and boulders immediately above bedrock level;
- Mixed layers of sandy gravelly silt with medium to high cobble content and occasional boulders, silty/sandy/gravelly clay with low to medium cobble and boulder content, and sandy silt with low cobble content in the shallow sections of the profile at each end of the crossing.

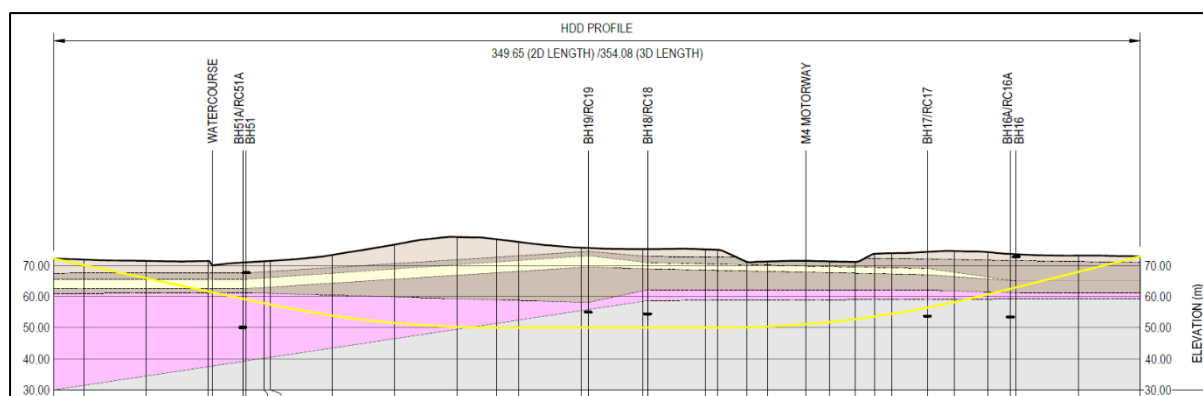


Figure 5-2: Preliminary HDD Crossing Profile Alignment

The minimum clearance distance between the preliminary HDD profile and the M4 Motorway and watercourse is 18.0m (Approx.) and 10.0m (Approx.) respectively. The resultant minimum depth of cover to the pipeline and drainage channels at the motorway is therefore expected to be greater than the minimum allowable figures of 1.2m and 1.6m respectively. The resultant minimum depth of cover to the pipeline at the watercourse is therefore expected to be greater than the minimum allowable figure of 1.6m. The preliminary HDD profile is within the limestone bedrock layer where the profile passes below the M4 Motorway. The minimum clearance distance between the HDD profile and the M4 Motorway and watercourse may be subject to change prior to construction during the detailed design of the crossing.

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5.2 Preliminary Pipeline Stress Check

5.2.1 Pipeline Installation Pull Force Check

A pipe installation pull force check has been performed for the preliminary crossing alignment. Proprietary HDD design software D-Geo Pipeline has been used to calculate the pipeline installation pull forces for the proposed pipeline. The anticipated pull force is provided in Table 5-1.

Table 5-1: Pipe Installation Pull Force Summary

Pipe OD (mm)	Pipe WT (mm)	Pipe Weight Downhole Empty (kg/m)	Friction Value Pipe Downhole	Estimated Maximum Pull Force (Tonnes)
323.9	12.7	-6.12	0.3	12.4

The pipe installation pull force is considered to be within the allowable limits for the pipeline (subject to confirmation). The estimated maximum pull force can be used as a guide to ensure that a suitable capacity HDD drilling rig is proposed for the pipeline installation operation.

5.2.2 Temporary Installation Stresses

A check on temporary installation stresses on the pipe has been performed for the preliminary crossing alignment. Proprietary HDD design software D-Geo Pipeline has been used to check temporary pipeline installation stresses for the proposed pipeline. The maximum temporary installation stresses on the pipeline are provided in Table 5-2.

The analysis of temporary installation stresses on the pipe includes installation forces, radius of curvature of the HDD bore, and depth of the HDD bore (drilling fluid hydrostatic pressure on pipe) for the start and end of the installation operation. A maximum allowable stress value of 377.27 N/mm² has been assumed for the temporary installation case. The analysis also assumes a single full pipe string length for the start of the pullback operation.

Table 5-2: Temporary Installation Stresses Summary

Maximum Stress on Pipe (Start of Pull) (N/mm ²)	Maximum Stress on Pipe (End of Pull) (N/mm ²)	Allowable Maximum Stress on Pipe during Installation (N/mm ²)	Status
238	151	377.27	OK

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5.3 Preliminary Ground Settlement Check

A preliminary ground settlement check for the M4 motorway has been performed based on the minimum clearance distance between the preliminary HDD bore alignment and the motorway surface. The settlement analysis has been performed using recognised ground settlement theory provided in Ref. 7. A maximum allowable ground settlement figure of 5.0mm for the motorway surface has been assumed for the purpose of analysis. A conservative ground volume loss of 50% has been assumed for the purpose of analysis. This figure is typically 20% for HDD applications and can be as low as 0% in strong bedrock. A conservative trough width parameter of 0.4 has been selected based on the presence of firm cohesive clay and granular materials above the limestone bedrock layer. The figure selected for the trough width parameter ignores the presence of stable bedrock at the level of the HDD bore. The results of the ground settlement check for the M4 motorway are provided in Table 5-3.

Table 5-3: M4 Motorway Ground Settlement Check Summary

Minimum Clearance Distance (m)	Assumed HDD Bore Diameter (mm)	Trough Width Parameter (K)	Assumed Volume Loss	Maximum Settlement at Road Surface (mm)	Status
18.0	508.0	0.4	50%	3.53	OK

The results of the ground settlement check for the M4 motorway indicate that estimated ground settlement values are within assumed allowable limits using conservative assumptions for the purpose of analysis. The HDD bore will be within the limestone bedrock layer where it passes below the M4 Motorway and, therefore, ground settlement risk is considered to be very low.

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5.4 Preliminary Drilling Fluid Hydrofracture Analysis

Hydrofracture, or frac-out, in HDD occurs when drilling fluid pressure exceeds the ability of the soil above the HDD bore to contain the drilling fluid, causing the drilling fluid to fracture the surrounding ground and potentially reach the surface. Risk of drilling fluid IR to the surface typically increases where depth of cover to the HDD bore is lowest, such as in the shallow sections at both ends of the HDD profile, and where the HDD profile passes below low points in the local terrain such as watercourses or natural/man-made depressions. Drilling fluid can also reach the surface through natural leak paths present in the soil layers. This is not considered in a hydrofracture analysis.

Contractors typically install steel casing pipe in the shallow section of a HDD bore at the HDD Entry Point in order to stabilise the shallow soil layers. This casing pipe can also minimise the risk of drilling fluid IR to the surface in this section of the HDD bore. Casing pipe can be used as a temporary contingency measure to stabilise soils and minimise risk of drilling fluid IR to the surface. However, the current pipeline design does not allow for casing pipe to be left in-situ permanently.

A preliminary drilling fluid hydrofracture analysis has been performed based on the preliminary HDD crossing profile and soils profile. Proprietary HDD design software D-Geo Pipeline has been used to perform the drilling fluid hydrofracture analysis.

Typical values for soil parameters required for design have been assumed for the purpose of analysis. Values should be assumed as preliminary and subject to confirmation during detailed design. It should be noted that a drilling hydrofracture analysis is typically only performed for HDD bores being drilled in non-rock soils and is not usually performed for bedrock conditions. However, dense gravel conditions have been assumed instead of bedrock for the purpose of analysis in order to mimic the potential voids present in the limestone bedrock.

Typical values for drilling fluid parameters required for design have been assumed for the purpose of analysis. These values are dependent on the construction methodology being proposed by the construction contractor and are potentially subject to change.

The analysis is performed for the three main stages of the HDD operation:

- Pilot Hole Drilling
- Bore Reaming/Hole Opening
- Pipeline Installation

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The drilling fluid hydrofracture analysis provides a baseline minimum required drilling fluid downhole pressure to ensure drilling fluid flow back to the surface, and maximum allowable drilling fluid pressures related to (1) deformation of the HDD bore and (2) soil cover. The maximum allowable drilling fluid pressure related to soil cover is considered to be the worst case in relation to risk of drilling fluid reaching the surface. Where there is a large working window for downhole pressure (large difference between minimum required and maximum allowable drilling fluid downhole pressure), risk of drilling fluid hydrofracture to the surface is considered to be low. Conversely, where there is a small working window for downhole pressure (small difference between minimum required and maximum allowable drilling fluid downhole pressure), risk of drilling hydrofracture to the surface is considered to be high. The results for the hydrofracture analysis are provided in graphical form.

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The results of the hydrofracture analysis for the pilot hole drilling operation are summarised in Figure 5-3. The graph shows a large working window for drilling fluid pressure over the majority of the crossing length, meaning risk of drilling fluid hydrofracture to the surface is potentially very low. The working window for drilling fluid pressure is smaller at the entry and exit sections where cover to the HDD bore is lower. However, conservative soil and drilling fluid parameters have been used for the purpose of analysis and hydrofracture risk is expected to be low in these areas. The shallow sections on HDD profiles are known areas of increased hydrofracture risk due to the reduced depth of cover to the HDD profile. Mitigation measures, such as reducing the drilling fluid pumping rate and downhole pressure in these sections, are typically employed by the contractor to reduce the potential for drilling fluid IR to the surface in shallow sections. In addition, continuous monitoring of drilling fluid volumes, and continuous monitoring of the surface for drilling fluid IR, are performed during construction. Contingency measures are expected to be in place in the event of drilling fluid IR to the surface.

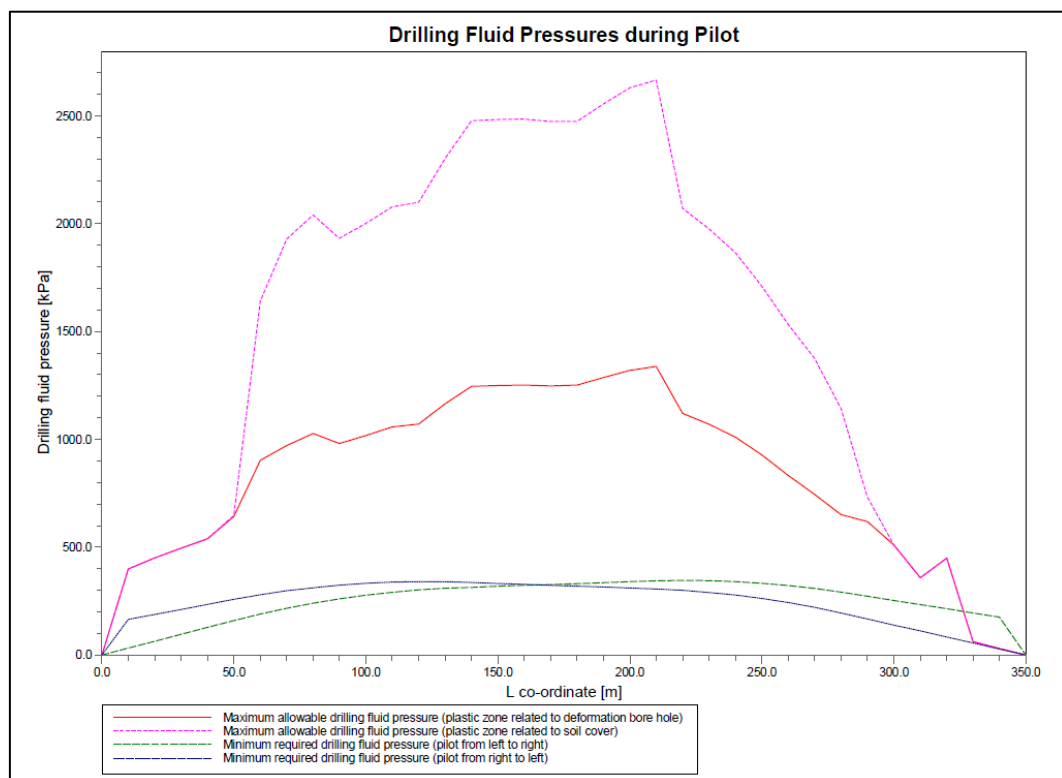


Figure 5-3: Drilling Fluid Hydrofracture Analysis Results (Pilot Hole)

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The results of the hydrofracture analysis for the bore reaming/hole-opening operation are summarised in Figure 5-4. The graph shows a large working window for drilling fluid pressure over the majority of the crossing length, meaning risk of drilling fluid hydrofracture to the surface is potentially very low. The working window for drilling fluid pressure is smaller at the entry and exit sections where cover to the HDD bore is lower. However, conservative soil and drilling fluid parameters have been used for the purpose of analysis and hydrofracture risk is expected to be low in these areas.

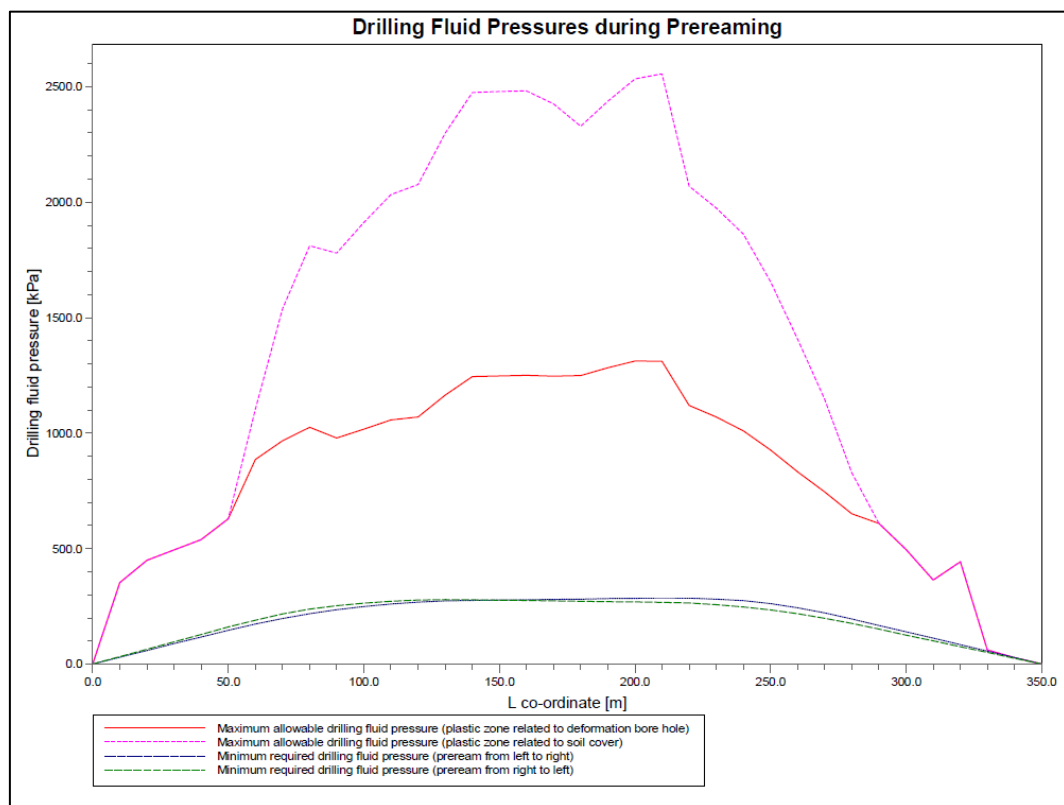


Figure 5-4: Drilling Fluid Hydrofracture Analysis Results (Bore Reaming/Hole-Opening)

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The results of the hydrofracture analysis for the pipeline installation operation are summarised in Figure 5-5. The graph shows a large working window for drilling fluid pressure over the majority of the crossing length, meaning risk of drilling fluid hydrofracture to the surface is potentially very low. The working window for drilling fluid pressure is smaller at the entry and exit sections where cover to the HDD bore is lower. However, conservative soil and drilling fluid parameters have been used for the purpose of analysis and hydrofracture risk is expected to be low in these areas.

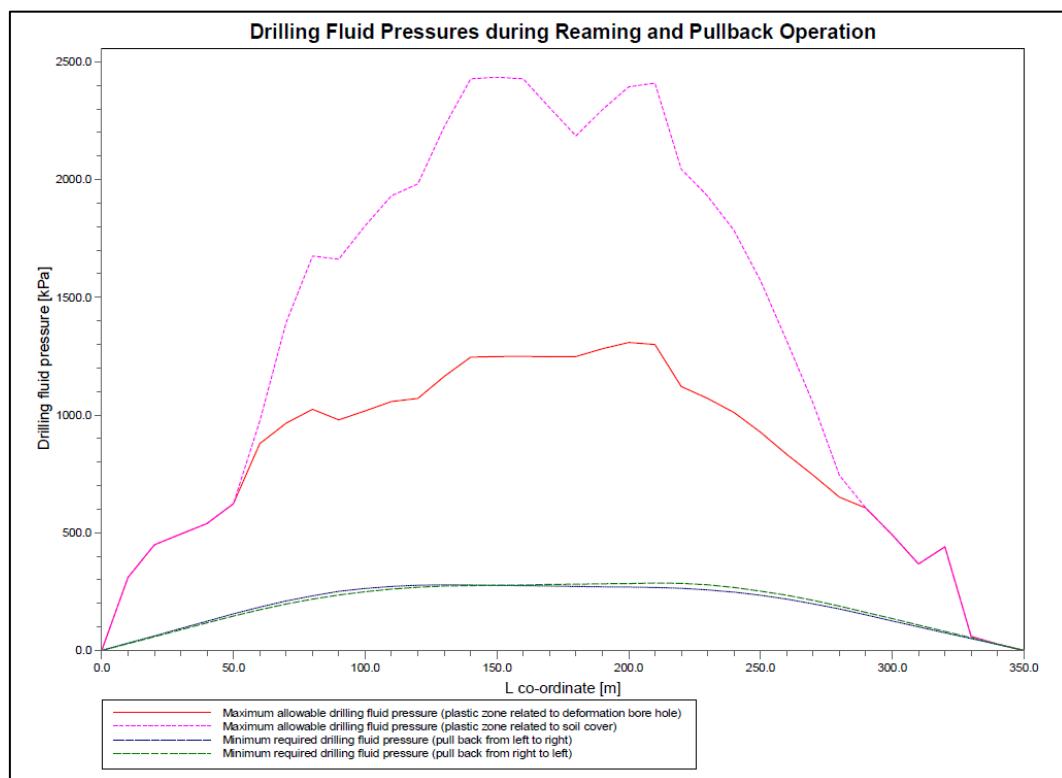


Figure 5-5: Drilling Fluid Hydrofracture Analysis Results (Pipeline Installation)

Overall, the risk of drilling fluid hydrofracture to the surface is considered to be low for this crossing. The north side of the crossing is at co-ordinate 0.0m on the graphs and the south side of the crossing is at co-ordinate 350.0m.

The watercourse on the south side of the crossing is at co-ordinate 300.0m (Approx.) on the graphs above. The working window for drilling fluid pressure is interpreted as being appropriate for the proposed operations and risk of drilling fluid hydrofracture to the watercourse is considered to be low.

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Contractors can implement contingency measures in the event of excessive drilling fluid losses to formation or drilling fluid IR to the surface. Contingency measures include the addition of Loss Control Measures (LCM) to the drilling fluid or controlled grouting of the HDD bore in areas of concern. Contractors will implement an emergency response procedure in the event of drilling fluid IR to the surface. This typically involves installing a soil bund around the drilling fluid that has come to the surface to prevent further spreading, pumping the drilling fluid back to the HDD site working area, and then reinstating the affected land.

Results presented in this document are considered to be preliminary. Conservative assumptions for various soil parameters and drilling parameters have been made for the purpose of analysis. Further assessment of drilling hydrofracture risk is expected to be performed during the detailed design phase of the works as the HDD crossing design and methodology is developed. The performance of a drilling fluid hydrofracture risk assessment during detailed design is typically a requirement of the controlling specification for the HDD works.

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6 Design Risk Assessment

A design risk assessment for the preliminary design of the HDD crossing is provided in Table 6-1 below. Residual risks are considered to be high-level risks that are relevant to future design and construction activities and provided for information only.

A geophysical survey is recommended for the crossing to establish bedrock level, particularly on the south side of the crossing where bedrock level was not encountered in boreholes BH51/BH51A/RC51A. Planning the HDD profile to pass through bedrock, where possible, may reduce overall risk for the crossing in terms of HDD bore stability. A geophysical survey can provide additional information on local bedrock level.

