Tionscadal Soláthair Uisce
Water Supply Project

Environmental Impact Assessment Report (EIAR)

Volume 3 of 6: Environmental Assessment

(Chapter 10) Soils, Geology and Hydrogeology

Document no: 32105801/EIARC10
Version: Final

December 2025

Uisce Éireann
Irish Water

Jacobs

TOBIN

Contents

Acronyms and Abbreviations

Acronym	Meaning
AlluvMIN	Alluvial undifferentiated
AminDW	Deep well-drained mineral soil, derived from mainly non-calcareous parent materials. Acid brown earths and Brown Podzolics will be included in this category
AminPD	Deep poorly-drained mineral soil, derived from mainly non-calcareous parent materials. Surface water gleys and groundwater gleys may be included in this category
AminSP	Shallow poorly-drained mineral soil, derived from mainly non-calcareous parent materials. Surface water and groundwater gleys may be included in this category
AminSPPT	Peaty, shallow poorly drained mineral soil derived from mainly acidic parent materials
AminSRPT	Shallow, reasonably drained mineral soil derived from mainly acidic parent materials
AminSW	Shallow well-drained mineral soil, derived from mainly non-calcareous parent materials. Lithosols and regosols are included in this category
APM	Aggregate Potential Mapping
BH	Borehole
BminDW	Deep well-drained mineral soil, derived mainly from calcareous parent materials.
BminPD	Deep poorly-drained mineral soil derived from mainly calcareous parent materials. Surface water gleys and groundwater gleys may be included in this category
BminPDPT	Poorly-drained mineral soils with peaty topsoil, derived from mainly calcareous parent materials. Peaty gleys are included in this category
BminSP	Shallow poorly-drained mineral soil, derived from mainly calcareous parent materials. Surface water gleys and groundwater gleys may be included in this category
BminSW	Shallow well drained mineral (Mainly basic)
BPS	Booster Pumping Station
BPT	Break Pressure Tank
BS	British Standards
CC	Construction Compound
CEMP	Construction Environmental Management Plan
CGS	County Geological Site
CIRIA	Construction Industry Research and Information Association
CWBMP	Construction Waste and By-Product Management Plan
DELG	Department of Environment and Local Government
DOC	Dissolved Organic Carbon
DORS	Devonian Old Red Sandstone
EIAR	Environmental Impact Assessment Report
EPA	Environmental Protection Agency
ESB	Electricity Supply Board
FCV	Flow Control Valve
GDA WRZ	Greater Dublin Area Water Resource Zone
GI	Ground Investigation
GSI	Geological Survey Ireland
GWB	Groundwater Body
GWDTE	Groundwater Dependent Terrestrial Ecosystem
GWS	Group Water Scheme

Acronym	Meaning
IFI	Inland Fisheries Ireland
IGH	Irish Geological Heritage
IGI	Institute of Geologists of Ireland
IMP	Intermediate Poleset
IPC	Integrated Pollution Control (EPA Licence)
LCRM	Land Contamination Risk Management
LiDAR	Light Detection and Ranging
LLO	Land Liaison Officer
LV	Low Voltage
mAOD	Metres Above Ordnance Datum
m bgl	metres below ground level
Ml	Million litres
Mld	Million litres per day
MPV	Maximum Parametric Values
MSDS	Material Safety Data Sheet
NHA	Natural Heritage Area
NRA	National Roads Authority
OHL	Overhead Line
OPW	Office of Public Works
OSI	Ordnance Survey Ireland
PAH	Polycyclic Aromatic Hydrocarbon
PCAS	Peatlands Climate Action Scheme
pNHA	Potential Natural Heritage Area
PSD	Pipe Storage Depot
PWS	Public Water Scheme
RWI&PS	Raw Water Intake and Pumping Station
RWRM	Raw Water Rising Main
SAC	Special Area of Conservation
SCADA	Supervisory Control and Data Acquisition
SMP	Soil Management Plan
SPA	Special Protection Area
SPZ	Source Protection Zone
SuDS	Sustainable Drainage Systems
SWMP	Surface Water Management Plan
TLPDSs	Till derived from Lower Palaeozoic and Devonian sandstones
TLPSsS	Till derived from Lower Palaeozoic shales/sandstone
TLs	Till derived from Carboniferous limestone
TMF	Tailings Management Facility
TPR	Termination Point Reservoir
WFD	Water Framework Directive

Acronym	Meaning
WTP	Water Treatment Plant
WwTP	Wastewater Treatment Plant
µS/cm	Microsiemens per centimetre
ZoC	Zones of Contribution

Glossary

Glossary	Meaning
Alluvial Deposit	Unconsolidated clay, silt, sand and gravel, deposited by a body of running water.
Aquifer	A permeable geological stratum or formation that can both store and transmit water in significant quantities.
Construction Working Width	The land temporarily fenced for the period of construction of the pipeline and its subsequent reinstatement to a pre-construction condition. It is normally 50m in width but may be locally widened near features such as crossings, or storage areas.
Category A Dam	Dams are categorised based on the consequences of a breach. A 'Category A' dam is one in which a breach 'could endanger lives in a community'.
Down-gradient	The direction in which groundwater or surface water flows (also referred to as down-slope). Opposite of up-gradient.
Environmental Impact Assessment	A systematic means of assessing the likely significant effects of a proposed project, undertaken in accordance with the EIA Directive and the relevant Irish legislation.
Environmental Protection Agency	National agency responsible for protecting and improving the environment of Ireland under the Environmental Protection Agency Acts 1992 to 2011.
ESB Networks (ESBN)	Owner of the electricity distribution system in Ireland, responsible for conducting maintenance, repairs and construction on the grid.
Fissure	Natural crack in rock.
Future Potential Connections	Future Potential Connections are advance provisions made at selected locations between the WTP and TPR by incorporating inline 'tee' fittings in the Treated Water Pipeline, with a valve on the take-off branch, so that a future connection could be made without disrupting the pipeline flow.
Groundwater	That part of the subsurface water that is in the saturated zone, i.e. below the water table.
Groundwater protection response	Control measures, conditions or precautions recommended as a response to the acceptability of an activity within a groundwater protection zone.
Groundwater Protection Zones	Zones delineated by integrating aquifer categories, Source Protection Areas and associated vulnerability ratings. The zones are shown on a map, each zone being identified by a code, e.g. SO/H (outer source area with a high vulnerability) or Rk/E (regionally important aquifer with an extreme vulnerability). Groundwater protection responses are assigned to these zones for different potentially polluting activities.
Groundwater Vulnerability	A term used to represent the intrinsic geological and hydrogeological characteristics that determine the ease with which groundwater may be contaminated by human activities.
Group Water Scheme	Group Water Schemes are community-run organisations which provide potable drinking water to their local members.
Horizontal directional drilling	A practice of drilling that uses steerable drilling rigs allowing horizontal alignment of straight or curved pipes and ducts without the need for open trenches.
Humification	The breakdown of plant material in the presence of oxygen. Microbes and fungi breakdown of lignin or organic substances and converted to humic substances.
Limestone	A sedimentary rock consisting chiefly of calcium carbonate ($CaCO_3$), primarily in the form of the mineral calcite. It is mostly formed by the accumulation of calcareous shells, cemented by calcium carbonate precipitated from solution.
Natura 2000 site	Natura 2000 is a European network of important ecological sites. The network is made up of Special Protection Areas (SPAs), and Special Areas of Conservation (SACs).
Over consolidated	Soils with lower overburden pressure than previously. This is typically a result of past ice ages or human activity.

Glossary	Meaning
Peatlands Climate Action Scheme	The Peatlands Climate Action Scheme (PCAS) provides for the restoration and rehabilitation of approximately 33,000 hectares of Bord na Móna peatlands that were previously harvested
Permeability	The term permeability, used in a general sense, refers to the capacity of a rock to transmit water. Such water may move through the rock matrix (intergranular permeability) or through joints, faults or other partings (fracture or secondary permeability).
Permanent Wayleave	Land within the construction wayleave, where Uisce Éireann retains rights of access for maintenance of the pipeline, and where certain restrictions apply to development and tree planting. It is typically 20m in width and normally positioned centred on the pipeline.
Public Water Schemes	Public Water Schemes are administered and maintained by Uisce Éireann; however local authorities provide certain services on behalf of Uisce Éireann through service level agreements.
National Parks and Wildlife Service	The National Parks and Wildlife Service is a division of the Department of Housing, Local Government and Heritage which manages the Irish State's nature conservation responsibilities. As well as managing the national parks, the activities of the National Parks and Wildlife Service include the protection of Natural Heritage Areas, Special Areas of Conservation and Special Protection Areas.
Saturated Zone	The uppermost level of saturation in an aquifer at which the pressure is atmospheric.
Sheet piles	Sections of sheet materials with interlocking edges that are driven into the ground to provide earth retention and excavation support. Sheet piling is used in construction to provide both temporary and permanent walls.
Shelly marl	A calcareous deposit formed in fresh water lakes by Charophyceae (Stoneworts) permeated by variable quantities of shells of fresh water molluscs.
Subsoil	The material between the topsoil and the bedrock.
Source Protection Zones	Zones delineated by integrating aquifer categories or source protection areas and associated vulnerability ratings. Groundwater protection responses are assigned to these zones for different potentially polluting activities.
Source Protection Area	The SPA is the catchment area around a groundwater source which contributes water to that source, divided into two areas: the Inner Protection Area and the Outer Protection Area.
Till	Unsorted glacial deposits consisting of boulders and cobbles mixed with very finely ground-up rock such as sand, silt or clay.
Trenchless technology	Trenchless technology is a group of methods and techniques used to install underground with minimal excavation or disruption to the surface.
Unsaturated zone	The zone between the land surface and the water table, in which pores and fissures are only partially filled with water. Also known as the vadose zone.
Washout Valve	A Washout Valve is typically located at a low point and is designed to allow residual water to be drained from the pipeline, during commissioning and during infrequent drain down of a section of the pipeline for maintenance or repair.
Water table	The uppermost level of saturation in an aquifer at which the pressure is atmospheric.
Zone of Influence	The Zone of Influence is the ‘radius of influence’ of a pumping well, i.e. the area where drawdown occurs due to pumping.
Zone of Contribution	The Zone of Contribution is the area that contributes water to the well or spring. It is a simple, intuitive, basic hydrogeological definition that is considered the best term for general use.

10. Soils, Geology & Hydrogeology

10.1 Introduction

1. This chapter reports the assessment of the likely significant effects of the Proposed Project on soils, geology and hydrogeology environments during the Construction and Operational Phases, in accordance with the requirements of the EIA Directive.

2. This chapter sets out the methodology used, describes the existing environment, assesses the predicted effects of the Proposed Project, proposes mitigation measures and assesses residual effects. The assessment has been completed in accordance with current relevant standards and guidance.

3. The assessment reported in this chapter has considered the mitigation that has been embedded into the design to avoid or reduce environmental effects. Embedded mitigation is an intrinsic part of the Proposed Project design and therefore the assessment of effects assumes all embedded design measures are in place. Embedded mitigation relevant to this topic is included in Section 10.5.1.

4. Table 10.1 provides a summary of the principal project infrastructure. A full description is provided in Chapter 4 (Proposed Project Description) of this Environmental Impact Assessment Report (EIAR).

Table 10.1: Summary of Principal Project Infrastructure

Proposed Project Infrastructure	Outline Description of Proposed Project Infrastructure*
Permanent Infrastructure	
Raw Water Intake and Pumping Station (RWI&PS) (Infrastructure Site) County Tipperary	• The RWI&PS would be located on a permanent site of approximately 4ha on the eastern shore of Parteen Basin in the townland of Garrynatineel, County Tipperary. In addition, approximately 1ha of land would be required on a temporary basis during construction. • The RWI&PS has been designed to abstract enough raw water from the River Shannon at Parteen Basin to provide up to 300Mld of treated water by 2050. • The RWI&PS site would include a bankside Inlet Chamber, the Raw Water Pumping Station Building, two Microfiltration Buildings, an Electricity Substation and Power Distribution Building, and Dewatering Settlement Basins. The tallest building on the RWI&PS site would be the Microfiltration Buildings which would be 10.9m above finished ground level. Additionally, there would be a telemetry mast, the top of which would be 14m above finished ground level. • Power for the RWI&PS would be supplied via an underground connection to the existing Birdhill 38 kV electricity substation. • A new permanent access road from the R494 would be constructed to access the proposed RWI&PS site. This access road would be 5m in width and 670m in length. • The RWI&PS site boundary would be fenced with a stock proof fence and a 2.4m high paladin security fence 5m inside the boundary. The site would be landscaped in line with the surrounding environment to reduce its visual impact.
Raw Water Rising Mains (RWRMs) (Pipeline) County Tipperary	• The RWRMs would consist of two 1,500mm underground pipelines made from steel that would carry the raw water approximately 2km from the RWI&PS to the Water Treatment Plant (WTP) at Incha Beg, County Tipperary. The water would be pumped from the pumping station at the RWI&PS to the WTP. • Twin RWRMs have been proposed so that one RWRM can be taken out of service for cleaning and maintenance while still providing an uninterrupted flow of raw water through the other RWRM. • The RWRMs would include Line Valves, a Lay-By, Air Valves and Cathodic Protection. • A 20m wide Permanent Wayleave would provide Uisce Éireann with operational access to the RWRMs.

