Appendix D

Report 1: Assessment of significant effects on the environment in respect of soils and geology

Report 2: Assessment of significant effects on the environment in respect of Hydrology

Report 3: Assessment of significant effects on the environment in respect of Hydrogeology

Foynes to Limerick Road (including the Adare Bypass)

Assessment of significant effects on the environment

in respect of Soils and Geology.

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1.1. Introduction

1.1.1. Soils and geology are addressed primarily in Chapter 8 (Soils and Geology) of Volume 2 of the EIAR, in the response to a request for further information and at the oral hearing by Mr Seamus MacGearailt and Mr Fintan Buggy of ROD-AECOM. A number of other chapters in the EIAR are also of relevance to the impact assessment including in particular Chapter 4 (Description of the Proposed Road Development), Chapter 9 (hydrogeology) and Chapter 10 (hydrology). The following is my examination and evaluation of the information presented by the applicant leading to a conclusion on the effects on the soils and geological environment arising from the construction and operation of the proposed road development (PRD).

1.2. Approach to study by the applicant

1.2.1. The applicant's assessment was prepared in accordance with the established guidelines for the completion of an EIAR by the EPA, European Commission and included TII adopted 'Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes' (NRA, 2008).

1.2.2. The applicant's understanding of the soils and geological environment is derived from desk studies of sources of published information such as the Geological Survey of Ireland (GSI), information from the constraints and route selection studies as well as pre-existing information from earlier schemes, consultation with prescribed/public bodies and feedback from consultations. Information gathered from site inspections undertaken over a five-year period from 2014 to 2018 also informed the applicant's understanding of the soils and geological environment. A programme of intrusive ground investigations was undertaken along the route of the PRD in the period between 2016 and 2019. The investigations generally consisted of boreholes and

rotary core sampling, excavation of trial pits, dynamic probing and the carrying out of in-situ and laboratory testing on the soils encountered to establish their geotechnical properties. Geophysical surveys were also carried out at various locations along the route of the PRD including at areas of known or suspected karst activity. Where potential areas of karstification were identified, additional ground verification was undertaken using additional boreholes and rotary cores at these locations. Standpipes and piezometers were installed in the soils and bedrock in areas of interest with respect to groundwater and monitoring of groundwater levels was undertaken to ascertain seasonal groundwater fluctuations. Groundwater quality was monitored at sensitive locations in order to determine baseline conditions generally and in areas of concern relating to potential ground contamination. The applicant provided details of the ground investigation locations and soil type findings, and these are illustrated in Figures 8.1 to 8.24 of Volume 3 of the EIAR. These figures also include longitudinal sections that illustrate the applicant's interpretation of the site investigation findings along the route of the PRD. Typical cross-sections of each of the road types proposed along Sections A,B,C and D, local and access roads are also provided as illustrated in Figures 4.69 to 4.70.

1.3. Board's Request for Further Information

1.3.1. The Board's request for further information (RFI) included seeking information on the following matters of specific relevance to soils and geology:

- provide a summary account of the site investigation records undertaken in key areas that informed the environmental component of the ground/site investigations;
- clarify the depth of bedrock encountered during the site investigation at representative locations;
- clarify and confirm the volumes of rock and various soil types that are estimated to be excavated;
- clarify and confirm the extent of existing karst features within 2km of the proposed road development;
- clarify the extent of karst anomalies;

- confirm the location and extent of soft ground and to address any additional resultant environmental effects;
- clarify and confirm whether or not contaminated and/or made ground is expected to be encountered including the nature and extent of such ground;
- identify the location of the proposed borrow pits and to address geological and hydrogeological impacts associated with use of borrow pits for deposition of unsuitable material.

1.3.2. The applicant provided a response on the matters raised in the RFI. The information provided within the relevant chapters of the EIAR, information provided in response to the RFI, and information advanced at the oral hearing are collectively considered in my assessment below.

1.4. Existing Environment (Soils and Geology)

Bedrock Geology

1.4.1. Based on a review of Figures 8.1 to 8.24 (Ground Investigation) contained in Volume 3 of the EIAR, rock was typically encountered at depths of between 0.3m and 6.5m below ground at the majority of locations investigated. At one location, Borehole/Rotary core (BH/RC) 03-06 at chainage (ch.)3+870, rock was not encountered until a depth of 17.1m was reached and the depth of the rock layer at this location was 3m. This area of exceptional depth to the top of the rock layer was checked and confirmed by the applicant as part of a review of the material and found to be accurate.

1.4.2. By reference to the information from GSI and site investigation, rock encountered is mainly limestone, however mudstone was encountered to the north of Rathkeale (ch.28+750 to ch.29+150), at Gortnagour (ch.58+350 to ch.58+550) and at Rower More (ch.59+850 to ch.61+150). The limestone bedrock was found to outcrop in numerous locations particularly in sections A and C of the proposed road development (PRD). The dark muddy limestone and shaly mudstones of the Rathkeale formation are found in Sections C and D in the vicinity of Rathkeale.

1.4.3. Weathering of rock was found to be intense in the top 1-4m layer of the rock, passing onto more competent rock at depth. Minor calcite veining was found to exist in some of the limestone rock.

Karst

1.4.4. It is set out in Section 8.3 of Chapter 8 that a number of BH/RCs revealed small **karst** voids along with areas of clay infill and large inflows of water, however, in the areas investigated, there was no evidence of ground instability caused by karst voids or a cause for concern in respect of strength and/or stability in the geotechnical sense. It is also stated earlier in the same section that no **karst surface depressions** (as opposed to turloughs or springs) were observed and no features were recorded within 2km of the PRD on the GSI database. Clarity was sought on the presence of karst in the RFI and in response, the applicant explained the different nomenclature they had used to distinguish 'surface depressions' from 'karst' in the limestone rock. As I understand, the surface depressions referred to relate to turloughs and springs which are of hydrogeological significance as distinct from karstified limestone of a geological/geotechnical significance, and which was encountered within the 2km buffer zone of the PRD alignment.

1.4.5. In relation to karst anomalies, further details were provided in the RFI response. It was stated that the anomalies were encountered through the use of geophysics at ch.1+150 to ch.1+200 and ch.50+750 to ch.50+950 and the areas were marked on accompanying drawings Fig R5.1 (Geophysics Survey Possible Karst Anomaly Plan Foynes to Ballyclogh – Section A) and Fig R5.2 (Geophysics Survey Possible Karst Anomaly Plan Rathkeale to Attyflin – Section D) together with details on how these were ground-verified using additional BH/RCs. The additional BH/RCs identified firm to stiff glacial till overburden soils overlaid on competent limestone bedrock. There was no evidence of voids or unstable ground conditions that would be of any geotechnical concern for constructing the road embankment at the identified locations. I am satisfied therefore that the areas of potential karst anomalies identified through geophysical surveying were resolved through additional site investigation as outlined. Overall, having reviewed the information provided in Chapter 8 and the accompanying drawings that represent the site investigation findings, I am satisfied that the presence of karst is well understood and while the limestone rock is karstified in a number of areas underlying the PRD, it is nonetheless competent rock and without any potential for geotechnical impacts in terms of stability and strength. It is clearly evident that the rock encountered is

suitable for use in respect of founding the PRD and where rock would be excavated, the excavated material is suitable for use as a material in the construction of the PRD.

Soils and Subsoils

1.4.6. Section 8.3 of Chapter 8 describes the subsoils/overburden encountered along the route of the PRD as comprising mainly glacial till derived from limestone bedrock. A number of areas of soft ground are also identified with thicknesses of typically less than 4m, but up to 6m in two areas (in Ardaneer at ch.1+300 and in an area north of Rathkeale at ch.29+050). The information on soft soils provided in the EIAR is expanded in the response to the RFI, where it is stated that 15 localised areas of soft ground were identified along the route of the PRD, and their locations, range of depths and soil types are detailed in Table 7.A (Areas of Significant Soft Ground) submitted with the response. The nature of these deposits include alluvium in Section A and isolated pockets of fen peat and lake marl mainly between Askeaton and Rathkeale. More extensive deposits of glacial fines and silts were generally found in Section C between Ballyclogh and Rathkeale with some peat, alluvium and lacustrine deposits also encountered. These soils in Section A, B and C were found to be moderately to well drained. Six areas in Section D were found to have soft ground deposits including glacial fines, lake sediments, alluvium and peat.

1.4.7. According to relevant information on the GSI website and the information presented on Figures 8.1 to 8.24 (Ground Investigation) contained in Volume 3 of the EIAR which I have examined, a large proportion of the PRD would pass through areas with thin or on occasions no subsoil cover.

Topsoil

1.4.8. As set out in Chapter 4 of the EIAR, 415,000 cubic metres of topsoil is estimated to be generated along the site of the PRD. This material is proposed to be reused for landscaping purposes in connection with the PRD.

1.4.9. In Section 15.3.3 of Chapter 15 (Material Assets and Land-Agriculture) of the EIAR it is stated that soils with distinct topsoil along the PRD route comprises mainly two soil associations; Elton which I note are fine loamy soils in texture from a limestone provenance and Ballinacurra which are fine loamy soils on limestone bedrock. Small

areas of Gurteen (alluvial soils), Boyne (alluvial soils) and peat soil types are also stated to be present.

Nature Conservation

1.4.10. Section C of the proposed Road passes close to the western edge of a Groundwater Dependent Terrestrial Ecosystem (GWDTE) Askeaton South Fens between ch.24+000 and ch.25+000. The Askeaton Fen complex, designated a Special Area of Conservation (SAC) for both *Cladium* (calcareous) and alkaline Fens has developed in basins between Limestone Hills and comprises a complex of individual sites spread over an area east and south-east of Askeaton.

1.4.11. There are a number of other European sites close to the PRD which form part of the Natura 2000 Network, including the Lower River Shannon SAC, which includes the estuary of the River Maigue, River Deel and River Ahacronane.

1.4.12. The issue of environmental effects on ecologically sensitive areas of wetland habitats/soft ground is addressed in Chapter 7 of the EIAR as part of the identification and assessment of impacts on key ecological receptors (KERs) and the Biodiversity Assessment report prepared by Dr Maeve Flynn, An Bord Pleanála's senior ecologist. Appropriate assessment is also considered in a separate report also prepared by Dr Flynn.

Contaminated soils and made ground

1.4.13. The PRD would cross the southern part of a fuel storage/coal storage facility in Craggs (Section A near ch.4+450 to ch.4+550). This area is illustrated in Figure 4.4 (Amended) of Volume 3 of the EIAR and the area is presented as an 'Enlargement extracted from Figure 4.4 of Volume 3 of the EIAR' on Page 20 of the RFI response document. In Section 3.4 of Mr Buggy's brief of evidence presented at the oral hearing, this area is stated to measure 60m x 40m area, triangular in shape, with contamination to about 300mm depth of coal dust. A total volume of 360 cubic metres of potentially contaminated soil is estimated to exist at this location.

1.4.14. The RFI response also referred to a second area of potentially contaminated soil at the location of a former gravel pit/quarry which was reinstated with material of unknown origin close to the PRD at Blossomhill (ch.51+650). This area is illustrated as an 'Enlargement from Figure 4.15 of Volume 3 of the EIAR' on Page 21 of the RFI

response. While it is stated that this area is close to the project corridor, and therefore likely to be outside of the area of excavation, its limits are not clearly defined. It is stated that the nearby borehole BHA 26 revealed no evidence of any infill or contamination in this vicinity.

1.4.15. Separate to the area of potentially contaminated soil/waste deposits, it is stated that **made ground** (as distinct from contaminated ground) is not commonly present along the specific route of the PRD, which predominantly traverses undeveloped agricultural land. In the RFI response, it is stated that where encountered, made ground was associated with engineering fill materials placed into existing road embankments and foundation layers beneath pavements. Four such locations have been identified in Table 8.A (Summary Table of Made Ground). In Section 9.3.1 (Soils and subsoils) of Chapter 9 (Hydrogeology) of the EIAR and drawing from GSI mapping, it is stated that made ground is present where the proposed road passes within urbanised areas such as Foynes, Askeaton, Rathkeale and Adare.

Concluding Comment on Existing Environment

1.4.16. I am satisfied that the applicant has provided a structured approach to the establishment of a working baseline for the geological and soils environment. I am also satisfied that the ground investigation was appropriately scoped based on desk studies and site walkovers. Anomalies raised as part of geophysical surveys were appropriately investigated and resolved. Overall, I am satisfied that the applicant has demonstrated a comprehensive knowledge of the baseline geological and soils environment on which the design of the PRD is brought forward, and potential significant effects can be identified.

Materials Balance

1.4.17. The following table provides a summary of the materials balance for the construction of the PRD as presented by the applicant in the EIAR (Table 4.20 of Chapter 4 – Project Description), the response to the RFI and in briefs of evidence and responses to questioning at the oral hearing.

Table 1 Materials Balance Summary

Material	Volume / Percentage of Material	Comments
Total Required Material to deliver the PRD		
Total material required for the PRD road construction.	**4 million cubic metres**	This includes all suitable material including rock and suitable engineering /structural fill for embankment construction and for capping material and includes for the replacement of soft ground. It does not include topsoil.
Materials Available on the site of the PRD		
Total Cut (Rock and other suitable and unsuitable materials).	**3 million cubic metres**	A total of 1.9 million cubic metres of suitable **rock** is estimated to become available from areas of 'cut' within the PRD site; Other than rock, the figure of 3 million cubic metres of total cut includes 1.1 million cubic metres of **other cut materials** (suitable and unsuitable). Of this figure of 1.1 million tonnes of other cut material, 800,000 cubic metres is deemed suitable for structural fill material and 300,000 cubic metres[1] is deemed unsuitable material for use as structural fill. The unsuitable material is stated to include 35,000 cubic metres of peat; Initially in Chapter 4 (Section 4.11.2 – Earthworks Quantities) and Chapter 8 (Section 8.4.1.7 – Soft Ground Improvement) of the EIAR, it is set out that **all** of the unsuitable material would be used for landscaping/capping,

[1] A figure of 300,000 cubic metres and 320,000 cubic metres are used by the applicant. This is discussed in my assessment below.

		however, it was clarified in the RFI response and at the oral hearing, that unsuitable material that would not be used in landscaping and capping would be deposited on site, potentially within worked out borrow pits. With the exception of a small amount of contaminated material, there would generally be no requirement to export unsuitable material off the site.
Total suitable structural fill material on the site of the PRD.	**2.7 million cubic metres**	This would include 1.9 million cubic metres of suitable rock and 800,000 cubic metres of other cut materials (both suitable and unsuitable)
Rock as a percentage of total cut.	**63% of total cut**	Calculation: 1.9 million ÷ 3 million (cubic metres) expressed as a percentage
Rock as a percentage of all of the suitable material.	**70% of suitable material**	Calculation: 1.9 million ÷ 2.7 million (cubic metres) expressed as a percentage
Materials Deficit and Sources of Additional Materials		
Materials Deficit	**1.3 million cubic metres** **(4 million less 2.7 million) cubic metres**	1,150,000 cubic metres of structural fill required for road construction and 150,000 cubic metres of suitable material required for capping.
Sources of Additional Suitable Structural Fill Material for road construction.	**1.3 million cubic metres (Materials Deficit)**	It is stated that borrow pits may be developed on the PRD site to win 500,000 cubic metres of required structural fill material. It is also stated that a modest degree of additional excavation may also be used to gain some of the required resources; It is also stated that ground improvement methods may be employed so as to reduce the

		volume of unsuitable material for structural fill; The balance of material (likely to be 800,000 cubic metres) would be imported onto the site from quarries in the region; While the use of borrow pits and other methods outlined are a possibility, the EIAR has also considered the need for importing all of the required material (1.3 million cubic metres of fill) in its assessment of impacts.
Other Material on the site of the PRD (Topsoil)		
Topsoil	**415,000 cubic metres**	This volume of topsoil is in addition to the suitable material set out above and would be removed initially and stored on site for re-use for landscape purposes.

1.4.21. As set out above, based on the applicant's estimates, there would be an overall net material balance deficit of approximately 1.3 million cubic metres, comprising 1.15 million cubic metres of rock-fill and 150,000 cubic metres of capping material. There are **two main areas** contributing to this deficit which are located in Section C (850,000 cubic metres) at ch.20+000 to ch.29+260 and 3.5km to the east of the River Maigue in Section D (240,000 cubic metres) at ch.50+000 to ch.65+550. The deficit of materials was explained by Mr MacGearailt at the oral hearing in which he outlined that the design was governed by the existing topography, environmental sensitives (for example watercourses crossed) and a number of project specifics. In turn, this generated the deficit. While the deficit of material is noted, it is not uncommon for such a large road project, and it is noted that it arises because of the need to take relevant environmental sensitives into account and which I am satisfied is the correct approach.

1.5. Impacts – Construction Phase

1.5.1. Potential impacts on the soils and geological environment that could arise are discussed below and are based on a review of EIAR information, information provided as part of the response to the RFI as well as the briefs of evidence presented at the oral hearing.

Deep Cuttings

1.5.2. Table 8.4 of Chapter 8 identifies areas where road cuttings are deeper than 7m. All of the soil types are glacial till and the bedrock encountered is limestone in those areas. The maximum cut is expected to be 19m at Mulderricksfield (ch.5+150 to ch.6+400) and 11m at Ballycannon (ch.52+400 to ch.56+000). These depths are not uncommon for a large engineering project such as that proposed, and I am satisfied that the rock is stable and can be removed and managed safely in its reuse for the construction of the PRD.

1.5.3. It is submitted in the EIAR that the deep cuttings may result in a minor positive educational impact/ benefit as a result of exposing geological strata to view. Based on other examples of more recent road construction projects and in line with TII adopted 'Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes' wherein it is stated that 'in some cases road development may actually facilitate enhanced geological understanding of a site by exposing more rock sections in (say) a new road cutting', I would therefore agree with the applicant's finding of minor positive impact in this regard.

Rock Excavation Methods

1.5.4. The methods of rock excavation would depend on the accessibility, orientation and frequency of discontinuities and the inherent strength of the rock as set out in Section 8.4.1.4 (Rock Excavation Methods) of Chapter 8. At the oral hearing, Mr MacGearailt outlined that rock would generally be excavated or ripped with an excavator. He also outlined that a rock breaker would likely be required for isolated harder sections of rock and blasting may be required for deeper more competent sections. The areas with potential for requiring blasting include a 19m deep cut at Mulderricksfield (ch.5+150 to ch.6+400) and potentially at the lowest levels of cut at Ballycannon (ch.52+400 to ch.56+000). In relation to two other locations at Ardaneer

(ch.1+350 to ch.1+750) with a depth of maximum cut up to 8m and Islandea (ch.60+000 to ch.60+500) with a depth of maximum cut up to 9m, according to Mr MacGearailt there is much lower likelihood that blasting would be required at these locations. However, the possibility is considered in my assessment given that there remains a possibility that blasting methods of extraction could be employed.

1.5.5. I am satisfied that the methods of excavation of rock, including excavation and ripping for most locations and the use of blasting in larger and deeper areas of rock, are well established methods of excavation of rock for projects of the nature proposed.