Table 6-1: Design Risk Assessment for Preliminary Crossing Design

Potential Hazard	Design Action	Residual Risk
Unexpected Ground Conditions	Review of project-specific site investigation data supplemented with information available in public domain for crossing location. Preliminary HDD profile designed to pass through most stable ground conditions.	Ground conditions between site investigation locations differs from assumptions made in review. Residual risk remains if HDD contractor does not interpret soils information correctly and does not plan works accordingly.
Insufficient clearance to existing infrastructure potentially resulting in breach of allowable settlement limits.	Location and approximate level of existing infrastructure has been established during site surveys. Minimum clearance of 10m (Approx.) between preliminary HDD profile and existing motorway proposed in design. Preliminary ground settlement checks performed in design using conservative assumptions and soil parameters.	HDD contractor will perform settlement checks for existing infrastructure prior to construction and design HDD profile to suit. Residual risk remains if HDD contractor does not maintain recommended clearance between HDD profile and existing infrastructure.
High installation loads on pipeline causing damage to pipeline.	Design checks performed for anticipated installation loads on pipeline.	HDD contractor will perform installation stress checks for proposed pipeline and HDD profile alignment prior to construction. Residual risk remains if HDD contractor does not monitor installation loads and does not maintain installation loads within recommended limits.

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Potential Hazard	Design Action	Residual Risk
Drilling fluid inadvertent returns to surface during drilling.	Ground levels and preliminary soil profile for crossing location established during site surveys and crossing assessment work. High-level assessment of drilling fluid hydrofracture risk performed based on assumed ground conditions and drilling parameters. Hydrofracture risk is considered to be low based on the assumed ground conditions, the preliminary crossing length and depth, and the maximum expected HDD bore diameter.	Site-specific hydrofracture analysis will be performed by HDD contractor prior to construction. HDD contractor will perform surface monitoring during drilling and will have drilling fluid containment and clean-up measures on site for the duration of the works. Residual risk remains if HDD contractor does not maintain downhole pressure within working envelope as recommended by hydrofracture analysis.

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1 Introduction

1.1 Project Description

Bord na Móna (BnM) are planning to convert the existing diesel generation peaking plant at the Edenderry Power Station to run on natural gas in an effort to reduce CO₂ emissions. A new 12" Outside Diameter (OD) high pressure gas pipeline is required to be installed between the existing gas transmission network and the power station in order to supply natural gas for the gas turbines. The new GNI143 Ballykilleen Pipeline will be approximately 23km in length between the proposed hot tap location (14301 Kilwarden Offtake Installation) on the existing GNI BGE/77 Pipeline to the West (PTTW) pipeline and an Above Ground Installation (AGI) facility within the BnM Renewable Energy Complex at Edenderry.

A number of special crossings of existing infrastructure and natural features will be required on the new pipeline route. The 4 No. main crossings identified are:

1. Kilwarden River (RVX1)
2. M4 Motorway (RDX4)
3. Yellow River (RVX2)
4. Grand Canal (WCX23)

1.2 Summary of Scope and Document Purpose

Fingleton White (FW) have been engaged by GNI to produce the design for the new gas supply pipeline between the existing high pressure gas transmission network and the AGI facility at Edenderry power station. MJS Project Services (MJS) have been engaged by Fingleton White to produce crossing construction method assessments and preliminary crossing designs for several trenchless crossings of existing infrastructure and natural features on the new pipeline route.

The purpose of this document is to provide a narrative to support the preliminary design of a HDD crossing of the Yellow River (RVX2) and to provide a summary of the associated design checks that have been performed. The Yellow River Crossing is currently in the planning phase. Therefore, the proposed crossing design should be considered as preliminary and potentially subject to change and further development during the detailed design and construction phases. The preliminary HDD crossing design is based on current HDD industry guidelines and best practices (Section 1.3) and takes into consideration site-specific conditions and constraints.

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1.3 References

Ref:	Document Number	Document Title
1	MJS-FW-GBNME-DWG-003	Yellow River Crossing – Preliminary Crossing Drawing
2	25882 – Gas to Bord na Móna, Edenderry – Phase 1 GI – HCC2 – Geotechnical Interpretive Report – Rev 0 (IGSL)	
3	DNV-ST-F121	Pipeline Installation Using Horizontal Directional Drilling (DNV)
4	NASTT's Horizontal Directional Drilling (HDD) Good Practice Guidelines (NASTT)	
5	Information and Recommendations for the Planning, Construction and Documentation of HDD Projects – DCA Technical Guidelines (DCA)	
6	Settlement above Tunnels in the United Kingdom – Their Magnitude and Prediction (O'Reilly and New)	

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1.4 Abbreviations / Acronyms

Term	Meaning
3LPE	3-Layer Polyethylene
3LPP	3-Layer Polypropylene
AGI	Above Ground Installation
AOD	Above Ordnance Datum
BGL	Below Ground Level
BH	Borehole
BnM	Bord na Móna
CO ₂	Carbon Dioxide
DCA	Drilling Contractors Association
DN	Diameter Nominal
DNV	Det Norske Veritas
FW	Fingleton White
GIR	Geotechnical Interpretive Report
GNI	Gas Networks Ireland
GSI	Geological Survey Ireland
HDD	Horizontal Directional Drilling
IFI	Inland Fisheries Ireland
ID	Internal Diameter
LCM	Loss Control Measures
MJS	MJS Project Services
NASTT	North American Society for Trenchless Technology
OD	Outside Diameter
PLSI	Point Load Strength Index
PTTW	Pipeline to the West
RC	Rotary Core
RVX	River Crossing
SPT	Standard Penetration Test
WT	Wall Thickness

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2 Pipeline Details

Details of the proposed route of the new gas pipeline (GNI143 Ballykilleen Pipeline) between the proposed offtake location (14301 Kilwarden Offtake Installation) on the existing GNI BGE/77 Pipeline to the West (PTTW) pipeline and an Above Ground Installation (AGI) facility within the BnM Renewable Energy Complex at Edenderry have been provided for the purpose of preliminary crossing design. The Yellow River Crossing is located between Ch11200.00 and Ch11500.00 (Approx.) on the proposed pipeline route.

The new gas pipeline will be a 12" (323.9mm) OD (DN300) carbon steel pipeline. Material grade of the pipeline will be L415 (X60), and the wall thickness (WT) of the pipeline will be 12.7mm at special crossing locations. The pipeline external coating thickness will be 2.5mm where 3-Layer Polyethylene (3LPE) is used and 10mm where 3-Layer Polypropylene (3LPP) is used. Pipeline field joint coating material and thickness is subject to confirmation.

The minimum depth of cover for the pipeline is 1.2m at Road Crossings (RDX), 1.6m at River Crossings (RVX), and 3.0m at the Grand Canal. The minimum depth of cover for the pipeline at the Yellow River Crossing is therefore assumed to be 1.6m to the riverbed, and 1.6m to bed level of any drainage channels present in the crossing extents.

In addition to the pipeline to be installed at the crossing of Yellow River, 2 No. 32/24mm diameter cable ducts are to be installed at the crossing. It is anticipated that the cable ducts will be attached to the outside of the pipeline and installed inside the same HDD bore during the pipeline installation operation. Alternatively, a parallel HDD bore can be drilled for the cable ducts at a spacing of 5-10m from the main HDD bore for the new pipeline. The preliminary analyses contained in this document are based on the installation of the pipeline only as this is the most onerous condition.

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3 Crossing Overview

3.1 Crossing Location Description

The Yellow River Crossing (RVX2) is located between Chainage 11200 and Chainage 11500 (Approx.) on the current route of the new GNI143 Ballykilleen Pipeline. The crossing location (Figure 3-1) is in agricultural land in Clongall, Co. Meath, close to the border with Co. Offaly and Co. Kildare. The nearest residential property is approximately 350m from the point where the current pipeline route crosses the Yellow River. The Yellow River joins the River Boyne approximately 150m downstream (east) from the point where the current pipeline route crosses the Yellow River.

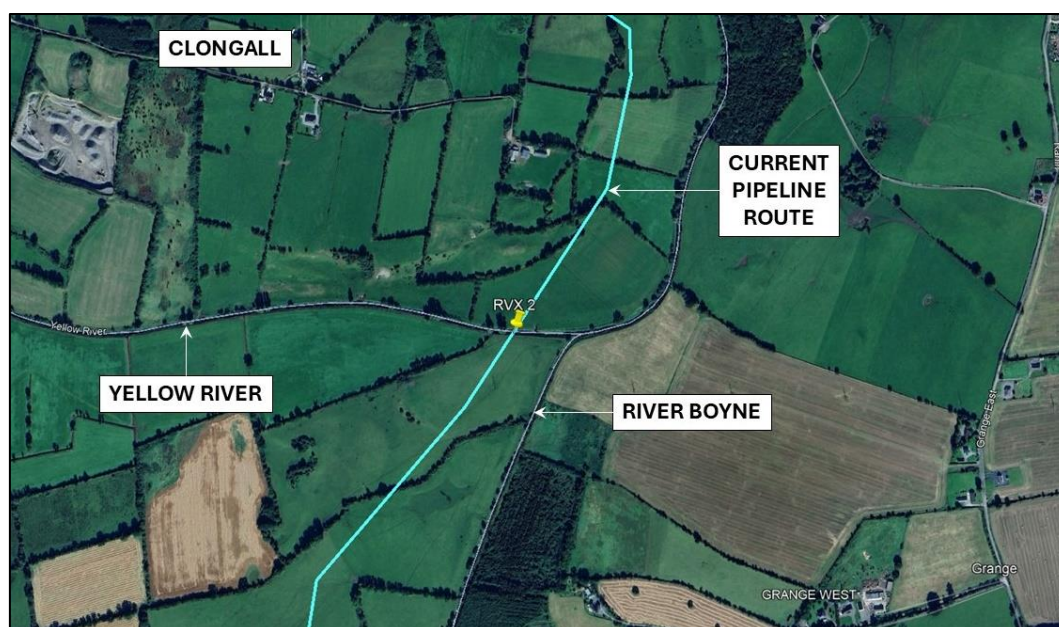


Figure 3-1: Yellow River (RVX2) Crossing Location

The north side of the crossing (Figure 3-2) is in flat agricultural pasture land with grass fields bounded by established trees.

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Figure 3-2: View from watercourse of North Side of Yellow River Crossing

The Yellow River watercourse (Figure 3-3) is approximately 10m wide between banks at the crossing location with vegetation-covered shallow banks sloping down to the river channel. Water depth is assumed as being less than 2m deep at the crossing location. Vegetation is present within the water channel potentially indicating a generally slow-moving body of water.



Figure 3-3: View of watercourse at Yellow River Crossing

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Land on the south side of the crossing (Figure 3-4) slopes gently upwards from the watercourse for a distance of approximately 100m before levelling out. The land is agricultural pasture land with grass fields bounded by established trees and hedgerows. Overhead power lines cross the proposed pipeline route on the south side of the Yellow River approximately 50-100m from the watercourse south bank.



Figure 3-4: View from watercourse of South Side of Yellow River Crossing

3.2 Local Constraints

3.2.1 Existing Infrastructure

The only existing infrastructure present along the pipeline route at the crossing location are the overhead power lines that cross the pipeline route on the south side of the Yellow River at Chainage 11500 (Approx.). The overhead power lines are not considered to be a major constraint for pipeline/crossing construction as the line height above ground level appears to be greater than 10m. However, the presence of the overhead power lines will be considered for the purpose of this assessment. No other major items of above ground or below ground infrastructure that would create major obstacles to pipeline/crossing construction are present.

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3.2.2 Natural Features

The main natural feature present along the pipeline route at the crossing location is the Yellow River watercourse, including the watercourse banks, which crosses the pipeline route at Chainage 11350 (Approx). It is assumed for the purpose of the assessment that trenchless construction methods are required at the crossing of the Yellow River in order to minimise disturbance to the watercourse. Large trees are also present along field boundaries but are not considered to be a major constraint for crossing construction. Minimum depth of cover for the pipeline at the watercourse crossing is 1.6m below lowest bed level.

The main environmental constraints present along the pipeline route at the crossing location are understood to be the Yellow River watercourse and the flood zone extents for the watercourse. A minimum setback distance of 20.0m is to be maintained between the crossing construction site boundaries on both sides of the watercourse, and the watercourse extents.

There is a strong preference, where possible, to avoid crossing construction works within the flood zone extents for the watercourse. Information has been provided in the form of shape files for 1:10 year, 1:100 year, and 1:1000 year flood zone extents. It is understood that the 1:10 year and 1:100 year flood zone extents apply and the 1:1000 year flood zone extent does not apply. Crossing extents will be assumed as being outside of the 1:100 year flood zone extents for the purpose of this assessment work.

The preliminary HDD profile will be designed so that the potential for negative impacts to the watercourse is minimised. Specified minimum allowable depth of cover between the pipeline and bed level of the Yellow River is 1.6m. Ground settlement is not considered to be a concern for the Yellow River where bed levels may fluctuate seasonally. The main objective of the preliminary HDD profile design will be to maximise depth of cover below the riverbed in order to minimise the potential for drilling fluid Inadvertent Returns (IR) to the river during drilling.

A depth of cover between the HDD profile and bed level of the Yellow River of 22.0m (Approx.) is currently proposed. A ground settlement check for the riverbed is provided in Section 5.3 of this document to ensure that estimated ground settlement for the river bed is not above unacceptable levels. No specific ground settlement limit for the river bed is anticipated. A preliminary drilling fluid hydrofracture assessment is provided in Section 5.4 of this document to show that the risk of drilling fluid IR to the surface is within acceptable limits for the preliminary HDD profile.

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3.2.3 Working Areas

The constraints present on the north side of the Yellow River Crossing for establishment of working areas for pipeline and crossing construction activities are assumed to be the estimated extents of the flood zone and the existing field boundaries where established trees and hedgerows are present. The preliminary crossing working area boundary will be planned to be a minimum of 20m (Approx.) outside the 1:100 year flood zone extents. Due to the proposed distance between the current pipeline route and the existing field boundaries, the field boundaries are not considered to be a major obstacle to pipeline/crossing construction.

The constraints present on the south side of the Yellow River Crossing for establishment of working areas for pipeline and crossing construction activities are assumed to be the estimated extents of the flood zone, the overhead power lines, and the existing field boundaries where established trees and hedgerows are present. The preliminary crossing working area boundary will be planned to be a minimum of 20m (Approx.) outside the 1:100 year flood zone extents and a minimum of 10m (Approx.) beyond the overhead power lines. Due to the proposed distance between the current pipeline route and the existing field boundaries, the field boundaries are not considered to be a major obstacle to pipeline/crossing construction.

An initial assessment of working area requirements and existing constraints indicates that sufficient space is available for construction of an HDD crossing on both sides of the Yellow River Crossing. HDD Entry and Exit Point sites can be located within the proposed pipeline construction working width (assumed as 30m width) on both sides of the crossing assuming a preliminary site working area requirement of 1000m² for both the HDD Entry Point and HDD Exit Point sites. Additional working area could be taken within the proposed pipeline construction working width by extending the area footprint along the pipeline route centreline, if required.

Due to the relatively straight alignment of the proposed pipeline route on the south side of the crossing, it is considered more appropriate to have the HDD pipe string fabrication corridor on this side of the crossing where it should be possible to fabricate the HDD pipe string within the proposed pipeline construction working width.

No other significant constraints are understood to be present for crossing construction. Temporary Working Area (TWA) requirements are expected to be subject to agreement with landowners, Inland Fisheries Ireland (IFI), and the overhead power line asset owner/operator.

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4 Ground Conditions Assessment

A Geotechnical Interpretive Report (GIR) for the Yellow River Crossing (Ref. 2) has been provided for information. The GIR contains a geotechnical desk study and a summary of the site investigation work that has been undertaken by the project.

4.1 Geotechnical Desk Study

The geotechnical desk study provided as part of the GIR (Ref. 2) is based on information available in the public domain for local geological conditions.

The Quarternary soils plot for the general area of the Yellow River Crossing (Figure 4-1) reveals widespread alluvium blanketing at the crossing location. The alluvium appears to track the course of the Yellow River and River Boyne covering deeper seated till and gravel.

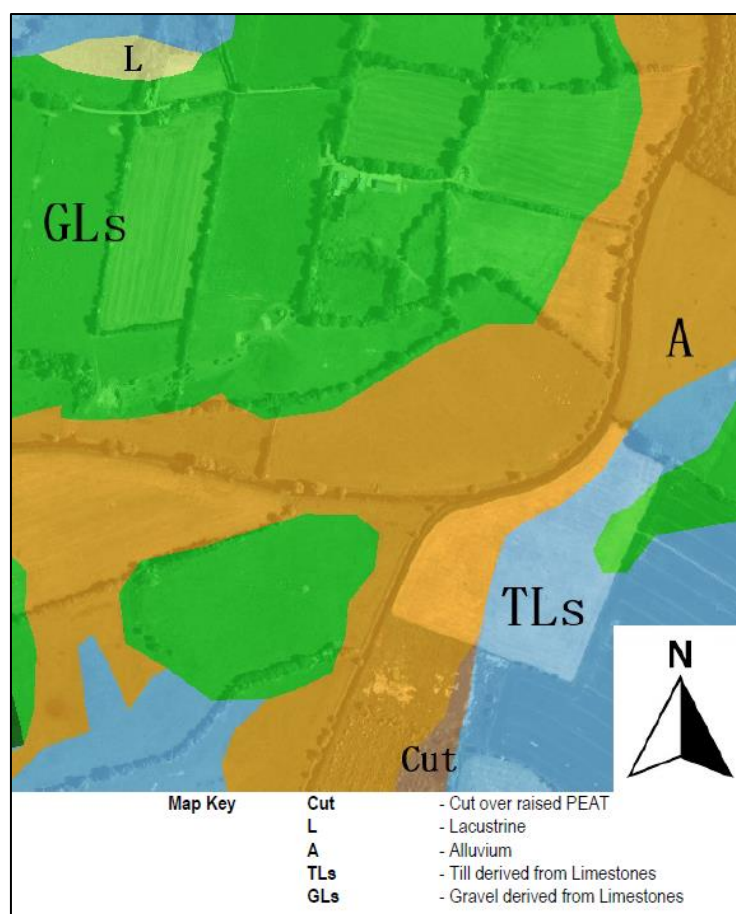


Figure 4-1: Quarternary Soils Plot for Yellow River Crossing Site Location (GSI)

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The bedrock geology plot for the general area of the Yellow River Crossing (Figure 4-2) shows that the site is underlain by the Lower Carboniferous, Edenderry Oolite Member of the Allenwood Formation. The Edenderry Oolite Member is described as a ‘partly skeletal calcarenite (bio-oosparite)’. A bio-oosparite is a bioclastic limestone that contains both biological fragments (bioclasts) and ooids, with a sparry calcite cement.

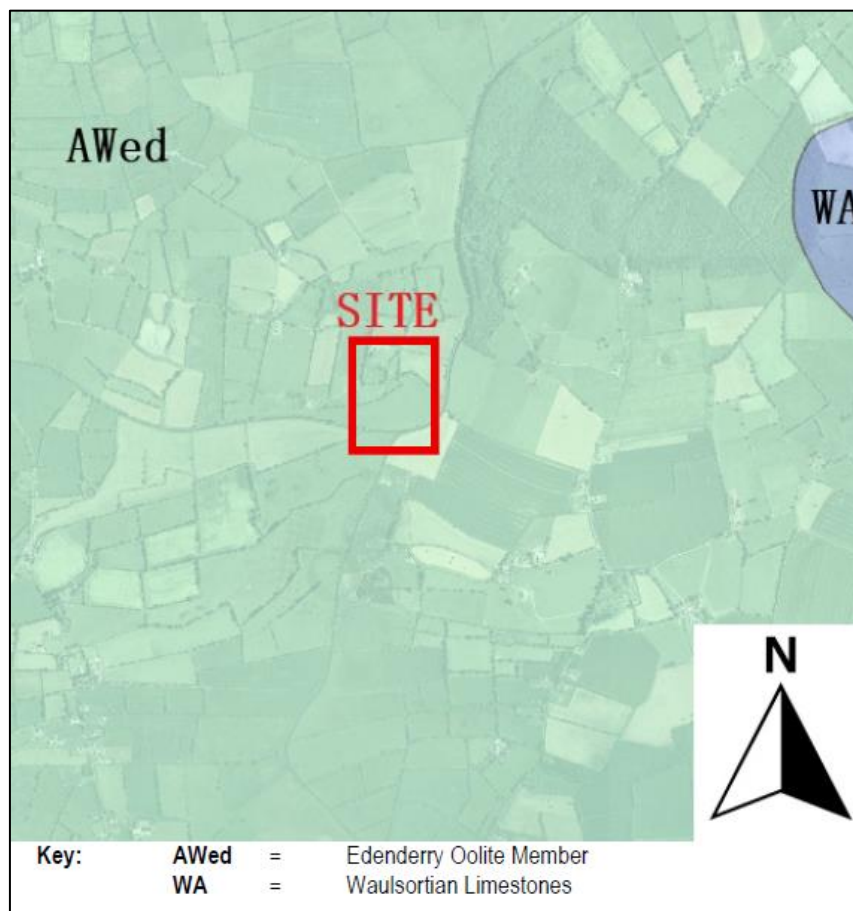


Figure 4-2: Bedrock Geology Plot for Yellow River Crossing Site Location (GSI)

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4.2 Review of Site Investigation Data

Site investigations have been completed for the Yellow River Crossing location. Details of the exploratory holes completed at the Yellow River Crossing location are summarised in Table 4-1.