Proposed Project Infrastructure	Outline Description of Proposed Project Infrastructure*
Water Treatment Plant (WTP) (Infrastructure Site) County Tipperary	• The WTP would be located on a permanent site of approximately 31ha at Incha Beg, County Tipperary, 2.6km north-east of the village of Birdhill, and 2km east of the proposed RWI&PS. In addition, approximately 2.5ha of land would be required on a temporary basis during construction. • The WTP would treat the raw water received from the RWI&PS via the RWRMs. Once treated, the High Lift Pumping Station (HLPS) would deliver the treated water onwards from the WTP to the Break Pressure Tank (BPT) at Knockanacree, County Tipperary, via the Treated Water Pipeline. • The WTP would comprise of a series of tanks and buildings including the Raw Water Balancing Tanks, Water Treatment Module Buildings, Sludge Dewatering Buildings, Sludge Storage Buildings, Clear Water Storage Tanks and HLPS, an Electricity Substation and Power Distribution Building, and the Control Building. The tallest building on the WTP site would be the Water Treatment Module Buildings which would be up to 15.6m above finished ground level. Additionally, there would be a telemetry mast, the top of which would be 14m above finished ground level. • There would also be a potential future water supply connection point at the junction between the permanent access road and the R445. • Power for the WTP would be supplied via an underground connection to the existing Birdhill 38 kV electricity substation. Solar panels would be placed on the roofs of the Chemical Dosing Manifold Building, the Water Treatment Module Buildings, Clear Water Storage Tanks and Sludge Storage Buildings, and at a number of locations on the ground to supplement the mains power supply. • A new permanent access road from the R445 would be constructed and would be 6m in width and 640m in length. • The WTP site boundary would be fenced with a stock proof fence and a 2.4m high palisade security fence 5m inside the boundary. The site would be landscaped in line with the surrounding environment to reduce its visual impact.
Treated Water Pipeline from the WTP to the BPT (Pipeline) County Tipperary	• The Treated Water Pipeline from the WTP to the BPT would consist of a single 1,600mm underground steel pipeline which would be approximately 37km long. The water would be pumped through this section of the Treated Water Pipeline by the HLPS. • The Treated Water Pipeline would include Line Valves, Washout Valves, Air Valves, Manways, Cathodic Protection and Lay-Bys. • A 20m wide Permanent Wayleave would provide Uisce Éireann with operational access to the pipeline (this Wayleave has been extended to approximately 30m at some Line Valves to provide access between the Lay-Bys and Line Valves). There would be an additional 10m wide Permanent Wayleave at certain locations for operational access to smaller pipes connecting Washout Valves with permanent discharge locations.
Break Pressure Tank (BPT) (Infrastructure Site) County Tipperary	• The BPT would be located on a permanent site of approximately 7ha in the townland of Knockanacree, County Tipperary. In addition, approximately 0.8ha of land would be required on a temporary basis during construction. • The BPT would be located at the highest point of the pipeline. It marks the end of the Treated Water Pipeline from the WTP to the BPT and the start of the Treated Water Pipeline from the BPT to the Termination Point Reservoir (TPR) in the townland of Loughtown Upper, at Peamount, County Dublin. It would act as a balancing tank and would be required to manage the water pressures in the entire Treated Water Pipeline during flow changes, particularly during start-up and shut-down. • The BPT site would include the BPT and a Control Building. The BPT would be a concrete tank divided into three cells covered with an earth embankment. The BPT tanks would be 5m in height and partially buried below finished ground levels. The Control Building would be 7.5m over finished ground level. Additionally, there would be a telemetry mast, the top of which would be 14m above finished ground level. • Access to the BPT site would be via a new permanent access road from the L1064 which would be 5m wide and 794m in length. • Power for the BPT would be supplied via an underground connection from the existing overhead power line. Solar panels would be placed on the south facing side of the control building roof, on the BPT and at ground level to the south of the site to supplement the mains power supply. • The BPT site boundary would be bounded by the existing hedgerow / tree line with a 2.4m high palisade security fence around the permanent infrastructure. The site would be landscaped in line with the surrounding environment to reduce its visual impact.

Proposed Project Infrastructure	Outline Description of Proposed Project Infrastructure*
Treated Water Pipeline from the BPT to the TPR (Pipeline) Counties Tipperary, Offaly, Kildare and Dublin (within the administrative area of South Dublin County Council)	• The Treated Water Pipeline from the BPT to the TPR would consist of a single 1,600mm underground steel pipeline, approximately 133km long. • The water would normally travel through the Treated Water Pipeline by gravity; however, flows greater than approximately 165Mld would require additional pumping from the Booster Pumping Station (BPS) in the townland of Coagh Upper, County Offaly. • The Treated Water Pipeline would include Line Valves, Washout Valves, Air Valves, Manways, Cathodic Protection, Lay-Bys and potential future connection points. • A 20m wide Permanent Wayleave would provide Uisce Éireann with operational access to the pipeline (this Wayleave has been extended to approximately 30m at some Line Valves to provide access between the Lay-Bys and Line Valves). There would be an additional 10m wide Permanent Wayleave at certain locations for operational access to smaller pipes connecting Washout Valves with permanent discharge locations.
Booster Pumping Station (BPS) (Infrastructure Site) County Offaly	• The BPS would be located on a permanent site of approximately 2.6ha in the townland of Coagh Upper, County Offaly. It would be located approximately 30km downstream from the BPT. In addition, approximately 3ha of land would be required on a temporary basis during construction. • The BPS would be required when the demand for water causes the flow through the pipeline to exceed approximately 165Mld. • The BPS site would consist of a single-storey Control Building with a basement below. It would have a finished height of 7.6m above finished ground level. There would also be a separate Electricity Substation and Power Distribution Building. Additionally, there would be a telemetry mast, the top of which would be 14m above finished ground level. • Power to the BPS would be supplied from an existing 38 kV electricity substation at Birr, through cable ducting laid within the public road network. There would be ground mounted solar panels on the southern side of the BPS site to supplement the mains power supply. • The site would be accessed directly from the L3003. • The BPS site boundary would be fenced with a stock proof fence and a 2.4m high palisade security fence between 5m -12m inside the boundary. The site itself would be landscaped in line with the surrounding environment to reduce its visual impact.
Flow Control Valve (FCV) (Infrastructure Site) County Kildare	• The FCV controls the flows in the Treated Water Pipeline from the BPT to the TPR. It would be a small permanent site of approximately 0.5ha in the townland of Commons Upper in County Kildare. In addition, approximately 0.6ha of land would be required on a temporary basis during construction. • It would consist of three 700mm diameter FCVs and three flow meters installed in parallel with the Line Valve and housed within an underground chamber. • Access to the FCV site would be directly off the L1016 Commons Road Upper. • Power supply to the FCV site would be provided from the existing low voltage network via a combination of overhead lines and buried cables. There would be ground mounted solar panels on the north-eastern side of the site to supplement the mains power supply. • Kiosks at the FCV site would house the Programmable Logic Controller, telemetry and power supply for the Line Valve. There would also be a telemetry mast, the top of which would be 14m above finished ground level. • The site boundary would be fenced with a stock proof fence and a 2.4m high palisade security fence 5m inside the boundary.

Proposed Project Infrastructure	Outline Description of Proposed Project Infrastructure*
Termination Point Reservoir (TPR) (Infrastructure Site) County Dublin (within the administrative area of South Dublin County Council)	• The TPR would be located on a permanent site of approximately 8.3ha adjacent to an existing treated water reservoir in the townland of Loughtown Upper, at Peamount, County Dublin (within the administrative area of South Dublin County Council) and would have capacity for 75Ml of treated water supply. In addition, approximately 1.1ha of land would be required on a temporary basis during construction. • It would be located at the downstream end of the Treated Water Pipeline from the BPT to the TPR and would be the termination point for the Proposed Project. It would be at this location that the Proposed Project would connect to the existing water supply network of the Greater Dublin Area Water Resource Zone (GDA WRZ). • The TPR would consist of an above-ground storage structure, associated underground Scour Water and Overflow Water tanks and a Chlorine Dosing Control Building. The TPR would be a concrete tank divided into three cells and covered with an earth embankment. The top of the TPR would be 11.2m above finished ground level. The Chlorine Dosing Control Building would be 8.4m over finished ground level. Additionally, there would be a telemetry mast, the top of which would be 14m above finished ground level. • Power for the TPR would be supplied via an underground connection to the existing electricity substation at Peamount Reservoir. There would be solar panels on top of a portion of the northern cell of the TPR to supplement the mains power supply. • A new permanent access road from the R120 would be constructed and would be 5m wide and 342m in length. • The TPR site would be bounded by the existing hedgerow to the west and existing fence to the east with a 2.4m high palisade security fence around the permanent infrastructure. The site itself would be landscaped in line with the surrounding environment to reduce its visual impact.
Proposed 38 kV Uprate Works – Power Supply to RWI&PS and WTP	
Proposed 38 kV Uprate Works Ardnacrusha – Birdhill (Power Supply) Counties Clare, Limerick and Tipperary	• The proposed 38 kV Uprate Works would be necessary to deliver adequate electrical power to the RWI&PS and WTP. • The proposed works would include the uprating of the existing Ardnacrusha – Birdhill Line and the replacement of polesets/structures with an underground cable along a section of the Ardnacrusha – Birdhill – Nenagh Line. • There would also be works at the existing Birdhill 38 kV electricity substation including the provision of a new 38 kV modular Gas Insulated Switchgear Modular Building, new electrical equipment and lighting, together with new fencing and associated works.
Temporary Infrastructure – Required for Construction Phase Only	
Construction Working Width Counties Tipperary, Offaly, Kildare and Dublin (within the administrative area of South Dublin County Council)	• A Construction Working Width would be temporarily required for the construction of the RWRMs and the Treated Water Pipeline, and the subsequent reinstatement of the land. • The Construction Working Width would generally be 50m in width but would be locally wider near features such as crossings, access and egress points from the public road network, Construction Compounds and Pipe Storage Depots.
Construction Compounds Counties Tipperary, Offaly, Kildare and Dublin (within the administrative area of South Dublin County Council)	• Eight Construction Compounds would be temporarily required to facilitate the works to construct the Proposed Project. Five Construction Compounds would be located along the route of the Treated Water Pipeline at the following Infrastructure Sites: RWI&PS, WTP, BPT, BPS and TPR, with an additional three Construction Compounds located at Lisgarriff (County Tipperary), Killananny (County Offaly) and Drummond (County Kildare). Construction Compounds would act as a hub for managing the works including plant/material/worker movement, general storage, administration and logistical support. • The Principal Construction Compound at the WTP would require 30ha of land during construction. • The other three Principal Construction Compounds would require land temporarily during construction ranging between approximately 12ha and 16ha. • The four Satellite Construction Compounds at the other permanent Infrastructure Sites (excluding the FCV) would require land during construction ranging between approximately 3ha and 12ha.
Pipe Storage Depots Counties Tipperary, Offaly and Kildare	• Nine Pipe Storage Depots would be temporarily required to supplement the Construction Compounds and would serve the installation of pipe between the WTP and the TPR. • Pipe Storage Depots would take direct delivery of the pipe for storage before onward journey to the required location along the Construction Working Width. • The Pipe Storage Depots would vary in size and require land temporarily during construction generally ranging between approximately 2ha and 7ha but with one site being larger at 11ha.

* Note all land take numbers in this table are affected by rounding to one decimal place.

5. This chapter should be read in conjunction with the following chapters, and their appendices, which expand upon the Proposed Project:
    - Chapter 4 (Proposed Project Description)
    - Chapter 5 (Construction & Commissioning)
    - Chapter 8 (Biodiversity)
    - Chapter 9 (Water)
    - Chapter 11 (Agriculture)
    - Chapter 19 (Resource & Waste Management).

6. The hydrogeology assessment in this chapter addresses likely significant effects associated with groundwater contained below the ground surface, within the soil and bedrock environment. Chapter 9 (Water) addresses effects associated with surface water, including watercourses, ponds and lakes. The transition between the two chapters is considered in context of groundwater-surface interactions. Dewatering of excavations is the Proposed Project activity that has the greater potential to affect such interactions. This chapter assesses the effects on groundwater due to drawdown of groundwater within excavations, while Chapter 9 (Water) considers potential effects on surface waters due to the temporary discharge of this groundwater into watercourses.