Processing of Excavated Rock

1.5.6. It is stated in the EIAR that earthworks would involve some processing of excavated (rock) material into suitable particle size. At the oral hearing, Mr MacGearailt explained that coarse sections of excavated rock would be crushed/broken up into smaller particles size that are suitable for transport and re-use as fill for embankment construction. He made the distinction that it was not intended to crush rock into very small size or fines. Mr MacGearailt also stated that for the base layer of embankments, coarser rock material would generally be used without the need to be broken up further. In Chapter 12 (Noise and Vibration), it is stated that crushing activities would be located at the source within the two main cuttings set back from noise sensitive areas. It is stated in the Environmental Operation Plan (EOP) that while the exact locations of rock processing areas would be determined by the appointed contractor, it is likely that this activity would take place within the road cutting itself.

1.5.7. For reasons of clarity, I have taken the approach in my assessment that crushing of rock at source is a possibility and that processing of excavated material in the compounds is also a possibility. The environmental effects that could potentially arise with crushing and processing involving the breaking of rock into smaller size particles are considered throughout my assessment in respect of soils and geology and my parallel assessments on hydrology and hydrogeology. These operations are a standard part of normal earthworks for such an engineering project.

1.5.8. Once the rock is excavated and reused in the manner proposed including adhering to the measures set out in the EOP and accompanying Construction and Erosion

Sediment Plan (CESP), I am satisfied that no significant adverse impacts on the **soils and geological** environment would arise. I have dealt with the environmental effects from rock excavation and processing on hydrology and hydrogeology in my other reports on these environmental topics. Other impacts, for example Noise & Vibration and Air Quality impacts are considered elsewhere in the inspectors report, informed by the respective EIAR chapters.

Karst

1.5.9. As set out above, geophysical surveys were used to identify possible anomalies that might suggest the presence of karst features. These anomalies were all ground verified using additional boreholes. These additional boreholes did not show evidence of voids or unstable ground conditions that would indicate instability or potential failure from a geological or geotechnical perspective. The response to the RFI asserts that no net significant adverse environmental impacts would arise from karst-related features. At the oral hearing, Mr Buggy confirmed that no significant adverse impacts to Soil and Geology receptors are expected in relation to karst features.

1.5.10. Some minor karst voids at the proposed Mulderricksfield cutting would be filled and sealed with concrete as a precautionary measure, and beyond this no other mitigation measures in respect of karst are proposed. I am satisfied with this aspect of the proposal, and it would not cause harm to the geological or soils environment or present any significant adverse impacts. I would therefore agree with the applicant's conclusion that no net significant adverse environmental impacts would arise from the proposed works in areas of karst.

Construction Dewatering

1.5.11. In areas of significant cut, temporary drainage would be required to allow excavation in areas of cut to be carried out within a dry environment. This would result in the temporary localised lowering of the water table. In areas of glacial till, the dewatering would be minimal, whereas in areas with porous bedrock, it could be more significant. While lowering of groundwater could potentially lead to localised instabilities in karst areas, it is submitted in Section 8.4.1.2 (Construction Dewatering) that construction dewatering is not required in potential karst areas. In the geotechnical context, this would relate to areas where there are confirmed

subterranean karst conduits and the statement specifically relates to pre-emptive dewatering undertaken before excavation and none is proposed in this construction project. Elsewhere it is noted that dewatering is proposed in areas of karst limestone as described in Chapter 9 (Hydrogeology) and in these areas the lowering of the water table would occur locally as excavation proceeds along the route. The anticipated areas where localised dewatering would occur are set out in Table 6.A (Anticipated Extent of Dewatering) of the RFI response document and the areas are illustrated in Figures R6.1 to R6.5 in Appendix A4 that is attached to the response to the RFI.

1.5.12. The impacts on groundwater in deep cuttings are addressed in more detail in Chapter 9 (Hydrogeology) of the EIAR and in my assessment report on this environmental topic. Otherwise, the main geotechnical issues that would arise on a project of the nature and scale proposed as a result of dewatering centres around the potential for differential settlement of underlying soil. However, given that all of the locations proposed for dewatering are within areas of rock cut, the risk of soil settlement as a result of dewatering for this project is not a concern.

1.5.13. I agree with the applicant's conclusion that no significant adverse impacts to the soils or geological environment would arise from construction dewatering as the intention is to lower the water table locally as it is encountered, and this would improve the working conditions.

Construction of High Embankments

1.5.14. Embankments are required to provide for an appropriate vertical alignment geometry, in accordance with TII standards and guidance and other applicable design codes. There are nine locations along the proposed route where the embankments would be construction to a height greater than 7m. These locations are set out in Table 8.5 (Areas of High Embankment) of Chapter 8 of the EIAR. Six would be constructed on Till and the remaining three embankments would be constructed on a mix of Till and Alluvium. Embankments would be constructed using material won from areas of cut and or sourced from borrow pits on site and/or imported from quarries.

1.5.15. I agree with the applicant's conclusion that no significant adverse environmental impacts would arise from the construction of high embankments primarily because

the embankments would be appropriately designed to comply with relevant engineering standards and would be founded on suitable ground.

Soft/Unsuitable soil

1.5.16. At the oral hearing, Mr Buggy referring to 320,000 cubic metres of soft ground, outlined that it comprises peat, soft glacial, alluvium, estuarine and lacustrine soils. He confirmed the volume of peat soils would be c.35,000 cubic metres, which is just above 10% of the volume of unsuitable materials.

1.5.17. Based on my engineering experience on projects of a similar nature, the volume of soft soil expected to be encountered is below average for such a major road project predominately because suitable soils and rock were encountered in ground investigation along the majority of the PRD mainline alignment. It is noted that both the figure of 320,000 and 300,000 cubic metres are referenced throughout the EIAR and RFI and at the oral hearing, however, the difference is not considered material in the context of management, impacts or mitigation.

Soil/Ground Improvement

1.5.18. At the oral hearing, Mr Buggy expanded on ground improvement options for unsuitable materials which had been previously referenced in Section 4.11.2 (Earthworks Quantities) of Chapter 4 of the EIAR. He stated that feasible options could include the use of lime modification, vertical drains or surcharge loading. The knowledge basis for soil improvement techniques is well understood from a civil/geotechnical engineering perspective and I am satisfied that once undertaken by a competent contractor and adhering to the measures outlined in the EOP and accompanying CESP, such methods would not create any additional impacts that could lead to significant environmental effects. Notwithstanding that the use of soil improvement is a possibility and that this would reduce the volume of soft soils to be excavated, provision for storage of the full identified volumes of soft/unsuitable soils and impacts have been fully assessed by the applicant in the EIAR.

Temporary storage of excavated material

1.5.19. As stated above, some of the excavated material would be used for non-structural fill and may therefore require temporary storage within the PRD site similar to topsoil for future use and any unsuitable material would be permanently stored in the voids created from worked out borrow pits. At the oral hearing, following questioning by Mr

Michael O'Donnell BL on behalf of his clients, Mr and Mrs Murphy (Sch-9), Mr MacGearailt, on behalf of the applicant stated that, similar to proposals for temporary storage of topsoils, the volumes would be small and the materials for non-structural fill would only be stored for short durations until required as material for the construction of the PRD. In respect of soils and geology, I am satisfied that once the materials are managed appropriately and comply with the measures set out in the EOP and CESP contained therein, no adverse impacts on soils and geology or other related environmental factors (such as hydrology and hydrogeology) are likely.

1.5.20. Overall, I am satisfied that no significant adverse environmental impacts would arise as a result of the removal, temporary storage and re-use of soft material for re-use as non-structural fill.

Excavations for significant structures

1.5.21. The primary structures required for the PRD comprise three railway bridges, a 210m clear span bridge over the River Maigue, four large river bridges, 18 river/stream bridges, 16 road overbridges/under bridges and one retaining wall. In some instances, it would be necessary to excavate soft material down to a competent layer and replace it with structural fill to allow for construction of foundations. Piled foundations, for example using driven piles or bored piles for structures, would also be used in other situations to distribute loads to a deeper competent layer. No unusual geotechnical conditions are expected that could create adverse environmental impacts on the soils or geology environment as a result of the ground excavations or proposals for piling through soft ground.

Contaminated soils and made ground

1.5.22. In Section 3.4 of Mr Buggy's brief of evidence, it is stated that it is proposed to excavate all of the potentially **contaminated soil**, to test the material in both areas before haulage to a licenced landfill facility, such as Integrated Material Solutions Ireland in Co. Dublin. Inert soil materials would be separated and while this inert material wasn't included in the 320,000 cubic metre of soft soils set out, the amount would be very small given that the overall amount of contaminated soils is itself very small and there is sufficient capacity on site to deposit the material.

1.5.23. I also note that the removal, treatment and/or disposal of contaminated soils would be governed by the procedures of the Waste Management Act 1996, as amended,

and all associated regulations and the requirements of the relevant waste management plans including the Waste Action Plan for a Circular Economy 2020-2025 and the National Hazardous Waste Management Plan 2021-2027 where applicable. Under the Waste Management Act, 1996, (as amended), the waste producer is responsible for waste from the time it is generated through until its legal recycling, recovery, or disposal (including its method of disposal). This includes transportation by an authorised waste contractor.

1.5.24. A submission from the Department of the Environment, Climate and Communications - Waste Policy & Resource Efficiency (FI-3) requested that the applicant consult with the Regional Waste Management Planning Office regarding the final plans in respect of waste, and the applicant has confirmed that their stated intention to consult with the office and this commitment has been added to the schedule of commitments under Item no. OH.49.

1.5.25. Similar to the management of contaminated ground, any **made ground** encountered would also be managed in accordance with the provisions of the Waste Management Act 1996, as amended and associated regulations and Waste Action Plan for a Circular Economy 2020-2025.

1.5.26. I also note the EOP contains a Section (Section 7) on Construction and Demolition Waste Management, and it is stated that the contractor would develop the Construction and Demolition Waste Management Plan. I am satisfied that the management of waste generally has been appropriately considered and waste would be managed in accordance with the waste hierarchy and the regulatory requirements. Section 7.2.6 (auditing) of the EOP outlines that the contractor will record the quantity and types of waste materials leaving the site.

1.5.27. I am satisfied that contaminated soils and made ground have been adequately considered and the proposals for management of same are such that no adverse impacts on the soils and geological environment would arise.

Sources of Material (Quarries and Borrow Pits) and Deposition Areas

1.5.28. As can be seen from the figures presented in Table 1 – Materials Balance Summary above, the overall project earthworks fill deficit, including material for capping, is c.1.3 million cubic metres. This is a substantial volume of material to be sourced from quarries in the region.

1.5.29. In Chapter 4 of the EIAR, it is stated that there are a number of commercial quarries in the vicinity of the PRD that may be utilised. Three are referenced in the inspectors report. In Section 8.4.1.9 (Importation and Deposition of Materials) of Chapter 8 of the EIAR, the applicant introduced the concept of borrow pits stating that the contractor may develop borrow pits within the PRD to source up to 500,000 cubic metres of suitable material including rock and other suitable materials. The aim of the borrow pits is to partially offset the net import volume required. It is stated that the borrow pits could subsequently be used to deposit unsuitable materials. It is further stated that in respect of borrow pits, the excavations would be limited to a few locations coinciding with the small number of large cuttings primarily at Ardaneer (ch.1+500 in Section A), Mulderricksfield (ch.5+100 to ch.6+450 in Section A) and at Ballycannon (ch.52+550 to ch.55+500 in Section D). It is asserted that any environmental impacts at these locations would generally be as described in this EIAR for the proposed road at these locations.

1.5.30. Borrow pits are not specifically addressed elsewhere in the EIAR, except for within section 10.4.13 (Impacts of Material Deposition Areas) of Chapter 10 (Hydrology) where the hydrological impacts associated with material deposition sites are discussed.

1.5.31. The Board issued a request for further information including on this matter (Item 9 Borrow Pits) to address the geological and hydrogeological impacts associated with the use of borrow pits for deposition of unsuitable material. In response, the applicant reiterated the likely locations as I have set out above. The applicant also stated that gaining of materials may involve some modest degree of additional excavation below the level of permanent works. The gaining of materials in this manner is a standard approach in road construction projects and as asserted, I am satisfied that it can be achieved without any discernible change to the vertical road alignment or any additional environmental impacts.

1.5.32. I agree with the applicants assertion that there would not be any adverse impacts on the soils and geological environment associated with the **borrow pits/additional excavation areas** should these be developed on site. The excavations are stated to take account of appropriate working arrangements and provision of safe cutting slope angles along the remaining overburden or bedrock. A drainage system and siltation control measures would be put in place around the perimeter of the

deposition areas where these would be above ground to prevent siltation of any drains or water courses. I refer the inspector and the Board to other measures set out in respect to protection of groundwater in my hydrogeology assessment report.

1.5.33. In relation to the **deposition of materials** in worked out borrow pits, I would agree with the applicants assertion that no impacts would arise on the soils and geological environment on the basis that the volumes of material would be small in the relative context and the material would also be required to be placed in a safe manner to ensure it is stable. I am satisfied that the proposal for deposition of unusable soils does not represent a risk to the soil and geology environment as it would be completely contained in the deposition area.

1.5.34. Notwithstanding the possibility that borrow pits /areas of excavation outlined may be used to source additional material, it is stated in Section 8.4.19 (Importation and Deposition of Materials) that local quarries have capacity to make up the shortfall whether material is sourced from the borrow pits (or areas of excavation) or not.

1.5.35. Traffic impacts of imported material transportation has been addressed in Chapter 4 (Description of the Proposed Road Development) of the EIAR and in the Brief of Evidence presented by Mr MacGearailt at the oral hearing and the haulage routes are shown on Figure 4.71 of Volume 3 of the EIAR. At the oral hearing, Mr MacGearailt clarified that Figure 4.71 in Volume 4 of the EIAR had an incorrect title which should be ‘Permitted Construction Access Routes for Light Vehicles’. This was corrected in the Corrigendum, with an amended Figure 4.71a ‘Permitted Haulage Routes’ included, and this amended figure was presented at the oral hearing. Transport routes / entry points into the project for earthwork fill would be restricted to seven locations off national and regional roads with the most heavily utilised routes for importing earthworks materials being at the N21 Rathkeale, the R518 at Graigeen and the N21 proposed Adare Junction at Gortaganniff.

1.5.36. The potential existing quarry sources in the region for imported material is also discussed in Chapter 4 and in response to issues raised in submissions raised by An Taisce (Env-3 and FI -1), a commitment was given at the oral hearing and this commitment is also set out in Item 4.11 of Chapter 19 (Mitigation and Monitoring Measures) and within Chapter 4 of the EIAR (Description of the Proposed Road Development) that while the contractor may source material from other quarries, only

quarries that conform to all necessary statutory consents would be permitted for use by the appointed contractor.

1.5.37. The predicted impact **magnitude** on soils and geology of importation of material to the site is stated by the applicant to be moderate to large in the context of the scale of loss of the reserves of the existing available quarries in the region, as defined in Table 8.2 of the EIAR and in Section 8.4.1.9 it is acknowledged that the loss of reserves would result in a **slight to moderate negative** impact on the existing soils and geology resource. Given the road is a major earthworks project, and that a considerable volume of suitable material is potentially required to be imported, I consider the impact of moderate to be accurate in terms of soils and geology.

Loss of Peat Soils

1.5.38. The removal of c. 35,000 cubic metres of peat soils from the PRD footprint and deposited on site is anticipated to have a slight adverse impact on soils and geology in the context of a loss of organic soils. The volume is small, and the peat soils are not associated with any features of ecological importance.

Slope Stability in Soil Cuttings

1.5.39. Slope stability in soil cuttings is addressed in Section 8.4.1.3 of Chapter 8 of the EIAR. The proposal submits that, taking the geological and soils profile into account, which comprises Till over weathered rock passing onto competent rock, and the absence of significant groundwater inflows that could create instability, the side slopes of the cuts can be stabilised using normal construction methods without the need for any specialist slope stabilisation interventions. Having considered the information presented, I am satisfied that slope stability is not a concern and would not lead to any adverse impacts on the soils and geological environment.

1.6. Operation Phase

1.6.1. In relation to the **operational phase** of the PRD, I would agree as outlined that no adverse impacts on soils or geology would result. The ground conditions are well understood and are sufficient to sustain and support the road infrastructure in the long term.

1.7. Mitigation

1.7.1. Avoidance as a mitigation measure was deployed during the Route Selection and the Design stage, by moving the PRD mainline either laterally or vertically, so as to ensure that it would not traverse or come in close proximity to sensitive geological or soil areas. Section 8.5 of Chapter 8 states that no mitigation measures are required to offset impacts on soils and geology during construction and operational phases of the PRD.

1.7.2. I note that karst voids encountered as part of the earthworks during construction would be filled with concrete, however, this is best practice and a precautionary measure (rather than mitigation) as set out above. In the RFI response, mitigation measures associated with the borrow pits/deposition areas include mounding of the deposited material followed by early topsoiling and grassing over to allow water to be collected and to minimise recharge to the borrow pits. I have dealt with further mitigation measures in respect of drainage of the borrow pits/deposition areas, in a separate assessment on the effects of the PRD on the hydrological and hydrogeological environment.

1.7.3. In the event that borrow pits or other areas along the PRD would be used to deposit unsuitable materials, the standard precautions would apply, including proper management of this material as detailed in Chapter 6 of the EOP and CESP contained therein.

1.8. Residual Impacts

1.8.1. Section 8.6 of Chapter 8 of the EIAR states that the residual impact on soils and geology from the importation of material to the site is considered to be **slight to moderate negative.** Having reviewed and evaluated the information presented and having carried out a site inspection, I am satisfied that a finding of moderate negative impact would be appropriate. The deep cuttings in rock at Mulderricksfield and Ballycannon along the PRD may result in a **minor positive educational benefit** where the geological strata are exposed to view.

1.8.2. No residual adverse impacts on the soils and geological environment would arise from the use of borrow pits for gaining of additional materials on site. Similarly, I am satisfied that no residual impacts would arise from use of areas in the PRD site or in worked out borrow pits on site to deposit unsuitable materials that would not be used

in connection with the construction, landscaping or embankment capping based on the above assessment.

1.8.3. Overall, based on the level of detail provided, which adequately identified the potential impacts, I agree with the conclusions reached that no significant adverse effects would arise on the soils and geological environment.

Interactions and Cumulative effects

1.8.4. I have reviewed the information provided in Chapter 17 of Volume 2 of the EIAR in respect of cumulative impacts and interactions together with the additional information on updated projects in the vicinity received by the Board during the oral hearing (15th February 2021).

1.8.5. In the assessment of interactions between the individual environmental disciplines I am satisfied that once relevant mitigation measures are implemented, no additional residual likely significant effects on soils and geology would arise as a result of the construction or operation of the PRD.

1.8.6. In respect to cumulative impacts, I am also satisfied that no potential for significant impacts arise on the geological environment as a result of the project when taken in combination with any other relevant plans or projects and therefore there is no potential for significant cumulative/ in-combination effects on soils and geology. I have also carried out a planning search to verify the projects (and their status) and am satisfied that none have since been granted permission that would result in addition cumulative impacts or additional impacts from interactions within the meaning of the EIA Directive and the Roads Act 1993, as amended.