Table 4-1: Exploratory Hole Details for RVX2

Borehole No.	Borehole Type	Borehole Coordinates	Borehole Level	Borehole Depth	Groundwater Level
BH22	Cable Percussion	660997.36 E 737285.65 N	+65.32m AOD	10.0m	3.0m BGL
BH23	Cable Percussion	661016.11 E 737270.90 N	+65.82m AOD	1.0m	No Water Strike
BH23A	Cable Percussion	661016.65 E 737269.96 N	+65.88m AOD	13.0m	3.0m BGL
BH24	Cable Percussion	660957.67 E 737231.14 N	+66.15m AOD	12.0m	1.0m BGL
BH25	Cable Percussion	660988.17 E 737220.98 N	+66.04m AOD	11.5m	3.0m BGL
BH53	Cable Percussion	661203.19 E 737557.30 N	+66.87m AOD	12.5m	1.5m BGL
BH54	Cable Percussion	661106.01 E 737454.98 N	+65.68m AOD	9.5m	3.0m BGL
BH55	Cable Percussion	660896.88 E 737102.23 N	+69.20m AOD	14.0m	3.0m BGL
RC22	Rotary Core (Symmetrix)	660986.83 E 737290.15 N	+65.24m AOD	20.0m	7.8m BGL
RC23A	Rotary Core (Symmetrix)	661016.65 E 737269.96 N	+65.88m AOD	20.0m	18.2m BGL
RC24	Rotary Core (Symmetrix)	660957.67 E 737231.14 N	+66.15m AOD	20.0m	3.3m BGL
RC25	Rotary Core (Symmetrix)	660988.17 E 737220.98 N	+66.04m AOD	20.0m	2.5m BGL
RC53	Rotary Core (Symmetrix)	661193.57 E 737534.88 N	+66.79m AOD	20.25m	3.8m BGL
RC54	Rotary Core (Symmetrix)	661106.01 E 737454.98 N	+65.68m AOD	20.4m	3.0m BGL
RC55	Rotary Core (Symmetrix)	660896.88 E 737102.23 N	+69.20m AOD	20.0m	5.1m BGL

The following descriptions (Majority of text descriptions taken directly from Ref. 2) summarise the ground conditions encountered across the site as identified by the exploratory locations. The geological cross-section included in Ref. 2 is provided in Annex A of this report for information.

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4.2.1 Topsoil

Topsoil was generally found to be between 0.2-0.3m thick in the boreholes. At location 23A, Topsoil was logged to a depth of 0.5m.

4.2.2 Made Ground

What was termed Concrete Fill was intercepted from 0.5-1.0m in BH23. This resulted in a re-setup bore being constructed (BH23A).

4.2.3 Superficial Deposits

Within metres of the riverbank on both north and south sides of the river, four holes were drilled, each to 20m. Initially, the holes were opened by cable percussion means. The bores achieved depths of between 10-13m prior to termination on obstruction / dense ground. As mentioned, Made Ground was unearthed at BH23 with possible buried concrete from 0.5-1.0m BGL.

The deposits beyond an initial cover of soft to firm sandy gravelly SILT were typically coarse grained, reporting a high sand and/or gravel component. Immediately north of the river, a medium dense very gravelly SAND passing to a very sandy GRAVEL was revealed in BH22 to 5.50m BGL. Interspersed layers of SILT and SAND combined to make up the uppermost 6m in BH23A. A layer of very gravelly SAND was then intercepted from 6.0-8.0m BGL (+57.88m AOD).

South of the river, in BH24, a firm to stiff sandy gravelly SILT was logged to 2.30m BGL (+63.85m AOD). A stiff CLAY was then recorded from 2.3-3.0m BGL. Once again, as with the north side of the river, a thick stratum of slightly clayey/silty sandy GRAVEL was logged from 3.0-6.0m BGL.

Variability in soil stratigraphy can be inferred by inspecting BH25. A firm to stiff slightly sandy slightly gravelly SILT/CLAY was found in BH25 from 1.5-6.0m BGL. This passed to a clayey/silty slightly gravelly SAND (from 6.0m BGL) and to a slightly gravelly SILT from 7.5m BGL.

Basal sandy GRAVEL layers were found in both BH24 from 10.8m BGL (+55.35m AOD) and in BH25 from 10.5m BGL (+55.54m AOD). Basal GRAVEL was also encountered in each of BH23A (from 11.7m BGL), BH53 (from 7.0m BGL) and BH55 (from 12.8m BGL).

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Located furthest south from the river, BH55 comprised initially stiff grey sandy gravelly SILT from 1.8-4.4m BGL (+64.80m AOD). No water strike was met. However, the likely erroneously low SPT values obtained at each of 5.0m, 6.0m and 7.5m BGL would suggest fines-dominant SILT/MARL soils are present and somewhat disturbed prior to testing. A medium dense grey silty slightly gravelly SAND was described from 9.0m BGL to the basal GRAVEL at 12.8m BGL (+56.4m AOD).

Moving northwards from the river, BH54 reported fine-dominant soils comprising soft to firm and firm sandy SILT and, from 7.8m BGL (+54.73m AOD), deeper-seated very stiff slightly sandy gravelly CLAY.

BH53, positioned approximately 475m north of the river saw low SPT blow counts to 7.0m BGL. This once again likely implies some disturbance of SILT-dominant soils ahead of in situ testing. “Soft” SILT and “loose” silty SAND were logged to 7.0m BGL. From 7.0m BGL, a predominantly medium dense very sandy GRAVEL took the borehole to completion at 12.5m BGL (+58.38m AOD).

Rotary drilling was used at each of the holes to achieve an end depth of 20.0m BGL. Symmetrix open hole drilling system took five of the seven holes to 20.0m BGL without encountering bedrock (RC22, 23A, 24, 25 & 55).

Overburden drilling in the 20.0m deep “open holes” found mixed sandy GRAVEL and gravelly CLAY deposits to 20.0m BGL in each of RC22, RC23A and RC24 beyond the cable percussion termination depths. SPT tests were taken in the drilled superficial soils proving dense / very stiff consistencies with test refusals commonplace, i.e. requiring >50 blows of the 63.5kg trip hammer to complete a 300mm test drive.

Openhole drilling in RC25 proved very dense clayey sandy GRAVEL from cable percussion borehole end depth (11.5m BGL) to 20.0m BGL (+46.04m AOD). Similarly, in RC55, very dense sandy cobbly GRAVEL was logged from 14.0m BGL (BH55 end depth) to 20.0m BGL.

Rotary coring methods were used in two of the drillholes where rock was intercepted shy of 20.0m BGL. Limestone rock was encountered at consistent depths in each of RC53 and RC54, at 12.7m BGL (+54.09m AOD) (RC53) and 15.8m BGL (+49.88m AOD) (RC54). Rockhead appears to rise somewhat moving north away from the river crossing. The geological cross section (Annex A) illustrates this rise in rockhead topography from south to north.

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Based on SPT test drives alone, there appears to be some softening at depth in the boreholes. This generally applies to silt-dominant soils and in silty sand. It may be the case that soils are disturbed by boring / drilling methods and that the resulting dilatancy in the silt promotes softening which delivers lower than expected SPT results. SPT tests were conducted from ground level in RC53, given the “follow-on” location was positioned approximately 45.0m from the original cable percussion borehole, BH53. The resulting SPTs corroborate the low values obtained during cable percussion boring for the same interval in BH53. A “soft grey brown sandy SILT” was logged by the driller from 2.2-8.4m. Blowing sands were recorded from 8.4-9.6m BGL coincident with a water strike at 8.4m BGL.

4.2.4 Bedrock

Rotary coring was conducted at two locations. These were RC53 and RC54, both to the north of the site. Coring successfully proved bedrock at depths ranging between 13.3-16.2m BGL. These depths corresponded to elevations of +53.49m AOD and +49.48m AOD. Cores were described as fresh to locally slightly weathered, strong to very strong, thickly to thinly bedded, dark grey/black, fine-grained, LIMESTONE (predominantly calci-siltite (sandy) limestone with subordinate argillaceous (muddy) limestone layers. The limestone was locally fossiliferous.

Discontinuity spacings in the rotary cores generally ranged from closely (60 to 200mm) to widely spaced (600 to 2000mm). The discontinuity surfaces were typically smooth and locally very rough, planar to curvilinear. Apertures were tight to open, locally exhibiting clay smearing with some calcite vein fill (up to 8mm). Dips were generally sub-horizontal, locally 30-40°, occasionally irregular, 70°.

The Point Load Strength Index (PLSI) test data produced $I_s(50)$ values ranging from 1.61-6.22 MPa with a mean value of 4.42 MPa. The PLSI strengths are suggestive of the presence of medium strong to very strong rock.

Using a correlation factor (K) of 22 to assess compressive strength, this suggests a characteristic strength envelope in the order of 35-137 MPa and categorizes the bedrock as medium strong (25-50MPa) to very strong (100-250MPa).

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4.2.5 Groundwater

Water ingress was recorded in both the cable percussion boreholes and rotary drillholes. The cable percussion boreholes intercepted groundwater between 3.8m BGL (BH22) and 10.5m BGL (BH25) with often two water strikes reported in one borehole. The deeper strikes were generally considered ‘rapid’ in intensity with significant rises in water level observed upon interception. This trait is suggestive of a deeper, unconnected or confined water body at depth with its own particular piezometric pressure.

Rotary ‘open-hole’ drilling also encountered both shallow and deep groundwater strikes. The shallowest strike was found in RC25 at 2.7m BGL while the deepest strike was noted in a GRAVEL deposit in RC24 at 18.7m BGL. Groundwater levels measured during the construction of follow-on rotary drillholes can often be skewed higher than expected given water is introduced during coring through an air / mist flush. RC54, which required rock coring from 16.2m BGL, met a strike at 15.8m BGL, presumably coincident with rockhead. Later monitoring taken at the end of the corehole (20.4m) saw water rest at 3.0m BGL.

Water monitoring at the installation in RC24 found water sitting at 3.19m BGL (05-June), 3.2m BGL (02-July) and 3.23 BGL (10-Sept). A data logger was installed in the well in mid-August and downloaded in early September. No appreciable rise or fall was recorded over the period.

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4.3 Suitability of Ground Conditions for HDD

Boreholes were completed in fields both immediately north and south of the Yellow River. Ground conditions between 0.0-20.0m depth BGL at the crossing location can generally be described as mainly mixed fluvioglacial layers overlying bedrock (encountered on north side of crossing only). The mixed fluvioglacial layers appear as upper sequences of CLAY/SILT (generally soft to firm and firm) with underlying deeper-seated, often water-bearing GRAVEL, SILT and silty SAND. There appears to be a mixture of soil types throughout the investigation area. Soft and soft to firm sandy SILT and loose SAND was identified at BH23A (2.0-3.80m BGL), BH25 (8.0-9.0m BGL), BH53 (2.50-7.0m BGL), BH54 (0.30-7.80m BGL) and BH55 (4.40-9.0m BGL). The potential for layers of soft or low strength deposits at numerous locations potentially warrants further investigation (According to Ref. 2).

Rotary coring was conducted at five of the seven borehole locations and proved the absence of bedrock to 20.0m BGL corresponding to depth levels between +45.24m AOD and +49.20m AOD. The overburden soils were largely found to be very dense and/or very stiff beyond cable percussion end depths of typically 10.0-12.0m BGL. Bedrock was encountered in the two boreholes positioned furthest north of the river. Possible rockhead was met at depths of 12.7m BGL (RC53) and 15.8m BGL (RC54) with coring commencing at 13.3m BGL (RC53) and 16.2m BGL (RC54). The bedrock recovered was reported as being strong to very strong, predominantly calcisiltite LIMESTONE.

An HDD crossing of the Yellow River is anticipated to potentially be within the limestone bedrock layer for the majority of the crossing length based on the current interpreted soil profile for the crossing. Should bedrock level be lower than anticipated on the south side of the crossing, the HDD profile may be in clayey/silty/sandy gravel with cobbles and occasional boulders for the most of the crossing length, the limestone bedrock layer for some of the crossing length, and soft to stiff sandy gravelly silt/clay with occasional cobbles in the shallow sections of the HDD profile at the crossing extents. Potential for encountering cobbles and boulders is considered to be low to medium, where cobbles/boulders could be encountered every 20-50m.

Cobbles and boulders are expected to be derived from the limestone bedrock and can be drilled through if the HDD equipment used is suitable for rock drilling. The HDD bore is expected to be self-supporting in the bedrock and gravel layer and the risk of bore collapse in the bedrock and gravel layers is considered to be very low and low to medium respectively. Routing the HDD profile deeper below ground level potentially reduces the risk of drilling fluid IR to formation or to the surface. A preliminary drilling fluid hydrofracture assessment is provided as part of this preliminary crossing design exercise (Section 5.4). However, this does not take into consideration the potential for natural leak paths to the surface to be present. The potential for natural leak paths to be present is considered to be low based

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on the ground conditions assessment. Karst features in the limestone bedrock layer have not been mapped at the crossing location in public domain mapping.

The presence of gravel, cobbles, and boulders can potentially cause issues for the HDD method, especially where loose gravel/cobble layers may exist, or where the majority of the crossing length is through a soil matrix containing a high percentage of gravel/cobbles with a low cohesive clay/silt material content. The gravel layer present at the crossing location contains cohesive materials (clay and silt) with sand also present within the soil matrix. Due to the anticipated small size of the HDD bore required for the 12" OD pipeline, the risk of bore collapse in the gravel layer is considered to be low to medium. The stiff clay layer above the gravel layer could potentially provide better conditions for drilling, as voids in gravel layers can also lead to drilling fluid migration into formation and to the surface. However, routing the HDD profile through the stiff clay layer at shallower depth could potentially increase hydrofracture risk due to reduced depth of cover. As bedrock level has not been established in this section of the crossing, it is likely that drilling will be through the dense gravel where cobbles and boulders are also understood to be present. It is recommended that a geophysical survey is performed for this crossing to establish bedrock level as it may be more appropriate to plan the HDD profile to pass through the limestone bedrock layer, if possible, to minimise risk of bore collapse.

The potential presence of artesian groundwater in the gravel layers will have to be taken into consideration by the construction contractor. Artesian groundwater can contribute to HDD bore instability, but the risk can be minimised by an optimised design. Typically, contractors will design the HDD profile to avoid areas where artesian groundwater may impact bore stability. Artesian groundwater conditions can normally be balanced by the heavier drilling fluid in the HDD bore.

An HDD solution appears to be feasible based on the anticipated ground conditions, the average length of HDD bore required, and the small diameter of HDD bore required. The preliminary HDD crossing design will consider the local constraints and ground conditions with the additional objective of minimising risk of drilling fluid IR to the surface. The HDD profile design and crossing construction methodology are expected to be developed further by the construction contractor and are expected to include further assessment of local ground conditions and associated risks.

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5 HDD Crossing Preliminary Design

5.1 Preliminary HDD Profile Design

The preliminary HDD profile design is generally based on the following objectives:

- Achieve a trenchless crossing of the Yellow River;
- Plan the HDD crossing alignment within the project order limits;
- Minimise HDD crossing length;
- Minimise complexity of pipeline tie-ins on both sides of the crossing;
- Cross the Yellow River at perpendicular, or close to perpendicular, angles;
- Maintain appropriate clearance (>10m) between construction working areas and land boundaries;
- Maintain appropriate clearance (>20m) between construction working areas and watercourses / flood zone extents;
- Maintain appropriate clearance (>10m) between construction working areas and overhead power lines;
- Maintain a minimum required depth of cover to the pipeline of 1.6m at the Yellow River;
- Maintain a minimum required depth of cover to the pipeline of 1.6m at drainage ditches;
- Plan the HDD profile within stable soils over the majority of the profile length;
- Plan the HDD profile maximum depth within the coverage of the site investigations;
- Achieve an HDD profile depth which minimises risk of ground settlement at existing infrastructure locations;
- Achieve an HDD profile depth which minimises risk of drilling fluid IR to the surface;
- Achieve an HDD profile length which allows the pipe string to be fabricated in a single length; and
- Provide a feasible HDD profile geometry for crossing construction and pipeline operation.

The proposed HDD crossing alignment and profile achieves all of the objectives listed above and includes a crossing of the Yellow River and a crossing of the overhead power lines to the south of the Yellow River.

The pipe string fabrication corridor is located on the south side of the crossing due to the better alignment of the pipeline construction working width on this side of the crossing. Some curvature of the pipe string is anticipated in order to be able to accommodate the required single pipe string length within the current pipeline construction working width boundary. The space available is considered to be appropriate for fabrication of a single pipe string.

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Curvature of the pipe string during fabrication can be a complex operation, particularly for larger diameter, heavier wall, steel pipelines. Curvature of a small diameter pipeline is a less complex operation. The contractor may choose to introduce straight sections in the pipe string to reduce overall complexity and temporary works requirements during fabrication, testing, and installation.

Standard practice is to use straight alignments in plan for HDD crossings in order to minimise the complexity of the pilot hole drilling operation. A straight alignment in plan is used for the preliminary HDD crossing alignment in order to provide a conservative approach. HDD crossings can be curved in plan when necessary. However, complexity of crossing construction may increase where short radius curves (approaching the operational limits of the drill pipe), or combined horizontal and vertical curves, are proposed.

The preliminary HDD crossing alignment crosses the Yellow River and overhead power lines between 60-80° (Figure 5-1). An entry angle of 14° and an exit angle of 12° have been used for preliminary design purposes. A minimum radius of curvature of 360m for the HDD profile has been assumed based on typical values used for HDD crossings of this size in similar ground conditions. The proposed radius of curvature ensures that installation and operation stresses on the pipeline should remain within allowable limits, and a greater depth of cover is achieved at the Yellow River. This results in a preliminary HDD crossing 2D length of approximately 510m in plan.

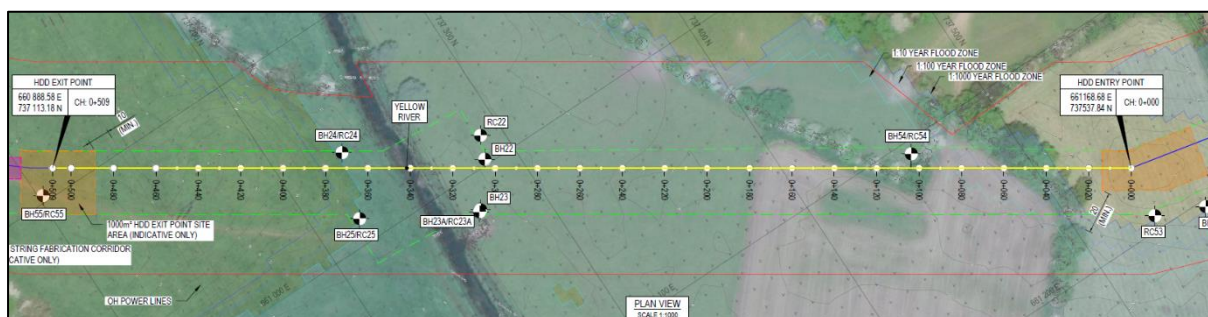


Figure 5-1: Preliminary HDD Crossing Plan Alignment

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The overall length of the crossing may be subject to change during the detailed design of the HDD crossing by the construction contractor. However, the overall length is not expected to change significantly. The crossing location and alignment of the pipeline in relation to the Yellow River is not expected to change. The final crossing extents and site area boundaries may be subject to change prior to construction during the detailed design of the crossing. However, the minimum allowable proximity distance to land boundaries, flood zone extents, overhead power lines, and the Yellow River must be observed.

The vertical alignment of the preliminary HDD profile (Figure 5-2) is expected to pass through the following soil layers (HDD equipment should be selected accordingly):

- Limestone bedrock mainly on the north side of the crossing;
- Clayey/silty/sandy gravel with cobbles and occasional boulders mainly on the south side of the crossing and immediately above bedrock level;
- Soft to stiff sandy gravelly silty/clay with occasional cobbles in the shallow sections of the profile at each end of the crossing.