7. This chapter is supported by the following documents:
    - Appendix A10.1 (Ground Investigations 2018)
    - Appendix A10.2 (Raw Water Intake Ground Investigations 2018/2019)
    - Appendix A10.3 (Petrol Station Assessment)
    - Appendix A10.4 (RWI&PS Ground Investigations 2022)
    - Appendix A10.5 (RWRM Ground Investigations)
    - Appendix A10.6 (WTP Ground Investigations)
    - Appendix A10.7 (Lot 1 Treated Water Pipeline TW 0 - TW 36000 WTP to BPT Ground Investigations)
    - Appendix A10.8 (BPT Ground Investigations)
    - Appendix A10.9 (Lot 2 Treated Water Pipeline, TWA 0 - TWC 10000 Ground Investigations)
    - Appendix A10.10 (BPS Ground Investigations)
    - Appendix A10.11 (Lot 3 Peatlands TWC 10000 – TWD 29000 Ground Investigations)
    - Appendix A10.12 (Lot 3 Peatlands TWD 29000 to TPR Ground Investigations)
    - Appendix A10.13 (TPR Ground Investigations)
    - Appendix A10.14 (Supplemental Ground Investigations for Lot 3)
    - Appendix A10.15 (Groundwater Levels: Summary of Private Groundwater Supplies (2021-2025))
    - Appendix A10.16 (Dewatering Calculations).

8. Figures which are referenced in the text are provided in Volume 5 of this EIAR.

9. This chapter reports the likely significant effects on soils, geology and hydrogeology as a result of the Construction and Operational Phases of the Proposed Project. In relation to effects relating to agricultural soils, these are dealt with in Chapter 11 (Agriculture) of the EIAR. An assessment of likely significant effects on surface water as a result of the Proposed Project is provided in Chapter 9 (Water).

10. An assessment of the compliance of the Proposed Project with the objectives of the Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy (the Water Framework Directive (WFD)) is provided in the Water Status Impact Assessment Report that has been submitted with the planning application. The assessment addresses both groundwater bodies (GWBs) and surface water bodies.

11. This assessment has been undertaken and reported by a team of competent experts. Refer to Chapter 2 (The Environmental Impact Assessment Process) for a description of the qualifications and expertise of the specialists that have inputted to this chapter.

10.2 Methodology

12. The information contained in this chapter assesses soils, geology and hydrogeology. This is necessary to identify and assess potential effects relating to each.

13. The likely significant effects on the ground conditions and on the existing soil, geology and groundwater conditions have been considered for the Construction and Operational Phases of the Proposed Project. Mitigation measures that will form part of the Proposed Project are described and the likely significant residual effects after the application of mitigation measures identified.

14. Likely significant effects on the soils, geology and hydrogeology environment have been identified based on the presence of three key factors:

    - A source or a potential impact
    - A receptor which can be adversely affected
    - A pathway or connection which allows the source to cause an effect on the receptor.

15. The assessment of the soils, geological and hydrogeological environment involved the following:

    - Description of the soils, geological and hydrogeological environment from literature and data review
    - Description of the soils, geological and hydrogeological environment from ground investigation data
    - Testing and determination of the composition of various geological strata
    - Assessment of groundwater vulnerability and groundwater abstraction points
    - Assessment of the aquifer potential of the geological material
    - Assessment of geological heritage
    - Assessment of geohazards
    - Assessment of extractive industries and mining
    - Assessment of potential contamination sites
    - Groundwater-surface water interactions.

10.2.1 Scope of Assessment

16. The principal objectives of this chapter are to identify:

    - Soils, geology and hydrogeology factors which would affect the technical viability of the Proposed Project
    - Likely significant effects that the Proposed Project would have on the soil, geological and hydrogeological conditions
    - Constraints that these features would place on the Proposed Project

- Mitigation measures which will be implemented to avoid or prevent adverse effects related to the Proposed Project
- Evaluation of significance of any residual effects.

17. This chapter assesses the likely significant effects of the Proposed Project on soils, hydrogeology and groundwater quality and geological features. The assessment covers the Construction and Operational Phases. Effects from testing and commissioning activities are assessed and presented within the Construction Phase sections of this chapter. Cumulative effects are assessed in Chapter 21 (Cumulative Effects & Interactions).

18. The scope of this soils, geology and hydrogeology assessment includes the following:
    - Soils:
        - Soil compaction and use, loss and damage of soils
        - Risk of encountering and/or introducing contamination.
    - Geological:
        - Risk of sterilising resources such as the development/extension of quarries and mineral deposits
        - Geomorphology and geohazards
        - Risk of encountering and/or introducing contamination
        - Impacts on geological heritage sites.
    - Hydrogeological:
        - Groundwater Flow Effects – i.e. Alteration of groundwater flow, Groundwater-Surface water interactions
        - Groundwater Quality Effects – i.e. Effect on Water supply wells and natural springs
        - Groundwater Dependent Terrestrial Ecosystems (GWDTE) – Effects on GWDTEs such as Special Area of Conservation (SAC)/Natural Heritage Area (NHA) wetland sites.

19. The Proposed Project would deliver nationally important strategic infrastructure with individual elements designed with a lifespan of 80 to 100 years. The strategic importance of the Proposed Project for water supply in the Eastern and Midlands Region is such that there is no plan to decommission these structures and Uisce Éireann is committed to maintaining and repairing them into the future. On this basis it is not likely that the structures will be decommissioned and therefore, decommissioning of the Proposed Project has not been considered further in this assessment.

10.2.2 Study Area

20. The Proposed Project covers an extensive study area that extends from north of Ardnacrusha Substation in County Clare, to the vicinity of Peamount Reservoir in County Dublin (within the administrative area of South Dublin County Council). It includes the Parteen Basin on the River Shannon, directly south of Lough Derg in County Tipperary, and areas through Tipperary and the Midland counties of Offaly and Kildare.

21. In accordance with Irish guidance (e.g. National Roads Authority (NRA) 2009 and Environmental Protection Agency (EPA) 2022), the study area has been defined using relevant guidance and professional judgement to identify potential source–pathway–receptor linkages, and likely significant effects associated with the Construction and Operational Phases of the Proposed Project.

22. The study area was a minimum 500m around the infrastructure sites (RWI&PS, WTP, BPT, BPS, FCV and TPR) and along either side of the length of the RWRMs and Treated Water Pipeline.

23. This study area reflects the potential for short term and long term effects. Dewatering would be required for a number of elements of the Proposed Project including the RWI&PS, RWRMs and Treated Water Pipeline. Temporary dewatering effects vary and may extend to 200m depending on soil/bedrock permeability, depth of the excavation, dewatering method and the water table elevation. Based on professional judgment, the Proposed Project design, the proposed construction depths and permeability data, a conservative study area of 500m was utilised. This study area is considered to be a suitable distance to enable description of baseline conditions and allow assessment of the soils, geology and hydrogeology environment.

24. For the 38 kV Uprate Works, a 50m wide study area was used. This is due to the limited depth and extent of excavations required for these works resulting in a low potential for likely significant effects.

25. The study area also considers the delineated Zones of Contribution (ZoC). A ZoC is the area surrounding a pumped well that encompasses all areas or features that supply groundwater recharge to the well. It is defined as the area required to support an abstraction from long-term groundwater recharge. Source Protection Zones (SPZs) are delineated for groundwater abstractions by integrating aquifer categories or source protection areas and associated vulnerability ratings. Groundwater protection responses are assigned to these zones for different potentially polluting activities. ZoCs and SPZs utilise the source–pathway–receptor framework, where the source refers to the pressures or the sources of contamination; the pathway is dictated by the groundwater travel times to the receptor and the capacity of the geological materials to attenuate contaminants along the way; and the receptor is the spring/borehole abstraction point.

26. There would be no direct impacts on GWDTEs. For indirect impacts on GWDTEs, a zone of influence has been considered where significant source–pathway–receptors occur. This varies with the type of GWDTE based on their characteristics, distance from the Proposed Project and nearest Proposed Project element. Likely significant effects on GWDTEs are reported in Chapter 8 (Biodiversity) and also assessed in Section 10.4.2 of this chapter.

10.2.3 Relevant Guidelines and Legislation

27. This impact assessment of the Proposed Project has been carried out in compliance with the relevant European and national legislation. The methodology adopted for this assessment is in accordance with the following legislation (any references to legislation include any amendments thereto):

    - The EIA Directive
    - The Planning and Development Act 2000 and the Planning and Development Regulations 2001 (as amended)
    - Water Framework Directive (2000/60/EC)
    - European Union (Drinking Water) Regulations 2023, as amended (S.I. No 99/2023)
    - Local Government (Water Pollution) (Amendment) Act 1990, as amended
    - The Local Government (Water Pollution) Act, 1977; and Local Government (Water Pollution) Regulations, 1978, as amended (S.I. No. 108/1978)
    - S.I. No. 722/2003 - European Communities (Water Policy) Regulations 2003
    - S.I. No. 9/2010 - European Communities Environmental Objectives (Groundwater) Regulations 2010, as amended
    - Waste Management Act 1996.

28. This chapter has been prepared by appropriately qualified and experienced specialists using the following guidance which is best practice and appropriate for the Proposed Project:

- Environmental Impact Assessment of Projects: Guidance on the preparation of the Environmental Impact Assessment Report (Directive 2011/92/EU as amended by 2014/52/EU) (European Commission 2017)
- Guidelines on the Information to be Contained in Environmental Impact Assessment Reports (EPA 2022)
- C552 - Contaminated Land Risk Assessment, A Guide to Good Practice (Construction Industry Research and Information Association (CIRIA) 2001)
- Land Contamination Risk Management (LCRM) (UK Environment Agency 2020)
- Guidelines for Planning Authorities and An Bord Pleanála on carrying out Environmental Impact Assessment (Department of Housing, Planning, and Local Government 2018)
- Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements (Institute of Geologists of Ireland (IGI) 2013)
- Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes (NRA 2009).

10.2.4 Data Collection Methods

10.2.4.1 Desk Study

29. A desk-based study has been carried out to collate the available information on the soil, geology and hydrogeology of the study area. A summary of the published geological references and data used in this chapter is included in the references listed at the end of this chapter.

30. The results of the desktop study were used to identify geological and hydrogeological features within the study area and to inform the field surveys. Relevant environmental data gathered during the desktop review were collated and used to assist with the assessment and evaluation. No impact assessments were made, or conclusions drawn, based upon the results of the desktop studies alone, with the exception of areas for which land access was not permitted – see Section 10.2.9.

31. An assessment was undertaken of geological features, potentially contaminated land sites and karst within the Proposed Project study area. The assessment was based on an evaluation of historical Ordnance Survey Ireland (OSI) mapping; LiDAR (Light Detection and Ranging); GSI datasets, OSI aerial photography and flyovers undertaken for the Proposed Project.

10.2.4.2 Field Surveys and Ground Investigations

32. Following the initial desktop assessment, field surveys were completed to gain a more robust understanding of the geological/hydrogeological environment within the study area. Site-specific details were recorded, which included logging of subsoil types in accordance with Code of Practice for Site Investigations (BS 5930:2015+A1:2020) (British Standards (BS) Institution 2015), mapping of vegetation indicators of wet/dry soils, mapping of potential karst features, identification of springs and wells, drainage details and notes on the general trafficability of soils.

33. Field surveys of the study area were conducted from February 2016 to June 2025. Field surveys were conducted along the proposed 50m wide Construction Working Width, from the RWI&PS to the TPR, as well as at the RWI&PS, WTP, BPT and TPR locations.

34. Ground investigations (GI) were undertaken in two main phases spanning the period May 2017 to January 2024 as summarised in Table 10.2. Phase 1 of the GI was undertaken by Integrated Global Solutions Limited between May 2017 and December 2017 for previous iterations of the project. The information collected remains valid and relevant for the purposes of assessing the likely significant effects of the Proposed Project. One hundred and thirty cable percussion (Shell & Auger) boreholes were completed

using Dando 2000 Cable Percussive Boring Rigs. Sixty-one rotary core boreholes were carried out to establish overburden conditions and rockhead and to establish the nature and integrity of the underlying rock. Four trial pits were excavated in 2017 for previous iterations of the project using a 13T wide-padded tracked excavator or JCB excavator. The information collected remains valid and relevant for the purposes of assessing the likely significant effects of the Proposed Project. This site investigation was carried out to provide detailed factual geotechnical information of the underlying ground conditions within the study area of the Proposed Project, and in order to assess potential impacts from construction methodologies for the preparation of an EIAR. Depth of peat data were available from the GI, field surveys and data from Bord na Móna. Results are included in Appendix A10.1 (2018 Ground Investigations). The GI data were supplemented by site walkovers and roadside surveys, Geological Survey Ireland (GSI) data, orthophotography and professional judgement. Where ground investigations were undertaken, subsoil deposits and selected exposures/sections were logged according to BS 5930:2015 +A1:2020.

35. The 2018 borehole locations were focused on the RWI&PS, WTP, BPT, BPS infrastructure sites and river, rail and road crossings, as well as areas identified as shallow rock on the GSI datasets. The main river crossings were identified for site investigation including the Nenagh, Ballyfinboy, Little Brosna, Silver, Figile, Daingean, Clodiagh and Liffey river crossings. Boreholes were drilled either side of the two M7 road crossings (BH004 and BH005 at Chainage TW – 5520; BH006 and BH007 at Chainage TW – 13100) and the two Grand Canal crossing points (BH032 and BH033 at Chainage TWD – 15050; BH038 and BH039 at Chainage TWE – 14150) – see Appendix A10.1.