1.9. **Other Matters/Submissions**

1.9.1. A submission made by Conor Enright (FI-2) refers to the possibility that the requirement for extra rock material may result in local quarries needing to increase production to meet the demand, which may create additional impacts not addressed in the EIAR. At the Oral Hearing, in response to my questioning, Mr. Buggy stated that it would be a decision for the appointed contractor which quarries to use, and there was a choice of three quarries in the area. Similarly, Mr MacGearailt stated in answer to questioning by Mr O'Donnell on behalf of Mr and Mrs Murphy (Sch-9) at Clonshire that the earthworks programme would extend over a period of 18 months to two years. I consider that will be an adequate amount of time to allow steady

production of stone and other suitable material, if required. As discussed in some detail above, up to 500,000 cubic metres of suitable material may be obtained from borrow pits/areas of excavation within the site boundaries.

1.9.2. Mr O'Donnell BL posed a number of questions concerning aspects of the development, including the nature and the depth of rock excavation, harnessing/processing of materials from rock and the sequencing of operations and the stockpiling of materials on site. Mr O'Donnell questioned if the areas in which excavated material would be temporarily stored were identified. He expressed his view that the development has not been sufficiently described and that in his view there are insufficient details contained in the EIAR/documentation before the Board. In response, at the oral hearing, Mr MacGearailt for the applicant, stated that the road would be built using standard construction methods and there was no need to describe these in detail for the purpose of assessing the environmental impact. He also provided information on the depths of rock, including that in **Section D** concerning the Murphy property, c.600,000 cubic metres of rock would be excavated. He outlined that a small quantum (c.150,000 cubic metres) of soft materials in Section D would be excavated and saved for landscaping / placing on top of embankments. He outlined that this material would be stored temporarily on site within the CPO lands similar to topsoil. In relation of sequencing, referring to Chapter 4 and Chapter 8 of the EIAR. Mr MacGearailt stated that the works would be sequenced so that operations of cut and fill could generally take place at numerous locations along the length of the works. He stated that material arising from an area of cutting further west of the Murphy property (at Ballycannon) would be transported to the vicinity of Murphy property for construction of an 800m length of embankment and thereafter for embankments from Gortnacrour further east. He also responded to questions on rock processing, and this has been set out in Section 1.6 (Impacts – Construction Phase) above.

1.9.3. Mr MacGearailt explained that at the location of rock excavation closest to the Murphys (Ballycannon), the method of extraction, i.e., ripping, rock breaking and/or blasting would be selected and designed to produce the rock in the shape and size needed, and thus avoiding the need for further processing at that location.

1.9.4. These operations (sequencing, processing and storage of material for re-use) are standard for a road project development and there is no evidence that any significant

adverse environmental impacts would arise on the soils and geological environment as a result of the operations described. As was also stated by Mr MacGearailt and as I know from my extensive experience in this field, that while the site investigation provides details of the rock and soils expected to be encountered, it is only when the ground is exposed that it can be truly verified across the site. I am satisfied that the site investigation programme is robust and accurate, and the proposals outlined in the earthworks programme, largely in Chapter 8 (Soils and Geology) and Chapter 4 (Project Description) are entirely reasonable and sufficient to allow an assessment of the potential environmental effects on the environment.

1.9.5. In response to submissions by Paul and Eileen Madden (Sch-30, 88 and 89) in which concerns were raised on the suitability of soft soils for the construction of the PRD, Mr MacGearailt stated that the volume of soft ground was modest when compared to other road projects. I would agree with this assertion that the volume of soft ground is modest, given my own knowledge and experience of other road projects. The nature and location of soft soil is well understood, and I am satisfied that the unsuitable material can be safely removed or improved as outlined in my assessment above without giving rise to any adverse impacts on the soils or geological environment. It was also submitted in the same submission that grout used in the Ground Investigation at RC10-09 was allowed to enter into a tributary of the Lismakeery Stream. At the oral hearing, Mr MacGearailt outlined that there is no filed record documenting that pollution occurred, or that the matter was raised with supervisory staff of the project team at the time. I am satisfied with the response and there is no evidence that any adverse environmental impacts were caused as a result of the geotechnical site investigation programme carried out.

1.9.6. Submissions from Conor Enright (FI-2) and Ian Gilvarry (Env-13 and FI-4) both commented on the apparent poor record keeping and quality control related to site walkovers. Mr MacGearailt stated in his Brief of Evidence that the ground investigation was supervised and monitored by the design team members and that weekly progress meetings were held, and that there were intermittent visits by geotechnical engineers during the ground investigation to confirm the quality of works undertaken. I am satisfied that there is a large volume of applicable information made available as part of the application, RFI response and at the oral hearing and it is sufficient for the carrying out of my assessment on soils and

geology and also of hydrology and hydrogeology which I have also assessed (See separate assessment reports).

1.10. **Conclusions (Soils and Geology)**

1.10.1. Having assessed the information provided by the applicant, as set out above, and having considered all of the submissions and objections received in written format and at the oral hearing, I am satisfied that the applicant has adequately investigated the existing environment, understands the soils and geological regime sufficiently that no *lacunae* exist. I am also satisfied that the effects on the soils and geology environment have been adequately identified and described and the proposed mitigation measures that are set out are both suitable and appropriate in the context of addressing the arising impacts. Overall, I am satisfied that with the adoption of the mitigation measures outlined, there would be no remaining adverse impacts that would give rise to significant effects on the soils geological environment as a result of the construction and operation of the proposed road development.

1.10.2. Having assessed the information provided by the applicant, as set out above, and having considered all of the submissions and objections received in written format and at the oral hearing, I am satisfied that the applicant has adequately investigated the existing environment, understands the soils and geological environment sufficiently and no *lacunae* exist and has proposed mitigation measures are both suitable and appropriate in the context of the proposed development. Following adoption of good construction practice and the mitigation measures, as proposed, with the principal measure being adherence to the EOP and water quality protection measures set out in the CESP during construction, it has demonstrated there would be no residual significant negative direct, indirect or cumulative impacts on the soils and geological environment.

Jerome Keohane

BSc, MSc, FCIWEM, C.Geol, C.WEM, MIEI.

14th February 2022

Foynes to Limerick Road (including the Adare Bypass)

Assessment of significant effects on the environment

in respect of Hydrology.

Prepared by: Jer Keohane BSc, MSc, FCIWEM, C.Geol, C.WEM, MIEI.

1.1. Introduction

1.1.1. Hydrology is addressed primarily in Chapter 10 (Hydrology) of the EIAR, in the response to a request for further information and at the oral hearing by Mr Anthony Cawley. I also note that in the study team outlined in Appendix 1.1, Mr Richard Reid of ROD-AECOM was referred to as a principal contributor. A number of other chapters in the EIAR are also of relevance to the impact assessment including in particular Chapter 4 (Description of the Proposed Road Development), Chapter 8 (Soils and Geology) and Chapter 9 (hydrogeology). The following is my examination and evaluation of the information presented by the applicant leading to a conclusion on the effects on the hydrological environment arising from the construction and operation of the proposed road development (PRD).

1.2. Approach to study by the applicant

1.2.1. The applicant's assessment focussed on the potential for impacts on the receiving watercourses that would be crossed by the PRD and also the impacts on surface watercourses that would receive discharge from road drainage outfalls. It also considered the potential of flooding and flood risk, morphological changes to watercourses and impacts on sites of ecological importance proximate to surface watercourses.

1.2.2. Relevant legislation and guidance documents have been considered with the key documents including: TII design guidelines on 'Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes' (NRA, 2008) and 'The Planning System and Flood Risk Management – Guidelines for Planning Authorities' (DoEHLG 2009).

1.2.3. The applicant's understanding of the existing hydrological environment is derived from a review of sources of published information from the constraints and route selection reports and various other sources including Ordnance Survey Ireland

(OSI), Environmental Protection Agency (EPA), Office of Public Works (OPW), Limerick City & County Council, National Parks and Wildlife Service (NPWS) and Geological Survey of Ireland (GSI). Site-specific topographical and hydrometric information and aerial photography were also reviewed to locate any potential features of hydrological interest, and these were further investigated on the ground during walkover surveys to assess the significance of any likely environmental impacts.

1.2.4. Other sources of information used include the River Basin Management Plan 2018-2021 (DHPLG), LIDAR data and Met Éireann meteorological data. The assessment was also informed by consultation with regulatory and other public bodies and from information gathered by site inspections/field surveys undertaken. As I have noted in a separate report on Soils and Geology, a programme of intrusive ground/geotechnical investigations was undertaken by the applicant during the period of 2016-2019.

1.2.5. Available topographical and hydrometric information referred to above was used to perform hydrological impact assessments of all culvert crossings and the proposed outfall designs, to ensure that they are designed to convey the required hydraulic flows.

1.2.6. Detailed stream surveys were also undertaken at areas where hydrological impacts were considered likely to occur. All of the culvert/bridge crossing locations, the proposed outfall locations and the ecologically sensitive areas were inspected, and field measurements were carried out along with observations of potential areas of flood risk.

1.3. Board's Request for Further Information

1.3.1. The Board's request for further information (RFI) included seeking information on the following matters of specific relevance to hydrology:

- provide a detailed assessment of the effects of the PRD and any mitigation measures designed to prevent adverse effects on Sea Lamprey;
- Address Inland Fisheries Ireland recommendation that the pre-construction works water sampling period should be extended to cover 12 months to capture seasonal variations in parameters;

- provide details of measures that are proposed to protect Irish Water's drinking water source during the construction and operation phases of the proposed road development.

1.3.2. The information provided within Chapter 10 of the EIAR, information provided in response to the RFI, and information advanced at the oral hearing are collectively considered in my assessment below.

Directive 2000/60/EC (Water Framework Directive)

1.3.3. The inspector and the Board will be aware that Directive 2000/60/EC (Water Framework Directive) (WFD) sets out the legal framework to protect and restore clean water and to ensure its long-term sustainable use. The core requirements of the WFD has been transposed into Irish law through the European Communities (Water Policy) Regulations 2003 as amended, and it applies to rivers, lakes, groundwater, and transitional coastal waters. In addition, the European Communities Environmental Objectives (Surface Waters) Regulations 2009 as amended, and the European Communities Environmental Objectives (Groundwater) Regulations 2010 as amended, give effect to the measures needed to achieve surface water and groundwater environmental objectives.

1.3.4. The main environmental objectives with respect to surface water bodies are:

- to prevent deterioration of the status of all bodies of surface water including the maintenance of high status in High status objective water bodies,
- to protect and enhance and restore all bodies of surface water with the aim of achieving good status (or high status where designated),
- to protect and enhance all artificial and heavily modified bodies of water with the aim of achieving good ecological potential and good surface water chemical status,
- to progressively reduce pollution from priority substances and cease or phase out emissions, discharges and losses of priority hazardous substances within river basin districts by 2027.

1.3.5. The overall status of a surface water body is assessed as a combination of ecological status and chemical status. For a surface water body to be in overall 'good status', both its ecological and its chemical status must be at least 'good'. The

overall status of a groundwater body is assessed as a combination of quantitative status and groundwater chemical status. The status of the water body is determined by the least favourable of the component assessments.

1.3.6. River Basin Management Plans (RBMPs) are used as a tool for achieving the protection, improvement and sustainable use of the water environment across Europe. These plans are prepared in 6-year cycles, during which a programme of measures must be implemented so as to achieve water quality objectives. Ireland is currently operating on its second-cycle river basin management plan that covers the period 2018-2021 with the third plan to cover the period 2022 – 2027 currently at draft stage (Draft River Basin Management Plan for Ireland 2022-2027) and at public consultation stage up to 31st of March 2022.

1.3.7. With respect to surface water body status, ecological status is rated from 'high' to 'poor' status, while chemical status is measured as either 'good' or 'fail' status.

1.3.8. The current condition of our waters is assessed against the standards and environmental objectives set out in the Water Framework Directive are monitored by the EPA. In total 2,718 surface waterbodies are monitored for ecological status and 514 groundwater bodies are assessed for groundwater status. The draft River Basin Management Plan 2022-2027 provides an analysis and this is based on the assessment of water bodies over the period 2013-2018. The numbers of waterbodies achieving high, good, moderate, poor and bad status in a waterbody type (as may be relevant) are outlined in Table 3 of the draft plan and repeated in Table 1 below for ease of reference by the inspector and the Board.

Table 1 Extract from Draft River Basin Management Plan 2022-2027 (based on assessment over 2013-2018 period) Prepared by the Department of Housing, Local Government and Heritage

Table 3. Summary of status for each waterbody type

Waterbody Type	Status					Total per waterbody type
	High	Good	Moderate	Poor	Bad	
Groundwater	-	474	-	40	-	514
Coastal	10	26	9	-	1	46
Transitional	7	23	30	14	6	80
Lake	17	96	72	28	11	224
Canal[1]	-	14	1	1	-	16
River	196	1052	653	442	9	2352
Total	**230**	**1685**	**765**	**525**	**27**	**3232**

1.4. Existing Environment (Hydrology)

1.4.1. In accordance with the EU Directive (2000/60/EC) 'The Water Framework Directive' (WFD), there is one single national River Basin District in Ireland, which is broken down into 46 catchment management units. These 46 catchment management units have been broken down further into 583 sub-catchments.

1.4.2. The site/route is located in the Shannon Estuary South catchment. The rivers along the PRD route and study area are stated to mainly feature a range of 'poor' to 'moderate' water quality status ratings. In accordance with the most up to date EPA data for the period 2013-2018 (2nd RBMP cycle), these ratings as indicated by the applicant are correct.

1.4.3. The watercourse crossings and outfalls in each of the four sections (A to D) of the PRD are presented in Table 10.1 (Road Section and Associated Catchments) of Chapter 10. In total there are 21 watercourse crossings and 32 surface water outfall discharge locations proposed along the route. All other culvert crossings proposed as part of this development traverse local drainage channels or drainage ditches.

1.4.4. The locations of each of the major watercourses along the route of the PRD are illustrated on Figure 10.1 (Watercourse Regional Overview) in Volume 3 of the EIAR. Ten Rivers have been identified comprising Rivers Ahacronane, Deel (x 2 locations), Greanagh A, Greenagh B, Clonshire River, River Maigue (x 2 locations) and Barnakyle.

1.4.5. In general, watercourses in the area flow from south to north towards the Lower Shannon Estuary.

1.4.6. Figure 10.2 illustrates catchments and sub-catchments identified on catchments.ie[2] website that are associated with the current River Basin Management Plan for Ireland 2018-2021. Figures 10.3 to 10.25 of the EIAR illustrate the applicant's drainage design proposals across the four sections (A to D) of the PRD and its surrounding study area. These figures show the road drainage network including location and types of culverts and bridge structures proposed, location and size of

[2] www.catchments.ie is a website that shares science and information about Ireland's water catchments. It is a collaboration between the Department of Housing, Local Government and Heritage, the Environmental Protection Agency, and the Local Authority Waters Programme.

attenuation ponds, outfalls and watercourse diversions. The road drainage catchments are also indicated through a colour coded key.

1.4.7. The watercourses in the western area of the PRD, Section A (Robertstown River and Ahacronane River) flow directly to the Shannon via Churchfield Creek which is in the the intertidal zone of the Shannon Estuary. Section B only crosses the Ballycullen Stream. Section C of the PRD crosses the River Deel in the townland of Milltown North and the River Deel discharges to the Shannon Estuary north of Askeaton. In section D, the PRD crosses the Greanagh River twice and it also crosses a tributary of the Greanagh River, the Clonshire River. The PRD crosses the River Maigue to the north of Adare, which is the largest watercourse crossed. The Maigue and Greanagh Rivers are tidal at the location of the PRD crossing points.

River Catchments

1.4.8. An overview of the principal river catchments in the area of the PRD is provided in Section 10.3.2 of Chapter 10 of the EIAR. It is based on Flood Studies Report (FSR: 1975) and Flood Studies Update Report (FSU: 2014) and I have set out a summary in Table 2 directly below together with any available knowledge on past drainage schemes (where known) included in Column 4. The catchment areas set out are drawn from the FSR method (where available) as it is considered to be more accurate than FSU. Where no FSR area is set out, the FSU catchment area is used.

Table 2 Summary of Rivers, Catchments Areas and gauged flow information

River	**Catchment Area (sq. km) where river traverses the PRD**	**Gauged flow information**	**Details of previous Drainage schemes where known.**
Robertstown River	30.4 (FSR)	No sources of gauged flow information for this river	Not recorded
Ahacronane River	21.7 (FSR)	No sources of gauged flow information for this river	Not recorded
Ballycullen (Lismakeery) Stream	11.1 (FSR)	No sources of gauged flow information for this river	Not recorded
River Deel	484.1 (FSU)	The Rathkeale gauging station has a	The River Deel catchment drainage

		good A2 Rating Classification for its flood flow-stage relationship. The record period available for the station is from 1953 to 2009.	scheme was completed in 1968 and focused on improving drainage for agricultural purposes.
Clonshire and Greanagh Rivers (Catchments are crossed three times, all in section D along the route of the PRD).	122 with final crossing having a catchment area of 84 (sq.m) (FSU)	No sources of gauged flow information for this river	A drainage improvement scheme has been undertaken (likely to have been in the 1960s/1970s) on the lower reaches of the Greanagh with flood embankments, back drains and flapped outlets present
River Maigue	1122sq.m catchment area overall. River Maigue has a catchment area of c.840 sq.m where it traverses the PRD. (FSU)	The closest gauging station is located upstream at Castleroberts and has a good A2 Rating Classification for its flood flow-stage relationship. The record period available for the station is from 1975 to 2009.	Multiple drainage improvement schemes have been undertaken throughout the catchment area. In the lower reaches of the River Maigue, flood embankments, back drains and flapped outlets are present which was undertaken between 1973 and 1986

Surface water quality

1.4.15. Water quality and macro-invertebrate community composition are expressed as a numerical Q-value or Biotic index. The Q-value system is a five-point scale Q1 (unsatisfactory condition) to Q5 (satisfactory condition) based on the proportions of five groups of macroinvertebrates, with different pollution tolerances. Drawing on data from EPA monitoring programmes, the breakdown of the biological river water quality classification system is set out in Table 10.3 of Chapter 10. Water quality of the relevant watercourses has been classified as generally moderate (Q3-4) with

most showing evidence of nutrient enrichment or high sediment loads stated to be as a result of intensive land management within the respective catchments.

Nature Conservation

1.4.16. Key ecological receptors (KERs) and ecological receptors (ERs) adjacent to the PRD have been identified and these are considered in more detail under the heading of Biodiversity in the lead inspectors report as informed by the Biodiversity Assessment report prepared by Dr Flynn and contained within Appendix C. The River Maigue within the Lower River Shannon SAC and River Shannon and River Fergus Estuaries SPA is traversed by the PRD. The impacts of the PRD on European sites while considered in the Biodiversity Section and more specifically the Appropriate Assessment section of this report, both informed by the assessment reports on both Biodiversity and Appropriate Assessment that were prepared by Dr Flynn.