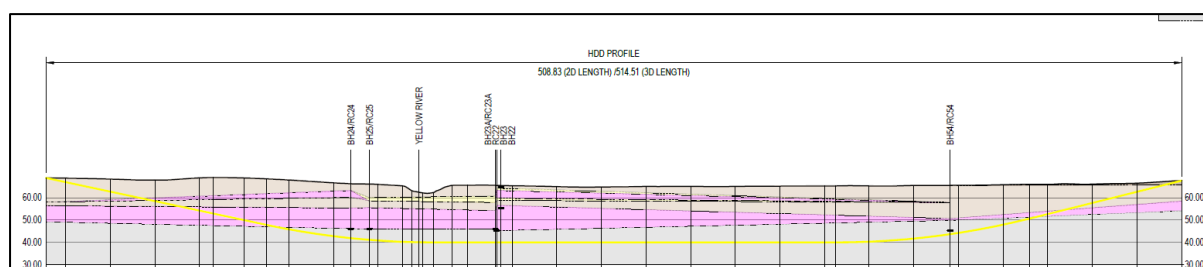


Figure 5-2: Preliminary HDD Crossing Profile Alignment

The minimum clearance distance between the preliminary HDD profile and the Yellow River is 22.0m (Approx.). The resultant minimum depth of cover to the pipeline at the Yellow River is therefore expected to be greater than the minimum allowable figure of 1.6m. The preliminary HDD profile is anticipated to be within the limestone bedrock or the gravel layer where the profile passes below the Yellow River. The minimum clearance distance between the HDD profile and the Yellow River may be subject to change prior to construction during the detailed design of the crossing.

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5.2 Preliminary Pipeline Stress Check

5.2.1 Pipeline Installation Pull Force Check

A pipe installation pull force check has been performed for the preliminary crossing alignment. Proprietary HDD design software D-Geo Pipeline has been used to calculate the pipeline installation pull forces for the proposed pipeline. The anticipated pull force is provided in Table 5-1.

Table 5-1: Pipe Installation Pull Force Summary

Pipe OD (mm)	Pipe WT (mm)	Pipe Weight Downhole Empty (kg/m)	Friction Value Pipe Downhole	Estimated Maximum Pull Force (Tonnes)
323.9	12.7	-6.12	0.3	13.8

The pipe installation pull force is considered to be within the allowable limits for the pipeline (subject to confirmation). The estimated maximum pull force can be used as a guide to ensure that a suitable capacity HDD drilling rig is proposed for the pipeline installation operation.

5.2.2 Temporary Installation Stresses

A check on temporary installation stresses on the pipe has been performed for the preliminary crossing alignment. Proprietary HDD design software D-Geo Pipeline has been used to check temporary pipeline installation stresses for the proposed pipeline. The maximum temporary installation stresses on the pipeline are provided in Table 5-2.

The analysis of temporary installation stresses on the pipe includes installation forces, radius of curvature of the HDD bore, and depth of the HDD bore (drilling fluid hydrostatic pressure on pipe) for the start and end of the installation operation. A maximum allowable stress value of 377.27 N/mm² has been assumed for the temporary installation case. The analysis also assumes a single full pipe string length for the start of the pullback operation.

Table 5-2: Temporary Installation Stresses Summary

Maximum Stress on Pipe (Start of Pull) (N/mm ²)	Maximum Stress on Pipe (End of Pull) (N/mm ²)	Allowable Maximum Stress on Pipe during Installation (N/mm ²)	Status
240	153	377.27	OK

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5.3 Preliminary Ground Settlement Check

A preliminary ground settlement check for the Yellow River has been performed based on the minimum clearance distance between the preliminary HDD bore alignment and the riverbed. The settlement check has been performed using recognised ground settlement theory provided in Reference 6. A conservative ground volume loss of 100% has been assumed for the purpose of analysis due to the potential for the HDD profile to be within the gravel layer below the Yellow River. This figure is typically 20% for HDD applications. A conservative trough width parameter of 0.4 has been selected based on the presence of cohesive clay and granular materials above the limestone bedrock layer. The figure selected for the trough width parameter ignores the potential presence of stable bedrock at the level of the HDD bore. The result of the ground settlement check for the Yellow River is provided in Table 5-3.

Table 5-3: Yellow River Ground Settlement Check Summary

Minimum Clearance Distance (m)	Assumed HDD Bore Diameter (mm)	Trough Width Parameter (K)	Assumed Volume Loss	Maximum Settlement at Riverbed (mm)	Status
22.0	508.0	0.4	100%	5.8	OK

The result of the ground settlement check for the Yellow River indicates that the estimated ground settlement value is not unacceptable and likely to be within assumed allowable limits using conservative assumptions for the purpose of analysis. It is assumed that there will not be a settlement limit in place for the riverbed due to the likelihood that riverbed level fluctuates seasonally. The HDD bore will be either within the limestone bedrock layer or dense gravel layer where it passes below the Yellow River and, therefore, ground settlement risk is considered to be low.

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5.4 Preliminary Drilling Fluid Hydrofracture Analysis

Hydrofracture, or frac-out, in HDD occurs when drilling fluid pressure exceeds the ability of the soil above the HDD bore to contain the drilling fluid, causing the drilling fluid to fracture the surrounding ground and potentially reach the surface. Risk of drilling fluid IR to the surface typically increases where depth of cover to the HDD bore is lowest, such as in the shallow sections at both ends of the HDD profile, and where the HDD profile passes below low points in the local terrain such as watercourses or natural/man-made depressions. Drilling fluid can also reach the surface through natural leak paths. This is not considered in a hydrofracture analysis.

Contractors typically install steel casing pipe in the shallow section of a HDD bore at the HDD Entry Point in order to stabilise the shallow soil layers. This casing pipe can also minimise the risk of drilling fluid IR to the surface in this section of the HDD bore. Casing pipe can be used as a temporary contingency measure to stabilise soils and minimise risk of drilling fluid IR to the surface. However, the current pipeline design does not allow for casing pipe to be left in-situ permanently.

A preliminary drilling fluid hydrofracture analysis has been performed based on the preliminary HDD crossing profile and soils profile. Proprietary HDD design software D-Geo Pipeline has been used to perform the drilling fluid hydrofracture analysis.

Typical values for soil parameters required for design have been assumed for the purpose of analysis. Values should be assumed as preliminary and subject to confirmation during detailed design. It should be noted that a drilling hydrofracture analysis is typically only performed for HDD bores being drilled in non-rock soils and is not usually performed for bedrock conditions. Dense gravel conditions have been assumed instead of bedrock for the purpose of analysis in order to mimic the potential voids present in the limestone bedrock.

Typical values for drilling fluid parameters required for design have been assumed for the purpose of analysis. These values are dependent on the construction methodology being proposed by the construction contractor and are potentially subject to change.

The analysis is performed for the three main stages of the HDD operation:

- Pilot Hole Drilling
- Bore Reaming/Hole Opening
- Pipeline Installation

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The drilling fluid hydrofracture analysis provides a baseline minimum required drilling fluid downhole pressure to ensure drilling fluid flow back to the surface, and maximum allowable drilling fluid pressures related to (1) deformation of the HDD bore and (2) soil cover. The maximum allowable drilling fluid pressure related to soil cover is considered to be the worst case in relation to risk of drilling fluid reaching the surface. Where there is a large working window for downhole pressure (large difference between minimum required and maximum allowable drilling fluid downhole pressure), risk of drilling fluid hydrofracture to the surface is considered to be low. Conversely, where there is a small working window for downhole pressure (small difference between minimum required and maximum allowable drilling fluid downhole pressure), risk of drilling hydrofracture to the surface is considered to be high. The results for the hydrofracture analysis are provided in graphical form.

Co-ordinate 0.0m on the graphs in this section relates to the north (HDD Entry Point) side of the crossing and Co-ordinate 509.0m relates to the south (HDD Exit Point) side of the crossing.

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The results of the hydrofracture analysis for the pilot hole drilling operation are summarised in Figure 5-3. The graph shows a large working window for drilling fluid pressure over the majority of the crossing length, meaning risk of drilling fluid hydrofracture to the surface is potentially very low. The working window for drilling fluid pressure is smaller at the entry and exit sections where cover to the HDD bore is lower. However, conservative soil and drilling fluid parameters have been used for the purpose of analysis and hydrofracture risk is expected to be low in these areas. The shallow sections on HDD profiles are known areas of increased hydrofracture risk due to the reduced depth of cover to the HDD profile. Mitigation measures, such as reducing the drilling fluid pumping rate and downhole pressure in these sections, are typically employed by the contractor to reduce the potential for drilling fluid IR to the surface in shallow sections. In addition, continuous monitoring of drilling fluid volumes, and continuous monitoring of the surface for drilling fluid IR, are performed during construction. Contingency measures are expected to be in place in the event of drilling fluid IR to the surface.

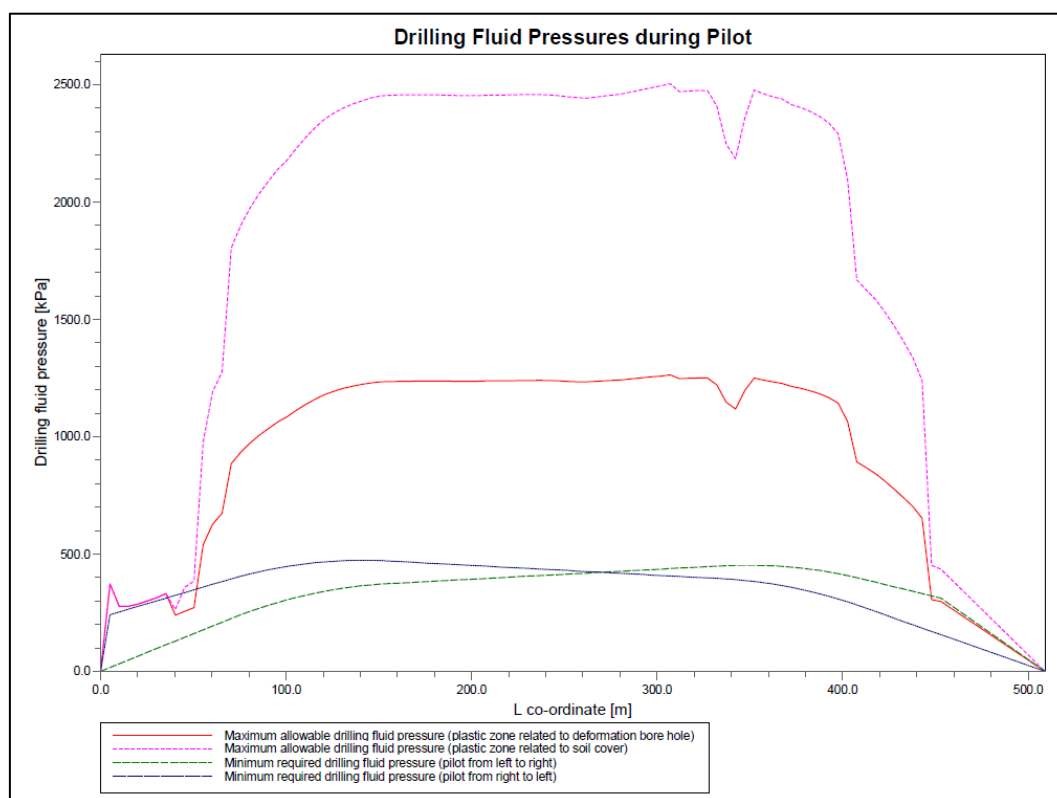


Figure 5-3: Drilling Fluid Hydrofracture Analysis Results (Pilot Hole)

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The results of the hydrofracture analysis for the bore reaming/hole-opening operation are summarised in Figure 5-4. The graph shows a large working window for drilling fluid pressure over the majority of the crossing length, meaning risk of drilling fluid hydrofracture to the surface is potentially very low. The working window for drilling fluid pressure is smaller at the entry and exit sections where cover to the HDD bore is lower. However, conservative soil and drilling fluid parameters have been used for the purpose of analysis and hydrofracture risk is expected to be low in these areas.

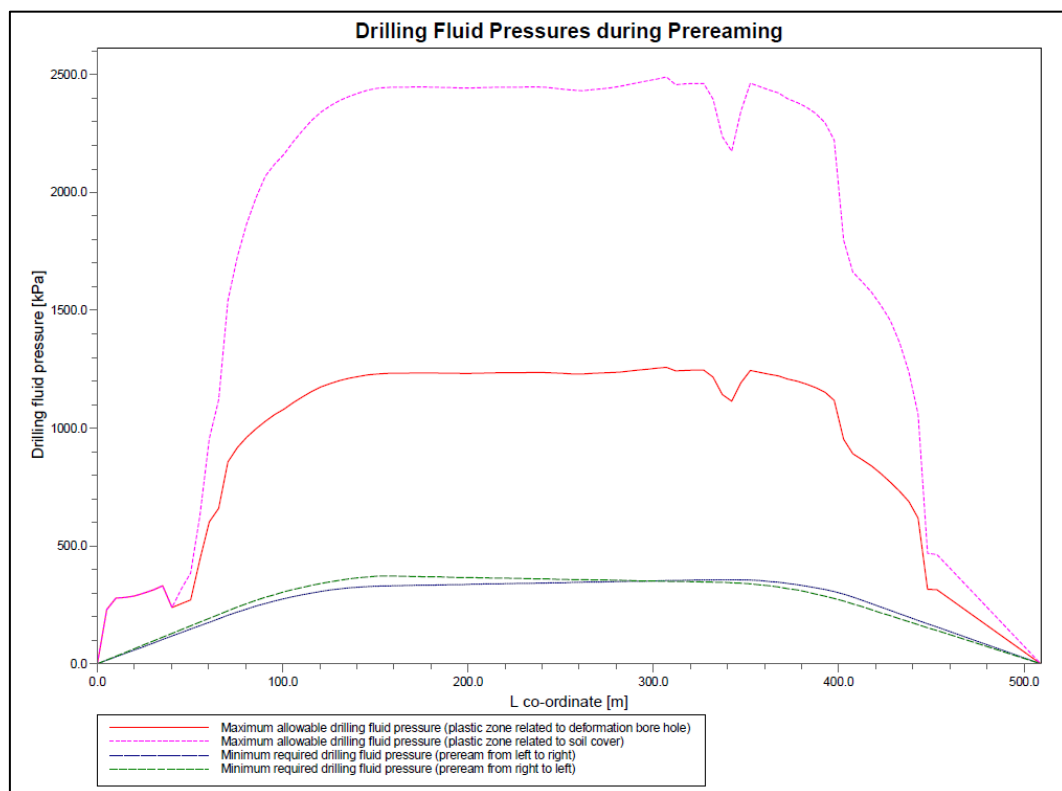


Figure 5-4: Drilling Fluid Hydrofracture Analysis Results (Bore Reaming/Hole-Opening)

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The results of the hydrofracture analysis for the pipeline installation operation are summarised in Figure 5-5. The graph shows a large working window for drilling fluid pressure over the majority of the crossing length, meaning risk of drilling fluid hydrofracture to the surface is potentially very low. The working window for drilling fluid pressure is smaller at the entry and exit sections where cover to the HDD bore is lower. However, conservative soil and drilling fluid parameters have been used for the purpose of analysis and hydrofracture risk is expected to be low in these areas.

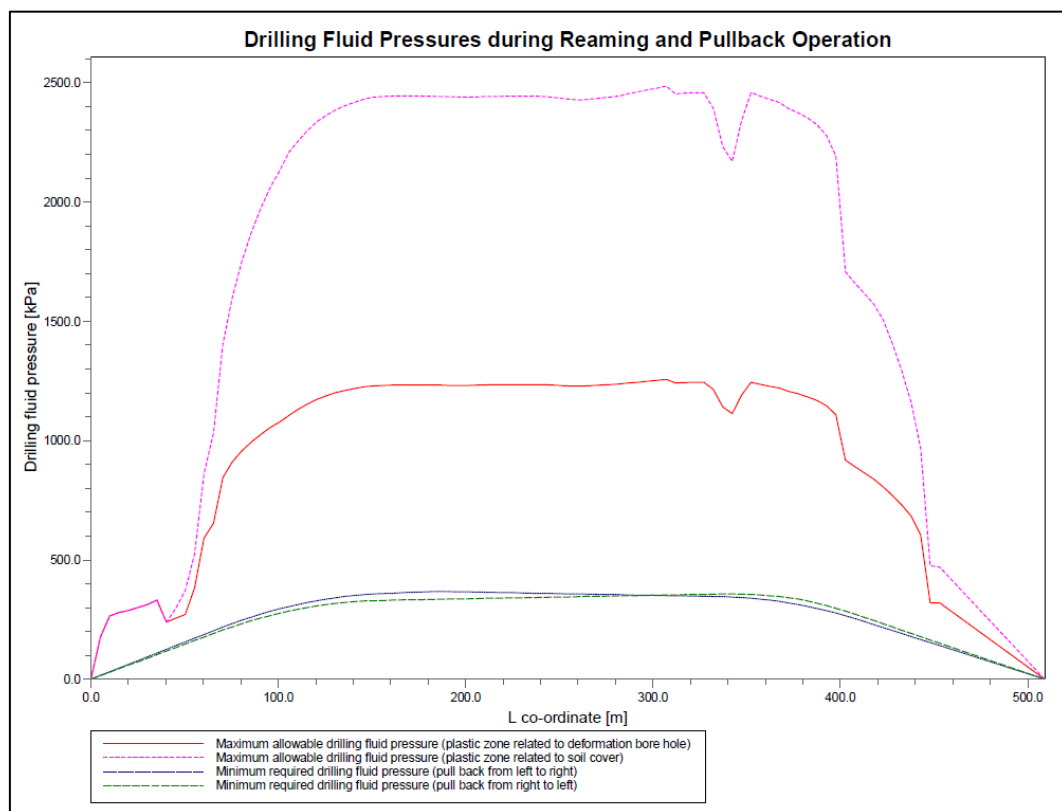


Figure 5-5: Drilling Fluid Hydrofracture Analysis Results (Pipeline Installation)

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Overall, the risk of drilling fluid hydrofracture to the surface is considered to be low for this crossing. The north side of the crossing is at co-ordinate 0.0m on the graphs and the south side of the crossing is at co-ordinate 509.0m.

The Yellow River is at co-ordinate 350.0m (Approx.) on the graphs above. The working window is interpreted as being appropriate for the proposed operations and risk of drilling fluid hydrofracture to the watercourse is considered to be low.

Contractors can implement contingency measures in the event of excessive drilling fluid losses to formation or drilling fluid IR to the surface. Contingency measures include the addition of Loss Control Measures (LCM) to the drilling fluid or controlled grouting of the HDD bore in areas of concern. Contractors will implement an emergency response procedure in the event of drilling fluid IR to the surface. This typically involves installing a soil bund around the drilling fluid that has come to the surface to prevent further spreading, pumping the drilling fluid back to the HDD site working area, and then reinstating the affected land.

Results presented in this document are considered to be preliminary. Conservative assumptions for various soil parameters and drilling parameters have been made for the purpose of analysis. Further assessment of drilling hydrofracture risk is expected to be performed during the detailed design phase of the works as the HDD crossing design and methodology is developed. The performance of a drilling fluid hydrofracture risk assessment during detailed design is typically a requirement of the controlling specification for the HDD works.

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6 Design Risk Assessment

A design risk assessment for the preliminary design of the HDD crossing is provided in Table 6-1 below. Residual risks are considered to be high-level risks that are relevant to future design and construction activities and provided for information only.

A geophysical survey is recommended for the crossing to help to provide further definition for bedrock level. Planning the HDD profile to pass through bedrock, where possible, may reduce overall risk for the crossing in terms of HDD bore stability. A geophysical survey can provide additional information on local bedrock level.

Table 6-1: Design Risk Assessment for Preliminary Crossing Design

Potential Hazard	Design Action	Residual Risk
Unexpected Ground Conditions	Review of project-specific site investigation data supplemented with information available in public domain for crossing location. Preliminary HDD profile designed to pass through most stable ground conditions.	Ground conditions between site investigation locations differs from assumptions made in review. Residual risk remains if HDD contractor does not interpret soils information correctly and does not plan works accordingly.
Insufficient clearance to existing infrastructure potentially resulting in breach of allowable settlement limits.	Location and approximate level of existing infrastructure has been established during site surveys. Minimum clearance of 10m (Approx.) between preliminary HDD profile and existing infrastructure proposed in design. Preliminary ground settlement checks performed in design using conservative assumptions and soil parameters.	HDD contractor will perform settlement checks for existing infrastructure prior to construction and design HDD profile to suit. Residual risk remains if HDD contractor does not maintain recommended clearance between HDD profile and existing infrastructure.
High installation loads on pipeline causing damage to pipeline.	Design checks performed for anticipated installation loads on pipeline.	HDD contractor will perform installation stress checks for proposed pipeline and HDD profile alignment prior to construction. Residual risk remains if HDD contractor does not monitor installation loads and does not maintain installation loads within recommended limits.