36. Phase 2 Ground Investigation works were undertaken between November 2021 and January 2024 as part of the Proposed Project with the majority of GI undertaken in 2022. Ground investigation works were undertaken by Priority Geotechnical Limited, Causeway Geotech Limited, Irish Drilling Limited, and Integrated Global Solutions Limited under the supervision of Mott MacDonald, acting as employer's representative on behalf of Uisce Éireann.

37. Phase 2 GI was divided into separate lots as outlined below. Lot 1 comprised the RWI&PS, RWRM, WTP and the Treated Water Pipeline from the WTP to the BPT. Lot 2 comprised the BPT, BPS and the Treated Water Pipeline between the BPT and Chainage TWC – 10200. Lot 3 comprised the Treated Water Pipeline from TWC – 10200, FCV and TPR. A summary of the number of boreholes and trial pits installed for the GI survey is shown in Table 10.2. Borehole logs and trial pitting data are included in Appendix A10.4 to Appendix A10.14 (Ground Investigations).

Table 10.2: Site Investigation for the Proposed Project

Targeted Areas	Number of Boreholes (2018)	Number of Boreholes (2022)	Trial Pits (2022)	Peat Probes (2022)
RWRMs, Treated Water Pipeline	135	-	-	-
Lot 1 – RWRM and Treated Water Pipeline from the WTP to the BPT	-	118	137	46
Pipeline Lot 2	-	199	462	444
Pipeline Lot 3	-	165	245	999
RWI&PS	2	8	-	-
WTP	3	167	95	-
BPT	2	31	41	-
BPS	2	12	24	-
TPR	2	27	36	-
Total	**146**	**727**	**1,040**	**1,489**

Table notes:

[1] Borehole comprised Cable Percussion, Rotary Boreholes, Dynamic probes, Geobore-S.

[2] Four trial pits undertaken in 2018

38. Geophysical surveys, consisting of ground conductivity, 2D-Resistivity and seismic refraction (p-wave) surveying were carried out in 2018 for previous iterations of the project in the Ardcrony/Ballythomas area, County Tipperary and at 22 river crossings along the Treated Water Pipeline (see Appendix A10.1: Ground Investigations 2018). The information collected remains valid and relevant for the purposes of assessing the likely significant effects of the Proposed Project. The main objectives of the geophysical survey were to establish the ground conditions in the Ardcrony/Ballythomas area, the depth to rock and the overburden thickness, to estimate the strength/stiffness/compaction of overburden and the rock quality, to establish the presence of faults and fracture zones and possible karstified rock.

39. A total of 74 geophysical survey lines were undertaken for the Proposed Project in 2022, consisting of ground conductivity, 2D-Resistivity and seismic refraction (p-wave) surveying for the Proposed Project focusing on the RWI&PS, BPT and along the Treated Water Pipeline (see Appendix A10.4 to Appendix A10.14 (2022 and 2023 Ground Investigations)).

40. Groundwater monitoring wells were installed in 14 of the 146 GI wells as part of previous iterations of the project in 2017 and 2018. Twelve months of groundwater level data were collected from nine wells: BH005, BH046, BH049, BH189, BH191, BH192, BH232, BH233 and BH234. Groundwater monitoring data are included in Appendix A10.1. Additional groundwater monitoring surveys were undertaken from June 2020 to August 2021, also for previous iterations of the project. The information collected remains valid and relevant for the purposes of assessing the likely significant effects of the Proposed Project. Site walkovers and ground investigation surveys were also conducted during this period. Results are included in Appendix A10.1. Groundwater monitoring at 122 borehole locations was undertaken for the Proposed Project in 2022–2023 as part of the Phase 2 GI works. Monitoring was undertaken for a period of 12 months at each location. Results are discussed in Section 10.3.10 and included in Appendix A10.4 to Appendix A10.14.

41. Hydrogeological field surveys were conducted within 500m of the infrastructure sites and pipelines and within 30m of the 38 kV Uprate Works. Detailed site walkovers were conducted at sensitive areas, including areas where water supply springs, wells and/or boreholes were located. Once identified, these were then assessed in respect to use, well characteristics, yield and recharge area. Results are included in Appendix A10.15. Field surveys were used to inform the assessments in this chapter and those presented in Chapter 9 (Water).

10.2.5 Consultations

42. Consultations, including the scoping of the EIAR, were undertaken with the following organisations who are of particular relevance to soils, geology and hydrogeology:

- EPA
- GSI
- National Parks and Wildlife Service
- Inland Fisheries Ireland (IFI)
- Irish Peatland Conservation Council
- Bord na Móna
- Group Water Schemes
- Local authorities
- National Federation of Group Water Schemes.

43. Consultation responses from key stakeholders, landowners and the public were reviewed and considered in compiling this chapter. Chapter 2 (The Environmental Impact Assessment Process) of the EIAR sets out the approach the Proposed Project has taken with regard to environmental scoping, including the EIAR Scoping Methodology Report (Uisce Éireann 2023) in respect of the Proposed Project and the Environmental Impact Statement Scoping Report[1] (Irish Water 2016a) relating to a previous iteration of the project.

44. Scoping consultation responses with relevance to soils, geology and hydrogeology are provided in Table 10.3 including details of how they have been addressed within the EIAR. Further detail on the Proposed Project consultation is included in Chapter 2 (The Environmental Impact Assessment Process) and responses received are in the Water Supply Project Eastern and Midlands Region – Consultation Report, which forms part of the Strategic Infrastructure Development planning application for the Proposed Project.

Table 10.3: Scoping Consultation Relevant to Soils, Geology and Hydrogeology

Consultee	Consultee Response	EIAR Response/Reference
GSI	Geoheritage should either be covered under the 'Soils and Geology' or the 'Material Assets' chapter. A number of County Geological Sites (CGS) are crossed by the Proposed Project. Impact on CGS should be minimised where possible. Consultation undertaken in August 2018 and September 2021.	Geological Heritage is addressed in this Soils, Geology & Hydrogeology chapter (Sections 10.3.9, 10.4.2.1.6 and 10.5.2.1.6).
IFI	Grand Canal crossing by directional drilling should be considered.	It is proposed to cross the Grand Canal by trenchless excavation (trenchless construction technique described in Chapter 5: Construction & Commissioning). Directional drilling is a form of trenchless excavation, however the method for this crossing would be either pipe jacking or auger bore.
	Micro tunnelling/directional drilling is recommended for a number of river courses to prevent disruption to aquatic habitats.	Larger FW2 water bodies and/or the FW2 water bodies ranked as being of 'high ecological value' and very likely to support important fish stocks, will be crossed by trenchless excavation. FW2 is a category of water bodies defined as 'Depositing/lowland rivers' in Fossitt's 'A Guide to Habitats in Ireland' (2000). Further detail on the proposed crossings is included in Chapter 5 (Construction & Commissioning).
National Federation of Group Water Schemes	Request to move Treated Water Pipeline from the BPT to the TPR route to the north of Ballinagar Zone of Contribution.	Pipeline moved to the north of the Zone of Contribution.

45. Consultation was also undertaken with Bord na Móna in relation to construction works within the Bord na Móna lands and how this will be considered given the rehabilitation plans and enhanced rehabilitation plans as part of the Peatlands Climate Action Scheme (PCAS). It was agreed that suitable surplus excavated peat materials would be used as part of rehabilitation (both rehabilitation plans and enhanced rehabilitation plans).

46. Prior to commencing the study, each landowner/occupier was initially contacted by an Uisce Éireann Landowner Liaison Officer (LLO) and informed that as part of this assessment, each landholding would be assessed individually. Issues raised by landowners include compaction, drainage impacts, preferential flow along the pipeline and impact on private water supplies. These are addressed in Section 10.5 and in Chapter 11 (Agriculture).

[1] As set out in Chapter 2 (The Environmental Impact Assessment Process), the Environmental Impact Statement Scoping Report (Irish Water 2016a) was based on a previous iteration of the project; however, feedback received from stakeholders informed future scoping and design development and has been considered in this assessment where relevant to the Proposed Project.

10.2.6 Appraisal Method for the Assessment of Impacts

47. A number of guidelines are available for the identification of potential effects on geology, soils and hydrogeology. Terminology for impact sensitivity, magnitude and duration follows that set out in the NRA Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes (2009). Using the NRA guidelines, the assessment examined the likely significant effects of the Proposed Project on the different elements of the soils, geological and hydrogeological environment, as set out in Section 10.2.1.

48. Criteria for evaluating the sensitivity of baseline receptors are shown in Table 10.4. Terminology for effect significance follows that set out in the Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes (NRA 2009), updated to include the criteria set out in EPA (2022) guidelines.

Table 10.4: Sensitivity of Receptors

Sensitivity	Criteria	Attributes
Very high	Important at a national or international scale with no/little potential for replacement or substitution	**Soils and Geology:** • Intact peatland which supports river, wetland ecosystem protected by EU legislation, e.g. SAC or Special Protection Area (SPA) status • Geological feature rare on a regional or national scale (NHA) • Sterilisation of a large mineral reserve – i.e. large existing quarry or pit • Proven economically extractable mineral resource **Hydrogeology:** • Groundwater which supports river, wetland protected by EU designation, e.g. SAC or SPA status • GWDTE associated with SAC
High	Important at a national scale with limited potential for replacement or substitution	**Soils and Geology:** • Contaminated soil on-site with previous heavy industrial usage • Large recent landfill site for mixed wastes • Geological feature of high value on a local scale (CGS) • Sterilisation of a mineral reserve – moderately sized existing quarry or pit • Active peatlands, i.e. active raised bog **Hydrogeology:** • Active raised bog, blanket bog or degraded raised bog still capable of regeneration groundwater dependent • Regionally Important Aquifer with multiple wellfields • Groundwater which supports river, wetland or surface water body ecosystem protected by national legislation – NHA status • Regionally important potable water source supplying more than 2,500 homes • Inner source protection area for regionally important water source
Medium	Important at a local scale with some potential for replacement or substitution	**Soils and Geology:** • Contaminated soil on-site with previous light industrial usage • Small recent landfill site for mixed wastes • Small existing quarry or pit sub-economic extractable mineral resource • Geological feature of moderate value on a local scale (CGS) • Well drained and/or high fertility soils • Degraded raised bog – not capable of regeneration **Hydrogeology:** • Regionally Important Aquifer Groundwater which provides large proportion of baseflow to local rivers • Groundwater which supports river, wetland or surface water body ecosystem – potential NHA (pNHA) status • Locally important potable water source supplying more than 1,000 homes • Outer source protection area for regionally important water source • Inner source protection area for locally important water source • Locally Important Aquifer – potable water source supplying more than 50 homes

Sensitivity	Criteria	Attributes
Low	Important at a local scale with potential for replacement or substitution	**Soils and Geology:** • Small historical and/or recent landfill site for construction and demolition wastes • Cutover peatlands • Turbary areas **Hydrogeology:** • Outer source protection area for locally important water source • Private potable water supplies
Negligible	Poor quality/low sensitivity at a local scale with potential for replacement or substitution	**Soils and Geology:** • Small historical and/or recent site for inert construction and demolition wastes • Poorly drained and/or low fertility soils • Uneconomical extractable mineral resource **Hydrogeology:** • No groundwater wells/abstractions • Wells not used for drinking water • Partial alteration of drainage within improved or drained lands

49. The magnitude of impacts considers the likely scale of the predicted change to the baseline conditions resulting from the predicted impact and considers the duration of the impact, i.e. temporary or permanent. Definitions of the magnitude of impact criteria are provided in Table 10.5 and are based on the NRA Guidelines (2009) and EPA Guidelines (2022).

Table 10.5: Magnitude of Impacts

Magnitude	Criteria	Effects on Attributes
High adverse	An impact, which obliterates sensitive characteristics of the soil, geology and hydrogeology environment	**Soils and Geology:** • Loss of high proportion of future quarry or pit reserves • Loss of active peatlands, i.e. Annex I habitat such as active raised bog • Removal of entirety of geological heritage feature – geological NHA • Requirement to excavate/remediate entire waste site **Hydrogeology:** • Changes to aquifer or unsaturated zone resulting in extensive change to existing water supply springs and wells, river baseflow or ecosystems • Potential high risk of pollution to groundwater from routine runoff • Calculated risk of serious pollution incident >2% annually
Medium adverse	Fundamental change to soil, geology and hydrogeology environment	**Soils and Geology:** • Soils – loss of degraded raised bog (non-annex I) >1ha • Loss of moderate proportion of future quarry or pit reserves • Removal of geological heritage feature – CGS • Requirement to excavate/remediate significant proportion of waste site **Hydrogeology:** • Changes to aquifer or unsaturated zone resulting in moderate change to existing water supply springs and wells, river baseflow or ecosystems • Potential medium risk of pollution to groundwater from routine runoff • Calculated risk of serious pollution incident >1% annually
Low adverse	Measurable change to soil, geology and hydrogeology environment	**Soils and Geology:** • Loss of cutover bog • Loss of small proportion of future quarry or pit reserves • Soils – loss of degraded raised bog (non-annex I) <1ha • Removal of small part of geological heritage feature **Hydrogeology:** • Changes to aquifer or unsaturated zone resulting in slight change to water supply springs and wells, river baseflow or ecosystems • Potential low risk of pollution to groundwater from routine runoff • Calculated risk of serious pollution incident >0.5% annually

Magnitude	Criteria	Effects on Attributes
Negligible	No measurable effects on soil, geology and hydrogeology environment	• No measurable changes in attributes, alteration of field drains
Low beneficial	Minor change to ground conditions, groundwater quality or flow regime	• Proposed Project results in a slight enhancement of geological heritage feature • Proposed Project contributes to bog rehabilitation locally
Medium beneficial	Measurable change to ground conditions, groundwater quality or flow regime	• Moderate enhancement of geological heritage feature or new geological heritage site • Remediation of small contamination site • Restoration of groundwater flow to GWDTE
High beneficial	Fundamental change to ground conditions, groundwater quality or flow regime	• Major enhancement of geological heritage feature or new geological heritage site • Remediation of large contamination site • Beneficial changes to aquifer or unsaturated zone resulting in extensive change to existing water supply springs and wells, river baseflow or ecosystems • Augmentation of regional groundwater supply

50. The quality of effects may be positive, neutral, or negative as follows:
    - Positive effect – A change which improves the quality of the environment
    - Neutral effect – A change which does not affect the quality of the environment
    - Negative effect – A change which reduces the quality of the environment.