Water Supply Sources from Rivers/Drinking Abstraction

1.4.17. The EIAR states that there are no water supply abstraction points from rivers downstream of crossing points of the PRD. However, in its written submission (Env-16) on the application, Irish Water highlighted that the Foynes/Shannon Estuary Public Water Supply abstraction point is 2.3km downstream of River crossing RVB01 and this had not been identified in the EIAR. This issue was raised by the Board in the request for further information. The matter is addressed below in consideration of hydrological impacts.

Concluding Comment on Existing Environment

1.4.18. I am satisfied that the applicant has provided a comprehensive and structured approach to the establishment of a working baseline for the hydrological environment. Overall, I am satisfied that the applicant has demonstrated a comprehensive knowledge of the baseline hydrological environment on which the design of the PRD is brought forward, and potential significant effects can be identified.

1.5. Hydrological impacts

1.5.1. Potential hydrological impacts that are considered likely to arise during the construction and operational phases are set out in the EIAR as falling into two broad categories of quantitative (affecting water levels and flows) and qualitative (affecting

water quality) impacts. In respect of the design flow and assessment of quantitative impacts, the flow used is based on gauged flow data, where available, or upstream catchment characteristics otherwise. Both methods used an additional standard factorial allowance for the related estimation method. A climate change allowance of 20% was also used in estimations. In addition, at locations where a channel is maintained under a drainage district or arterial drainage scheme, an arterial drainage factor of 1.6 was incorporated. The impacts including those identified in the applicant's assessment are discussed below.

General Hydrological Impacts (Construction)

- Construction of structures near or in watercourses could alter the stream/river bed and bank morphology with the potential to alter erosion and deposition rates either locally or downstream;
- Construction activities / earthworks (including excavation of rock, processing of material, temporary storage and fill/embankments construction, drainage and other works) either in or adjacent to the watercourse channels could lead to an increased turbidity through re-suspension of bed sediments and release of new sediments that may negatively alter aquatic ecology.

1.5.2. Having reviewed the information provided, and based on my own professional knowledge, I am satisfied that the main contaminants arising from construction runoff and associated impacts are those that I have set out in Table 3 below.

Table 3 Main contaminants arising from construction runoff and associated impact.

Main contaminants arising from construction runoff	**Associated Impact (Consultant's Assessment)**
Elevated silt/sediment loading in construction site runoff	Long-term damage to aquatic ecosystems by smothering spawning grounds and gravel beds and clogging the gills of fish
Spillage of concrete, grout and other cement-based products	Significant impacts to watercourses altering the pH, smothering the stream bed and physically damaging fish through burning and clogging of gills by fine silt
Accidental Spillage of hydrocarbons from construction plant and at Storage depots / construction compounds	Toxic to plants and animals, coats banks with oil film, contaminating soils.

Faecal contamination arising from inadequate treatment of on-site toilets and washing facilities	Risk to amenity users of watercourse, risk to animals, promotes eutrophication

1.5.3. In the absence of mitigation, the impacts could vary between slight to significant in terms of rating during construction.

General Hydrological Impacts (Operational)

1.5.4. In relation to potential operational impacts, the following are set out and considered of relevance.

- permanent interference with river, streams and floodplains at bridge and culvert crossing points that are not appropriately designed;
- removal of flood storage as a result of the road footprint encroaching on the floodplain area could lead to a reduction in the flood attenuating function of the floodplain;
- permanent diversion of water between drainage catchments may lead to changes in the watercourse morphology;
- interference with local drainage can lead to deterioration of the hydraulic capacity and exacerbation of flood risk and potentially give rise to impacts on bank-side ecology where drains are altered/removed;
- increased runoff to watercourses at proposed storm outfalls, due to road pavement (impervious area), leading to increased flood flow / increased frequency of flooding;
- deterioration of water quality in receiving watercourses at drainage outfalls from routine road runoff, which contains sediment and other contaminants;
- road drainage and associated storm outfalls providing a pathway for contaminants from accident spillages associated with HGVs to gain rapid unattenuated access to receiving water;
- increased salinity of watercourses caused by salt run-off can alter the ecological balance of the aquatic system and increase the bioavailability of chemical contaminants.

1.5.5. In the absence of mitigation, the impacts could vary between slight to significant in terms of rating in the operation phase.

Impacts from Flood Risk and Flood Risk Assessment

1.5.6. The currently available information in respect of flooding is held on the OPW national flood information portal (www.floodinfo.ie). The Preliminary Flood Risk Assessments (PFRA) and Catchment Flood Risk Assessment and Management (CFRAM) flood mapping were stated to have been consulted by the applicant at the initial screening stage to establish the existing flood risk environment using information available at the time. Whilst the CFRAM maps are still available on the OPW website, the PFRA maps are no longer publicly available and have in effect been superseded by the National Indicative Fluvial Mapping (NIFM). The NIFM are 'predictive' flood maps showing indicative areas predicted to be inundated during a theoretical fluvial flood event with an estimated probability of occurrence. Indicative fluvial maps have been produced for catchments greater than five square kilometres as the chosen hydrological assessment methodology is not suitable for very small catchments. The CFRAM maps, based on modelling, show areas predicted to be inundated during a theoretical or 'design' flood event with an estimated probability of occurrence. I have considered both the NIFM and CFRAM maps in my assessment.

1.5.7. The predicted design fluvial flood levels and flood flows for modelled watercourses (Robertstown in Section A, River Deel in Section C, Greanagh River in Section D and River Maigue in Section D) for the 1% Annual Exceedance Probability (AEP)[3] return period flood event is presented in Table 10.11 of Chapter 10 of the EIAR. A summary of the outcome of the applicant's Flood Risk Assessment (FRA) in respect of the road vertical alignment is set out in Table 10.12 (Flood Risk Assessment Summary: Road Vertical Alignment) also in Chapter 10. The FRA is stated to have found minimal flood risk to the proposed PRD vertical alignment at watercourse locations modelled and no mitigation was found to be required. This is consistent with the flood risk summary results presented in Table 10.12 and the information available on the aforementioned OPW national flood information portal

[3] Annual Exceedance Probability (AEP) refers to the probability of a flood event of a given magnitude being equalled or exceeded in any given year. A 1% AEP flood event has a 1%, or 1 in a 100, chance of occurring or being exceeded in any given year.

(www.floodinfo.ie) outlined above including the CFRAM and NIFM mapping resource.

1.5.8. The associated road drainage network, including the road pavement drains, sub-surface, interceptor, collector and toe drains, have been designed to maintain the natural drainage regime of the land through which the road development passes, in order to ensure that risk is not exacerbated by the PRD infrastructure during either construction or development. A minimum freeboard allowance of greater than 300mm between the soffit level and the design flood level would be provided at all water crossing structures. A greater clearance is proposed at all significant river crossings because of access requirements with the resultant actual freeboard of typically 2.5m to 4.5m and more above flood levels at these locations.

1.5.9. I am satisfied that there would be no increased flood risk as a result of the PRD and sufficient allowance for climate change has been built in to the design of all culvert/bridge crossings. I also note that Section 50 consent applications for all culvert and diversion arrangements have been submitted to the OPW for approval.

Impact of Hydraulic Structures and Stream Diversions

Watercourse Bridge and Culvert Crossings

1.5.10. Tables 10.15 and 10.16 of Chapter 10 set out a summary of the proposed watercourse bridge and culvert crossings and include catchment area and proposed sizes taking into account biodiversity requirements for fish and for mammal passages. Many of the streams that would be intercepted are relatively small and the proposed dimensions mirror the existing stream channel dimensions.

1.5.11. In respect of larger watercourse crossings, more significant structures are required. In some cases, structures are required to span over a public road or access track used by farmers or anglers in addition to the watercourse, while in other cases, structures are required to extend to clear floodplains, with an example given that a 140m long bridge would span the river floodplain and existing N69 road at Robertstown. A bridge structure of 87m would cross the River Deel, two bridge structures (36m and 81m long) would cross the River Greanagh where the PRD crosses the river twice. The largest bridge structure is the River Maigue bridge crossing with a length of 210m proposed. The impact is assessed as a slight to imperceptible local impact which I deem to be an accurate rating in respect of

hydrology considerations of these hydraulic structures on the basis that they have been designed to appropriate standards and they include measures that would avoid any increase in flood risk and have built in an allowance for climate change.

Stream Diversions

1.5.12. The construction of minor watercourse crossings throughout the PRD would necessitate the localised diversion/realignment of the existing non-fishery sensitive watercourses for engineering reasons. It is also asserted in the EIAR that the diversion of a watercourse can lead to a change in the watercourse morphology leading to the following impacts:

- lower gradients resulting in increased flow area and deposition, thereby promoting vegetation and growth of weeds in channels during periods of low flow;
- steeper gradients leading to faster flow velocities, increased local bed erosion and shallower low-flow depth;
- sharp bends and change in direction leading to erosion and deposition and changes to river channel morphology;
- loss of natural floodplains leading to an increase in upstream flood levels;
- change to natural low flow channels leading to impacts on fisheries and other animals;
- change to existing vegetation leading to impact on fisheries and other species (such as otters and badgers).

1.5.13. Table 10.17 (Proposed Diversion of Watercourses) provides summary details of proposed diversions of watercourses with 29 diversions recorded at 23 locations. It is stated that where possible, stream diversions/realignments are not proposed on watercourses that have a biodiversity value.

1.5.14. In the absence of mitigation, I consider the impacts would range from imperceptible to moderate.

Impacts on Water Quality from Drainage Outfalls and Accidental Spillage

1.5.15. The PRD has 32 separate drainage outfall discharge points along its route, all which would discharge to surface watercourses. These outfalls have the potential to adversely impact on water quality in the receiving watercourse through contaminants that are contained in road drainage waters, as well as a result of spillage of contaminates in the event of a road collision or similar event when the road becomes operational. These impacts are assessed by using the guidelines provided in the applicable TII document 'Road Drainage and the Water Environment (TII, 2015)'. The storm outfalls also have the potential to impact on the flood and morphological regime of the receiving water by increasing the volume and rate of runoff during storm events.

Water quality from Drainage outfalls

1.5.16. While potential impacts from drainage outfalls are acknowledged, it is also asserted that with the proposed road drainage outfalls in place, an overall slight improvement in water quality of the receiving watercourses would invariably result, because the managed drainage system would replace the current situation of untreated storm drainage being discharged from the existing N21 and N69 national roads.

1.5.17. While I note that the traffic volumes along the existing N21 and N69 would reduce considerable with the new PRD in place, the unmanaged drainage systems on these roads would remain in place. However, the reduced traffic volumes on the existing roads would result in a more dilute run-off with lower concentrations of contaminants derived from tyres, exhaust particulate matter and hydrocarbons. The transfer of traffic onto the new PRD would create a new source of contamination, but in this case, the treatment and attenuation systems provided as part of the PRD would again result in a reduced mass concentration of contaminants. There would therefore be a net decrease in contaminant loading overall, and I would agree that this can be quantified as a slight (net) improvement as asserted by the applicant.

Water Quality as a result of accidental spillage

1.5.18. Accidental spillage has been risk assessed in accordance with Road Drainage and the Water Environment (TII, 2015) in which it was found that the overall spillage risk for the entire development would be less than 0.4% or 1:250-year probability. Given this finding of a very low spillage risk and that volumes arising would not be

substantial, I am satisfied that no specific mitigation measures are required. The point is also made that the number of road collisions would likely reduce because of the new road infrastructure, which would be safer. While noting that the N21 and N69 roads would continue to function with significantly reduced traffic levels, I am satisfied that the net result would be fewer road traffic collisions and corresponding less frequent accidental spillages. I would agree with the applicant's assertion that that this would lead to a positive impact with a rating of imperceptible positive having regard to the low risk of occurrence in any case.

Storm Discharge impacts on Flooding/Morphology

1.5.19. The applicants findings are that the flood impact of the road storm discharge would be 'slight to moderate' adverse impact where the receiving watercourse catchment is small (catchment area <1km^2), slight to moderate impact (for a catchment area of 1 to 10km^2) and slight to imperceptible impact (for a catchment area exceeds 10km^2). The reduction of impact in larger catchments is stated to be due to the smaller storm-water volume relative to the natural stream and river flood volume. I would agree with this finding based on my evaluation of the information provided and my knowledge and experience of other projects of a similar nature.

Routine Road Runoff on Receiving Waters

1.5.20. TII document Road Drainage and the Water Environment (including Amendment No. 1 dated June 2015) gives guidance and assessment tools for the impact of road projects on the water environment, including the effects of runoff on surface waters.

1.5.21. The **Highways Agency Water Risk Assessment Tool (HAWRAT)** is the established tool used to assess the effects of road runoff on surface water quality and uses toxicity thresholds based on UK field research programmes which are consistent with the requirements of the WFD and appropriate for assessment of National Road Schemes in Ireland. The UK research programme has shown that pollution impacts from routine runoff on receiving waters are broadly correlated with Annual Average Daily Traffic (AADT).

1.5.22. A HAWRAT was carried out on all 32 outfalls along the PRD. The HAWRAT assessment has tested for the 10,000 - 50,000 vehicles/day range, which is well above the projected traffic figures for the PRD and thus actual pollutant concentrations are expected to be considerably lower than the estimates from the

assessment. The assessment included the proposed storm water treatment (sedimentation and filtering) measures within the drainage network and the attenuation ponds.

1.5.23. At the oral hearing, the output from the HAWRAT assessment was presented and a copy has been placed on the application file. The HAWRAT process is one that is worked through a progressive stepped procedure. Step one considers the discharge quality to assess if it presents a potential contamination risk. Step two considers dilution potential in the watercourse and also includes two tiers of assessment for contaminated sediment accumulation. Tier two of step two is only undertaken if Tier one fails. Failure of Step two requires the implementation of mitigation measures to treat the run-off before discharge. Step three considers the impact following the implementation of mitigation measures.

1.5.24. Noting the ultimate basis of assessment is a pass/fail, all of the outfalls passed the HAWRAT assessment. I would agree with the assertion made by Mr Cawley for the applicant at the oral hearing that this represents an anticipated imperceptible impact to water quality of receiving surface waters. Given the outcome of the HAWRAT, it can be also concluded that the PRD would not interfere with the achievement of the environmental objectives of the WFD with respect to surface water.

Impacts on Natural Heritage

1.5.25. Impacts on KERs, many of which include watercourses and European Sites are dealt with under the heading of Biodiversity and Appropriate Assessment in Dr Flynn's report and the inspector's assessment. Direct impacts on the Lower River Shannon SAC are confined to the River Maigue crossing, and with hydrological conditions being under tidal influence at this area, there are low risks to water quality. While all watercourses within the zone of influence of the PRD are part of the wider lower River Shannon SAC catchment, and by extension the overlapping River Shannon and River Fergus SPA, indirect hydrological effects on the SAC from other watercourse crossings are considered imperceptible. Nonetheless, site specific construction measures will be deployed at the River Maigue Bridge construction to protect the conservation interests of the Lower River Shannon SAC and pollution control measures are proposed to be implemented at all watercourses to exclude downstream impacts as set out under the heading of mitigation measures below.

Impacts on Irish Water Supply Sources

1.5.26. The Foynes/Shannon Estuary Public Water Supply abstraction point is 2.3km downstream of river crossing RVB01 and as stated above, this was not identified initially in the EIAR, however, it was subsequently addressed by the applicant in the response to the RFI with potential for impact on water quality set out. Mitigation measures were also set out in the RFI response and are considered below under the heading of Mitigation.

Impacts from Borrow Pits and Material Deposition Areas

1.5.27. As discussed in the soils and geology assessment report, borrow pits may be developed on the PRD site to gain up to 500,000 cubic metres of required structural fill material. As set out, this would be a matter for the contractor to decide, while both the option of importing of all the 1.3 million cubic metres of material from quarries or sourcing 500,000 cubic metres from borrow pits and the remainder from borrow pits have been adequately assessed by the applicant in respect of hydrology. Three potentially suitable areas adjacent to the main cuttings have been identified as suitable borrow pits at Ardaneer (ch.1+500 in Section A), Mulderricksfield (ch.5+100 to 6+450 in Section A) and at Ballycannon (ch.52+550 to 55+500 in Section D). It is asserted that any environmental impacts at these locations would generally be as described in this EIAR for the proposed road at these locations. The applicant also stated that gaining of materials may involve some modest degree of additional excavation below the level of permanent works. This is a standard approach in road construction projects and as asserted, it can be achieved without any material change to the vertical road alignment. An estimated 35,000 cubic metres of peat soils and other small amounts of unsuitable material that cannot be used in connection with landscaping or otherwise used on the site would be placed in the borrow pits if developed or alternatively deposited in other areas within the PRD site.

1.5.28. Poor management during construction/excavation and filling of these areas could give rise to contaminated run-off, including silt and nutrients with a consequential slight to moderate negative impact on surface water quality.

Impacts – Concluding comment

1.5.29. I am satisfied that the applicant has sufficiently demonstrated an understanding of the hydrological impacts that would arise in the area, and these have been adequately identified.

1.6. Mitigation

1.6.1. Mitigation of impacts through avoidance was employed during the route selection stage and the design stage, by moving the proposed road development either laterally or vertically, so as to ensure that it does not traverse or come in close proximity to sensitive hydrological features where possible. The EIAR has demonstrated the application of a wide range of mitigation measures. These have been divided into construction and operational measures, as set out below.

Construction Phase Mitigation

1.6.2. The principal measure to mitigate hydrological impacts involves adherence to an Environmental Operating Plan (EOP), which includes detailed measures and measures specific to each major watercourse and is included in Appendix 4.1 of the EIAR, and which contains the following overarching measures.

- an Emergency Response Plan setting out emergency procedures to be undertaken in the event of an accidental spillage of chemical, fuel or other hazardous waste;
- a Water Quality Management Plan including a Construction Erosion and Sediment Control Plan (CESP) setting out the control, treatment and disposal of potentially contaminated construction surface water;
- having all the appropriate permits and licences in place for in-stream construction;
- taking cognisance of relevant guidance documents for construction on, over and near water;

1.6.3. Based on the relevant technical guidance documents for working over or near water, for example, Shannon Regional Fisheries Board-Protection and Conservation of Fisheries Habitats with particular reference to road construction, CIRIA C648 Control of Water Pollution from Linear Construction sites, Guidelines for the crossing

of watercourses during the construction of National Road Schemes (TII 2006), the following specific measures have been prescribed in order to protect all catchment, watercourses and ecologically sensitive or protected areas.