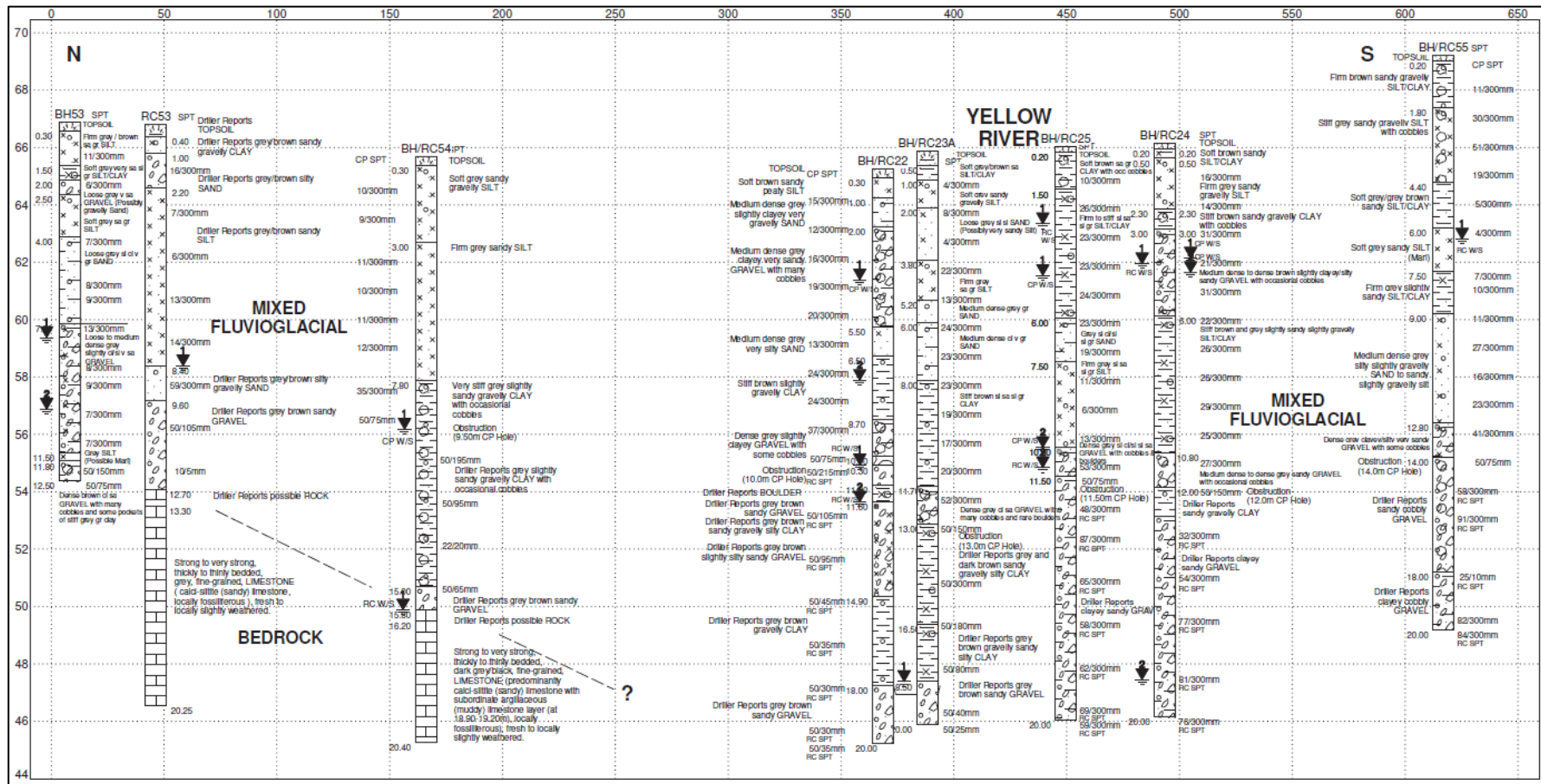
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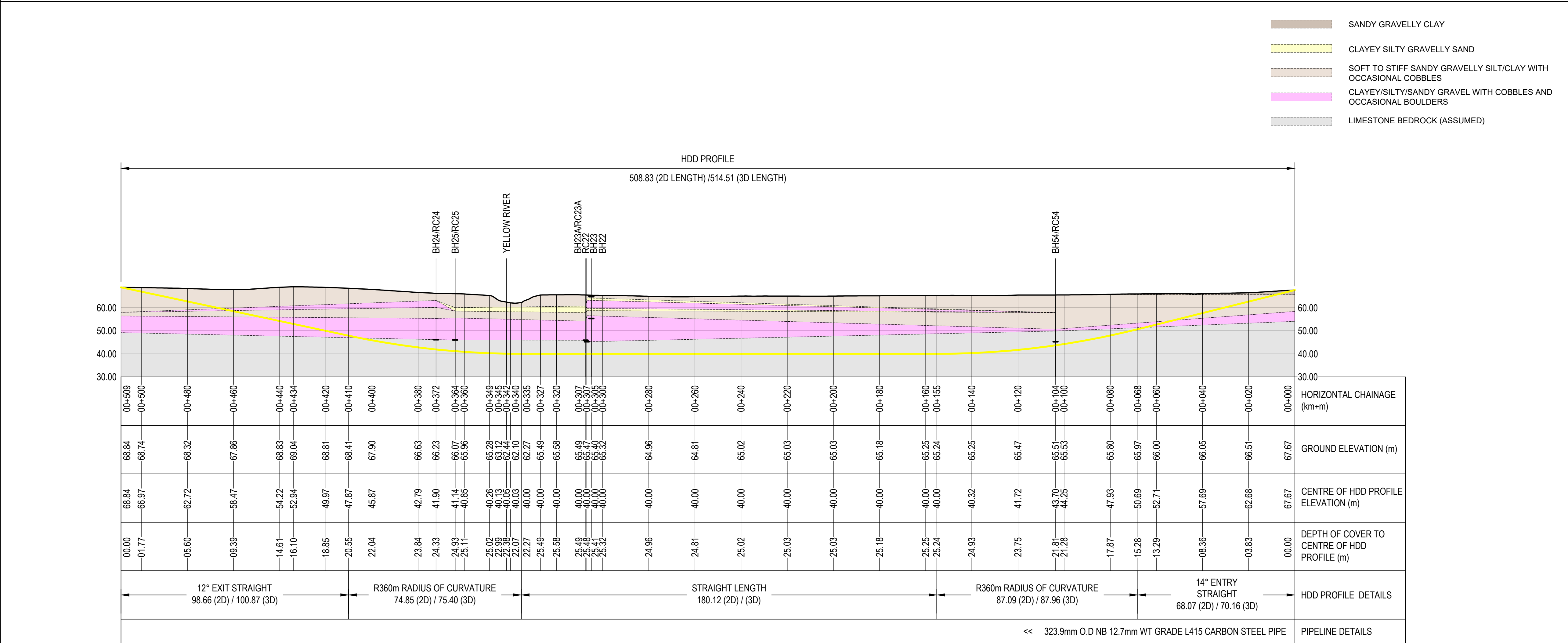
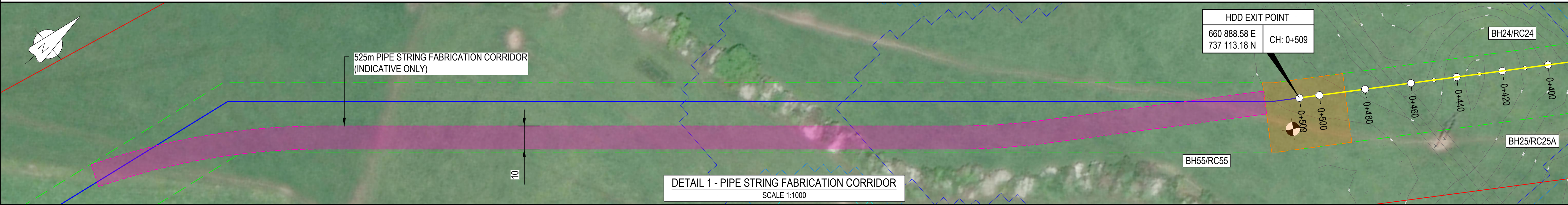
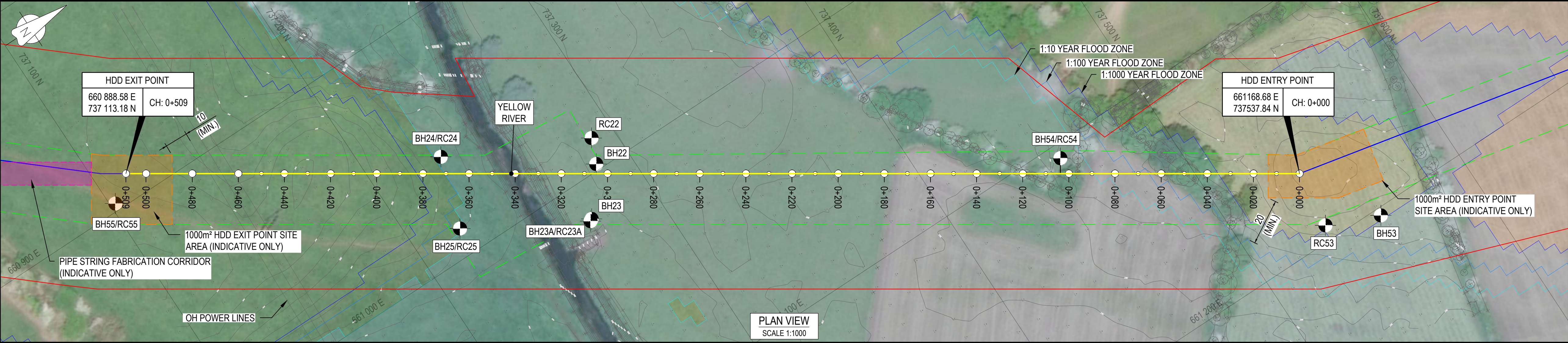
Potential Hazard	Design Action	Residual Risk
Drilling fluid inadvertent returns to surface during drilling.	Ground levels and preliminary soil profile for crossing location established during site surveys and crossing assessment work. High-level assessment of drilling fluid hydrofracture risk performed based on assumed ground conditions and drilling parameters. Hydrofracture risk is considered to be low based on the assumed ground conditions, the preliminary crossing length and depth, and the maximum expected HDD bore diameter.	Site-specific hydrofracture analysis will be performed by HDD contractor prior to construction. HDD contractor will perform surface monitoring during drilling and will have drilling fluid containment and clean-up measures on site for the duration of the works. Residual risk remains if HDD contractor does not maintain downhole pressure within working envelope as recommended by hydrofracture analysis.

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Annex A – Geological Cross-Section for Yellow River Crossing





NOTES

- ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE. CHAINAGES (km) ARE LOCAL TO THE DRAWING. COORDINATES ARE IN METRES.
- THE REFERENCED CO-ORDINATE SYSTEM IS IRISH TRANSVERSE MERCATOR (ITM15). ELEVATIONS ARE SHOWN TO THE SURVEY DATUM, MALIN HEAD.
- TOPOGRAPHIC SURVEY DATA HAS BEEN TAKEN FROM MURPHY GEOSPATIAL (MGS) DRAWING MGS-60130-RVX2_T_ITM_REV 0.
- SATELLITE IMAGERY IS PROVIDED BY ESRI WORLD IMAGERY.
- CROSSING LAYOUT AND PROFILE GEOMETRY IS INDICATIVE ONLY AND SUBJECT TO DEVELOPMENT BY OTHERS DURING DETAILED DESIGN.
- SOILS PROFILE SHOWN HAS BEEN INTERPRETED FROM EXISTING SITE INVESTIGATION DATA AND IS CONSIDERED TO BE PRELIMINARY AND FOR INFORMATION PURPOSES ONLY. SOIL LAYER BOUNDARY LEVELS SHOWN ARE ASSUMED FOR PRELIMINARY DESIGN PURPOSES ONLY.
- DESIGN AND CONSTRUCTION OF CROSSING SHALL BE COMPLETED IN ACCORDANCE WITH THE MINIMUM REQUIREMENTS OF RELEVANT PROJECT SPECIFICATIONS AND INDUSTRY GUIDELINES.
- HDD ENTRY AND EXIT POINTS SHOWN ARE CONSIDERED TO BE PRELIMINARY AND POTENTIALLY INTERCHANGEABLE DURING CONSTRUCTION. THE PRELIMINARY HDD PROFILE AND PIPE STRING FABRICATION CORRIDOR SHOWN IS NOT AFFECTED.

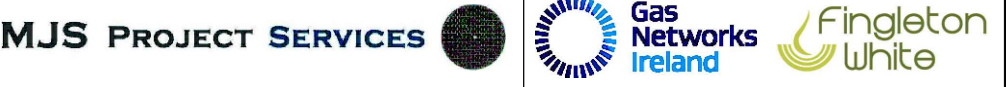
LEGEND

- BOREHOLE (EXISTING)
- HDD ALIGNMENT CHAINAGE POINT
- PROPOSED HDD ALIGNMENT
- PROPOSED PIPELINE ROUTE
- PROJECT ORDER LIMITS
- PIPELINE CONSTRUCTION WORKING WIDTH
- TOPOGRAPHIC SURVEY DATA
- END OF BOREHOLE
- HDD ENTRY/EXIT SITE
- PIPE STRING FABRICATION CORRIDOR
- FLOOD ZONE

REFERENCES

- MJS-FW-GBNME-REP-006
YELLOW RIVER CROSSING - PRELIMINARY CROSSING DESIGN REPORT
- MGS-60130-RVX2_T_ITM_REV 0
TOPOGRAPHICAL SURVEY
- 25882 GAS TO BORD NA MONA, EDENDERRY - PHASE 1 GI - HCC2_REV 0
GEOTECHNICAL INTERPRETIVE REPORT

REV	DATE	PURPOSE OF REVISION	DRAWN	CHECKED	REVIEWED	APPROVED
C	26/08/26	ISSUED FOR INFORMATION	NP	DM	MS	
B	28/11/25	ISSUED FOR INFORMATION	NP	DM	MS	
A	12/11/25	ISSUED FOR INFORMATION	NP	DM	MS	



PROJECT NAME: GAS TO BORD NA EDENDERRY PROJECT

DRAWING TITLE: YELLOW RIVER CROSSING PRELIMINARY CROSSING DRAWING

DRAWING NO.: MJS-FW-GBNME-DWG-003	SCALE: 1:1000	SHEET SIZE: A1	REV: C
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 	Grand Canal Crossing – Preliminary Crossing Design Report	MJS PROJECT SERVICES 
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<i>Project:</i>	Gas to Bord na Mona, Edenderry
<i>Main Client:</i>	Gas Networks Ireland
<i>MJS Client:</i>	Fingleton White
<i>Location:</i>	Ireland

<i>MJS Project No.:</i>	2525
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<i>Document Title:</i>	Grand Canal Crossing – Preliminary Crossing Design Report
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<i>Document Type:</i>	Report

Grand Canal Crossing – Preliminary Crossing Design Report

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1 Introduction

1.1 Project Description

Bord na Móna (BnM) are planning to convert the existing diesel generation peaking plant at the Edenderry Power Station to run on natural gas in an effort to reduce CO₂ emissions. A new 12" Outside Diameter (OD) high pressure gas pipeline is required to be installed between the existing gas transmission network and the power station in order to supply natural gas for the gas turbines. The new GNI143 Ballykilleen Pipeline will be approximately 23km in length between the proposed hot tap location (14301 Kilwarden Offtake Installation) on the existing GNI BGE/77 Pipeline to the West (PTTW) pipeline and an Above Ground Installation (AGI) facility within the BnM Renewable Energy Complex at Edenderry.

A number of special crossings of existing infrastructure and natural features will be required on the new pipeline route. The 4 No. main crossings identified are:

1. Kilwarden River (RVX1)
2. M4 Motorway (RDX4)
3. Yellow River (RVX2)
4. Grand Canal (WCX23)

1.2 Summary of Scope and Document Purpose

Fingleton White (FW) have been engaged by GNI to produce the design for the new gas supply pipeline between the existing high pressure gas transmission network and the AGI facility at Edenderry power station. MJS Project Services (MJS) have been engaged by Fingleton White to produce crossing construction method assessments and preliminary crossing designs for several trenchless crossings of existing infrastructure and natural features on the new pipeline route.

The purpose of this document is to provide a narrative to support the preliminary design of a HDD crossing of the Grand Canal (WCX23) and to provide a summary of the associated design checks that have been performed. The Grand Canal Crossing is currently in the planning phase. Therefore, the proposed crossing design should be considered as preliminary and potentially subject to change and further development during the detailed design and construction phases. The preliminary HDD crossing design is based on current HDD industry guidelines and best practices (Section 1.3) and takes into consideration site-specific conditions and constraints.

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1.3 References

Ref:	Document Number	Document Title
1	MJS-FW-GBNME-DWG-004	Grand Canal Crossing – Preliminary Crossing Drawing
2	25882 – Gas to Bord na Móna, Edenderry – Phase 1 GI – HCC4 – Geotechnical Interpretive Report – Rev 0 (IGSL)	
3	DNV-ST-F121	Pipeline Installation Using Horizontal Directional Drilling (DNV)
4	NASTT's Horizontal Directional Drilling (HDD) Good Practice Guidelines (NASTT)	
5	Information and Recommendations for the Planning, Construction and Documentation of HDD Projects – DCA Technical Guidelines (DCA)	
6	Settlement above Tunnels in the United Kingdom – Their Magnitude and Prediction (O'Reilly and New)	

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1.4 Abbreviations / Acronyms

Term	Meaning
3LPE	3-Layer Polyethylene
3LPP	3-Layer Polypropylene
AGI	Above Ground Installation
AOD	Above Ordnance Datum
BGL	Below Ground Level
BH	Borehole
BnM	Bord na Móna
CO ₂	Carbon Dioxide
DCA	Drilling Contractors Association
DN	Diameter Nominal
DNV	Det Norske Veritas
FW	Fingleton White
GIR	Geotechnical Interpretive Report
GNI	Gas Networks Ireland
GSI	Geological Survey Ireland
HDD	Horizontal Directional Drilling
ID	Internal Diameter
LCM	Loss Control Measures
MJS	MJS Project Services
NASTT	North American Society for Trenchless Technology
OD	Outside Diameter
PLSI	Point Load Strength Index
PTTW	Pipeline to the West
RC	Rotary Core
SPT	Standard Penetration Test
WCX	Watercourse Crossing
WT	Wall Thickness

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2 Pipeline Details

Details of the proposed route of the new gas pipeline (GNI143 Ballykilleen Pipeline) between the proposed offtake location (14301 Kilwarden Offtake Installation) on the existing GNI BGE/77 Pipeline to the West (PTTW) pipeline and an Above Ground Installation (AGI) facility within the BnM Renewable Energy Complex at Edenderry have been provided for the purpose of preliminary crossing design. The Grand Canal Crossing is located between Ch17900.00 and Ch18100.00 (Approx.) on the proposed pipeline route.

The new gas pipeline will be a 12" (323.9mm) OD (DN300) carbon steel pipeline. Material grade of the pipeline will be L415 (X60), and the wall thickness (WT) of the pipeline will be 12.7mm at special crossing locations. The pipeline external coating thickness will be 2.5mm where 3-Layer Polyethylene (3LPE) is used and 10mm where 3-Layer Polypropylene (3LPP) is used. Pipeline field joint coating material and thickness is subject to confirmation.

The minimum depth of cover for the pipeline is 1.2m at Road Crossings (RDX), 1.6m at River Crossings (RVX), and 3.0m at the Grand Canal. The minimum depth of cover for the pipeline at the Grand Canal Crossing is therefore assumed to be 3.0m to the canal bed, and 1.6m to the bed level of any drainage channels present in the crossing extents. Minimum depth of cover for the pipeline at the Grand Canal Greenway is assumed as 1.2m for the purpose of preliminary design.

In addition to the pipeline to be installed at the crossing of the Grand Canal, 2 No. 32/24mm diameter cable ducts are to be installed at the crossing. It is anticipated that the cable ducts will be attached to the outside of the pipeline and installed inside the same HDD bore during the pipeline installation operation. Alternatively, a parallel HDD bore can be drilled for the cable ducts at a spacing of 5-10m from the main HDD bore for the new pipeline. The preliminary analyses contained in this document are based on the installation of the pipeline only as this is the most onerous condition.

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3 Crossing Overview

3.1 Crossing Location Description

The Grand Canal Crossing (WCX23) is located between Chainage 17900 and Chainage 18100 (Approx.) on the current route of the new GNI143 Ballykilleen Pipeline. The crossing location (Figure 3-1) is in agricultural land in Co. Offaly where the townlands of Rathmore, Ballycolgan, Monasteroris, and Edenderry meet, approximately 2km west of the town of Edenderry. The nearest residential property is over 400m from the point where the current pipeline route crosses the Grand Canal.