51. Terms relating to the duration of effects are as described in the EPA's Guidelines on the Information to be contained in Environmental Impact Assessment Reports (2022) as set out in Chapter 2 (The Environmental Impact Assessment Process).

52. A qualitative approach was used in the assessment, following the significance classification in Table 10.6 and through professional judgement. The significance of the effect has been determined through the consideration of the importance/sensitivity of the receptor (attribute) likely to be impacted and the magnitude (the degree or level) of that impact. Effects have been identified as beneficial, adverse or neutral, temporary or permanent and their significance as Profound, Very Significant, Significant, Moderate, Slight, Not Significant or Imperceptible as shown in Table 10.6. Both the adverse and beneficial effects are considered. Effects which are classified as Moderate (or greater) are considered Significant.

53. Throughout the development of the Proposed Project, measures have been adopted as part of the evolution of the project design and approach to construction, to avoid or otherwise reduce adverse impacts on the environment. These mitigation measures are referred to as embedded mitigation. They are an inherent part of the Proposed Project and are effectively 'built in' to the impact assessment. Where Moderate to Profound effects are identified, additional mitigation measures are proposed. Some effects do not require mitigation beyond the embedded mitigation measures described. However, measures outlined in Section 10.5 will also be implemented.

Table 10.6: Significance of Environmental Effect (Adapted from EPA Guidelines 2022)

Magnitude of Impact	Sensitivity of Receptor				
	Negligible	**Low**	**Medium**	**High**	**Very High**
Negligible	Imperceptible (Not Significant)	Not Significant	Not Significant	Not Significant	Not Significant
Low	Not Significant	Not Significant/Slight (Not Significant)	Slight (Not Significant)	Moderate (Significant)	Significant
Medium	Not Significant	Slight (Not Significant)	Moderate (Significant)	Significant	Very Significant
High	Not Significant	Moderate (Significant)	Significant	Very Significant	Profound

10.2.6.1 Variation in Appraisal Methodology

54. The is no variation in appraisal methodology. EPA and NRA guidelines have been applied throughout this chapter.

55. Intrusive site investigations were not undertaken for the 38 kV Uprate Works due to the limited excavation required when compared to the water supply infrastructure. Potential impacts on soils, geology and hydrogeology from the 38 kV Uprate Works are limited, due to the existing infrastructure and small footprint potentially impacted.

10.2.7 Construction Flexibility

56. At this stage of the development of the Proposed Project there are a number of points of detail which cannot be finalised. This is due to factors such as unknown site constraints or obstacles that may affect the construction of the permanent infrastructure. Although a high level of ground investigation has been obtained to inform the planning application for the Proposed Project, further site investigations will be undertaken following grant of planning permission. This will inform a confirmed design for construction. This is a standard delivery approach and as a result, for a linear project of this nature, scale and complexity, it is typical that a level of construction flexibility is required. This flexibility in construction is necessary to provide a mechanism to overcome these matters during the later stages of the Proposed Project. The elements which are subject to construction flexibility are summarised in Table 10.7 and this also explains how this flexibility has been accounted for within the assessment reported in this chapter. Chapter 4 (Proposed Project Description) and Chapter 5 (Construction and Commissioning) in Volume 2 of this EIAR provides further detail.

57. The construction works necessary to deliver the permanent design (including the construction flexibility defined in Table 10.7) would take place within the Construction Working Width which defines the extent of the Planning Application Boundary. For the assessment reported in this EIAR this means that the construction works could take place anywhere within the Construction Working Width.

58. The assessment reported in this chapter has taken account of this construction flexibility and assessed all the likely significant effects that could arise. For this assessment, the likely significant effects reported in this chapter would not change regardless of the alignment or location of infrastructure elements within the defined construction flexibility in Table 10.7 (i.e. the difference in effects would be imperceptible for the purpose of the assessment).

Table 10.7: Definition of Construction Flexibility

Design Element	Construction Flexibility	How this has been Applied / Assessed in this Chapter
Pipeline	Treated Water Pipeline and RWRMs horizontal alignment – to allow for construction flexibility to overcome site constraints or obstacles the pipeline could be anywhere within a 20m Pipeline Corridor as defined in Chapter 4 (Proposed Project Description).	The assessment has identified the likely significant environmental effects from the horizontal alignment of the pipeline being within the 20m Pipeline Corridor.
Pipeline	Treated Water Pipeline vertical alignment – to allow construction flexibility to overcome site constraints or obstacles, the vertical alignment of the pipeline could vary between 1.2m and 4.4m to the crown of the pipe. Exceptions would be at proposed trenchless crossing locations (which due to the construction approach would be deeper than 4.4m to crown) and where it has been identified that for hydraulic purposes, the crown of the pipeline would need to be deeper than 4.4m. These have been included in the vertical alignment set out in the Planning Application for the Proposed Project and consequently have been assessed for significant environmental effects as reported in this EIAR. These include e.g. TWB 27100 - 27700 and TWC 2600 - 2750. In these instances, the construction flexibility would be the crown of the pipe not being deeper than that shown in the Planning Application Drawings and not shallower than 1.2m. The excavation needed for the pipeline is assumed to be the largest needed for the lowest vertical parameter set out.	The assessment has identified the likely significant environmental effects from the vertical alignment of the pipeline within the upper and lower parameter.
Valves	The location of valves, and associated pipeline features, that need to be above the pipeline could change if there is a change in the vertical or horizontal alignment of the pipeline, as a result of the construction flexibility defined in the two rows above. The construction flexibility would allow them to move within the 20m Pipeline Corridor. However, the location of these pipeline features would be limited to remaining within the land parcels as identified and assessed within the EIAR (but still remaining within the 20m Pipeline Corridor).	The assessment has identified the likely significant environmental effects from the valves being located within this construction flexibility.
Outfall connections	To construct the smaller connection pipes between washout valves and washout outfalls, a small amount of construction flexibility would be required to overcome onsite obstacles or constraints. To allow for this, the connecting pipe could be anywhere within a 10m corridor.	The assessment has identified the likely significant environmental effects from the outfall connections being within the10m corridor.
Outfall locations	The outfall headwalls and discharge point would have to move with the alignment of the outfall pipeline, as set out above, and so the discharge point could move within the same 10m construction flexibility. To allow for the headwalls to move 10m either side of the current pipeline alignment, a total construction flexibility width of 20m has been allowed for the headwalls.	The assessment has identified the likely significant environmental effects from the outfalls being located within the 20m construction flexibility.

10.2.7.1 Variation in Construction Methods

59. In addition to the construction flexibility defined in Table 10.7 there may also be the potential for variation in the method of construction to be used to build the Proposed Project. This variation would be necessary to deal with, for example, uncertainties in ground conditions or on-site constraints. Chapter 5 (Construction & Commissioning) includes further detail on these, including the reasoning why different techniques may be required. This could include:

    - Use of raft foundations or concrete piled foundations at the WTP
    - Use of auger bore or pipe jacking for trenchless crossings
    - Using trenchless crossing or open excavation for the crossing of low voltage power lines
    - Different construction techniques for working in poor ground include peat materials.

60. The assessment reported in this chapter has been based on any of these construction techniques being adopted.

61. In addition, as set out in Appendix A5.3 (Methods of Working in Peat), four slightly different methods for constructing the pipeline in areas of peat soils have been defined. To allow for variation in ground conditions it has been assumed for the purpose of the assessment reported in this EIAR that either Method 2, 3 or 4 could be used in areas where the depth of peat is greater than 1m. Where the depth of peat is less than 1m, Method 1 is proposed to be used and it is not expected that there would be any deviation from this methodology. The environmental effects from Methods 2, 3, and 4 would be similar. However, Methods 3 and 4 would result in additional permanent infrastructure in the form of stone pillars (Method 3) or piled supports (Method 4) below the pipeline. Consequently, Method 4 would require piling and as such, would have a slighter greater environmental impact. Therefore, the EIAR is based on the application of Method 4 where the depth of peat is greater than 1m. However, in areas where Methods 2, 3, or 4 could be used, the environmental assessment has considered whether these different methods would result in different likely significant effects and therefore the assessment reported in this chapter has identified the likely significant effects from any of the three techniques. The differences in depth of excavation between the different methods would not be substantial in the context of effects on temporary peat storage and reinstatement. Embedded mitigation is included in Appendix A5.3 in relation to peat stability during construction. Section 10.5 sets out the mitigation measures in relation to peat storage and reinstatement. These measures will apply regardless of the working in peat method used. Therefore, for this assessment, the likely significant effects reported in this chapter would not change regardless of the working in peat method used (i.e. the difference between the methods would be imperceptible for the purpose of the assessment).

10.2.8 Cumulative Effects Assessment

62. As noted in Chapter 2 (The Environmental Impact Assessment Process), intra-project cumulative effects are described within respective topic chapters, while inter-project cumulative effects are described in Chapter 21 (Cumulative Effects & Interactions).

63. Intra-project effects of note in relation to soils, geology and hydrogeology are the assessment of dewatering impacts on biodiversity receptors (GWDTE), peat loss, alteration of groundwater flow and quality, surface water receptors (watercourses), and cultural heritage receptors (buried archaeology and structures). Identified interactions are assessed within the respective topic chapters and summarised in Chapter 21.

64. Approximately 31% of the pipeline (52.9km) passes through peatlands, a substantial proportion of which are lands owned by Bord na Móna. The pipeline is routed through eight bogs which are included in Bord na Móna's rehabilitation plans or enhanced rehabilitation plans under PCAS. The PCAS scheme provides for the restoration and rehabilitation of approximately 33,000 hectares of Bord na Móna peatlands that were previously harvested. Further details of the PCAS scheme are included in Section 10.3.2. and Table 10.12. The implications of the Proposed Project in relation to the rehabilitation schemes are discussed in this chapter.

10.2.9 Difficulties Encountered in Compiling Information

65. The assessments of the RWI&PS, WTP, BPT, BPS, FCV and TPR were informed by field surveys and GI undertaken at each infrastructure location. Although access was not granted along all 172km of the pipeline, assumptions have been made up to 150m along the length of the pipeline as defined in Appendix A5.3 (Methods of Working in Peat). This is of sufficient accuracy to allow a robust assessment of significant effects to be made and the lack of access has not materially affected the assessment of the pipeline due to the availability and analysis of existing desk study data and site investigations along the Construction Working Width.

66. The overall area of land within the study area of the Proposed Project not surveyed between 2016 and 2025 was 23%. Where no access for site walkovers or GI was available, national datasets, historical information, aerial photography and a review of potential sensitive receptors was undertaken. The information that has informed the assessment is sufficient to identify and assess the likely significant effects. The limitations described in this chapter do not have a material impact on the assessment conclusions.

67. In conclusion, no significant constraints were encountered during the compilation of this chapter and a robust evaluation of the likely significant effects of all aspects of the Proposed Project has been undertaken for the purpose of preparing this EIAR.

10.3 Baseline Environment

10.3.1 Topography and Geomorphology

68. In the vicinity of the Proposed Project, the geomorphology is shaped principally during the last glacial age (the Midlandian), with subsequent modification throughout the post glacial Holocene period. Most of the Quaternary (subsoils) sediments were deposited during the last glaciation period, directly from the huge ice sheets.

69. The GSI has published a 1:250,000 scale Physiographic units map of Ireland. Physiographic maps are cartographic representations of the broad-scale physical landscape units of a region. The GSI geomorphology maps are shown on Figure 10.87 to Figure 10.91.

70. The topographic elevation along the Construction Working Width ranges from between 24mAOD (metres above ordnance data) to 152mAOD. In general, there is a low gradient (<1%) with local variations.

71. A number of Electricity Supply Board (ESB)/Office of Public Works (OPW) embankments are constructed along the shoreline of the Parteen Basin and River Shannon. The 38 kV Uprate Works are located on a mixture of low-lying agricultural and afforested land, with a small number of dwellings and farm buildings near O'Brien's Bridge and Birdhill. The area is generally characterised by a gently undulating drumlin landscape with occasional gravel hillocks and an extensive alluvial flat along the rivers.