- construction compound areas set back a minimum of 10m from river and stream channels and out of potential floodplain areas (Flood Zones A or B);
- prevent surface water flowing onto the construction area by provision of berms, diversion channels and cut-off ditches;
- management of excess material stockpiles to prevent silt run-off, using for instance establishment of vegetation on exposed soil and the diversion of runoff water to construction settlement ponds;
- use of grassed buffer areas, timber fencing with silt fences or earthen berms close to turloughs, fens, stream and river channels and lakes;
- locations for silt fences are outlined in the EOP;
- use of settlement ponds, silt traps and bunds, as well as minimising construction within watercourses;
- permits will be obtained from OPW for any in stream works;
- fencing off watercourses at a minimum distance of 5m from site compounds/storage areas and employ measures to ensure that silt laden or contaminated surface water runoff from compounds would not discharge directly to the watercourse;
- ensure compounds would not be located within lands designated as Flood Zones A or B, in accordance with The Planning System and Flood Risk Management Guidelines (OPW, 2009);
- the storage of oils, fuel, chemicals and hydraulic fluids will be in secure areas within the site compounds;
- storage tanks with secondary containment provided by means of an above ground bund to capture any oil leakage;
- foul drainage from all site offices and construction facilities will be taken off-site;

- construction discharge would be treated so as not to reduce the environmental quality standard of the receiving watercourses;
- fencing off riparian vegetation along the identified sensitive watercourses to provide a buffer zone (minimum of 5m except at crossing points);
- any surface water abstracted from a river for use during construction will be through a pump fitted with a filter to prevent intake of fish;
- the use and management of concrete in or close to watercourses will be carefully controlled to avoid spillage.

1.6.4. It is submitted that where feasible, minor watercourse diversions/realignments would be carried out in dry ground by diverting the stream locally around the works area and when the channel has become established, the watercourse would then be diverted onto the new road alignment.

1.6.5. As noted in section 10.4.13 of Chapter 10 (Hydrology) of the EIAR, any material deposition sites for very soft alluvium or peat materials would be bunded sites and would have double erosion control fencing (silt fence) and a sediment settlement pond at the outlet. Runoff from any material deposition areas, whether they would be in worked out borrow pits or in other areas within the PRD site, would be contained and treated in temporary settlement ponds upstream of its outfall to the receiving watercourses. These ponds would then be maintained until the material deposition areas have stabilised and become adequately vegetated. In addition, the specific construction sequence for these areas would allow for settlement of sediment prior to discharge to the receiving watercourse. I am satisfied that the amount of material to be deposited on site is small in relative terms and the measures outlined combined with the general measures outlined in the EOP and CESP would be sufficient to ensure that no adverse environmental impacts on adjoining watercourses in respect of material deposition areas. The site environmental manager (SEM) will be appointed for the duration of the works and to inspect and monitor the measures for effectiveness on behalf of the employer. The results of the inspection/monitoring regime will be stored in the SEM's Monitoring file and will be made available for inspection / audit by the Client, NPWS or IFI staff.

Operational Stage Mitigation

Water Quality Impact Mitigation

- all road pavements drainage would be controlled and managed and would include 50 cubic metres of pre-treatment in terms of silt traps placed upstream of the outfalls (within the attenuation ponds);
- the proposed drainage system would incorporate a range of pollution control measures, including filter drains, sealed drainage systems, use of a vegetated lined wetland system upstream of outfalls and attenuation ponds;
- all pond and storage systems would be fitted with a manual penstock to close off outfalls and contain spillage from within the pond/storage system (for pumping and appropriate disposal);

Other Hydrology Mitigation measures

- storm runoff management through attenuation would reduce risk of flooding to 1% AEP;
- all culverts and bridges are designed to prevent permanent impact to the river morphology;
- in relation to watercourse diversions, localised mitigation measures have been identified to prevent bank erosion at sites of bends, which were found often to coincide with the proposed culvert.

1.6.6. The applicant provided a response to the RFI referring to specific sections of Chapters 9 (Hydrogeology) and 10 (Hydrology) of the EIAR and that water quality monitoring would be undertaken for groundwater and surface water for 12 months prior to construction and state that the measures outlined would ensure the protection of surface waters and groundwater during the construction and operation phases.

1.6.7. It is therefore asserted that the measures proposed in Chapter 9 (Section 9.5) and Chapter 10 (Section 10.5.) of the EIAR for the protection of surface waters and groundwater during both construction and operation stages, would ensure that the quality of drinking water sourced at the Foynes/Shannon estuary public supply at

Askeaton would not be compromised by the PRD. The response also referred to a number of construction and operation mitigation measures, including proposals that all road drainage would pass through pollution control and/or ponds (operation) and that the construction works would adhere to the EOP and associated water quality protection measures.

1.6.8. During the oral hearing, Mr Cawley stated that the conclusion reached regarding the impacts arising from all of the proposed outfalls, both independently and in combination with the Irish Water abstraction point, would result in a very low risk and magnitude of impact. He stated that adherence to good construction practices, as fully outlined in the EOP would ensure the protection of water quality in all drainage catchments and watercourses traversed by the PRD. He noted that in response to the above clarifications, Irish Water advised that they were satisfied with the mitigation measures proposed, and they further stated that they have no objection in principle to the proposed development and they recommended a number of conditions to be attached should the Board approve the development.

1.6.9. I have reviewed Irish Water's response dated 2nd of December 2020 received by the Board in which Irish Water stated that they are satisfied that the applicant has provided information on mitigation measures to ensure the protection of public drinking sources in the area. It is also stated that Irish Water have no objection in principle and recommend a number of conditions to be attached in the event that the Board approve the development. Having regard to the mitigation measures proposed, I am also satisfied that, subject to the conditions generally as recommended by Irish Water, there would be no remaining impact on the drinking water source.

Additional Mitigation Measures / updates provided at oral hearing

1.6.10. In addition to general mitigations/commitments outlined in Chapter 19 of the EIAR and Chapter 5 of the NIS, in its response on Item 14 (IFI recommendation) of the RFI, the applicant stated its agreement to the IFI recommendation that 12 months of monthly samples would be undertaken pre-construction on the seven watercourses listed in section 6.8.2 of the EOP. These watercourses are listed as Robertstown River, Ahacronane River, Lismakeery Stream, River Deel, Clonshire River,

Greanagh River and the River Maigue. This was added to the schedule of commitments at the oral hearing (Item OH.4).

1.6.11. A number of additional measures relating to hydrology were also put forward at the oral hearing as part of an updated schedule of commitments (OH.5 to OH.45 inclusive). To a large extent these include a commitment for the adherence to standard best practice construction management measures including the following: OH.16 (river crossings would only be installed during months of July to September), OH.28 (the recommendations included in the both the IFI document Guidelines on Protection of Fisheries During Construction Works in and Adjacent to Waters (IFI, 2016) and OH.31 (the Biosecurity Protocol for Field Survey Work (IFI, 2010) will be implemented in full). In response to a request from Inland Fisheries Ireland to lessen any possible shock impact of piling on fish at the oral hearing, the applicant has committed to a slow ramped up approach to piling at this location; OH.45 (the timing of any instream works would be confined to July to September in any one year).

Concluding comments on Mitigation

1.6.12. I am satisfied that appropriate and best practice mitigation measures have been applied to mitigate potential significant hydrological impacts associated with the construction (including earthworks outlined) and operation of the road, and that there are adequate safeguards to ensure that this philosophy carries through to the construction and operational phases of the project. I also note the additions to the schedule of commitments, which was submitted during the Oral Hearing on 16th of February 2021 referred to above.

1.7. Residual Impacts

1.7.1. The majority of impacts identified would be mitigated such that no adverse residual impacts would remain at either the construction or operational phase. The following residual impacts are those that I predict would arise.

- a slight to imperceptible adverse impact in terms of diversion of run-off / overland flow;
- a slight to imperceptible adverse impact in terms of loss of floodplain storage;
- a slight positive impact on water quality in watercourses in the study area, contributing to the objectives of the River Basin Management Plan 2018-2021

in respect of protecting and improving the water quality status of the surface waters, as the proposed road drainage would give rise to a net improvement of the current situation of untreated storm drainage being discharged from the existing N21 and N69 roads;

- as a result of the managed drainage and pollution control measures that will be put in place, the risk from accidental spillages from traffic would lead to an imperceptible positive residual impact when compared to the current situation, which is less controlled.

Interactions and Cumulative effects

1.7.2. I have reviewed the information provided in Chapter 17 of Volume 2 of the EIAR in respect of cumulative impacts and interactions together with the additional information on updated projects in the vicinity received by the Board during the oral hearing (15th February 2021).

1.7.3. In the assessment of interactions between the individual environmental disciplines I am satisfied that once relevant mitigation measures are implemented, no additional residual likely significant effects on hydrology would arise as a result of the construction or operation of the PRD.

1.7.4. In respect to cumulative impacts, I am also satisfied that no potential for significant impacts arise on the hydrological environment as a result of the project when taken in combination with any other relevant plans or projects and therefore there is no potential for significant cumulative/in-combination effects on hydrology.

1.7.5. I have also carried out a planning search to verify the projects (and their status) and am satisfied that none have since been granted permission that would result in addition cumulative impacts or impacts from interactions within the meaning of the EIA Directive and the Roads Act 1993, as amended.

1.8. **Other matters/Submissions/Objections**

1.8.1. A number of submissions raised concerns regarding the impact of watercourses and the risk of flooding that could arise as a result of the PRD, William O'Meara (Env-34), Cornelius Giltinane (Sch-17), Patrick O'Connell (Sch-84), An Taisce (Env-3 and FI-1) and Simon White & Others (FI-8). In response, Mr Cawley outlined that the drainage system was designed in accordance with TII design standards and the Manual of

Road Works documents (MCRW) that incorporates best practice including climate change allowances. He outlined that all surface water drainage runoff would be attenuated prior to discharge into receiving watercourses and that flooding assessments were carried out on all watercourse crossings and that there would be no worsening to current flooding regime. He stated that flood risk modelling was undertaken for the larger bridge structures including the bridge crossing of the Maigue and Greanagh rivers and in relation to the existing flooding conditions at Lismakeery, he stated that a flood model that was developed showed that there would be no worsening of existing flood conditions.

1.8.2. Responding to a concern raised by Simon White & Others (FI-8) about flooding of the River Deel and that attenuation ponds would become submerged in conditions of flood he confirmed that the ponds within the Deel flood plain are bunded to prevent inundation during flood events, up to the 1% AEP condition plus allowance for climate change as required by the relevant standards.

1.8.3. Eamonn & Lorraine Kelly (Env-9) raised a concern that the clearance of the Greanagh River at Kilknockan is excessive. In response, Mr Cawley outlined that the height of the crossing is also governed by the nearby underbridge UB09 to the west. Referring to the RFI response and at the oral hearing, Ian Gilvarry (FI-4) asserted that the applicant did not undertake sufficient assessment of how the project would influence the attainment of 'good' status under the WFD by 2027. At the oral hearing, Mr Cawley stated that the applicant addressed the importance of the WFD and outlined the current status of surface water in the area within Chapters 9 (Hydrogeology) and 10 (Hydrology) of the EIAR. It is my considered opinion that the applicant has shown due regard for the importance of watercourses and their significance under the WFD in the assessment of potential impacts. I am satisfied that, subject to the mitigation outlined, the PRD would not prevent or delay any watercourse in attaining and maintaining 'good' status under the WFD notwithstanding that the main watercourses are currently rated as 'poor' to 'moderate' status. Mr Gilvarry also referred to a legal case **Sweetman v An Bord Pleanála (Approved) [2021] IEHC 777.** No argument was advanced by Mr Gilvarry as to its relevance of this legal case to the PRD. I also note that this legal case has not been concluded.

1.8.4. A number of objectors to the CPO, including Stephen and Bridget Keary (Sch-108), Patrick O'Sullivan (Sch-86), Denis Lane (Sch-21), Cornelius Giltinane (Sch-17), John Brennan (Sch-50), Ruairí Brennan (Sch-97), Sam and Nicola Brennan (Sch-100) and Maeve and Thomas O'Kelly (Sch-64) expressed concern regarding potential impacts on their existing drainage from construction or from road run-off. The applicant stated during the oral hearing that the design approach to drainage was that the existing drainage regime would be maintained as much as possible and would only be altered where a change in direction or outfall was required. The need for attenuation ponds to attenuate flows was explained by the applicant in briefs of evidence, and their role in preventing flooding was highlighted. I am satisfied that the drainage design is well considered and centres on maintaining the natural drainage regime.

Concluding Comment on Other matters/Submissions

1.8.5. I am satisfied that the concerns raised in submissions and objections have been adequately addressed through design and appropriate mitigation measures and, as such, would not alter the findings above.

1.9. **Conclusions (Hydrology)**

1.9.1. Having assessed the information provided by the applicant, as set out above, and having considered all of the submissions and objections received in written format and at the oral hearing, I am satisfied that the applicant has adequately investigated the existing environment, understands the hydrological regime sufficiently and no *lacunae* exist and has proposed mitigation measures are both suitable and appropriate in the context of the proposed development. To a large extent, the PRD has been designed so that potential significant effects on the hydrological environment have been eliminated through engineering design avoidance. Beyond that, following adoption of good construction practice and the mitigation measures, as proposed, with the principal measure being adherence to the EOP and water quality protection measures set out in the CESP during construction, it has demonstrated there would be no residual significant negative direct, indirect or cumulative impacts on the hydrogeological environment.

1.9.2. I am equally satisfied that with the adoption of mitigation set out, there would be no risk that the surface waterbodies would either fail to comply with its WFD

environmental objectives, or that there would be any compromise to the delivery of the programme of measures set out in the RBMP for Ireland 2018-2021, as a result of the proposed road development, alone or cumulatively with other projects.

Jerome Keohane

BSc, MSc, FCIWEM, C.Geol, C.WEM, MIEI.

14th February 2022

Foynes to Limerick Road (including the Adare Bypass)

Assessment of significant effects on the environment

in respect of Hydrogeology.

Prepared by: Jer Keohane BSc, MSc, FCIWEM, C.Geol, C.WEM, MIEI.

1.1. Introduction

1.1.1. Hydrogeology is addressed primarily in Chapter 9 (Hydrogeology) of the EIAR, in the response to a request for further information and at the oral hearing by Mr Anthony Cawley. I also note that in the study team outlined in Appendix 1.1, Chapters 9 – Hydrogeology, Dr Patrick Morrisey of ROD-AECOM was referred to as a principal contributor. The following is my examination and evaluation of the information presented by the applicant leading to a conclusion on the effects on the hydrogeological environment arising from the construction and operation of the proposed road development (PRD).

1.2. Approach to study by the applicant

1.2.1. The applicant's assessment was prepared in accordance with the EPA guidelines for the preparation of an EIAR and by reference to TII adopted design guidelines, including 'Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes' (NRA, 2008).

1.2.2. The applicant's understanding of the existing hydrogeological environment was derived initially from a review of data sources of published information including OSI, GSI, Teagasc, EPA, LCCC, NPWS, OPW mapping, Met Éireann meteorological data and the River Basin Management Plan for Ireland (2018-2021) (Department of Housing, Planning and Local Government). Consultations were undertaken by the applicant's team with regulatory/prescribed bodies including GSI, NPWS, OPW and LCCC Environment and Water Services Departments.

1.2.3. Field surveys were carried out and areas of concern/sensitive locations were visited and assessed. Intrusive ground investigations were undertaken during the period of 2016-2019. Geophysical surveys were carried out at various locations along the

route including at areas of known or suspected karst activity. Standpipes and piezometers were installed which allowed groundwater and pore water pressure to be monitored and gain an understanding of seasonal groundwater fluctuations.

1.2.4. Groundwater quality was also monitored at sensitive locations in order to determine baseline conditions, and in areas of concern relating to potential groundwater pollutants. The applicant provided details of the ground investigation locations and soil type findings, and these are illustrated in Figures 8.1 to 8.24 of Volume 3 of the EIAR. These figures illustrate the applicant's interpretation of the site investigation findings along the route of the PRD. I have reviewed these in detail as part of my assessment.

1.3. Board's Request for Further Information

1.3.1. The Board's request for further information included seeking information on the following matters of specific relevance to hydrogeology:

- provide a summary account of the site investigation records undertaken in key areas that informed the environmental component of the ground/site investigations;
- clarify the depth of bedrock encountered during the site investigation at representative locations;
- clarify and confirm the extent of existing karst features within 2km of the proposed road development;
- clarify the extent of karst anomalies;
- identify the locations where dewatering would occur, to confirm the extent of dewatering required and to address any environmental effects, as necessary;
- impacts that could potentially arise as a result of dewatering on the Craggs, Barrigone and Croagh-Farrandonnelly group water schemes (GWSs) should be addressed;
- clarify and confirm whether or not contaminated and/or made ground is expected to be encountered, including the nature and extent of such ground;

- identify the location of the proposed borrow pits and to address geological and hydrogeological impacts associated with use of borrow pits for deposition of unsuitable material;
- the proposed use of low permeability barriers and drainage blankets as mitigation measures.

1.3.2. The applicant provided a response on the matters raised in the request for further information (RFI). The information provided within Chapter 9 of the EIAR, information provided in response to the RFI and information advanced at the oral hearing are collectively considered in my assessment below.

1.4. Existing Environment (Hydrogeology)

Bedrock Geology

1.4.1. Based on the information provided by the applicant in both Chapters 9 (Hydrogeology) and 8 (Soils and geology), the geology along the route of the PRD indicates that it is predominantly underlain by limestone, however mudstone was encountered to the north of Rathkeale (ch.28+750 to ch.29+150), at Gortnagour (ch.58+350 to ch.58+550) and at Rower More (ch.59+850 to ch.61+150). The limestone bedrock was found to outcrop in numerous locations particularly in sections A and C of the proposed road development (PRD). The dark muddy limestone and shaly mudstones of the Rathkeale formation are found in Sections C and D in the vicinity of Rathkeale.

Soils and Subsoils

1.4.2. According to the GSI Quaternary Mapping, subsoils/overburden within the study area comprise mainly Till derived from Limestone and these are considered to be of low to moderate permeability. The site investigations largely confirmed the Quaternary Subsoil Mapping. Isolated pockets of Fen peat and Lake Marl were found to be located mainly between Askeaton and Rathkeale. Alluvium deposits are present alongside the main rivers. Further information on the soils and subsoils are also set out in Chapter 8 (Soils and Geology) and has been considered in my assessment of the same environmental topic.

Contaminated soils and made ground

1.4.3. Two areas of potential **contaminated soils** were identified by the applicant in the course of the application. Both areas are relatively small and are adequately understood. I refer the inspector and the Board to further detail provided in my assessment report on soils and geology. Separate to the area of potentially contaminated soil/waste deposits, it is stated that **made ground** (as distinct from contaminated ground) is not commonly present along the specific route of the PRD, which predominantly traverses undeveloped agricultural land. Four locations of made ground have been identified as part of the response to the RFI in Table 8.A (Summary Table of Made Ground). In Section 9.3.1 (Soils and subsoils) of Chapter 9 (Hydrogeology) of the EIAR it is stated that made ground is present where the PRD would pass within urbanised areas such as Foynes, Askeaton, Rathkeale and Adare.

Groundwater Resources-Aquifers

1.4.4. By reference to the GSI mapping, the applicant has set out three types of aquifer classification that are found along the route, including the following:

- Regionally important Karst Aquifer with conduit flow (Rkc);
- Regionally important Karst Aquifer with diffuse flow (Rkd);
- Locally important Bedrock Aquifer moderately productive only in local zones (Ll).