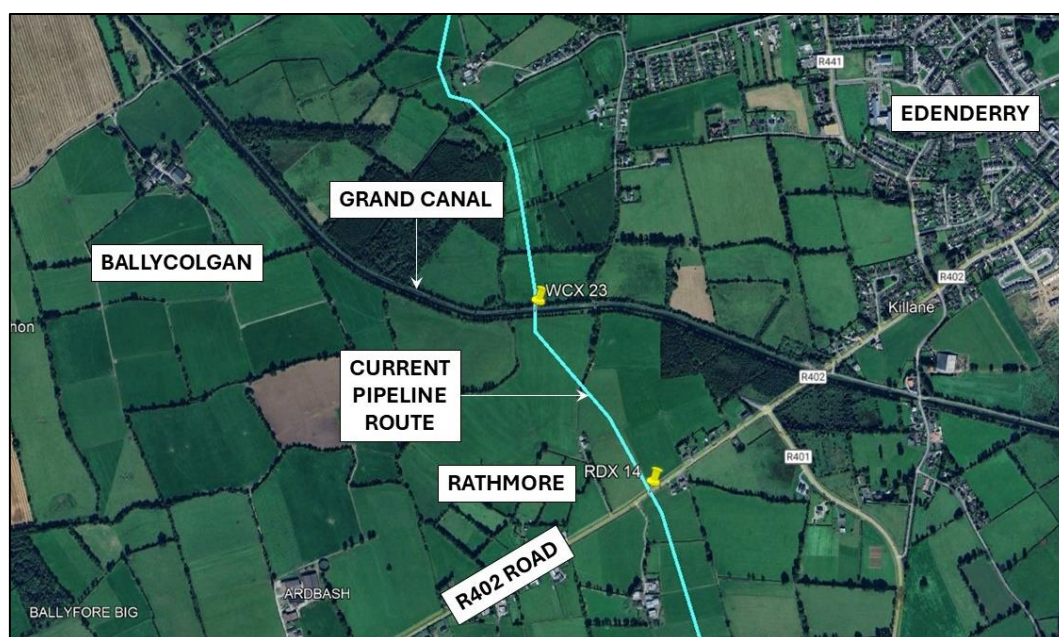


Figure 3-1: Grand Canal (WCX23) Crossing Location

Land on the north side of the crossing (Figure 3-2) is flat agricultural pasture land with grass fields bounded by established trees and hedgerows.

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Figure 3-2: View of North Side of Grand Canal Crossing

The Grand Canal (Figure 3-3) is approximately 10m wide between banks at the crossing location with vegetation-covered shallow banks. Water depth is assumed as being less than 2m deep at the crossing location. Vegetation is present within the water channel which is typical for this type of canal.



Figure 3-3: View of Grand Canal close to proposed Crossing Location

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Land on the south side of the crossing (Figure 3-4) is agricultural pasture land which slopes gently upwards from the canal boundary with grass fields bounded by established trees and hedgerows. A drainage channel is present on the north side of the canal between the Grand Canal Greenway footpath and the land boundary to the north.



Figure 3-4: View of Grand Canal from Rathmore Bridge to East of Crossing Location

3.2 Local Constraints

3.2.1 Existing Infrastructure

The only existing infrastructure present at the crossing location is understood to be the canal channel, the Grand Canal Greenway footpath, and a large drainage channel on the north side of the canal, all of which are located between the land boundaries on the north and south sides of the canal. No other major items of above ground or below ground infrastructure that would create major obstacles to pipeline/crossing construction are present.

The preliminary HDD profile will be designed so that the potential for negative impacts to existing infrastructure is minimised. Specified minimum allowable depth of cover between the pipeline and bed level of the Grand Canal is 3.0m. Ground settlement limits at canal bed level and Grand Canal Greenway surface level are expected to be subject to agreement with relevant asset owner/operators. An objective of the preliminary HDD profile design will be to maximise depth of cover below the canal channel and Greenway in order to minimise the potential for ground settlement and to minimise the potential for drilling fluid Inadvertent Returns (IR) to the canal channel and surface during drilling.

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A depth of cover between the HDD profile and bed level of the Grand Canal of 9.5m (Approx.) is currently proposed. A ground settlement check for the canal bed and Greenway surface is provided in Section 5.3 of this document to ensure that estimated ground settlement for the canal bed and Greenway surface is not above unacceptable levels. No specific ground settlement limit for the canal bed is anticipated. A ground settlement limit for the Greenway surface of 10mm is assumed for preliminary design purposes. A preliminary drilling fluid hydrofracture assessment is provided in Section 5.4 of this document to show that the risk of drilling fluid IR to the surface is within acceptable limits for the preliminary HDD profile.

3.2.2 Natural Features

No significant natural features or major environmental constraints are understood to be present along the pipeline route at the proposed Grand Canal Crossing location. Large trees are present along land and field boundaries on both sides of the crossing. The crossing will be designed to avoid all woodland areas and to ensure that no crossing construction activities will take place within the Grand Canal and Grand Canal Greenway land boundary.

3.2.3 Working Areas

The only constraint present on the north side of the Grand Canal Crossing for establishment of working areas for pipeline and crossing construction activities are assumed to be the field boundaries where established trees and hedgerows are present. Due to the proposed distance between the current pipeline route and the existing field boundaries this is not considered to be a major obstacle to pipeline/crossing construction.

The only constraint present on the south side of the Grand Canal Crossing for establishment of working areas for pipeline and crossing construction activities are assumed to be the field boundaries where established trees and hedgerows are present. Due to the proposed distance between the current pipeline route and the existing field boundaries this is not considered to be a major obstacle to pipeline/crossing construction.

An initial assessment of working area requirements and existing constraints indicates that sufficient space is available for construction of an HDD crossing on both sides of the Grand Canal Crossing. HDD Entry and Exit Point sites can be located within the proposed pipeline construction working width (assumed as 30m width) on both sides of the crossing assuming a preliminary site working area requirement of 1000m² for both the HDD Entry Point and HDD Exit Point sites. Additional working area could be taken within the proposed pipeline construction working width by extending the area footprint along the pipeline route centreline, if required.

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Due to the relatively straight alignment of the proposed pipeline route on the north side of the crossing, it is considered more appropriate to have the HDD pipe string fabrication corridor on this side of the crossing where it should be possible to fabricate the HDD pipe string within the proposed pipeline construction working width.

It is not considered possible to complete an HDD crossing of the Grand Canal based on the current pipeline route alignment and a more suitable alignment will be proposed as part of this preliminary crossing design exercise. As a result, the proposed pipeline route centreline and construction working width will need to be adjusted to suit. Working area requirements for an HDD crossing of the Grand Canal should not be affected. The detailed design pipeline route shall include the required centreline realignment in order to conform with the proposed crossing alignment.

No significant constraints are understood to be present for crossing construction. Temporary Working Area (TWA) requirements are expected to be subject to agreement with landowners and Waterways Ireland.

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4 Ground Conditions Assessment

A Geotechnical Interpretive Report (GIR) for the Grand Canal Crossing (Ref. 2) has been provided for information. The GIR contains a geotechnical desk study and a summary of the site investigation work that has been undertaken by the project.

4.1 Geotechnical Desk Study

The geotechnical desk study provided as part of the GIR (Ref. 2) is based on information available in the public domain for local geological conditions.

The Quarternary soils plot for the general area of the Grand Canal Crossing (Figure 4-1) reveals widespread limestone till. Alluvium deposition follows a ditch line to the west of the site, which presumably follows a meandering, possibly ephemeral stream course. There are also instances of ‘cut over raised peat’ to the northwest and east of the crossing point. The presence of over-consolidated clay and gravel till was proven largely at depth during the investigation. Soft consistency soils were also noted in BH28 to a depth of 2.4m BGL.

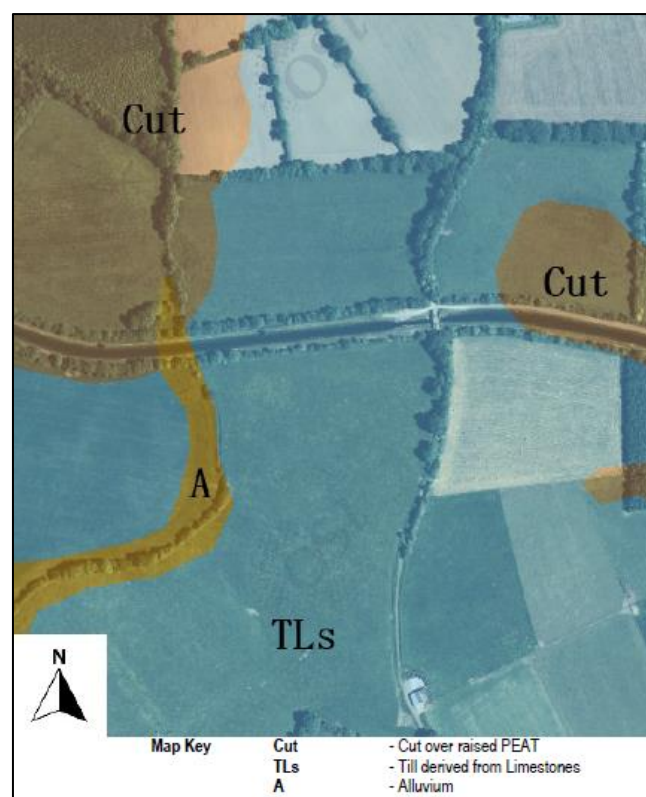


Figure 4-1: Quarternary Soils Plot for Grand Canal Crossing Site Location (GSI)

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The bedrock geology plot for the general area of the Grand Canal Crossing (Figure 4-2) shows that the site is underlain by Lower Carboniferous, Edenderry Oolite Member of the Allenwood Formation. The Edenderry Oolite Member is described in McConnell, Philcox & Geraghty (1994) as a “partly skeletal calcarenite (bio-oosparite)”. A bio-oosparite is a bioclastic limestone that contains both biological fragments (bioclasts) and ooids, with a sparry calcite cement.

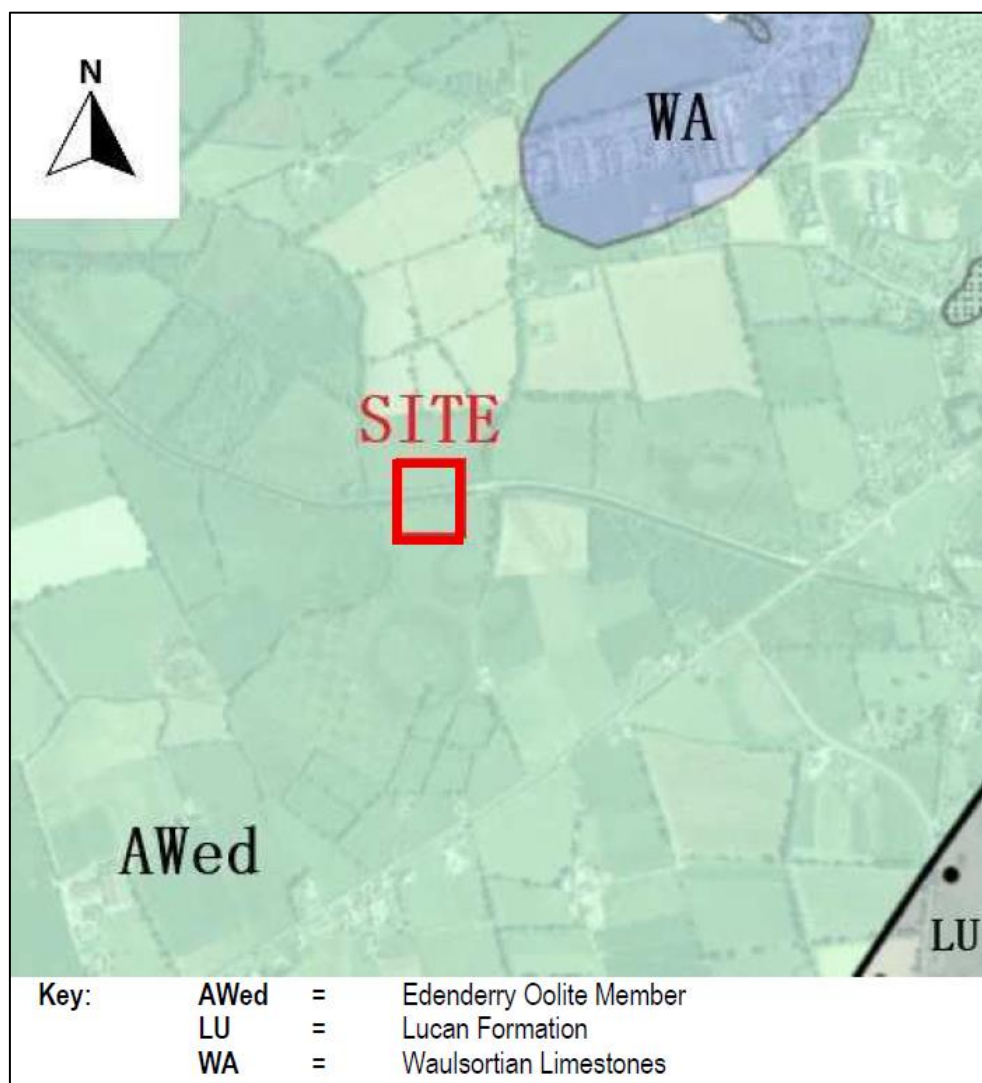


Figure 4-2: Bedrock Geology Plot for Grand Canal Crossing Site Location (GSI)

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4.2 Review of Site Investigation Data

Site investigations have been completed for the Grand Canal Crossing location. Details of the exploratory holes completed at the Grand Canal Crossing location are summarised in Table 4-1.

Table 4-1: Exploratory Hole Details for WCX23

Borehole No.	Borehole Type	Borehole Coordinates	Borehole Level	Borehole Depth	Groundwater Level
BH28	Cable Percussion	660822.46 E 731757.88 N	+77.04m AOD	3.5m	2.7m BGL
BH28A	Cable Percussion	660822.56 E 731757.61 N	+77.40m AOD	9.5m	2.7m BGL
BH29	Cable Percussion	660793.31 E 731731.78 N	+77.05m AOD	6.0m	0.8m BGL
BH30	Cable Percussion	660823.77 E 731665.35 N	+78.62m AOD	4.5m	No Water Strike
BH30A	Cable Percussion	660826.31 E 731669.50 N	+78.26m AOD	6.0m	4.8m BGL
BH31	Cable Percussion	660793.16 E 731629.16 N	+79.21m AOD	1.0m	No Water Strike
BH31A	Cable Percussion	660793.16 E 731629.16 N	+79.21m AOD	5.5m	No Water Strike
RC28A	Rotary Core (Symmetrix)	660822.56 E 731757.61 N	+77.40m AOD	20.0m	9.8m BGL
RC29	Rotary Core (Symmetrix)	660793.31 E 731731.78 N	+77.05m AOD	18.3m	6.6m BGL
RC30A	Rotary Core (Symmetrix)	660826.31 E 731669.50 N	+78.26m AOD	17.5m	No Water Strike
RC31A	Rotary Core (Symmetrix)	660793.16 E 731629.16 N	+79.21m AOD	18.2m	No Water Strike

The following descriptions (Majority of text descriptions taken directly from Ref. 2) summarise the ground conditions encountered across the site as identified by the exploratory locations. The geological cross-section included in Ref. 2 is provided in Annex A of this report for information.

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4.2.1 Topsoil

Topsoil was generally found to be between 0.1-0.3m thick in the boreholes. At location BH29, a peaty TOPSOIL remarked as “TOPSOIL/PEAT” was logged to a depth of 0.5m BGL. This borehole was also found to be the topographically lowest of all four locations.

4.2.2 Superficial Deposits – Glacial Till

With the exception of location BH28, no soft soils were evident at the Grand Canal exploratory hole locations. BH28, based on SPT N-values obtained from tests at both 1.0m and 2.0m BGL, reported soft brown sandy gravelly SILT. It extended to 2.4m BGL where a stiff grey gravelly CLAY with boulders was encountered. The existence of boulders in the soil column may be a factor when considering why three of the four holes required re-setups during cable percussion boring.

Each of the three other boreholes initially reported firm and firm to stiff CLAY passing into more consolidated stiff brown and grey gravelly CLAY till deposits. The two holes positioned south of the canal (BH30A & BH31A) encountered stiff to very stiff sandy gravelly CLAY with cobbles to 5.0m BGL / +73.26m AOD and 5.5m BGL / +73.71m AOD respectively.

The holes to the north of the canal found, beneath initial stiff grey and brown CLAY, a sequence of medium dense to dense brown and grey sandy GRAVEL with cobbles. BH29 ended in this material at 6.0m BGL / +70.68m AOD. Elsewhere, BH28A extended beyond the base of the GRAVEL deposit revealing a very stiff brown sandy gravelly cobbly CLAY from 9.0m BGL. BH29 ended on obstruction at 9.50m BGL / +67.90m AOD.

Rotary drilling methods were used to extend the bores in each case.

Limestone rock was encountered at consistent depths in each of RC29, RC30A and RC31A, between 5.50m and 6.40m BGL. Rockhead appears to fall away somewhat nearing location RC28A to the north of the canal crossing. The geological cross section (Annex A) illustrates the fall in rockhead topography from south to north across the canal.

Based on SPT test drives at 1.0m and 2.0m depth BGL, there exists a soft layer in BH28A. This appears to be the exception with N-values typically suggestive of a firm mantle of indigenous CLAY/SILT becoming stiff generally from 2.0m depth BGL.

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4.2.3 Bedrock

Rotary drilling was conducted at four locations at WCX23, both immediately north and south of the Grand Canal. Coring successfully proved bedrock at each of the four locations with rockhead depths ranging from 5.9-11.8m BGL. These depths corresponded to elevations of +73.31m AOD and +65.60m AOD.

Discontinuity spacings in the rotary cores generally ranged from closely (60-200mm) to widely spaced (600-2000mm). The discontinuity surfaces were typically smooth and locally rough, planar to irregular. Apertures were tight to open, locally exhibiting clay smearing with some calcite veinfill (up to 15mm). Dips were generally sub-horizontal, locally 30-45°, occasionally irregular.

The point load strength index (PLSI) test data produced $Is(50)$ values ranging from 2.61 to 6.63 MPa with a mean value of 4.27 MPa. The PLSI strengths are suggestive of the presence of strong and very strong rock.

Using a correlation factor (K) of 22 to assess compressive strength, this suggests a characteristic strength envelope in the order of 57 to 146 MPa and categorizes the bedrock as strong (50 to 100MPa) to very strong (100 to 250MPa).

4.2.4 Groundwater

Water ingress was recorded in both the cable percussion boreholes and rotary drillholes. The cable percussion boreholes intercepted groundwater at its shallowest at 3.0m BGL (BH28) while rotary drilling in bedrock encountered groundwater at its deepest, at 15.5m BGL in RC29. Two separate strikes were intercepted in RC29 both at rockhead (6.6m BGL) and, as mentioned, deeper in the bedrock at 15.5m BGL. The most intense strike occurred in cable percussion borehole BH29 where water in the buried GRAVEL layer rose rapidly from a strike level at 3.5m BGL to a depth of 0.8m BGL inside 20 minutes.

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4.3 Suitability of Ground Conditions for HDD

Boreholes were completed in fields both immediately north and south of the Grand Canal. They each encountered upper sequences of CLAY/SILT (generally firm becoming stiff with depth) with underlying deeper-seated, water-bearing GRAVEL found in three of the four holes (BH28A, BH29 & BH30A). Based on SPT results, a soft SILT soil was identified at location 28 to a depth of 2.4m BGL. In the GIR, it was stated that the presence of possible soft ground at one of the four locations warrants further investigation.

Rotary coring at the four borehole locations proved LIMESTONE bedrock from 5.9-11.8m BGL corresponding to elevations of +73.31m AOD and +65.60m AOD. The deepest bedrock was flagged in RC28A where a thicker than normal overlying sequence of GRAVEL and COBBLES was logged to a depth of 9.25m BGL, with CLAY completing the soil column to possible bedrock at 10.8m BGL. Rock coring commenced at 11.8m BGL at RC28A.

An HDD crossing of the Grand Canal is anticipated to be within limestone bedrock, gravel, or stiff clay layers over the majority of the crossing length. Potential for encountering cobbles and boulders is considered to be low to medium, where cobbles/boulders could be encountered every 20-50m.

Cobbles and boulders are expected to be derived from the limestone bedrock and can be drilled through if the HDD equipment used is suitable for rock drilling. The HDD bore is expected to be self-supporting in the bedrock layer and the risk of bore collapse in the bedrock layer is considered to be very low. Routing the HDD profile in the bedrock layer where the bore passes below the Grand Canal will reduce the risk of ground settlement in the vicinity of the Grand Canal and Grand Canal Greenway. A preliminary ground settlement check for the Grand Canal and Grand Canal Greenway is provided as part of this preliminary crossing design exercise (Section 5.3).

Routing the HDD profile deep into the bedrock layer could reduce the risk of drilling fluid IR to formation or to the surface. A preliminary drilling fluid hydrofracture assessment is provided as part of this preliminary crossing design exercise (Section 5.4). However, this does not take into consideration the potential for natural leak paths to the surface to be present. The potential for natural leak paths to be present is considered to be low based on the ground conditions assessment. Karst features have not been mapped at the crossing location in public domain mapping.