72. The RWI&PS and WTP sites are located in an area generally characterised as gently rolling drumlin landscape. The GSI Physiographic Unit for the same area is categorised as 'Rolling ice-moulded sediments'. Drumlins take a variety of forms with the majority elongated in the direction of ice flow. Most drumlins in the RWI&PS and WTP sites are composed of glacial tills and a small number are rock-cored. The drumlins in the area of both the RWI&PS and WTP are orientated north to south, indicating the direction of glacial ice flows. The RWI&PS and WTP would be located on a mixture of agricultural (predominantly pasture) and afforested land, with a small number of dwellings and farm buildings in the immediate surrounding areas. An extensive alluvial flat is located to the south of the WTP site and RWI&PS site along the Kilmastulla River.

73. Elevations at the RWI&PS range from approximately 31mAOD along the Parteen Shore, to approximately 35mAOD to the north of the RWI&PS. To the south of the RWI&PS site, an ESB embankment forms the shoreline of Parteen Basin. This is known as Fort Henry Embankment. The RWRMs traverse north-east from Parteen Basin Reservoir to the proposed WTP. Elevations at the WTP site range from approximately 41mAOD to the south, to approximately 61mAOD to the north.

74. The BPT site is located north of Cloughjordan in County Tipperary, approximately 2km west of the County Offaly border. The BPT site is located on an elevated north-west/south-east ridge between 135mAOD and 150mAOD. The BPT is located to the north of a large 'crag and tail', a glacial landform, consisting of a rock hill and tapering ridge, which is produced by selective erosion and deposition beneath an ice sheet.

75. The BPS is located in Coagh Upper, County Offaly on a relatively flat site between 85mOD and 91mAOD. A number of small hills are traversed between Mountbolus and Geashill County Offaly. The TPR is located in Peamount, County Dublin on a relatively flat site between 77mAOD and 78mAOD.

76. The Treated Water Pipeline from the WTP to the BPT traverses north-east from the WTP site through the northern part of County Tipperary to the BPT. For the most part, the elevation slopes upwards towards the BPT site, a high point in the vicinity of the County Tipperary/County Offaly border.

77. The Treated Water Pipeline from the BPT to the TPR continues to skirt the southern perimeter of County Offaly, maintaining a due east direction through County Kildare and onwards to the TPR in County Dublin. Through the Midlands, the profile remains relatively flat between 80mAOD and 90mAOD with changes of profile at river crossings and occasionally where glacial till and gravel deposits are crossed by the pipeline. The gradient along the FCV and Treated Water Pipeline from the BPT to the TPR is shallow and typically flat to 1/50 gradient (to the horizontal) across the peatland areas.

10.3.2 Soils and Subsoils

78. Information concerning soil types is contained in General Soil Map of Ireland (An Foras Talúntais 1980); Soils of County Clare (An Foras Talúntais 1971); Soils of Co. Limerick (An Foras Talúntais 1966); Soils of Tipperary, North Riding (An Foras Talúntais 1993); Soils of Co. Offaly (An Foras Talúntais 2003); Soils of Co. Kildare (An Foras Talúntais 1970); and on the GSI website[2]. Information regarding the soil classifications was obtained from the GSI web-mapping site, which includes soil information from the Teagasc/EPA soil and subsoil mapping project (Teagasc 2006).

79. Acidic (non-calcareous) soils are mainly located in the western section of the Proposed Project. Acidic soils occur at the RWI&PS, RWRMs, WTP, from Chainage TW – 0 to TW – 16400 near Nenagh and an area of the 38 kV Uprate Works. Basic soils dominate from TW – 16400 to the TPR. Soils are shown on Figure 10.1 to Figure 10.4.

80. Information concerning the Quaternary (Subsoil) Geology is sourced from the GSI website (GSI 2013). Most of the Quaternary (subsoils) sediments were deposited during the Ice Age itself, either directly from the ice sheets that moved from north-west to south-east or from the meltwater following the slowly melting ice sheets. Refer to subsoils maps – Figure 10.5 to Figure 10.8.

81. The following sections describe the soils and subsoils at each infrastructure site.

10.3.2.1 Raw Water Intake and Pumping Station (RWI&PS)

82. A range of soil types are present near the RWI&PS site at Parteen Basin. The principal mapped soil group at the RWI&PS is BminSW – Shallow well mineral soil, derived from mainly calcareous parent materials. Based on the site walkovers and GI information, soils on the RWI&PS are deep and comprise surface water/groundwater gleys. Gley soils are typically saturated for varying periods of the year and are typically heavy textured.

83. The underlying subsoils at the RWI&PS comprise a sand horizon overlying clayey till. Grey gravelly, silty, fine to medium SAND was encountered to an average depth of 4m below ground level (m bgl) on the RWI&PS site. The sandy horizon overlies firm to stiff pinkish orangish brown slightly sandy gravelly SILT/CLAY with occasional subangular sandstone boulders and cobbles. Based on the borehole data, the depth of subsoil varies from 8.4m bgl in RWI-BH015 to 15.2m bgl at RC-138. See Appendix A10.1 (2018 Ground Investigations) and Appendix A10.4 to Appendix A10.14 (2022 and 2023 Ground Investigations) and Figure 10.28. No peat was encountered at the RWI&PS.

[2] www.gsi.ie

84. A large and deep excavation/pit is located 0.3km to the north of the RWI&PS site and runs north–south along Parteen Basin. No bedrock exposure is noted at this location. The excavation is a former borrow pit utilised in the construction of Parteen Basin and its embankments. The pit is approximately 0.1km wide and 0.6km long and marked on the 25" OSI maps. The semi-mature afforestation indicates the borrow pit has not operated for a significant period of time. The western pit face is approximately 3m high and >6m high on the eastern bank.

85. To the south of the RWI&PS site, a large area of alluvial soils is mapped along the shoreline of Parteen Basin, largely associated with the Kilmastulla River.

10.3.2.2 Twin RWRMs

86. A range of soil types are present near the WTP site and along the twin RWRMs (refer to Figure 10.1). The principal soil group along the twin RWRMs is AminPD – Deep poorly-drained mineral soil, derived from mainly non-calcareous parent materials. Surface water gleys and groundwater gleys may be included in this category.

87. Based on the GI data, the soils along the RWRM comprise poorly-drained, grey to light brown CLAY, consistent with the classification as surface water/groundwater gleys. Alluvial soils are mapped along a drainage ditch (WBX001) at Chainage RW – 200. Peaty soils were encountered along drainage ditch (WBX003) at Chainage RW – 1000.

88. With reference to GSI mapping, the subsoils primarily comprise Till derived from Lower Palaeozoic and Devonian sandstones (TLPDSs). Till derived from Lower Palaeozoic shales/sandstone (TLPSsS) are also present on the north and north-western boundary of the site (refer to Figure 10.5). Subsoils along the RWRM are variable but are predominantly comprised of firm brown slightly sandy slightly gravelly CLAY with low cobble content.

10.3.2.3 WTP

89. The principal soil group at the WTP is AminPD – Deep poorly-drained mineral soil, derived from mainly non-calcareous parent materials. Surface water gleys and groundwater gleys may be included in this category. Soils at the WTP site (Image 10.1) comprise poorly-drained, grey to light brown CLAY, consistent with the classification as surface water/groundwater gleys. Based on the site walkover and site investigation data, the soils on site are surface water gleys.

90. A total of 170 boreholes and 95 trial pits were completed at the WTP site – see Appendix A10.6 and Figure 10.28. The underlying subsoils at the WTP site comprise till derived from various rock formations. Glacial till is composed of a heterogeneous mixture of clay, sand, gravel and boulders. With reference to GSI mapping, the subsoils primarily comprise Till derived from Lower Palaeozoic and Devonian sandstones (TLPDSs). Till derived from Lower Palaeozoic shales/sandstone (TLPSsS) are also present on the north and north-western boundary of the site (refer to Figure 10.5).

91. Natural deposits were predominantly described as Till; soft to stiff, (slightly) sandy (slightly) gravelly CLAY/ SILT, with varying Cobble content, extending from depths 9.6m bgl to 28.0m bgl – see Appendix A10.6. Occasional deposits of clayey gravelly SAND and clayey sandy GRAVEL were also identified. The subsoils depths vary between 9.6m bgl (WTP-BH070) to 35.10m bgl (WTP-BH013). The subsoils on the WTP have a high clay content >15% and moderate/low permeability. No bedrock exposure was encountered. To the south of the WTP site, an area of alluvial soils is present along the Kilmastulla River. Localised peaty soils (<0.5m) and peat horizons were encountered along the WTP access road. The peat is not active, highly modified/drained and is used as pastureland. Peat was noted in the following trial pits:

- WTP-TP087 (0.4-1m bgl) – Dark brown, clayey fibrous PEAT
- WTP-TP091 (0.6-1.3m bgl) – dark brown, slightly clayey fibrous PEAT

- WTP-TP119 (0.3-1.2m bgl) slightly clayey fibrous PEAT.

Image 10.1: WTP Looking South-East – Poorly Drained Soils with Frequent Rushes

10.3.2.4 Break Pressure Tank (BPT)

92. The mapped soils are BminDW – Deep well-drained mineral soil, derived from mainly calcareous parent materials and BminSW – Shallow well-drained mineral soil, derived from mainly calcareous parent materials.

93. With reference to GSI mapping, the subsoils primarily comprise till derived from carboniferous limestones (TLs). Borehole data to the west of the BPT confirms the presence of deep, well-drained soils (>10m at RC196). Shallow bedrock was recorded to the east of the BPT site – see Appendix A10.1 and Appendix A10.8. Site investigation locations for the BPT are shown on Figure 10.39.

94. Based on topography and the geomorphology of the area, the depth of soils becomes shallower on the backslopes and shoulders of the hill, i.e. to the centre and east of the site. The BPT site is on a crag and tail where rock depth varies over short distances. Rock near the surface is mapped to the south and east of the BPT site, with evidence of outcrop on the northern and southern boundaries. No peat deposits were encountered on the BPT site. Borehole data from 2022 confirms subsoils to the west of the BPT predominantly comprise firm to stiff orangish reddish brown (slightly) sandy (slightly) gravelly SILT, with varying cobble content of limestone extending from depths of 1.7m bgl (BPT-BH001) to 26.1m bgl (BPT-BH008). Occasional deposits of very dense angular to subangular fine to course dark grey limestone GRAVEL and (slightly) silty SAND were encountered extending to a depth of 30.5m in BPT-BH027, with occasional deposits of sandy gravelly CLAY encountered throughout the west of the site. Soils to the east of the BPT also comprised glacial till, with firm dark reddish brown sandy SILT extending to 0.4m bgl in BPT-BH010, and greyish brown silty sandy fine to coarse grey limestone GRAVEL extending to a depth of 2.9m bgl (BPT-BH032). Occasional deposits of (slightly) gravelly CLAY were also encountered to the east of the site. Based on the borehole data, the subsoil depths vary between 0.40m bgl in BPT-BH010 and 30.5m bgl in BPT-BH027. Subsoil thickness decreases to the north-west. Subsoil thickness decreases from west to east across the site with deeper soils to the west of the site and shallow soils to the centre and east of the site. A number of deeper infilled channels occur on the BPT as identified by geophysics and borehole data – see Appendix A10.8 and Section 10.3.3. The depth of subsoil varies over short distances, likely due to the irregular bedrock surface. Approximately 250m to the east of the BPT, shallow, well-drained soils occur (2.1m at RC197).

10.3.2.5 Booster Pumping Station (BPS)

95. Deep soils predominate at the BPS site. The main soils include Grey Brown Podzolics and Brown Earths. The mapped soils are BminDW – Deep well-drained mineral soil, derived from mainly calcareous parent materials, and BminPD – Deep poorly-drained mineral soil, derived from mainly calcareous parent materials.

96. With reference to GSI mapping, the subsoils primarily comprise TLs (refer to Figure 10.6). Borehole data to the west of the BPS (BH098) confirms the presence of glacial till material – see Appendix A10.1 and Appendix A10.10. Site investigation locations for the BPS are shown on Figure 10.48. Based on borehole data for BH098, the till primarily comprises cohesive soils, namely soft greyish brown sandy CLAY. Small historical gravel pits are located 200m to the south and east of the BPS site. There is no evidence of rock outcrop on the site or the adjacent stream.

97. Borehole data reveal subsoils on the BPS are predominantly made up of a layer of (slightly) gravelly (slightly) silty greyish brown CLAY with occasional cobbles, overlying a layer of brown, dense becoming very dense (very) silty and (very) sandy GRAVEL with occasional cobbles and boulders, see Appendix A10.10. Occasional horizons of 1m to 5m silty gravelly SAND and occasional deposits of gravelly sandy SILT were also identified. Bedrock was not encountered in any of the boreholes to a depth of 20.4m bgl (BPS-BH008) and no peat deposits were encountered on the BPS site.

10.3.2.6 Flow Control Valve (FCV)

98. Shallow soils predominate at the FCV site. The main soils include Grey Brown Podzolics and Brown Earths. The mapped soils are BminPD – Deep poorly-drained mineral soil, derived from mainly calcareous parent materials.