1.4.5. The Regionally important Karst Aquifers (Rkc and Rkd) cover the large majority of the area through which the PRD passes. The Locally important Bedrock Aquifer occur at the end of the PRD at Foynes (start to ch.4+000) and Adare (ch.62+000 to the eastern end) and along a short section at Rathkeale. The distribution of these aquifers is shown in Figure 9.4 of Volume 3 of the EIAR.

Directive 2000/60/EC (Water Framework Directive)

1.4.6. The inspector and the Board will be aware that Directive 2000/60/EC (Water Framework Directive) (WFD) sets out the legal framework to protect and restore clean water and to ensure its long-term sustainable use. The core requirements of the WFD has been transposed into Irish law through the European Communities (Water Policy) Regulations 2003 as amended, and it applies to rivers, lakes, groundwater, and transitional coastal waters. In addition, the European Communities

Environmental Objectives (Surface Waters) Regulations 2009 as amended, and the European Communities Environmental Objectives (Groundwater) Regulations 2010 as amended, give effect to the measures needed to achieve surface water and groundwater environmental objectives.

1.4.7. The main environmental objectives with respect to groundwater bodies are:

- prevent or limit the input of pollutants into groundwater and to prevent the deterioration of the status of all bodies of groundwater
- protect, enhance and restore all bodies of groundwater, ensure a balance between abstraction and recharge, with the aim of achieving good status
- reverse any significant and sustained upward trend in the concentration of any pollutant resulting from the impact of human activity

1.4.8. For natural waters the WFD environmental objectives relate to achieving or maintaining **good chemical and quantitative status for groundwaters**. With respect to groundwater, there are just two status ratings – 'good' and 'poor'.

1.4.9. River Basin Management Plans (RBMPs) are used as a tool for achieving the protection, improvement and sustainable use of the water environment across Europe. These plans are prepared in 6-year cycles, during which a programme of measures must be implemented so as to achieve water quality objectives. Ireland is currently operating on its second-cycle river basin management plan that covers the period 2018-2021 with the third plan to cover the period 2022 – 2027 currently at draft stage (Draft River Basin Management Plan for Ireland 2022-2027) and at public consultation stage up to 31st of March 2022.

1.4.10. The current condition of our waters is assessed against the standards and environmental objectives set out in the Water Framework Directive are monitored by the EPA. In total 2,718 surface waterbodies are monitored for ecological status and 514 groundwater bodies are assessed for groundwater status. The draft River Basin Management Plan 2022-2027 provides an analysis and this is based on the assessment of water bodies over the period 2013-2018. The numbers of waterbodies achieving high, good, moderate, poor and bad status in a waterbody type (as may be relevant) are outlined in Table 3 of the draft plan and repeated in

Table 1 of my parallel report on hydrology. In respect of groundwater, 474 are rated as ‘good’ and 40 are rated as ‘poor’

1.5. **Existing Environment (Hydrogeology)**

Regional Hydrogeology and Groundwater Bodies

1.5.1. Groundwater Bodies (GWBs) are management units under the WFD. They are subdivisions of large geographical areas of aquifers. By reference to GSI mapping, Sections A, B and C pass through the **Askeaton GWB**, which mainly comprises of a Regionally important karstified (Rkc) aquifer. Dry weather flows are relatively low across this GWB indicating low aquifer storativity. The main discharges from this GWB are to the Rivers Deel, Ahacronane and Shannon Estuary to the north. A number of group water schemes (GWSs) are located within this GWB, due to the productive nature of the limestone. Section C also passes close and adjacent to the western edge of the Groundwater-Dependent Terrestrial Ecosystem (GWDTE) **Askeaton South Fens GWB** at ch.24+000 and 25+000. The GWB discharges to the ground surface at Askeaton Fen maintaining the wetland system. Section C also passes through a portion of the **Shanagolden GWB** which is stated to be generally poor productive, and it discharges to rivers and streams towards the Shannon estuary.

1.5.2. Section D passes through the **Fedamore Groundwater** GWB for almost its entire length. The majority of this GWB is comprised of a Regionally important karstified (Rkd) aquifer as indicated in Figure 9.4 and GSI mapping. A small portion of the western end of Section D is within the **Newcastle West GWB** which is generally dominated by karst rocks. The main discharges are to the streams and rivers crossing the GWB, particularly the Rivers Maigue, Clonshire and Greanagh.

Groundwater Quality and Risk

1.5.3. The **Quality** and **Risk** status for each of the GWBs identified along or adjacent to the PRD are set out in Table 9.5 of Chapter 9. Three of the four GWBs (Askeaton, Newcastle West and Fedamore) are identified in this table as having a ‘poor’ quality status and being ‘at risk’ of not achieving ‘good’ status. Shanagolden GWB was reported as ‘good’ quality status and ‘probably not at risk’ and Askeaton South Fens GWDTE is listed as not having any data reported for either GWB quality status or risk status. While the source for these assignments of quality and risk have not been

set out in the EIAR, I note that they align with those that are contained in a water information resource 'watermaps – our plan' which is available on a web resource with historic data, watermaps.wfdireland.ie. Having carried out a review of current EPA maps on https://gis.epa.ie/EPAMaps/ (February 2022), it revealed different data. Specifically, the EPA data revealed that the five aforementioned GWBs have a reported 'good quality' status (both chemical and quantitative) under the WFD quality assessments and a risk category of 'under review' for all five of the GWBs. I am satisfied that the EPA data and associated rating of 'quality' and 'risk' status outlined are current and more relevant and I have considered these in my assessment. Where a waterbody has a 'review' status, this is set out on the EPA mapping as meaning 'either because additional information is needed to determine their status before resources and more targeted measures are initiated or the measures have been undertaken, e.g. a wastewater treatment plant upgrade, but the outcome hasn't yet been measured/monitored'. I note that the data relates to the period 2013-2018 and having reviewed the data for the previous cycle 2010-2015, there has been no change to either 'risk' or 'status' since that previous cycle.

1.5.4. The applicant monitored groundwater quality at six boreholes in Sections A, B and C between December 2016 and June 2017. The monitoring revealed that the groundwater was generally poor in terms of bacteria with elevated levels of E-coli and Total Coliforms at nearly all locations indicating faecal contamination either by human or animal sources. Otherwise, groundwater chemistry quality was found to be good with nitrate, phosphate, total phosphorus and other parameters of concern were within acceptable drinking water limits.

Groundwater Vulnerability

1.5.5. The aquifer groundwater vulnerability to pollution, which is based on the soil permeability, the depth of the overburden and the unsaturated depth, is primarily classified as 'High(H)' and 'Extreme (E)' or Extreme (X)' along the majority of the proposed route, largely as a consequence of shallow subsoils or areas of no sub-soil cover.

1.5.6. The 'Extreme (X)' category is a subset of the 'Extreme' category and relates to areas of bedrock outcrop or sub-crop (<1m), or within 30m of a location of point recharge (i.e. karst feature). There are areas of 'Moderate' to 'Low' groundwater vulnerability

along the River Maigue Estuary upstream to Adare. The applicant found that there are areas mapped as Extreme (E) or Extreme (X) in Section A on the GSI mapping that revealed deeper subsoil cover (between 10.4m and 17m) of moderate permeability subsoil above limestone. Examples of these areas include locations at RC02-05 (ch.2+650) and RC03-06 (ch.3+850) as shown in Figures 8.1 and 8.2 (Ground Investigation) respectively. Given the greater extent of subsoil encountered, I would agree with the applicant's assertion that in those areas of Section A, as described, the groundwater vulnerability of 'High' or 'Moderate' rating would be more appropriate than Extreme (E) or Extreme (X) given the aquifer would have protection from overburden. In areas B, C and D, the site investigations were found to largely agree with the GSI vulnerability mapping set out above.

Karst

1.5.7. The limestone aquifer underneath the site of the PRD is karstified. In general, the degree of karstification reduces from west to east and is concentrated in Sections A, B and the initial part of Section C.

1.5.8. From a geotechnical perspective karst is a relevant consideration because of the presence of voids and weathering creating possible instability and potential geohazards for construction. This has been considered by the applicant in Chapter 8 (Soils and Geology) of the EIAR and dealt with from a geotechnical perspective in my separate assessment of soils and geology. For reasons set out in that assessment, largely because competent rock was revealed through site investigation, no issues of a significant geotechnical concern are present in respect of karst.

1.5.9. In the context of hydrogeology, the karstification of the underlying aquifer is of relevance because enlarged fractures or conduits can increase groundwater vulnerability that in turn can lead to faster transit times for contaminants, and as such greater water quality impact magnitudes arise.

1.5.10. In Chapter 8 (Soils and Geology) the applicant stated that there were no surface depressions observed within 2km of the PRD. In Chapter 9 (Hydrogeology), reference is made to a number of karst features encountered, including surface depressions associated with turloughs. Clarity on this matter was sought from the applicant as part of the request for further information. In response, the applicant set

out the different nomenclature that they had used explaining that any surface depressions encountered within the 2km buffer zone of the PRD comprise turloughs and springs, being features of hydrogeological significance rather than features that might infer karst instability from a geotechnical sense. The relevant karst features of hydrogeological significance associated with turloughs, and springs and their locations are identified directly below in the context of the existing environment.

Surface Karst Features (Turloughs and Springs)

1.5.11. Four Karst Features comprising turloughs were identified in the study area. These include:

- **Lough Selleher Turlough,** located between two peaks of elevated ground between Craggs and Mulderricksfield, south of the PRD at ch.5+500;
- **Tomdeely Turlough** and **Tomdeely North Turlough**, located approximately 1.5km and 2km respectively north of the proposed PRD alignment and 5km east of Foynes, are described as having bases within the local groundwater table;
- **Foleys Turlough** feature is located on agricultural lands north of the existing N69 at Morgans North, approximately 2km north of the PRD alignment and 4.6km east of Foynes.

1.5.12. A number of springs including karst springs within 3km of the PRD were identified and are described.

Karst features revealed from geophysical surveying

1.5.13. Geophysical surveys were carried out across 22 transect profiles along the route of the PRD. For the majority of these transects, no evidence of karst features was detected and weathered limestone overlying more competent limestone bedrock was generally recorded, which aligns with the information gathered by the applicant during site investigations. A possible karst feature was identified in Section A at ch.1+180 and the portion of the resistivity profile that picked up this feature is shown on Plate 9.1 (Portion of the resistivity profile at GP01) in Chapter 9 of the EIAR. This feature corresponds to the area identified at the location of a karst spring on GSI mapping. It is in an area where the construction would comprise the construction of a low embankment. I note that the feature extends to depth but is not wide (<10m) and

is likely to be related to a zone of weathered rock that feeds the spring. As the spring is recorded as emerging at this location, while not stated by the applicant, I consider that the risk of contamination is a potential impact, as is the loss of a potential water supply.

Groundwater Flooding

1.5.14. Since the application was received by the Board and the oral hearing has been concluded, areas of groundwater flooding have been mapped on the GSI mapping resource. These indicate groundwater flooding at Doohyle Beg and Clochatrida, both near Rathkeale. These areas of groundwater flooding do not encroach on the PRD footprint. A low-lying area of land which forms a portion of Key Ecological Receptor (KER) 4 at Rincullia ch.3+600 to ch.3+950 is not shown as an area of groundwater flooding on the GSI database, however the applicant has asserted that pluvial/groundwater flooding occurs at a low point in the field following periods of extended rainfall. I am satisfied by reference to the location of the groundwater flooding, they would not be negatively impacted by the PRD.

Groundwater Recharge

1.5.15. The GSI Groundwater recharge map across the area indicates generally high recharge rates across the entire area with recharge coefficients typically ranging between 35% and 85% (of effective rainfall) resulting in annual recharge depth of 200 - 676mm. Higher zones of recharge are indicated at areas of bedrock outcrops (450 – 676mm). In the karstified limestone aquifers, the shallow weathered zone together with the fractured bedrock are considered to be able to accept high recharge rates.

Groundwater Abstractions for Private Group Water Schemes

1.5.16. The applicant notes that groundwater is abstracted at various locations along the PRD route for four GWSs, such as **Craggs-Barrigone GWS** in Section A, **Cappagh GWS** and **Croagh Farrandonnelly GWS** near sections B and D close to **Rathkeale** and **Coshma-Killeen GWS** east of Adare in Section D.

1.5.17. The **Coshma-Killeen GWS** and **Cappagh GWS** were both considered to fall outside the scope of impact assessment, with the sources being one and two kilometres from the PRD respectively and as such they are not discussed further in any of the documents. I am satisfied that the PRD would not cause any impact on these two

GWSs because of the separation distance and that they would be outside of any zone of contribution (ZOC).

1.5.18. The **Craggs-Barrigone GWS** is supplied from a 29m deep borehole source in the townland of Ballyellinan c.3km west of Askeaton. The borehole is within Dinantian Pure Un-bedded Limestones of the Waulsortian Limestone formation. The scheme supplies in excess of 63 connections with a reported average abstraction rate of 130m^3/day and a maximum yield of 180-240m^3/day (GSI, 2015). The PRD alignment intersects the mapped ZOC of this GWS at a location c. 900m south of the main borehole supply. The location of the supply borehole and its mapped ZOC are illustrated on Plate 9.2 of Chapter 9. Figure 9.3 shows the supply borehole and the location of the proposed road cutting. The mapped ZOC has an area of 1.2km^2.

1.5.19. The GSI vulnerability mapping of the area indicates a rating of Extreme (E) or Extreme (X) and this corresponds with the information gathered in the site investigation where thin subsoils are noted or where subsoils are absent. The main water strike was reported to be encountered at a bedrock fracture of c.24m below ground level (BGL) at approximately -12m Ordnance Datum (OD). At the same location, in terms of vertical alignment, the PRD would be at a vertical location of 33m OD.

1.5.20. The main source for the **Croagh–Farrandonnelly GWS** is a c.80m deep borehole located c.600m south of the PRD in Croagh village adjacent to the existing N21. Its location is illustrated in Plate 9.4 of Chapter 9. Bedrock was encountered at c.5.5m at this location. The ground elevation at the borehole supply location is at c.28m OD with an average static water level of c.26.8mOD. The GWS is stated to have an average abstraction rate of 54m^3/day. The estimated daily peak demand (including a factor of safety of 1.5) is 123m^3/day. The borehole is within the Fedamore GWB and within a Regionally important aquifer that is dominated by diffuse flow (Rkd).

1.5.21. Groundwater vulnerability in the areas that incorporates the ZOC is generally ‘moderate’ to ‘high’. Site investigations revealed that subsoils have ‘low’ to ‘moderate’ permeability. Site investigations also revealed a groundwater level at an average depth of 5m below ground level (c.22mOD to c.30mOD). The PRD is proposed to be in cutting with an average cut depth of 7m in this section, which would be 2m below the average groundwater level. The proposed road alignment

intersects the mapped zone of contribution (ZOC) and its location relative to the borehole and ZOC is also indicated on Figure 9.4. The ZOC is located in a rural area with intensive agricultural enterprises and one-off housing.

Private Water Supplies (Domestic and Agricultural Groundwater Supplies)

1.5.22. More than 70 groundwater supply boreholes or springs for domestic and agricultural supply were identified by the applicant during its assessment of the study area. Locations of known and suspected wells are illustrated in Figures 9.6 to 9.16 in the EIAR.

Groundwater Flow and interactions with surface waters (Site Conceptual Model)

1.5.23. Groundwater flow in Sections A and B is generally in a northern direction towards the Shannon Estuary. Groundwater seepage and springs are located in low-lying areas at the foot of elevated lands in the vicinity of the Shannon. Groundwater also discharges locally to the main rivers and streams, which also flow in a general northerly direction towards the Shannon Estuary. Groundwater quality in all four sections is rated as poor in terms of bacteria, but otherwise is a moderate to good standard.

Nature Conservation and Ecological Receptors

1.5.24. There are a number of European sites which form part of the Natura 2000 network within the study area that are of significance for the hydrogeological environment. These include the Lower River Shannon SAC (site code no. 002165) and Askeaton Fen Complex SAC (site code no 002279).

1.5.25. The Lower River Shannon SAC is hydrologically linked to the proposed road development, as a downstream receptor both by surface watercourse and by groundwater flow northwards from the alignment of the proposed road development towards the Shannon Estuary. The River Fergus and River Shannon Estuaries Special Protection Area (SPA) is similarly hydrologically linked falling within the same area of the SAC within estuarine areas.

1.5.26. The Askeaton Fen Complex SAC is a groundwater-fed system that is located in close proximity to Section C of the PRD. At its closest point, it is located 0.5km downstream of the proposed road alignment near ch.25+000.

1.5.27. In addition, there are a number of Natural Heritage Areas/proposed Natural Heritage Areas (NHA/pNHA) sites that are considered to be sensitive in terms of groundwater (and/or surface water), all forming part of the Askeaton Fen Complex SAC. These include:

- Ballinvirrick Marsh pNHA (Site Code: 001427);
- Cappagh Fen pNHA (Site Code: 001429);
- Ballymorrisheen Marsh pNHA (Site Code: 001425);
- Gorteennamrock Fen pNHA (Site Code: 001433)

1.5.28. Four KERs comprising hydrogeological sensitive (groundwater fed) fen wetland habitats were recorded as comprising:

- Fen Wetland at Rincullia (KER 4) – This is an area of Rich Fen Wetland featuring localised bedrock drainage/flooding feature A low lying area of land which forms a portion of KER4 at Rincullia. Bedrock is shallow or exposed in this location and pluvial/groundwater flooding occurs at a low point in a field, which slowly percolates to bedrock following periods of extended rainfall. The rocky nature of the surrounding lands has led to the development of dense scrub woodland.
- Fen Wetland at Ballellinan (KER 7) - This is an area of Rich Fen wetland (confirming to Annex I habitat Alkaline Fen) and wet grassland located to the north of Ballycullen House at Ballyellinan. bordering the L6062-L1220. Areas of exposed bedrock near the centre and along the perimeter of this site are likely providing groundwater to this wetland habitat. There is a karst spring source noted in the GSI karst database some 420m to the west of the western boundary of this fen wetland. The supply borehole for the Craggs/Barrigone GWS is located approximately 170m further north of this spring (c.500-600 north-west).
- Fen Wetland at Lismakeery (KER 11) - This is an area of Rich Fen wetland (confirming to Annex I habitat Alkaline Fen) and wet grassland fed by groundwater seepages around the perimeter. The area is noted as ‘Liable to Floods’ on historic Ordnance Survey Mapping and has been extensively drained towards the adjacent Lismakeery Stream.

- Fen Wetland at Blossomhill (KER 21) - This is an area of Rich Fen wetland (conforming to Annex I habitat Alkaline Fen) and wet grassland located between the existing N21 to the south and Doohyle Lough to the north. It is listed as 'benefiting lands' by the OPW. This area has been drained with conveyance through small lakes and through Doohyle Lough and subsequently drains north-west to the River Deel.