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The presence of gravel and cobbles can cause issues for the HDD method, especially where loose gravel/cobble layers may exist, or where the majority of the crossing length is through a soil matrix containing a high percentage of gravel/cobbles with a low clay/silt content. The gravel/cobbles layers present at the crossing location contain cohesive materials (clay and silt) with sand also present within the soil matrix. Due to the anticipated small size of the HDD bore required for the 12" OD pipeline, the risk of bore collapse in the gravel/cobbles layers is considered to be low.

The potential presence of artesian groundwater in the gravel layers will have to be taken into consideration by the construction contractor. Artesian groundwater can contribute to HDD bore instability, but the risk can be minimised by an optimised design. Typically, contractors will design the HDD profile to avoid areas where artesian groundwater may impact bore stability. Artesian groundwater conditions can normally be balanced by the heavier drilling fluid in the HDD bore.

An HDD solution appears to be feasible based on the anticipated ground conditions, short length of HDD bore required, and small diameter of HDD bore required. The preliminary HDD crossing design will consider the local constraints and ground conditions with the additional objectives of minimising risk of ground settlement, and the objective of minimising risk of drilling fluid IR to the surface. The HDD profile design and crossing construction methodology are expected to be developed further by the construction contractor and are expected to include further assessment of local ground conditions and associated risks.

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5 HDD Crossing Preliminary Design

5.1 Preliminary HDD Profile Design

The preliminary HDD profile design is generally based on the following objectives:

- Achieve a crossing of the Grand Canal and Grand Canal Greenway;
- Plan the HDD crossing alignment within the project order limits;
- Minimise HDD crossing length;
- Minimise complexity of pipeline tie-ins on both sides of the crossing;
- Cross the Grand Canal at perpendicular, or close to perpendicular, angles;
- Maintain appropriate clearance (>10m) between construction working areas and land boundaries;
- Maintain appropriate clearance (>20m) between construction working areas and the Grand Canal watercourse;
- Maintain a minimum required depth of cover to the pipeline of 3.0m at the Grand Canal;
- Maintain a minimum required depth of cover to the pipeline of 1.6m at drainage ditches;
- Maintain a minimum required depth of cover to the pipeline of 1.2m at the Grand Canal Greenway;
- Plan the HDD profile within stable soils over the majority of the profile length;
- Plan the HDD profile maximum depth within the coverage of the site investigations;
- Achieve an HDD profile depth which minimises risk of ground settlement at existing infrastructure locations;
- Achieve an HDD profile depth which minimises risk of drilling fluid IR to the surface;
- Achieve an HDD profile length which allows the pipe string to be fabricated in a single length; and
- Provide a feasible HDD profile geometry for crossing construction and pipeline operation.

The proposed HDD crossing alignment and profile achieves all of the objectives listed above. However, due to the current alignment of the pipeline route being unsuitable for the HDD crossing length being proposed, a new pipeline route alignment will be required to incorporate the proposed HDD crossing alignment, which is required to ensure a straight HDD crossing alignment in plan. The detailed design pipeline route shall include the required centreline realignment in order to conform with the proposed crossing alignment.

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The pipe string fabrication corridor is located on the north side of the crossing due to the better alignment of the pipeline construction working width on this side of the crossing. No curvature of the pipe string is anticipated.

Standard practice is to use straight alignments in plan for HDD crossings in order to minimise the complexity of the pilot hole drilling operation. A straight alignment in plan is used for the preliminary HDD crossing alignment in order to provide a conservative approach. HDD crossings can be curved in plan when necessary. However, complexity of crossing construction may increase where short radius curves (approaching the operational limits of the drill pipe), or combined horizontal and vertical curves, are proposed.

The preliminary HDD crossing alignment crosses the Grand Canal close to a perpendicular alignment (Figure 5-1). Entry/exit angles of 12° have been used. A minimum radius of curvature of 360m for the HDD profile has been assumed based on typical values used for HDD crossings of this size in similar ground conditions. The proposed radius of curvature ensures that installation and operation stresses on the pipeline should remain within allowable limits, and a greater depth of cover is achieved at the Grand Canal. This results in a preliminary HDD crossing 2D length of approximately 190m in plan.



Figure 5-1: Preliminary HDD Crossing Plan Alignment

The overall length of the crossing may be subject to change during the detailed design of the HDD crossing by the construction contractor. However, the overall length is not expected to change significantly. The crossing location and alignment of the pipeline in relation to the Grand Canal is not expected to change. The final crossing extents and site area boundaries may be subject to change prior to construction during the detailed design of the crossing. However, the minimum allowable proximity distance to land boundaries and the Grand Canal must be observed.

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The vertical alignment of the preliminary HDD profile (Figure 5-2) is expected to pass through the following soil layers (HDD equipment should be selected accordingly):

- Limestone bedrock for the majority of the crossing length;
- Stiff clay, sandy gravel, cobbles, and soft silt/clay layers in the shallow sections of the profile at each end of the crossing.

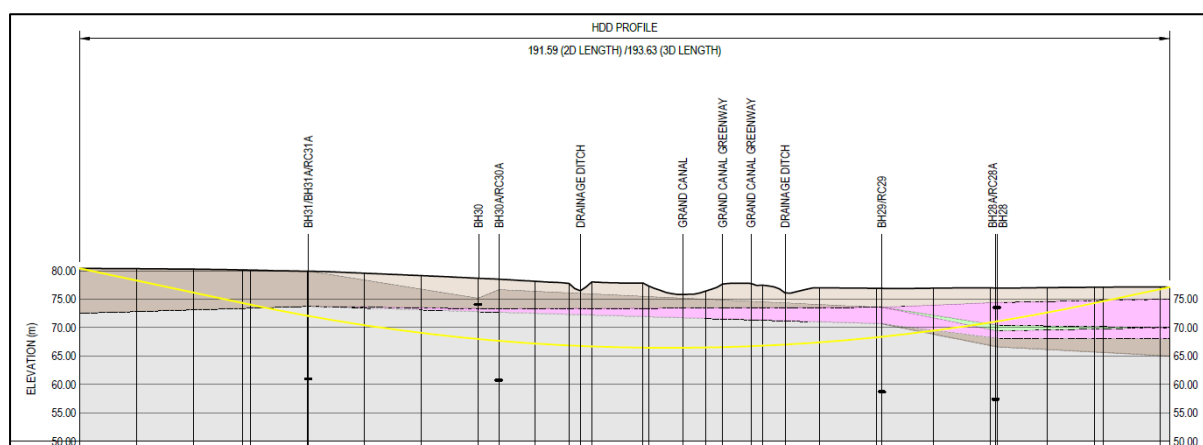


Figure 5-2: Preliminary HDD Crossing Profile Alignment

The minimum clearance distance between the preliminary HDD profile and the Grand Canal is 9.0m (Approx.). The resultant minimum depth of cover to the pipeline at the Grand Canal is therefore expected to be greater than the minimum allowable figure of 3.0m. The preliminary HDD profile is within the limestone bedrock layer where the profile passes below the Grand Canal. The minimum clearance distance between the HDD profile and the Grand Canal may be subject to change prior to construction during the detailed design of the crossing.

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5.2 Preliminary Pipeline Stress Check

5.2.1 Pipeline Installation Pull Force Check

A pipe installation pull force check has been performed for the preliminary crossing alignment. Proprietary HDD design software D-Geo Pipeline has been used to calculate the pipeline installation pull forces for the proposed pipeline. The anticipated pull force is provided in Table 5-1.

Table 5-1: Pipe Installation Pull Force Summary

Pipe OD (mm)	Pipe WT (mm)	Pipe Weight Downhole Empty (kg/m)	Friction Value Pipe Downhole	Estimated Maximum Pull Force (Tonnes)
323.9	12.7	-6.12	0.3	10.9

The pipe installation pull force is considered to be within the allowable limits for the pipeline (subject to confirmation). The estimated maximum pull force can be used as a guide to ensure that a suitable capacity HDD drilling rig is proposed for the pipeline installation operation.

5.2.2 Temporary Installation Stresses

A check on temporary installation stresses on the pipe has been performed for the preliminary crossing alignment. Proprietary HDD design software D-Geo Pipeline has been used to check temporary pipeline installation stresses for the proposed pipeline. The maximum temporary installation stresses on the pipeline are provided in Table 5-2.

The analysis of temporary installation stresses on the pipe includes installation forces, radius of curvature of the HDD bore, and depth of the HDD bore (drilling fluid hydrostatic pressure on pipe) for the start and end of the installation operation. A maximum allowable stress value of 377.27 N/mm² has been assumed for the temporary installation case. The analysis also assumes a single full pipe string length for the start of the pullback operation.

Table 5-2: Temporary Installation Stresses Summary

Maximum Stress on Pipe (Start of Pull) (N/mm ²)	Maximum Stress on Pipe (End of Pull) (N/mm ²)	Allowable Maximum Stress on Pipe during Installation (N/mm ²)	Status
236	150	377.27	OK

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5.3 Preliminary Ground Settlement Check

Preliminary ground settlement checks for the Grand Canal and Grand Canal Greenway have been performed based on the minimum clearance distance between the preliminary HDD bore alignment and the canal bed and greenway surface. The settlement checks have been performed using recognised ground settlement theory provided in Ref. 6. A maximum allowable ground settlement figure of 10mm for the greenway surface has been assumed for the purpose of analysis. A conservative ground volume loss of 50% has been assumed for the purpose of analysis. This figure is typically 20% for HDD applications and can be as low as 0% in strong bedrock. A conservative trough width parameter of 0.4 has been selected based on the presence of cohesive clay and granular materials above the limestone bedrock layer. The figure selected for the trough width parameter ignores the presence of stable bedrock at the level of the HDD bore. The results of the ground settlement checks for the Grand Canal and Grand Canal Greenway are provided in Table 5-3 and Table 5-4.

Table 5-3: Grand Canal Ground Settlement Check Summary

Minimum Clearance Distance (m)	Assumed HDD Bore Diameter (mm)	Trough Width Parameter (K)	Assumed Volume Loss	Maximum Settlement at Canal Bed (mm)	Status
9.0	508.0	0.4	50%	7.1	OK

Table 5-4: Grand Canal Greenway Ground Settlement Check Summary

Minimum Clearance Distance (m)	Assumed HDD Bore Diameter (mm)	Trough Width Parameter (K)	Assumed Volume Loss	Maximum Settlement at Greenway Surface (mm)	Status
10.0	508.0	0.4	50%	6.4	OK

The results of the ground settlement checks for the Grand Canal and Grand Canal Greenway indicate that estimated ground settlement values are not unacceptable and likely to be within assumed allowable limits using conservative assumptions for the purpose of analysis. The HDD bore will be within the limestone bedrock layer where it passes below the Grand Canal and Grand Canal Greenway and, therefore, ground settlement risk is considered to be very low.

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5.4 Preliminary Drilling Fluid Hydrofracture Analysis

Hydrofracture, or frac-out, in HDD occurs when drilling fluid pressure exceeds the ability of the soil above the HDD bore to contain the drilling fluid, causing the drilling fluid to fracture the surrounding ground and potentially reach the surface. Risk of drilling fluid IR to the surface typically increases where depth of cover to the HDD bore is lowest, such as in the shallow sections at both ends of the HDD profile, and where the HDD profile passes below low points in the local terrain such as watercourses or natural/man-made depressions. Drilling fluid can also reach the surface through natural leak paths. This is not considered in a hydrofracture analysis.

Contractors typically install steel casing pipe in the shallow section of a HDD bore at the HDD Entry Point in order to stabilise the shallow soil layers. This casing pipe can also minimise the risk of drilling fluid IR to the surface in this section of the HDD bore. Casing pipe can be used as a temporary contingency measure to stabilise soils and minimise risk of drilling fluid IR to the surface. However, the current pipeline design does not allow for casing pipe to be left in-situ permanently.

A preliminary drilling fluid hydrofracture analysis has been performed based on the preliminary HDD crossing profile and soils profile. Proprietary HDD design software D-Geo Pipeline has been used to perform the drilling fluid hydrofracture analysis.

Typical values for soil parameters required for design have been assumed for the purpose of analysis. Values should be assumed as preliminary and subject to confirmation during detailed design. It should be noted that a drilling hydrofracture analysis is typically only performed for HDD bores being drilled in non-rock soils and is not usually performed for bedrock conditions. However, dense gravel conditions have been assumed instead of bedrock for the purpose of analysis in order to mimic the potential voids present in the limestone bedrock.

Typical values for drilling fluid parameters required for design have been assumed for the purpose of analysis. These values are dependent on the construction methodology being proposed by the construction contractor and are potentially subject to change.

The analysis is performed for the three main stages of the HDD operation:

- Pilot Hole Drilling
- Bore Reaming/Hole Opening
- Pipeline Installation

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The drilling fluid hydrofracture analysis provides a baseline minimum required drilling fluid downhole pressure to ensure drilling fluid flow back to the surface, and maximum allowable drilling fluid pressures related to (1) deformation of the HDD bore and (2) soil cover. The maximum allowable drilling fluid pressure related to soil cover is considered to be the worst case in relation to risk of drilling fluid reaching the surface. Where there is a large working window for downhole pressure (large difference between minimum required and maximum allowable drilling fluid downhole pressure), risk of drilling fluid hydrofracture to the surface is considered to be low. Conversely, where there is a small working window for downhole pressure (small difference between minimum required and maximum allowable drilling fluid downhole pressure), risk of drilling fluid hydrofracture to the surface is considered to be high. The results for the hydrofracture analysis are provided in graphical form.

Co-ordinate 0.0m on the graphs in this section relates to the south (HDD Entry Point) side of the crossing and Co-ordinate 192.0m relates to the north (HDD Exit Point) side of the crossing.

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The results of the hydrofracture analysis for the pilot hole drilling operation are summarised in Figure 5-3. The graph shows a large working window for drilling fluid pressure over the majority of the crossing length, meaning risk of drilling fluid hydrofracture to the surface is potentially very low. The working window for drilling fluid pressure is smaller at the entry and exit sections where cover to the HDD bore is lower. However, conservative soil and drilling fluid parameters have been used for the purpose of analysis and hydrofracture risk is expected to be low in these areas. The shallow sections on HDD profiles are known areas of increased hydrofracture risk due to the reduced depth of cover to the HDD profile. Mitigation measures, such as reducing the drilling fluid pumping rate and downhole pressure in these sections, are typically employed by the contractor to reduce the potential for drilling fluid IR to the surface in shallow sections. In addition, continuous monitoring of drilling fluid volumes, and continuous monitoring of the surface for drilling fluid IR, are performed during construction. Contingency measures are expected to be in place in the event of drilling fluid IR to the surface.

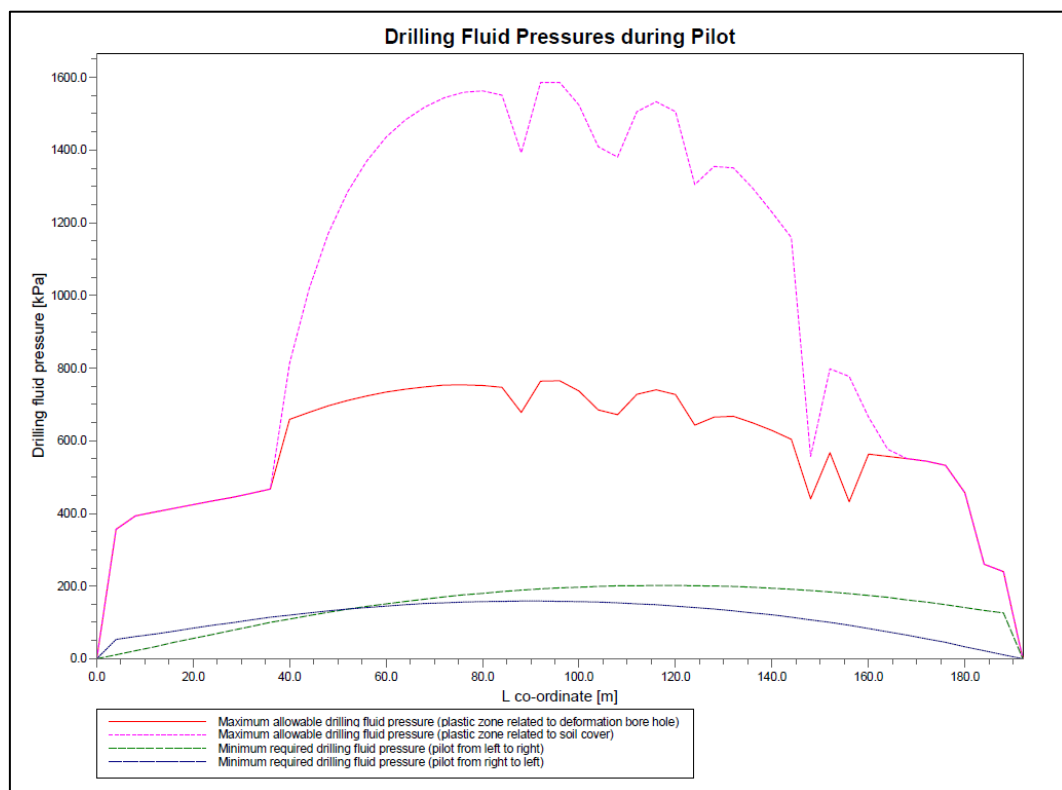


Figure 5-3: Drilling Fluid Hydrofracture Analysis Results (Pilot Hole)

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The results of the hydrofracture analysis for the bore reaming/hole-opening operation are summarised in Figure 5-4. The graph shows a large working window for drilling fluid pressure over the majority of the crossing length, meaning risk of drilling fluid hydrofracture to the surface is potentially very low. The working window for drilling fluid pressure is smaller at the entry and exit sections where cover to the HDD bore is lower. However, conservative soil and drilling fluid parameters have been used for the purpose of analysis and hydrofracture risk is expected to be low in these areas.

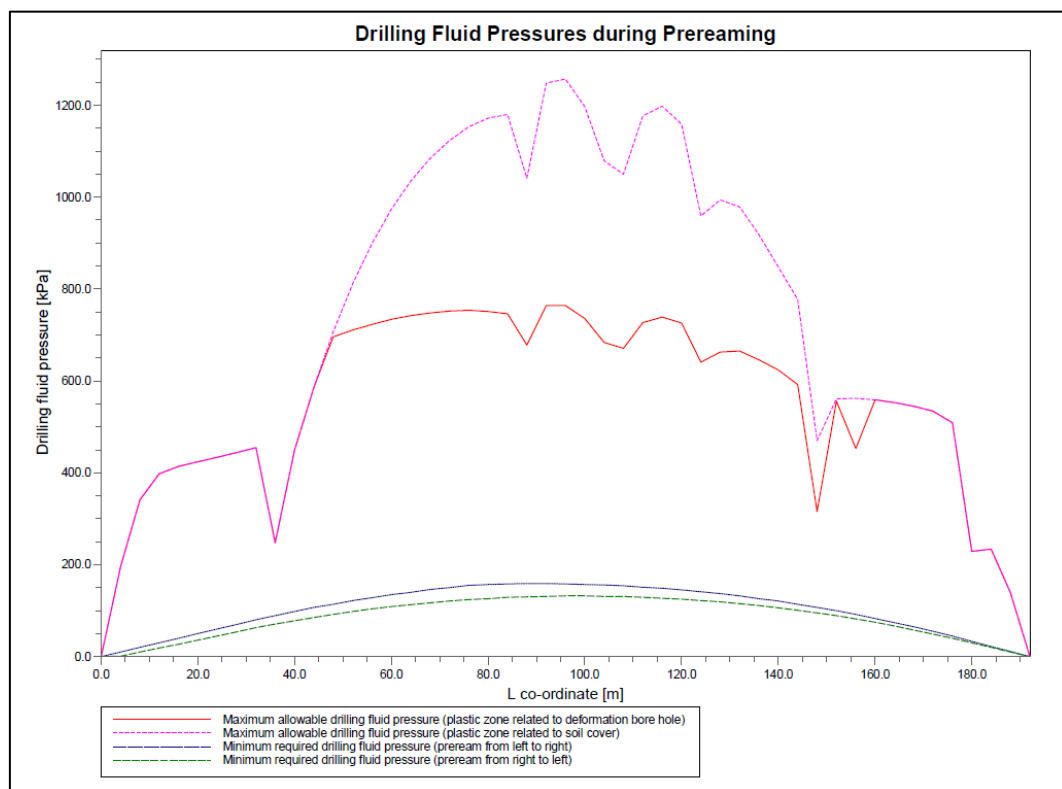


Figure 5-4: Drilling Fluid Hydrofracture Analysis Results (Bore Reaming/Hole-Opening)

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The results of the hydrofracture analysis for the pipeline installation operation are summarised in Figure 5-5. The graph shows a large working window for drilling fluid pressure over the majority of the crossing length, meaning risk of drilling fluid hydrofracture to the surface is potentially very low. The working window for drilling fluid pressure is smaller at the entry and exit sections where cover to the HDD bore is lower. However, conservative soil and drilling fluid parameters have been used for the purpose of analysis and hydrofracture risk is expected to be low in these areas.