99. With reference to GSI mapping, the subsoils primarily comprise TLs (refer to Figure 10.8). Site investigation locations for the FCV are shown on Figure 10.79. Borehole data to the west of the FCV (BH213) confirms the presence of glacial till material – see Appendix A10.1 and Appendix A10.10. Based on borehole data for the area, the till primarily comprises cohesive soils, namely soft greyish brown sandy CLAY. Borehole data reveal subsoils on the FCV are predominantly made up of a layer of (slightly) gravelly (slightly) silty greyish brown gravelly CLAY with occasional cobbles and boulders. Based on the borehole data, the subsoil depth is 2.5m bgl (BH213). No peat deposits were encountered on the FCV site.

10.3.2.7 Termination Point Reservoir (TPR)

100. The TPR site is mapped as shallow, well-drained, mineral soil, derived mainly from calcareous parent materials and mapped as Shallow well drained mineral – Mainly basic (BminSW).

101. Site investigation locations for the TPR are shown on Figure 10.81. Ground investigation data confirm the presence of shallow well-drained subsoils at the site (>2m in RC185 and RC186). Based on borehole data for the area, the till primarily comprises cohesive soils namely grey/brown, firm to stiff, slightly sandy CLAY – see Appendix A10.1 and Appendix A10.13.

102. Borehole data confirm that soils on the TPR site comprise a layer of firm becoming stiff to very stiff, brown sandy gravelly CLAY with occasional cobbles extending to depths ranging from 0.4m bgl (TPR-DS-001) to 2.15m bgl (TPR-BH-002), frequently overlying a layer of brown clayey/silty slightly sandy GRAVEL extending to depths of up to 3.0m bgl (TPR-DS-015). Made Ground deposits were also encountered to the east of the TPR site comprising brown gravelly sandy clay overlying a layer of clayey silty angular gravel encountered in TPR-BH-009 and TPR-BH-012. A layer of orangish brown clayey/silty sandy GRAVEL extending to a depth of 1.05m was encountered, overlying a layer of stiff greyish brown slightly

sandy slightly gravelly CLAY, with occasional cobbles of limestone extending to a depth of 1.7m in TPR-DS-010. No peat deposits were encountered on the TPR site.

10.3.2.8 Construction Compounds and Pipe Storage Depots

103. Eight Construction Compounds are required to facilitate the construction of the Proposed Project including four Principal Construction Compounds and four Satellite Construction Compounds. A summary of the soils and subsoils at each location is detailed in Table 10.8.

Table 10.8: Soils and Subsoils at Construction Compounds

Construction Compound (CC)	Soils	Subsoils
CC0 Satellite – Garrynatineel, County Tipperary at RWI&PS	AminDW – Acidic Deep Well Drained Mineral soils	Predominantly till derived from sandstone and shales
CC1 Principal – Incha Beg, County Tipperary at WTP	AminPD – Acidic Deep Poorly Drained Mineral soils	Predominantly till derived from sandstones and shales
CC2 Principal – Lisgariff, Ballylusky, County Tipperary	BminDW – Predominantly basic Deep Well Drained Mineral soils	Predominantly till derived from limestone, some sand and gravels (esker gravels)
CC3 Satellite – Knockanacree, County Tipperary at BPT	BminSW and BminDW – Shallow to Deep well drained soils	Predominantly till derived from limestone
CC4 Satellite – Coagh Upper, County Offaly at BPS	BminDW – Basic Deep Well Drained and Poorly Drained Mineral soils	Predominantly till derived from limestone
CC5 Principal – Killananny, County Offaly	BminDW – Basic Deep Well Drained Mineral soils and Cutover peat	Predominantly till derived from limestone and cutover peat
CC6 Principal – Drummond, County Kildare	BminPD – Basic Deep Poorly Drained Mineral	Predominantly till derived from limestone
CC7 Satellite – Peamount, County Dublin at TPR	BminDW and BminPD – Basic Deep Well Drained and Poorly Drained Mineral soils	Predominantly till derived from limestone

104. Pipe Storage Depots (PSD) would serve the installation of pipe between the WTP and the TPR. A summary of the soils and subsoils based on the Teagasc/EPA and GSI Quaternary data, is detailed in Table 10.9.

Table 10.9: Soils and Subsoils at Pipe Storage Depots (PSD)

Pipe Storage Depot	Soils	Subsoils
PSD1 – Carrigatogher, County Tipperary	BminDW – Deep well drained mineral (Mainly Basic)	Predominantly till derived from limestone
PSD2 – Toora, County Tipperary	BminDW – Deep well drained mineral (Mainly Basic)	Predominantly till derived from limestone
PSD3 – Boveen, County Offaly	BminDW – Deep well drained mineral (Mainly Basic)	Predominantly till derived from limestone
PSD4 – Fortel, County Offaly	BminDW – Deep well drained mineral (Mainly Basic) Cut – Cutover/cutaway peat (In some areas)	Cutover Peat overlying till derived from limestone
PSD5 – Derrinboy, County Offaly	BminDW – Deep well drained mineral (Mainly Basic)	Cutover Peat overlying till derived from limestone
PSD6 – Derryweelan, County Offaly	BminDW – Deep well drained mineral (Mainly Basic) BminPDPT – Peaty poorly drained mineral (Mainly basic)	Predominantly till derived from limestone
PSD8 – Rathlumber, County Offaly	BminSW – Shallow well drained mineral (Mainly basic)	Cutover Peat overlying till derived from limestone
PSD9 – Baltracey/Graigpottle, County Offaly	BminDW – Deep well drained mineral (Mainly Basic)	Predominantly till derived from limestone
PSD10 – Barberstown Lower, County Kildare	BminPD – Mineral poorly drained (Mainly basic)	Predominantly till derived from limestone

10.3.2.9 Treated Water Pipeline

105. A large range of soils are present along the Treated Water Pipeline. The predominant soil groups include:

- AminPD – Deep poorly-drained mineral soil, derived from mainly non-calcareous parent materials. Surface water gleys and groundwater gleys are included in this category
- AminDW – Deep well-drained mineral soil, derived from mainly non-calcareous parent materials. Acid brown earths and Brown podzolics will be included in this category.

106. Acidic soils are located along the western sections of the Treated Water Pipeline from the WTP to the BPT between Chainage TW – 0 to TW – 16400. Basic soils dominate from TW – 16400 to the TPR. Refer to Figure 10.1 to Figure 10.4. Cutover peat is the main soil type in east Offaly TWC – 12000 and west Kildare TWD – 27700.

107. General information concerning the Quaternary (Subsoil) Geology is contained on the GSI website. Refer to Figure 10.5 to Figure 10.8 of the EIAR. Most of the Quaternary sediments were deposited during the Ice Age itself, either directly from the huge ice sheets that moved from north-west to south-east or from the meltwater following the slowly melting ice sheets.

108. With reference to the GSI mapping, the subsoils underlying the Construction Working Width primarily comprise TLs, as shown in Table 10.10.

109. Quaternary deposits such as peat, lacustrine and alluvial subsoils are also present along the Construction Working Width. In east County Offaly and north County Kildare, extensive areas of cutover peat overlie glacial deposits along the Construction Working Width. Limited areas of shelly marl or lacustrine deposits were encountered during the ground investigations. Subsoils are absent – bedrock is at or near the surface along 0.3% of the Construction Working Width.

Table 10.10: Subsoil Classifications Along Construction Working Width

Subsoil Group	% of Construction Working Width Within Subsoil Category
Alluvium (Undifferentiated)	3.8%
Glaciofluvial sands and gravels	3.8%
Glaciolacustrine deposits (undifferentiated)	0.7%
Peat	31.1 %
Till	61.6%
Total	100%

10.3.2.9.1 Treated Water Pipeline from the WTP to the BPT

110. A large range of soils are present along the Treated Water Pipeline from the WTP to the BPT. Topsoil encountered along the route is between 0.1 to 0.6m thickness. This topsoil overlies glacial till, consisting of sandy gravelly clay with frequent cobbles, firm or stiff in the upper horizons becoming very stiff with depth. Occasional sand or gravels deposits were encountered. Peat is mapped along the Treated Water Pipeline from the WTP to the BPT; however, peat was absent or shallow based on the GIs. Peaty soils and peat were encountered in a number of trial pits at PSD1, immediately north and south of the R445. Spongy fibrous and pseudo-fibrous peat variants encountered in BH-11594, BH-12406A, and BH-12658. Ground investigations related to the Treated Water Pipeline from the WTP to the BPT are included in Appendix A10.1 and Appendix A10.7.

111. The Construction Working Width is located north of, and parallel to the Kilmastulla River at TW – 2300 to TW – 6700. There are no proposed crossings of the Kilmastulla River. The subsoils encountered to the north of the Kilmastulla River were predominantly described as glacial till. BH-2461 (TW – 2400) comprised firm to very stiff brown slightly sandy slightly gravelly CLAY with low cobble content extending to depths of 6.7m. Deeper subsoil material was encountered in BH-6016, located approximately 0.1km to the north of the Kilmastulla River, comprising a layer of medium dense very gravelly very silty fine to coarse SAND with low cobble content, extending to a depth of 3.4m, overlying layers of (slightly) sandy (slightly) gravelly CLAY and slightly sandy slightly clayey GRAVEL, which were firm and stiff in the upper horizons becoming very stiff with increasing depth to 21.7m bgl. This horizon was found overlying a layer of very dense grey cobbles and boulders of limestone with orangish brown sandy CLAY to a depth of 24.7m bgl.

112. The alluvial material encountered in the borehole locations at the primary river crossings are described hereunder. A crossing of the River Nenagh occurs at TW – 19450 (WCX016). The underlying subsoil material encountered at BH-19407, within the trenchless location, comprises firm becoming stiff brown slightly sandy gravelly CLAY extending to a depth of 1.1m bgl overlying a layer of dense grey sandy subangular to angular fine to coarse GRAVEL with high cobble content extending to a depth of 2.2m bgl. Shallow bedrock is present at the Nenagh crossing. Weathered to competent LIMESTONE underlies the subsoils at 2.5m bgl, becoming strong (locally medium strong) massive grey LIMESTONE at 3.5m bgl.

113. Three areas are mapped as peat subsoils on the GSI/Teagasc data between the WTP and BPT. Based on peat probing data, peat is shallow to absent in these areas as detailed in Table 10.11.

Table 10.11: Treated Water Pipeline WTP to the BPT – Peat Depths and Mapped Peat Length

Name of bog[1]	Chainage	Total Length (m)	Inferred Peat Depth (m)	
			Average	Maximum
Peat subsoil in private land #1[2]	TW – 10175 to TW – 10500	325	0.3	0.8
Peat subsoil in private land #2	TW – 31500 to TW – 31650	150	No Peat	No Peat
Peat subsoil in private land #3	TW – 32825 to TW – 33550	725	No Peat	No Peat

Table notes:

[1] Numbering as per Appendix A5.3 (Methods of Working in Peat)

[2] Note, peat probe data may overestimate depth of peat where it is underlain by soft tills or lacustrine deposits

10.3.2.9.2 Treated Water Pipeline from the BPT to the TPR

114. Soils encountered along the Treated Water Pipeline from the BPT to the TPR route primarily consist of topsoil, typically in 0.1 to 0.6m thickness overlying Glacial Till, consisting of layers of sandy gravelly clay with frequent cobbles, and occasional deposits of sands or gravels. A description of the subsoils on the main river crossings is given below from west to east. Ground investigation data for the Treated Water Pipeline from the BPT to the TPR is included in Appendix A10.1, Appendix A10.9, Appendix A10.11, Appendix A10.12 and Appendix A10.14.

115. Borehole data reveal soil adjacent to the Little Brosna River comprised peaty topsoil over dry black amorphous PEAT to a depth of 1.3m bgl, overlying a layer of firm wet brownish black fibrous PEAT to a depth of 2.0m bgl. This peat layer overlies a greyish black very gravelly very silty medium to coarse SAND layer (with low cobble content), extending to a depth of 6.5m bgl, with coarse sandstone and limestone GRAVEL and coarse SAND to 7.8m bgl (BH-49654).

116. At the Silver [Kilcormac] River crossing to the west of the river, topsoil overlies a layer of firm greyish brown slightly sandy slightly gravelly SILT at BH-77404 to a depth of 6.0m bgl. Gravel is subangular to rounded fine to coarse of limestone. Cobbles and boulders are of grey limestone. BH-77477 lies to the east of the Silver River and encountered similar material, comprising a layer of topsoil over stiff brownish grey (slightly) sandy (slightly) gravelly SILT with low cobble and boulder content to a depth of 9.3m bgl, with layers of dense brown silty very sandy subangular fine to coarse limestone GRAVEL, with low cobble content.

117. Soils at the Clodiagh [Tullamore] River crossing are predominantly made up of a layer of topsoil overlying firm becoming dense (slightly) sandy (slightly) gravelly SILT or silty sandy GRAVEL, with low cobble content, extending to a depth of 10.45m bgl (BH-89604), with occasional layers of medium dense grey slightly silty gravelly fine to coarse SAND.