Concluding Comment on Existing Environment

1.5.29. Having reviewed all of the information on file and publicly available information, particularly the information available on the GSI resource, I am satisfied that the hydrogeological features of importance have been correctly and accurately identified and examined by the applicant. Those identified as of extremely high importance include the two European sites (Askeaton Fen Complex SAC and Lower River Shannon SAC), a Bedrock aquifer classified by the GSI as a Regionally Important Karst Aquifer (RKc and Rkd) and the two GWSs (Craggs/Barrigone GWS and Croagh-Farrandonnelly GWS).

1.6. Assessment of Potential Impacts

1.6.1. The main elements of the earthworks are set out in Chapter 4 and 8 of the EIAR and as clarified in the response to the RFI and at the oral hearing. Reference was made to cut, fill and embankment construction. The works described would also involve some processing of material by breaking the excavated rock into smaller particle size. In the EOP it is stated that some of the cuttings/processing areas would generally include a material stockpile where material is stored temporarily before being hauled to the areas of fill along the PRD. These are standard elements of a road project.

1.6.2. The potential impacts on the hydrogeology environment from the PRD are examined by the applicant in Section 9.4 of Chapter 9 of the EIAR. For each hydrogeological feature the magnitude of the impact is assessed in the absence of mitigation and, in combination with the importance of the attribute (i.e. the significance of a potential impact), and an impact rating has been applied. The impact rating takes into account the sensitivity and importance of the feature, in combination with the character/magnitude/duration/likelihood/and consequences of any potential impact using the magnitude and impact ratings from 'Road Drainage and the Water

Environment' (TII, 2015). Impacts and mitigation are also dealt with in the Environmental Operating Plan (EOP) contained in Appendix 4.1 of Volume 4A of the EIAR.

1.6.3. I have reviewed the EIAR, the RFI response and the information put forward at the oral hearing. The following is my assessment of the impacts, informed by the applicant's assessment, during construction and operation phases.

Rock Excavation – Areas of Cut

1.6.4. Areas of cut have the potential to impact on the level of the groundwater table and to cause deterioration in aquifer water quality by increasing aquifer vulnerability during the construction period through a loss of overburden. In the absence of sealed drainage, this can lead to infiltration of contaminates to groundwater. Extensive road cuttings can lead to a significant increase in runoff volume to be conveyed within the road drainage system and this can lead to an adverse impact on receiving waters in terms of chemistry and water balance. Groundwater quality can be indirectly impacted from the excessive run-off of potentially contaminated surface water.

1.6.5. Where cut sections intercept the groundwater table, dewatering of the intercepted aquifer can result. In the areas of deep cut and in the absence of mitigation, potential arises for direct temporary adverse impact to the quality of the underlying aquifer during construction. Impacts on flow regime on the underlying aquifer can persist into the operation phase.

1.6.6. The identified aquifers most at risk are the Regionally Important karstified aquifers at cut section ch.5+100 to ch.6+400 at Muldericksfield and at ch.52+400 to ch.56+000 at Ballycannon. Consequent to the loss of overburden, there is potential to intercept the local groundwater table and to intercept groundwater flows and overland runoff. There is also potential for contaminated road drainage entering the underlying aquifer in the areas of cut. I note that the two areas of cut are within a Regionally-important karstified aquifer. In the absence of mitigation, the applicant has rated the impact as 'moderate' in terms of significance. I am satisfied that there is significant assimilative capacity available in the aquifer to dilute any inputs from normal road drainage. Furthermore, contamination events, should they occur, would coincide with times of significant rainfall, when there would be significant recharge through the aquifer that would attenuate any discharge. Therefore, based on my assessment on

this matter, I agree with the applicant's rating of this impact as **'moderate'** adverse in the absence of mitigation.

Road Drainage

1.6.7. The drainage design is such that there are no proposed drainage outfalls that would directly discharge to groundwater. The applicant carried out a groundwater risk assessment in relation to potential impacts on groundwater from the PRD drainage system and specifically in relation to the use of permeable drainage systems. The assessment was carried out in line with 'Road Drainage and the Water Environment (including Amendment No. 1)' (TII, 2015). Using the response risk matrix as part of this approach, the applicant determined that a significant portion of the PRD has a response of **R4,** indicating that the use of permeable road drainage systems is **Not Acceptable.** In less vulnerable areas where the overburden depth is greater than 5m (aquifer vulnerabilities of moderate and low) unlined drainage systems are deemed **Acceptable** (with conditions), as the groundwater protection response is **R2(1), R2(2) and R2(3)** in accordance with the Groundwater Protection Response Matrix set out in Table 9.8. The drainage design took account of the risk assessment findings and suggests that the impact level would be reduced from **slight/moderate permanent impact** to **slight**. The 'slight' rather than 'no or imperceptible' rating of impact is stated to be appropriate because of the potential for leakage that can occur over time, notwithstanding the robust nature of the drainage system proposed.

1.6.8. A summary of the proposed locations of sealed drainage systems along the PRD is set out in Table 9.9 of Chapter 9. At each outfall, either one or two attenuation ponds would be provided, and it is proposed that these ponds would receive the same level of treatment as the road drainage system. For example, where a sealed drainage system is proposed, the associated attenuation ponds would be lined with a geomembrane and cohesive material so as to prevent infiltration to ground. Where permeable drains are permitted and proposed, attenuation ponds would be lined with cohesive materials only.

1.6.9. Additional pollution control features are proposed to be incorporated into the drainage design upstream of the proposed outfalls. These include the use of filter drains and the use of a vegetated sediment bay to remove nutrients from the drainage water.

1.6.10. I would also agree with the applicant's predicted impact ratings, based on the information provided which I consider to be comprehensive together with my review of available information on other sources, including in particular the GSI resource and the site investigation findings.

Construction Dewatering

1.6.11. It is stated in Section 8.4.1.2 (Construction Dewatering) of Chapter 8 (Soils and Geology) that in areas of significant cuts, temporary drainage would be required to remove surface and ground water to allow excavation in a dry environment by locally lowering the ground water table as the depth of excavation progresses. This would occur locally as the work proceeds. In the response to the RFI (Item 6) it is stated that groundwater levels can be lowered during construction by dewatering operations as temporary pumping of excavations locally in which groundwater is encountered, to allow construction operations to proceed.

1.6.12. During the operation phase, as I have noted above and as asserted by the applicant in the response to the RFI (Item 6), groundwater level can be lowered permanently by the road drainage. This would occur where the invert of the road drain(s) would be below the level of the groundwater. The applicant used the Sichardt drawdown formula[4] to calculate the radius of influence and assess the drawdown effect. The anticipated extent of dewatering is presented in Table 6.A of the RFI response and indicated graphically in Figures R6.1 to R6.5 in Appendix A4 that accompanied the response. The applicant confirmed that following review, no ground-water dependent or otherwise environmentally sensitive habitats within the anticipated drawdown zones would result.

Impact on Bedrock aquifer characteristics

1.6.13. An assessment of the environmental impacts on aquifer characteristics is set out in Table 9.10 of the EIAR. In respect of the **Regionally Important aquifer** (with 'high' importance), the rating of impact is set as **slight to moderate** in respect of impacts to hydrochemistry in the aquifer or overlying subsoil caused by routine surface water, and slight in respect of localised changes to groundwater levels caused by

[4] Ro = C(H-hw)*√K where Ro is the Radius of influence measured in m, C is an empirical coefficient (3000), H-hw is the maximum drawdown depth at the excavation and K is the hydraulic conductivity (m/sec) of the various media considered (limestone bedrock or overburden soils

dewatering, as well as slight in respect of localised changes to up-gradient groundwater levels and hydrochemistry as a result of flow restriction. In respect of the **Locally Important aquifer** (with 'low' importance), the rating of impact is deemed as **imperceptible** with respect of localised changes to up-gradient groundwater levels, groundwater levels in the aquifer and down-gradient changes.

1.6.14. I would largely agree with the applicant's predicted impact ratings, based on the information provided, which I consider to be comprehensive and my review of available information on other sources, including in particular the GSI resource and the site investigation findings.

Impact on European Sites and Natural and Proposed Natural Heritage Sites

Askeaton Fen Complex SAC

1.6.15. The Askeaton Fen Complex SAC is a groundwater fed system that is located within 500m of the PRD at ch.25+000. In addition to the information provided in the EIAR and in the RFI, the findings of impacts were explained in detail and clarified, where requested, during the Oral hearing. The EIAR concludes that the proposed Road Sections A, B and D would have no hydraulic connection with the Askeaton Fens complex. In Section C, the road would be at grade or on slight embankments where it is close to the Fen Complex. Furthermore, the water balance calculations indicate that the PRD would be sited down gradient of the fen complex. Outflow streams from the Fen would cross the road, but there is expected to be a neutral impact on these surface water features.

1.6.16. The impact assessment correctly identified potential localised changes to groundwater and surface water flow regime and hydrochemistry as small adverse magnitude localised impacts representing an imperceptible impact on the SAC. This is indicated graphically in Plate 9.5 of the EIAR which is reproduced below.

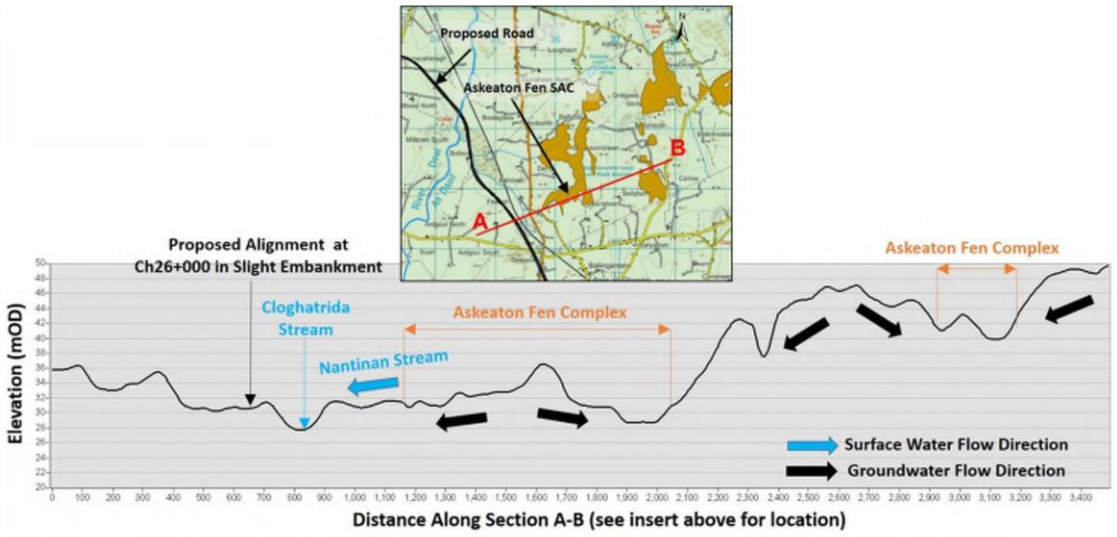

Plate 9.5: Groundwater Conceptual Site Model of Askeaton Fen SAC and its interaction with the proposed road development

1.6.17. No potential Impact on the Askeaton Fen SAC is predicted by the applicant to arise during either the construction or operational phase and a rating of **imperceptible impact** on the Askeaton Fen Complex SAC as a result of the PRD, is deemed appropriate.

Lower River Shannon SAC

1.6.18. The Lower River Shannon SAC is hydrologically linked to the PRD as a downstream receptor from each of the surface water features either crossed by the PRD or to which road drainage would be discharged. The Shannon Estuary is a discharge zone target for the Askeaton GWB. Each of the five GWBs, which are crossed by the proposed road development, are also hydraulically linked to the major rivers and streams providing baseflow and therefore ultimately discharging to the SAC indirectly via the River Deel, the Maigue or the Ahacronane. This SAC is predominantly a surface water system and is not particularly sensitive to groundwater flows. The main potential impact would relate to contamination of the aquifer impacting the SAC water quality as a downstream receptor. Only very limited infiltration of runoff will occur and only in areas where it is appropriate to do so as the subsoil provides protection to the aquifer. It is highly unlikely for any impact to this SAC arising from groundwater pollution and accordingly, I am satisfied with the applicant's assigned rating of **imperceptible** Impact.

Impact on Surface Karst Features (Turloughs and Springs)

1.6.19. The potential impacts on these turloughs and karst spring features identified above include localised changes to groundwater levels in the aquifer, impacts on subsoil from dewatering in cut sections and localised changes to down-gradient hydrochemistry in the aquifer and overlying subsoil because of routine surface runoff and spillages. These have all been rated as '**imperceptible**' because of the small magnitude of impact. None of these turloughs are a priority habitat under the European Habitats Directive.

Impacts on KERs

1.6.20. The potential arises for moderate impact on groundwaters flows within these habitats, due to the road alignment both in cutting and embankment works, which potentially could capture groundwater flow in the road drainage and divert to surface flows. This potential impact is rated as **slight negative** at KER 4 in respect of both increased frequency of localised groundwater flooding and localised pollution of the bedrock aquifer by routine surface runoff and spillages, as **moderate negative** at KER 7, KER 11 and KER 21 in respect of increased frequency of localised groundwater flooding and as **imperceptible negative** impact in respect of localised pollution of the bedrock aquifer by routine surface runoff and spillages.

Impact on Group Water Scheme Supplies

Craggs-Barrigone GWS

1.6.21. The construction of the PRD comprises an area of deep cut c.19m in bedrock at Craggs/ Mulderricksfield, c.900m upgradient of the Barrigone GWS borehole at ch.6+000. The applicant conducted significant field studies at **Craggs Barrigone**, leading to a well-informed conceptual site model that is illustrated on Plate 9.7. The PRD has potential to interact with the GWS because, as set out above, it intersects the mapped ZOC. The predicted impacts are set out in Table 9.18 and would include a reduction in water supply yield at the GWS borehole and contamination of the water supply from road drainage entering the aquifer through weathered bedrock. An impact rating of **moderate negative** is predicted by the applicant which I consider accurate based on the impacts described.

Croagh- Farrandonnelly GWS

1.6.22. The PRD would be in an area of deep cut c.7.5m in bedrock at Ballycannon/Croagh, c.600m upgradient of the GWS supply borehole. The applicant developed a groundwater conceptual site model of the area, and this is illustrated on Plate 9.9. The predicted impacts are set out in Table 9.18 and include a reduction in yield of water supply at the GWS borehole and contamination of the water supply from road drainage entering the aquifer through weathered bedrock. An impact rating of **moderate negative** is predicted by the applicant which I consider accurate based on the impacts described.

Impacts on private groundwater supplies along the PRD

1.6.23. An impact assessment was carried out for all known and/or potential supplies within 300m of the PRD. The potential impact rating for the majority of these was assessed as **imperceptible** because of the road being at grade, or on embankment, or well removed from the PRD, or being upgradient. Others are rated as having a **slight negative** impact and are those groundwater supplies set out in Table 9.18 (Rate of significant environmental impacts on groundwater resources) and are presented on Figure 9.5, 9.6-9.16 of Volume 3 of the EIAR. These impact ratings are considered accurate based on the impacts described.

Impacts from Borrow Pits/Deposition areas

1.6.24. As set out in Chapter 8 (Soils and Geology), there is a possibility that borrow pits would be developed on site to source up to 500,000 cubic metres of suitable material. The development of borrow pits is standard practice for road projects where the overall aim is to reduce the extent of imported material from quarries. Section 8.4.1.9 of the EIAR identifies possible borrow areas at the locations of three large cuttings in rock along the route, namely in the Ardaneer area (ch.1+500, Section A), in Mulderricksfield area (ch.5+100 to ch.6+450, Section A) and at Ballycannon (ch.52+550 to ch.55+500, Section D). It is also stated in the RFI that some modest degree of additional excavation below the level of permanent works may be utilised to gain more rock materials. Again, this is a standard approach in road construction projects, and I am satisfied that as set out this slight extra cut depth would not affect the vertical alignment of the road.

1.6.25. In evidence presented at the oral hearing, the applicant assures that the deposition of the small amount of unsuitable peats and small amounts of very soft alluvium soils would not give rise to any detrimental environmental impacts on the hydrogeological (or hydrological) environment as the material would be chemically inert. However, based on my knowledge of peat soils, there can be other resultant impacts from peat deposition as a result of seepage of water into the underlying aquifer when peat is stored in unsuitable conditions. If stored on unprotected ground or bare rock, there is also a possibility of leaching of deleterious material and fines into the groundwater environment. An impact rating of **slight negative** is considered accurate on the basis of the relatively small amount (35,000 cubic metres) of peat soils requiring management in relative terms and the availability of areas suitable for deposition that are available on the PRD site.

Impacts on groundwater features from processing of rock and temporary storage of material on site

1.6.26. I would agree as set out also in the EOP that the impacts that could arise from such processing and temporary storage of material would include potential for sediment that could become mobilised during periods of heavy rainfall. From a hydrogeological perspective, this could in turn lead to environmental effects on groundwater receptors. These groundwater features are identified and described in Table 6.3 of the EOP and include the Turloughs, Karst Springs, groundwater flooding feature at Rincullia, Craggs-Barrigone and Croagh-Farrandonnelly GWS, Domestic Groundwater supplies and Fens and these are considered in my assessment.

Impacts – Concluding comment

1.6.27. I am satisfied that the applicant has sufficiently demonstrated an accurate understanding of the hydrogeological impacts that would arise in the area, and these have been adequately identified.

1.6.28. **Mitigation**

General Mitigation

1.6.29. Avoidance as a mitigation measure was deployed in the first instance during the Route Selection stage and also at the project design stage. Where avoidance was not possible, local modifications were employed to avoid or reduce impacts on the hydrogeological environment. General mitigation measures designed to address

impacts on aquifers and groundwater resources are set out in Section 9.5.1.1 for both the operation and construction phases and the main measures are considered below.

Construction Mitigation

1.6.30. The broad approach to mitigation during construction aligns with adherence to best environmental practices and measures that are set out in the EOP. During the construction phase any compound areas / service yards would be located away from key hydrogeological sensitive areas and features. Where significant groundwater flows are encountered in deep bedrock cut sections, mitigation would involve either piping, construction of gravel-filled pathways or short diversions. While, as set out above, there was no evidence of significant below ground karst features along the road alignment, it is stated that the appointed contractor would be made aware of any areas of potential karst features located at shallow depths, and site traffic in these areas should be kept to a minimum to reduce the potential compression and collapse of subsurface karst features. This follows best practice and is appropriate as part of good construction management.

1.6.31. Where water supply wells and springs are located underneath the footprint of the PRD, these would be sealed to prevent contaminants entering the aquifer and to ensure that there would be no likely significant effects on any private or GWSs supply sources.

Operation

1.6.32. In respect of **aquifers and groundwater supplies**, measures that were considered in the design include re-aligning the road up-gradient of the source protection areas for high yielding water supply springs and wells, minimising the depth of road cutting within a source protection area or ZOC, providing sealed drainage along sections of the road overlying vulnerable parts of locally important or regionally-important aquifers, ensuring waters containing suspended solids are passed through settlement systems and sealing of abandoned wells. It is also stated that groundwater monitoring may be appropriate in certain instances instead of providing mitigation measures.