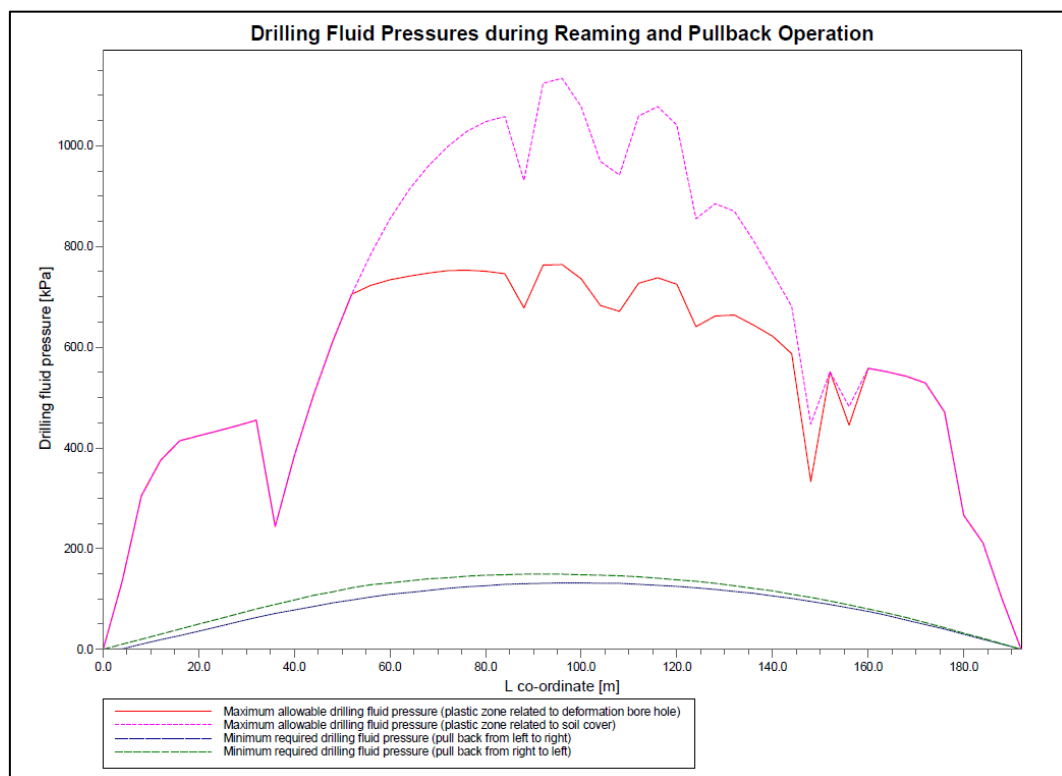


Figure 5-5: Drilling Fluid Hydrofracture Analysis Results (Pipeline Installation)

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Overall, the risk of drilling fluid hydrofracture to the surface is considered to be low for this crossing. The south side of the crossing is at co-ordinate 0.0m on the graphs and the north side of the crossing is at co-ordinate 192.0m.

The Grand Canal is at co-ordinate 105.0m (Approx.) on the graphs above. The working window is interpreted as being appropriate for the proposed operations and risk of drilling fluid hydrofracture to the watercourse is considered to be low.

Contractors can implement contingency measures in the event of excessive drilling fluid losses to formation or drilling fluid IR to the surface. Contingency measures include the addition of Loss Control Measures (LCM) to the drilling fluid or controlled grouting of the HDD bore in areas of concern. Contractors will implement an emergency response procedure in the event of drilling fluid IR to the surface. This typically involves installing a soil bund around the drilling fluid that has come to the surface to prevent further spreading, pumping the drilling fluid back to the HDD site working area, and then reinstating the affected land.

Results presented in this document are considered to be preliminary. Conservative assumptions for various soil parameters and drilling parameters have been made for the purpose of analysis. Further assessment of drilling hydrofracture risk is expected to be performed during the detailed design phase of the works as the HDD crossing design and methodology is developed. The performance of a drilling fluid hydrofracture risk assessment during detailed design is typically a requirement of the controlling specification for the HDD works.

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6 Design Risk Assessment

A design risk assessment for the preliminary design of the HDD crossing is provided in Table 6-1 below. Residual risks are considered to be high-level risks that are relevant to future design and construction activities and provided for information only.

A geophysical survey is recommended for the crossing to help to provide further definition for bedrock level. Planning the HDD profile to pass through bedrock, where possible, may reduce overall risk for the crossing in terms of HDD bore stability. A geophysical survey can provide additional information on local bedrock level.

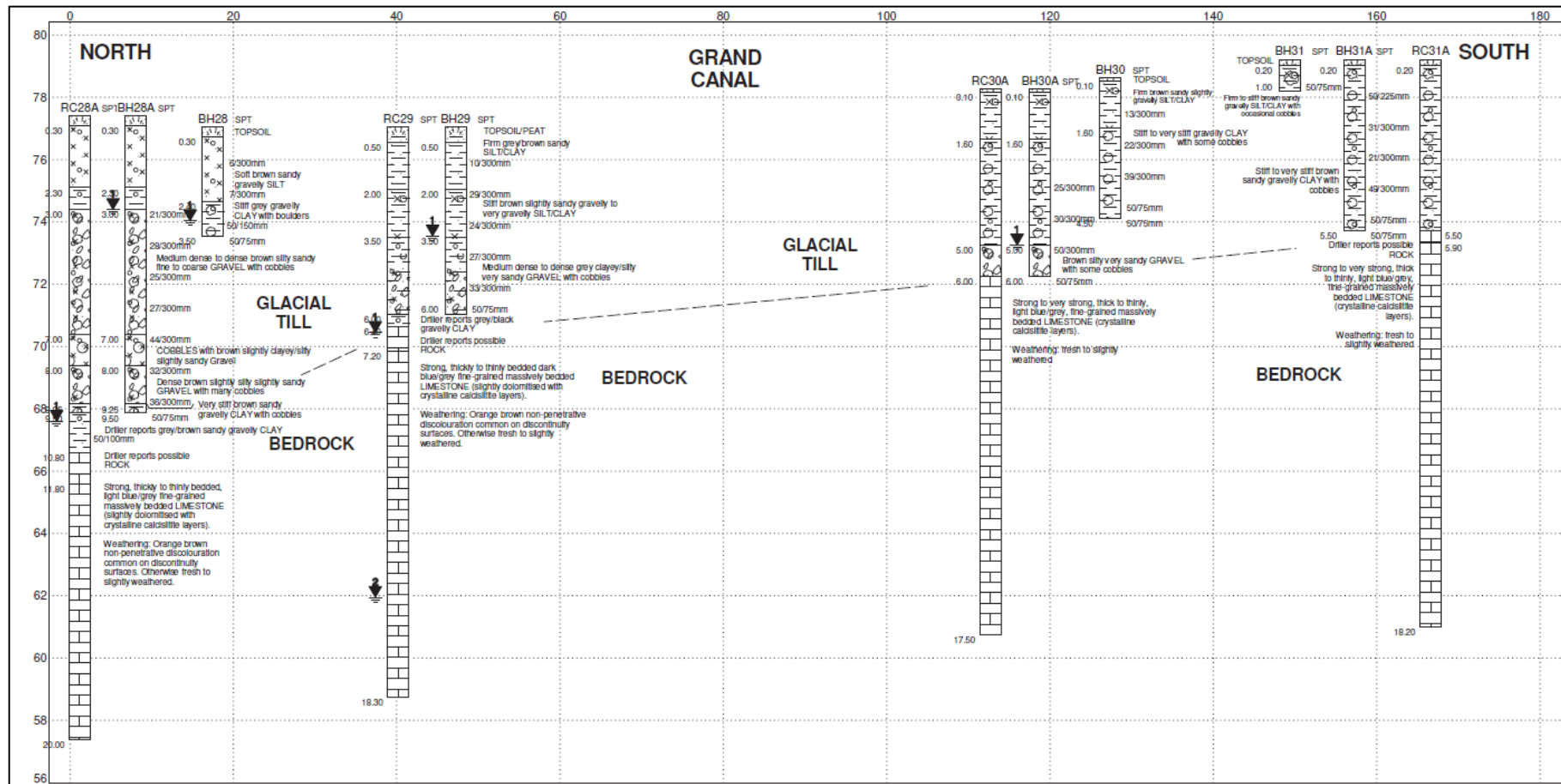
Table 6-1: Design Risk Assessment for Preliminary Crossing Design

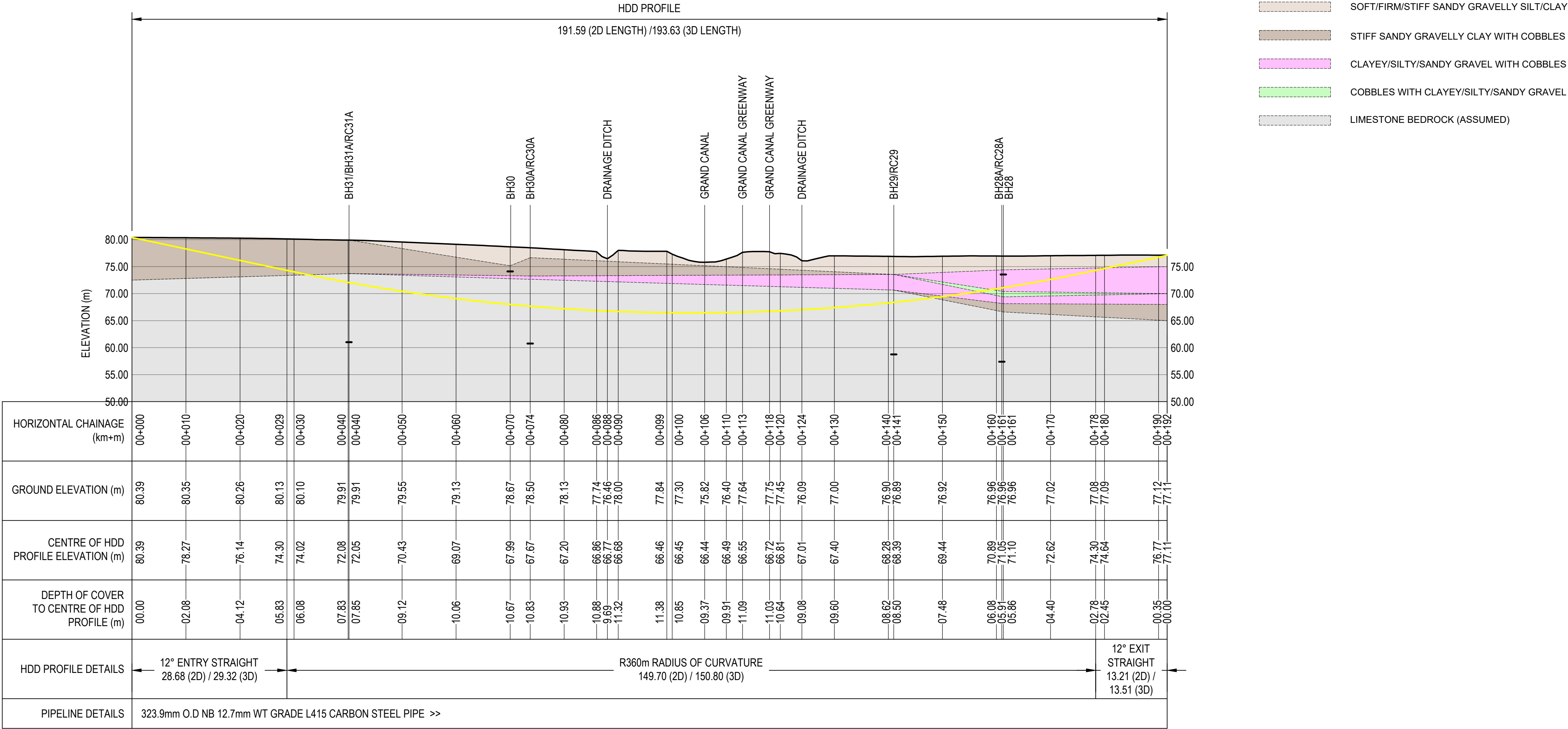
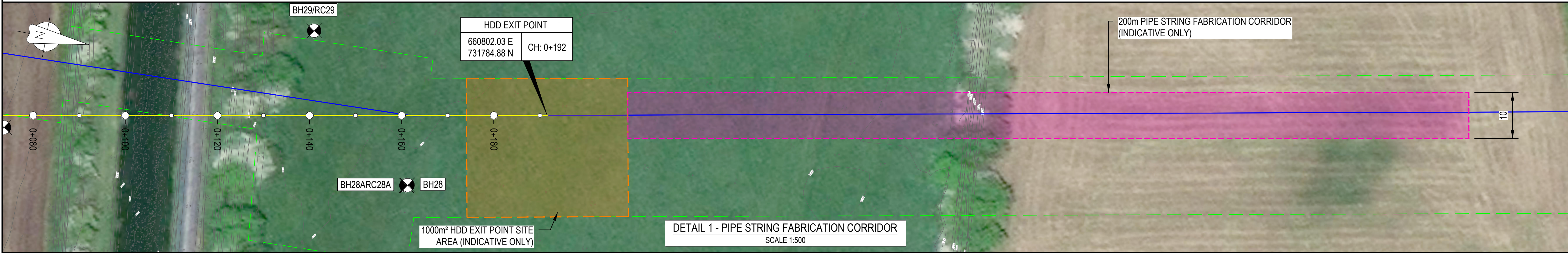
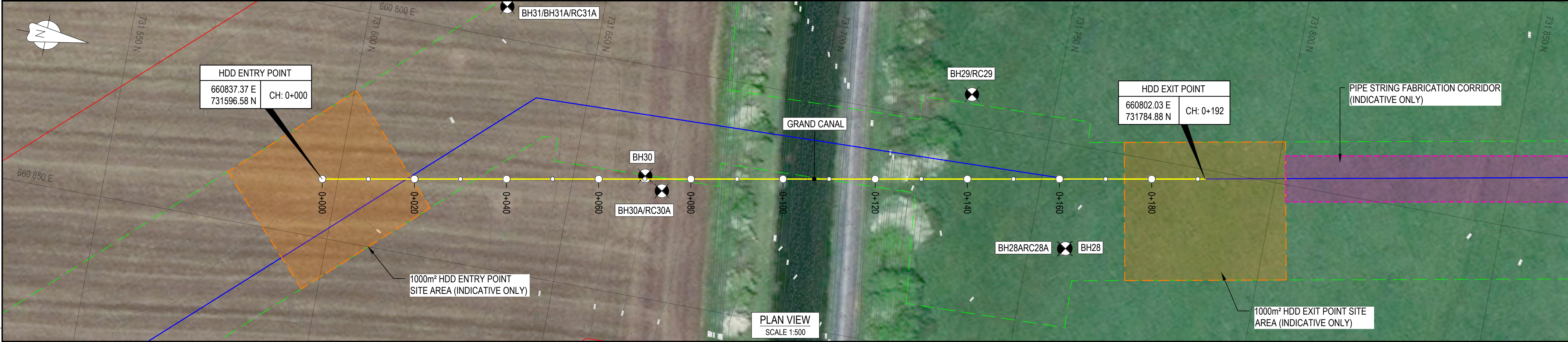
Potential Hazard	Design Action	Residual Risk
Unexpected Ground Conditions	Review of project-specific site investigation data supplemented with information available in public domain for crossing location. Preliminary HDD profile designed to pass through most stable ground conditions.	Ground conditions between site investigation locations differs from assumptions made in review. Residual risk remains if HDD contractor does not interpret soils information correctly and does not plan works accordingly.
Insufficient clearance to existing infrastructure potentially resulting in breach of allowable settlement limits.	Location and approximate level of existing infrastructure has been established during site surveys. Minimum clearance of 10m (Approx.) between preliminary HDD profile and existing infrastructure proposed in design. Preliminary ground settlement checks performed in design using conservative assumptions and soil parameters.	HDD contractor will perform settlement checks for existing infrastructure prior to construction and design HDD profile to suit. Residual risk remains if HDD contractor does not maintain recommended clearance between HDD profile and existing infrastructure.
High installation loads on pipeline causing damage to pipeline.	Design checks performed for anticipated installation loads on pipeline.	HDD contractor will perform installation stress checks for proposed pipeline and HDD profile alignment prior to construction. Residual risk remains if HDD contractor does not monitor installation loads and does not maintain installation loads within recommended limits.

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Potential Hazard	Design Action	Residual Risk
Drilling fluid inadvertent returns to surface during drilling.	Ground levels and preliminary soil profile for crossing location established during site surveys and crossing assessment work. High-level assessment of drilling fluid hydrofracture risk performed based on assumed ground conditions and drilling parameters. Hydrofracture risk is considered to be low based on the assumed ground conditions, the preliminary crossing length and depth, and the maximum expected HDD bore diameter.	Site-specific hydrofracture analysis will be performed by HDD contractor prior to construction. HDD contractor will perform surface monitoring during drilling and will have drilling fluid containment and clean-up measures on site for the duration of the works. Residual risk remains if HDD contractor does not maintain downhole pressure within working envelope as recommended by hydrofracture analysis.

Annex A – Geological Cross-Section for Grand Canal Crossing





PROFILE VIEW
SCALE 1:1000

NOTES

- ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE. CHAINAGES (km) ARE LOCAL TO THE DRAWING. COORDINATES ARE IN METRES.
- THE REFERENCED CO-ORDINATE SYSTEM IS IRISH TRANSVERSE MERCATOR (ITM15). ELEVATIONS ARE SHOWN TO THE SURVEY DATUM, MALIN HEAD.
- TOPOGRAPHIC SURVEY DATA HAS BEEN TAKEN FROM MURPHY GEOSPATIAL (MGS) DRAWING MGS-60130-WCX1_T_ITM_REV 0.
- SATELLITE IMAGERY IS PROVIDED BY ESRI WORLD IMAGERY.
- CROSSING LAYOUT AND PROFILE GEOMETRY IS INDICATIVE ONLY AND SUBJECT TO DEVELOPMENT BY OTHERS DURING DETAILED DESIGN.
- SOILS PROFILE SHOWN HAS BEEN INTERPRETED FROM EXISTING SITE INVESTIGATION DATA AND IS CONSIDERED TO BE PRELIMINARY AND FOR INFORMATION PURPOSES ONLY. SOIL LAYER BOUNDARY LEVELS SHOWN ARE ASSUMED FOR PRELIMINARY DESIGN PURPOSES ONLY.
- DESIGN AND CONSTRUCTION OF CROSSING SHALL BE COMPLETED IN ACCORDANCE WITH THE MINIMUM REQUIREMENTS OF RELEVANT PROJECT SPECIFICATIONS AND INDUSTRY GUIDELINES.
- HDD ENTRY AND EXIT POINTS SHOWN ARE CONSIDERED TO BE PRELIMINARY AND POTENTIALLY INTERCHANGEABLE DURING CONSTRUCTION. THE PRELIMINARY HDD PROFILE AND PIPE STRING FABRICATION CORRIDOR SHOWN IS NOT AFFECTED.

LEGEND

- BOREHOLE (EXISTING)
- 0+XX
- PROPOSED HDD ALIGNMENT
- PROPOSED PIPELINE ROUTE
- PROJECT ORDER LIMITS
- PIPELINE CONSTRUCTION WORKING WIDTH
- TOPOGRAPHIC SURVEY DATA
- END OF BOREHOLE
- HDD ENTRY/EXIT SITE
- PIPE STRING FABRICATION CORRIDOR
- FLOOD ZONE

REFERENCES

- MJS-FW-GBNME-REP-008
GRAND CANAL CROSSING - PRELIMINARY CROSSING DESIGN REPORT
- MGS-60130-WCX1_T_ITM_REV 0
TOPOGRAPHICAL SURVEY
- 25882 GAS TO BORD NA MONA, EDENDERRY - PHASE 1 GI - HCC4_REV 0
GEOTECHNICAL INTERPRETIVE REPORT

C	26/08/26	ISSUED FOR INFORMATION	NP	DM	MS
B	28/11/25	ISSUED FOR INFORMATION	NP	DM	MS
A	07/11/25	ISSUED FOR INFORMATION	NP	DM	MS
REV	DATE	PURPOSE OF REVISION	DRAWN	CHECKED	REVIEWED



PROJECT NAME:

GAS TO BORD NA EDENDERRY PROJECT

DRAWING TITLE:

GRAND CANAL CROSSING
PRELIMINARY CROSSING DRAWING

DRAWING NO.:	SCALE:	SHEET SIZE:	REV:
MJS-FW-GBNME-DWG-004	1:500	A1	C

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