1.6.33. It is further stated that all groundwater supplies that are currently in use and that lie within the footprint of the PRD would be either replaced by either a new supply or by

connection to an existing public or group water scheme. Subject to agreement with the relevant landowner, all groundwater supplies within 300m of 5m-deep road cutting areas would be monitored for water level and quality prior to construction (quarterly for 12 months), during construction (bi-monthly) and for a specified period thereafter (quarterly for 12 months). I note that these commitments are set out in the Mitigations document (Chapter 19 of the EIAR) that would form part of the schedule of environmental commitments.

Site Specific Mitigation

1.6.34. Site specific mitigation measures (construction and operation) are dealt with under headings of Extreme Vulnerability Areas and Hydrogeological features and are considered below.

Extreme to High Vulnerability Areas

Construction

1.6.35. Prior to the commencement of construction works, clean runoff water from lands adjacent to and up gradient of the works area would be diverted to local watercourses through the installation of cut-off ditches. Soiled construction runoff water would be passed through a settlement pond (either temporary or permanent pond system) prior to discharge. The treated water would be discharged to a surface waterbody and/or depending on the subsoil conditions may also discharge to ground so as to maintain the existing recharge conditions.

Operational

1.6.36. In areas of ‘Extreme’ and ‘High’ vulnerability and at areas near sensitive ecological receptors, a sealed drainage system would be used. The rationale has been set out above and this measure is an inherent part of the drainage design as an avoidance measure. All outfalls would pass through an attenuation pond or similar to protect both surface and groundwater from any adverse quality and/or quantity impacts of the road drainage discharge.

Hydrogeological Features

KERs

1.6.37. Mitigation to protect KER 4 (Rincullia), KER 7 (Fen Wetland at Ballyellinan), KER 11 (Fen Wetland at Lismakeery) and KER 21 (Fen Wetland at Blossomhill) sites include

measures such as drainage neutral design, sealed road drainage, provision of drainage blankets under the road alignment, drainage links under the alignment to maintain spring flow to the fen, and construction of impermeable bunds to impede longitudinal flow along the road alignment and away from the fens.

Mitigation for Craggs-Barrigone GWS

1.6.38. To ensure certainty of continued water supply and quality to the Craggs/Barrigone GWS during the construction phase, a temporary connection has been agreed with Irish Water. It is stated that Irish Water have confirmed that the flow capacity is available to meet the existing demands of the GWS if required. However, in the unlikely event that a temporary reduction in yield occurs, the applicant referred to the mitigation measures outlined in the EIAR, comprising two options (i) connection of the public water supply to the GWS reservoir in advance of the main construction of the PRD or (ii) in the event of a significant impact to quality or yield of the source as a result of the PRD, provide a new suitably located replacement /additional borehole and pump system. The cost associated with the construction of this temporary connection from the GWS reservoir to the existing public water supply would be borne by the LCCC. The connection would be constructed before construction works commence on the PRD and as noted, this would ensure that the GWS would have a guaranteed supply.

1.6.39. In the unlikely event that the Craggs/Barrigone source is permanently impacted through loss of well yield due to the construction works, and a suitable alternative borehole cannot be found, LCCC have further confirmed that a permanent connection of the Public Water Supply to the Limerick City Regional Supply Scheme at Clarina would be facilitated. The cost of this permanent connection, should it be required, would also be borne by LCCC. These assurances are reasonable and were added to the schedule of commitments (OH.52) at the oral hearing. The routings for the proposed temporary and permanent connections are shown in Figures TWM and PWM attached to the Hydrology and Hydrogeology brief of evidence (also submitted as part of the Supplementary Information document to An Bord Pleanála on 15th February 2021). The route has also been assessed by other environment specialists (Human Health, Biodiversity, cultural heritage, noise and vibration, air quality & climate, landscape and visual). I am satisfied that there would be no additional

impact arising from these connections (either temporary or permanent) on the hydrogeological environment.

1.6.40. It is also set out that it is intended to provide a sealed drainage system between ch.4+000 and ch.7+150 to ensure no pollution of the underlying aquifer in this area where bedrock would be exposed by the proposed cutting.

1.6.41. Overall, I am satisfied that all potential impacts to this GWS have been identified adequately addressed through the proposed mitigation and that provision has been made for the unlikely and worst-case scenario that the Craggs/Barrigone source is permanently impacted through loss of well yield.

Mitigation for Croagh-Farrandonnelly GWS

1.6.42. The proposed mitigation measures feature prior, during and post construction monitoring, with provision of a replacement borehole or connection to a public water supply, should a significant impact in quality or yield be observed.

1.6.43. A sealed drainage system would be provided between ch.53+150 and ch.55+800 to ensure no pollution of the underlying aquifer in this area where bedrock will be exposed by the proposed cutting.

1.6.44. In addition to the aforementioned mitigation, the EOP would provide further protection during construction in respect of both GWSs.

Mitigation for private groundwater supplies along the PRD

1.6.45. All groundwater supplies within 300m of road cuts greater than 5m depth will be monitored as stated above, and appropriate measures taken on a case-by-case basis, should any significant impacts be identified. The applicant has set out their commitment to providing an alternative supply via connection to a public or GWS, should this be required.

Slatted and Slurry Tanks

1.6.1. I also note the additions to the schedule of commitments which was submitted during the Oral Hearing on 16th February 2021 and this includes a commitment for the provision of pre- and post-condition surveys on slatted tanks/slurry storage adjacent to the PRD for owners of two respective plots (CPO plot no. 324 – Miriam Linehan and CPO plot no. 133 – Patrick O'Connell) (OH 48). Undertaking a pre-construction (baseline) surveys of these tanks when in use can be an onerous task and would

involve emptying of the tanks as outlined by Mr Cawley at the Oral Hearing. Nonetheless, the applicant is satisfied that it is possible to undertake the surveys as confirmed by Mr MacGearailt at the oral hearing.

Borrow Pits/Deposition Areas

1.6.2. Whilst the impacts from deposition areas were not addressed in Chapter 9 (Hydrogeology) I have noted in section 10.4.13 of Chapter 10 (Hydrology) of the EIAR, it is stated that any material deposition sites for very soft alluvium or peat materials would be bunded sites with double erosion control fencing (silt fence) and a sediment settlement pond at the outlet. Runoff from any material deposition areas, whether they would be in worked out borrow pits or in other areas within the PRD site, would be contained and treated in temporary settlement ponds upstream of its outfall to the receiving watercourses. These ponds would then be maintained until the material deposition areas have stabilised and become adequately vegetated. In addition, the specific construction sequence for these areas would allow for settlement of sediment prior to discharge to the receiving watercourse. Provided the settlement ponds are rendered low permeability, and the measures outlined in the EOP are adhered to, there will be no remaining impacts groundwater.

1.6.3. In the RFI response, it is stated that in respect to Borrow Pits/Deposition areas ground levels would be reinstated following deposition of backfill. However, this is unlikely, since the borrow pits may be used to gain up to 500,000 cubic metres of material and the amount of material that would be stored would be approximately 35,000 cubic metre of peat soils and other small amounts of very soft alluvium soils. This surplus is likely to be a very small amount of material and can be readily managed by placement along the sides of rock cuttings or in borrow pits if these are available. The peat and other unsuitable material would be placed above the groundwater table. Reference is made in the RFI to the placement of cohesive fill material and a geosynthetic separator, as deemed necessary (at the formation level of the deposition) to prevent migration of fines into the underground sources. The material would be deposited and shaped to enhance runoff from peat through creating a cambered surface. In a short timeframe, the peat would become drier and stable. I am satisfied that the proposal for deposition of peat into borrow pits or other suitable areas on site would not represent a risk to the hydrogeological environment noting in particular that it would be completely contained in the deposition area(s).

Processing / Temporary Storage of Material on site for reuse

1.6.4. The mitigation for processing/crushing and temporary storage of materials on site would follow the erosion and sediment control measures for the earthworks. These are set out in Table 6.6.1 (General) of the EOP. Other avoidance measures are set out in 6.6.2 and principal control measures are set out in Section 6.6.3.

Site Environmental Manager

1.6.5. A Site Environmental Manager would be appointed for the duration of the works and to inspect and monitor the measures for effectiveness on behalf of the employer. The results of the inspection/monitoring regime will be stored in the SEM's Monitoring file and will be made available for inspection / audit by the Client, NPWS or IFI staff.

Concluding Comment on Mitigation

1.6.6. I am satisfied that appropriate mitigation measures have been applied to mitigate potential impacts associated with the construction and operation of the road, and that there are adequate safeguards to ensure the protection of the hydrogeological environment during the construction and operational phases of the project.

1.7. **Residual Impacts**

1.7.1. Residual impacts are set out in Table 9.20 of the EIAR in which it is asserted that with mitigation, most impacts would be **imperceptible negative** in terms of their rating of significance. Residual impacts on the Craggs/Barrigone GWS and Croagh-Farrandonnelly GWS would have a rating of **slight** negative in terms of significance. I have also noted additional impacts and mitigation proposed that arose during the application process and at the oral hearing.

1.7.2. Having reviewed all of the information on file and assessed the mitigation measures proposed, including mitigation by avoidance and design, as well as other measures set out in Chapter 9 (Hydrogeology) in the EIAR, Chapter 19 (Mitigation Measures), the additions to the schedule of commitments presented during the oral hearing on 16th February 2021, and based on my own engineering knowledge and experience, I am satisfied with the accuracy of residual impact ratings outlined.

Interactions and Cumulative effects

1.7.3. In the assessment of interactions between the individual environmental disciplines I am satisfied that once relevant mitigation measures are implemented, no residual

likely significant effects would exist as a result of the construction or operation of the PRD.

1.7.4. In the assessment of cumulative impacts, I agree with the conclusion that there is no potential for significant cumulative impacts arising in combination with any other plans or projects and therefore no potential for significant in-combination effects on hydrogeology.

Other Matters/Submissions raised

1.7.5. **Mr Ian Gilvarry (Env-13 and FI-4)** raised an issue on the applicant's response to the RFI on Item 6 in respect to the extent of dewatering and the supporting field surveys at sensitive locations. At the oral hearing, Mr Cawley stated that in the response to the RFI details of the dewatering assessment identifies the locations associated with road cut excavations that may result in drawdown and dewatering of the surrounding groundwater. Mr Cawley also stated that the drawdown radius of influence was calculated using the Sichardt drawdown formula and that the formula combined with the site investigation borehole and water table monitoring data was used to calculate the zones of drawdown. Table 1 of the Brief of Evidence (Extent of Potential Dewatering by proposed road cut excavations into the limestone bedrock) presents a copy of Table 6.A (anticipated Extent of Dewatering) that was previously presented in the EIAR.

1.7.6. In my experience this formula is conservative is the determination of the area of influence and the corresponding estimate of impact. The calculated values of drawdown radius do not encroach on any known or mapped water sources or hydrogeological features of significance. I am satisfied that dewatering has been adequately considered and would not cause adverse impacts on groundwater.

1.7.7. Mr Gilvarry also asserted that the applicant did not undertake sufficient assessment of how the project would influence the attainment of 'good' status under the WFD. I have dealt with this as a hydrological matter in my parallel assessment report on hydrology in which I concluded that the applicant has shown due regard for the importance of watercourses and their significance under the WFD in the assessment of potential impacts. I am satisfied that the PRD would not prevent or delay any watercourse in attaining good ecological status under the WFD notwithstanding that the main watercourses are currently rated as 'poor' to 'moderate' status. In relation to

hydrogeology, the WFD applies to groundwater bodies which are distinct volumes of groundwater within aquifers. A number of objectives for the protection of groundwater are set out in the Directive. These include the implementation of measures to prevent or limit input of pollutants, protect or enhance and restore all bodies of groundwater status, reverse trend of pollutants and ensure compliance with relevant standards and objectives.

1.7.8. I am also satisfied that the PRD would not prevent or delay any of the GWBs in achieving and maintaining good status having regard to the mitigation measures proposed including in particular the adoption of the EOP and the Construction Erosion and Sediment Control Plan (CESP).

1.7.9. Mr Gilvarry's submission also asserts that the response to the Irish Water submission (item 15 of the RFI) regarding the location of its public supply abstraction point located c.2.3km downstream of River Deel crossing was dismissive in that the applicant merely refers back to the EIAR. As set out in my parallel hydrology report, I have reviewed a response from Irish Water dated 2nd of December 2020 received by the Board in which it is stated that Irish Water is satisfied that the applicant has provided information on mitigation measures to ensure the protection of public drinking sources in the area. It is also stated that Irish Water have no objection in principle and recommend a number of conditions to be attached in the event that the Board approve the development. Having regard to the mitigation measures proposed for the protection of surface water and groundwater during the construction and operation stages outlined above, I am also satisfied that, subject to the conditions generally as recommended by Irish Water, there would be no remaining impact on the water source.

1.7.10. On behalf of **Craggs Barrigone GWS (Sch-121)**, Mr Patrick O'Connell raised concerns regarding the potential loss of water supply and the need for a new borehole. These matters have been addressed above under the headings of impacts and mitigation. The applicant has put forward measures that would ensure that the GWS would have a guaranteed supply of water for both the construction and operation (if required) and the cost would be borne by the applicant.

1.7.11. On his own behalf, **Mr Patrick O'Connell (Sch-84)** also expressed concerns during the Oral Hearing that his current water supply from Craggs Barrigone GWS might be

affected during construction. Mr MacGearailt stated that any existing water supply arrangements will be re-positioned and connected in advance to provide continuity of supply. He also stated that there are arrangements in place to provide temporary supply to Craggs Barrigone, should there be any impact. However, he also referred to Mr Cawley's evidence that there was unlikely to be any impact.

1.7.12. Mr O'Connell also referred to Lough Selleher Turlough which he states is c.180m from his farm and stated that this feature floods in winter. He raised concerns that the construction of the cut at Mulderricksfield may damage the natural underground drainage system from the turlough, which could lead to a backup in the turlough and flooding of his farm. In response, Mr Cawley stated in his brief of evidence that the proposed roadway is almost 400m downgradient of the Turlough at ch.5+500 and would not impact its hydrogeological regime in terms of recharge or drainage and consequently will not result in any flood impact to surrounding lands. I am satisfied that the impacts on Lough Selleher turlough have been adequately assessed and no additional impacts would arise based on the points raised in this submission, which are adequately responded to by the applicant.

1.7.13. **Joan Kennedy (Sch-47)** and **Thomas and Maeve Kelly (Sch-64)** raised concerns about protecting private wells and also the pollution risk to groundwater. These issues have been dealt with in consideration of impacts and mitigation on private wells and groundwater above.

1.7.14. Ms. Kennedy raised a concern that the location of the PRD did not consider the impact on a septic tank and a percolation area. It is stated by the applicant that no such incident of domestic wastewater treatment plants or soakaways are within the setback distances required under the EPA (Code of Practice for Water Treatment systems for single houses' (2009) along the PRD and where it does potentially occur the dwelling house is being acquired as part of the PRD. I note that the Code of Practice has been updated in 2021, however, the setback distance requirements have not been altered in the new Code in respect of onsite wastewater treatment systems (which include percolation areas). Specifically, I note that the minimum separation distance required between a road and a septic tank/plant and infiltration/ treatment area of 4m is required and would not be exceeded with the proposal for the road infrastructure. I am satisfied that in respect to impact on performance, as the setback distances would still be achieved, there would not be any impact on

performances of domestic wastewater systems, including septic tanks and percolation areas or any other proprietary systems.

1.7.15. In his submission, **Mr Conor Enright (FI-2)** raised concerns about the effects of blasting on the integrity of septic and slurry tanks, and which might possibly cause damage resulting in water pollution. At the oral hearing, following my questioning on this matter, Mr MacGearailt on behalf of the applicant committed to the carrying out of pre- and post-condition surveys for the slatted tanks / slurry storage adjacent to the proposed road development including Patrick O'Connell (Sch-133) and other farms including the O'Shaughnessy farm owned by Denis O'Shaughnessy (CPO no.215) adjacent to the Mulderricksfield cut and also for Miriam Linehan (CPO no.324) adjacent to the Ballycannon cut, who the applicant noted has a slatted tank within 300m of the PRD. I note that these have been added to the schedule of commitments, and although the O'Shaughnessy farm is not mentioned in this OH.48, it should also be included since it was committed to at the oral hearing and is reasonable.

1.7.16. The presence of springs was referred to by **Paul and Eileen Madden (Sch-30, 88 and 89)** who stated that the area around the high lough (Doohyle Lough) comprises a network of springs and waterlogged ground in both Dohyle Lough and Kyletaun. In that sense, the Maddens express concerns about constructability of the Motorway section (Section D) due to the instability of soils and the potential risk of peat slide, and they also refer to the potential for flooding of the farmyard and local wells because groundwater and springs are all interconnected.

1.7.17. In response, Mr MacGearailt stated that these areas are familiar to the design team and that there would be no interaction between the road and these springs. He stated that the soft material was relatively small (in comparison to other road schemes) in a hollow and therefore did not present any slope stability issues. As part of the road design and maintenance proposal, neutral changes to drainage are applied and as such I am satisfied as asserted by the applicant that the road would not exacerbate flooding by blocking water escape routes from Doohyle.

1.7.18. On the final day of the oral hearing, **Mr O'Donnell on behalf of Bryan and Iseult Murphy (Sch-9)** expressed concern that dewatering at Ballycannon could dry out and impact the geomorphology of a private well on Mr Murphy's land, similar to

occurrences at Arcon mine in Galmoy, Co. Kilkenny. Mr O'Donnell also stated that the dewatering could impact on Clonshire castle which he stated is in a fragile state and could be undermined because of the land being dewatered around it.

1.7.19. I am satisfied that the scale of dewatering in both duration and volume would not be comparable to that of the referenced mine. Furthermore, the required drawdown to facilitate construction is well understood and as set out by Mr Cawley at the oral hearing, the zone of influence would be outside of the Murphy lands and would not dry out a well. Having regard to all of the information provided and by applying my knowledge in this field, I am satisfied that the Murphy property, including the private well source at Clonshire, lies outside of the zone of influence of dewatering and no negative impact would occur on the private well and similarly no impacts would arise on the lands around the castle as a result of localised dewatering at Ballycannon.

1.8. Conclusions on Hydrogeology

1.8.1. Having assessed the information provided by the applicant, as set out above, and having considered all of the submissions and objections received in written format and at the oral hearing, I am satisfied that the applicant has adequately investigated the existing environment, understands the hydrological regime sufficiently and no *lacunae* exist and has proposed mitigation measures are both suitable and appropriate in the context of the proposed development. To a large extent, the PRD has been designed so that potential significant effects on the hydrological environment have been eliminated through engineering design avoidance. Beyond that, following adoption of good construction practice and the mitigation measures, as proposed, with the principal measure being adherence to the EOP and water quality protection measures set out in the CESP during construction, it has demonstrated there would be no residual significant negative direct, indirect or cumulative impacts on the hydrological environment.

1.8.2. I am equally satisfied that with the adoption of mitigation set out, there would be no risk that the groundwater bodies would either fail to comply with its WFD environmental objectives, or that there would be any compromise to the delivery of the programme of measures set out in the RBMP for Ireland 2018-2021, as a result of the proposed road development, alone or cumulatively with other projects.

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14th February 2022