118. Natural deposits at the River Figile were described as peaty topsoil to a depth of 0.2m, overlying soft to very stiff, slightly sandy slightly gravelly CLAY, with varying cobble content extending to depth of 6.2m.

119. Soils at the River Liffey crossing comprise a layer of topsoil overlying interbedded layers of brown silty SAND/grey sandy SILT/ black clayey sandy GRAVEL/ grey silty sandy gravelly CLAY, with occasional cobbles to a maximum depth of 15.1m bgl (BH–161516).

120. Peat is the predominant soil group between Geashill, County Offaly and Timahoe, County Kildare (Chainage TWC – 10000 to TWD – 29400). Ground investigation data are included in Appendix A10.11. No active raised bog or degraded raised bog still capable of regeneration is present within the Construction Working Width. Ecological surveys have confirmed there are no areas of active raised bogs within the Construction Working Width – see Chapter 8 (Biodiversity). Degraded raised bog not capable of regeneration (Non Annex I) is located at Island/Clonad, County Offaly (TWC – 13400), Mount Lucas, County Offaly (TWC – 17200 to TWC – 17300), Esker (TWC – 23550), Co. Offaly, and Timahoe, County Kildare (TWD – 21550).

121. In all cases, raised bog habitats recorded within the Proposed Project had undergone drainage or cutting at some point in time and therefore did not conform with the Annex I habitat criteria for ‘active raised bogs (7110)’ or ‘degraded raised bogs still capable of natural regeneration (7120)’ (Appendix A8.4: Target Habitat Surveys Report). The total area classified as Degraded Raised Bog (Non Annex I) is 1.1ha, or 0.09% of habitats within the Proposed Project (Appendix A8.4: Target Habitat Surveys Report). A total of 0.4ha of the degraded raised bog relates to turbary / turf banks.

122. Where peat occurs along the Treated Water Pipeline in Tipperary, the shallow peat areas are reclaimed and utilised for agriculture. The Treated Water Pipeline from the BPT to the TPR traverses Bord na Móna land and other peatland sites. Additional data on the peat depths are included in Appendix A5.3, Annex A. During the initial route selection, areas of active raised bog were avoided.

123. Bord na Móna has a significant extent of drained peatlands (c.15km), where peat harvesting previously occurred, along the Construction Working Width of the Proposed Project; these are detailed in Table 10.12. Bord na Móna has undertaken a programme of peatland rehabilitation across many of its bogs previously harvested for peat extraction. Bord na Móna are rehabilitating their bogs in accordance with their IPC licence. In addition, they are currently delivering an enhanced rehabilitation programme, the PCAS schemes, over and above that required under their IPC licence, which will help deliver climate action and biodiversity objectives.

124. For three of the bogs - Ballydermot, Timahoe North and Gilltown - Bord na Móna are currently preparing Rehabilitation Plans.

125. For all of the remaining sites Bord na Móna have published Enhanced Rehabilitation Plans, the PCAS plans, for each of these bogs in 2021[3] and 2022[4].

126. PCAS provides for the restoration and rehabilitation of approximately 33,000 hectares of Bord na Móna peatlands that were previously harvested. Bord na Móna will rehabilitate a total of 79,300 hectares and restore 81,000 hectares of bog. There are no restoration works within the Proposed Project as there are no active raised bogs. Details of the PCAS schemes are included in Table 10.12. The peat production fields will gradually recolonise with vegetation (wetland, heath or scrub) and low lying areas will start to rewet (due to drain blocking). Based on the peatland rehabilitation plans and previous rehabilitation works; the peat extraction areas will naturally re-vegetate in a 10–20 year time period.

127. Outside of the Bord na Móna lands, private turf cutting (turbary) is limited but ongoing at two locations along the Construction Working Width where degraded raised bog is present. Approximately 60m of degraded raised bog occurs at TWC – 17300 and 20m at TWC – 23530. Peat was also historically extracted (milled peat extraction) at Kilcumber Bog, Co. Offaly. Peat extraction has ceased in Kilcumber since 2019.

128. Details of the Bord na Móna and private commercial peatlands crossed are shown in Table 10.12 along with a summary of the Von Post results[5]. Additional moisture content and organic content data is included in Appendices A10.11 and A10.12. While peat depths vary across the peatland sites, in general peat is less than 3m deep with deeper areas present on the Bord na Móna headlands.

[3] https://www.bnmpcas.ie/bogs-peatlands-climate-action-scheme/

[4] https://www.bnmpcas.ie/2022bogsrehabilitation/

[5] The Von Post scale classification is a qualitative system used to classify peat according to its degree of decomposition (humification), and moisture content.

Table 10.12: Summary of Main Cutover Peatlands Along Construction Working Width

Peatland	Bog Group	Chainage	Rehabilitation/ PCAS plan	Description and Current Land Uses	Underlying Soils/Geology	Figure Reference
Clonad Bog, Co Offaly	Allen group – EPA licence P0503-01	TWC – 11850 to TWC – 13400	Rehabilitation and PCAS measures implemented.	Cutover peat – All peat harvesting ceased in 2020. PCAS measures implemented.	Peat was historically extracted at Clonad Bog and ceased in 2020. Peat is absent in some areas of Clonad Bog. Peat depth varies from 0.2m to 4.6m. Peat comprises Brown Fibrous peat – Von Post H3-H5. Peat is underlain by deep till comprised of soft brown very sandy slightly gravelly CLAY. Subsoils in the surrounding area are mapped as till derived from limestones. Depth to bedrock is >5m.	Figure 10.3 and 10.105
Mount Lucas, Co Offaly	Allen group – EPA licence P0503-01	TWC – 13400 to TWC –17200	Rehabilitation and PCAS measures implemented.	Cutover peat and windfarm. PCAS measures implemented.	Peat was historically extracted at Mount Lucas Bog. Peat is absent in some areas of Mount Lucas Bog and extraction ceased in the 2000s. Peat depth varies from 0.2m to 2.8m. Peat comprises Brown fibrous peat – Von Post H3-H5. Peat is underlain by deep till. The till is predominantly a SILT with variable composition of clay, sand, gravel, pebbles and cobbles. Subsoils are soft to firm/stiff with medium cobble content. Sandy and gravelly horizons are occasional within the till. These occur at different depths within and between boreholes. Subsoils in the surrounding area are mapped as till derived from limestones. Depth to bedrock is >5m.	Figure 10.3 and 10.105
Esker, Co Offaly	Allen group – EPA licence P0503-01	TWC – 20275 to TWC – 21300 and TWC – 23200 to TWC – 23475	Rehabilitation and PCAS measures implemented.	Cutover peat – peat harvesting ceased in 2019. PCAS measures implemented.	Peat was historically extracted at Esker Bog and ceased in 2019. Peat is absent in some areas of Esker Bog. Peat depth varies from 0.2m to 5.0m. Peat comprises Brown Fibrous peat – Von Post H3-H5. Peat is underlain by deep till. The till is predominantly a CLAY with variable composition of silt, sand, gravel, pebbles and cobbles. Subsoils are soft becoming firm/stiff with depth. Sandy and gravelly horizons are occasional within the till. These occur at different depths within and between boreholes. Subsoils are comprised mainly of soft brown very sandy slightly gravelly CLAY. Subsoils in the surrounding area are mapped as cutover peat and gravels derived from limestones. A private turf bank is located to the east of the Bord na Móna Bog. Gravels are present to the south of the Esker river and to the east of Esker Bog. Depth to bedrock is >5m.	Figure 10.3 and 10.106
Cloncreen, Co Offaly	Allen group – EPA licence P0503-01	TWD – 2200 to TWD – 2950	Rehabilitation and PCAS measures implemented.	Cutover peat – peat harvesting ceased in 2020, Cloncreen windfarm in operation from 2022. PCAS and Rehabilitation measures outside of Construction Working Width.	Peat was historically extracted at Cloncreen Bog. Peat is absent in some areas of Cloncreen Bog with deeper depth remaining on the former peat extraction headlands. Peat depth varies from 0.2m to 4.5m. Peat comprises Brown Fibrous peat – Von Post H2-H5. Peat is underlain by deep tills. The till is predominantly a SILT/CLAY with variable composition of clay, silt, sand, gravel, pebbles and cobbles. Subsoils are soft becoming firm/stiff with depth. Sandy and gravelly horizons are occasional within the till. These occur at different depths within and between boreholes. Subsoils in the surrounding area are mapped as cutover peat and till derived from limestone. Depth to bedrock is >5m.	Figures 10.106 and 10.107

Peatland	Bog Group	Chainage	Rehabilitation/ PCAS plan	Description and Current Land Uses	Underlying Soils/Geology	Figure Reference
Kilcumber, Co Offaly	NA – Private Bog	TWD – 4200 to TWD – 6400	No rehabilitation plans as Private Lands.	Cutover peat (peat harvesting ceased in 2019). Cushaling windfarm constructed in 2024/2025.	Peat was historically extracted at Kilcumber Bog. Peat is absent in some areas of Kilcumber Bog. Peat depth varies from 0.2m to 3.0m. Peat comprises Brown Fibrous peat – Von Post H2-H5. Occasional pseudo-fibrous H7-H8 horizons (0.4m) within the fibrous peat. Peat is underlain by deep till. The till is predominantly a SILT/CLAY with variable composition of clay, silt, sand, gravel, pebbles and cobbles. Subsoils are soft becoming firm/stiff with depth. Sandy and gravelly horizons are occasional within the till. These occur at different depths within and between boreholes. Subsoils in the surrounding area are mapped as cutover peat and till derived from limestones. Depth to bedrock is >5m.	Figure 10.3 and 10.107
Ballydermot Bog - Codd 1 and Codd 2 Glashabaun North Glashabaun South Derrybrennan, Co Kildare	Allen group – EPA licence P0503-01 Codd, Derrybrennan and Glashabaun bogs also known as Ballydermot Bog	TWD – 6400 to TWD – 8500 TWD – 9400 to TWD – 15000	Decommissioned – Draft rehabilitation plan (some works undertaken on site).	Cutover peat – peat harvesting ceased in 2020. Proposed windfarm and rehabilitation plan (rehabilitation plan will be finalised alongside windfarm proposals).	Peat was historically extracted at Ballydermot Bog until 2020. Peat is absent in some areas of Ballydermot Bog. Peat depth varies from 0.2m to 1.7m. Peat comprises Brown Fibrous peat – Von Post H2-H5. Occasional (0.3 m) pseudo-fibrous H7-H8 horizons within the fibrous peat. Peat is underlain by deep till. The till is predominantly a SILT/CLAY with variable composition of clay, silt, sand, gravel, pebbles and cobbles. Subsoils are soft becoming firm/stiff with depth. Occasional horizons of grey/ brown very sandy clayey GRAVEL with low cobble content present within the till. These occur at different depths within and between boreholes. Subsoils in the surrounding area are mapped as till derived from limestones. Depth to bedrock is >5m.	Figure 10.3 and 10.108
Timahoe South, Co Kildare	Allen group – EPA licence P0503-01	TWD – 17200, TWD – 18900 to TWD – 21550	Rehabilitation and PCAS measures implemented.	Natural regeneration with some forestry. Rehabilitation and PCAS measures ongoing.	Peat was historically extracted at Timahoe South Bog and ceased in the 1990s. Peat depth varies from 0.2m to 4.5m. Peat comprises Brown Fibrous peat – Von Post H2-H4. Peat is underlain by deep till comprised mainly of soft brown very sandy slightly gravelly CLAY. The till is predominantly a CLAY with variable composition of silt, sand, gravel, pebbles and cobbles. Subsoils are soft becoming firm/stiff with depth. Sandy and gravelly horizons are occasional within the till. These occur at different depths within and between boreholes. Subsoils in the surrounding area are mapped as cutover peat and till derived from limestones. Depth to bedrock is >5m.	Figure 10.3 and 10.110
Timahoe North, Co Kildare	Allen group – EPA licence P0503-01	TWD – 21550 to TWD – 23650. TWD – 24300	Proposed rehabilitation plan and PCAS measures (work is on-going on the Enhanced Rehabilitation Plan).	Natural regeneration with access roads and some forestry. Solar farm under construction to the west of Construction Working Width.	Peat was historically extracted at Timahoe North Bog. Peat depth varies from 0.2m to 1.7m. Peat comprises Brown Fibrous peat – Von Post H2-H5. Peat is underlain by deep till comprised of soft brown very sandy slightly gravelly CLAY. The till is predominantly a CLAY with variable composition of silt, sand, gravel, pebbles and cobbles. Subsoils are soft becoming firm/stiff with depth. Sandy and gravelly horizons are occasional within the till. These occur at different depths within and between boreholes. Subsoils in the surrounding area are mapped as cutover peat and till derived from limestones. Depth to bedrock is >5m.	Figure 10.3 and 10.110
Gilltown, Co Kildare	Kilberry Group – P0506-01	TWD – 26500 to TWD – 27300	Rehabilitation measures proposed.	Natural regeneration with some forestry.	Peat was historically extracted at Gilltown Bog. Deeper peat is absent in some areas of Gilltown Bog on the bog headlands. Peat depth varies from 0.3m to 4.9m. Peat comprises Brown Fibrous peat – Von Post H3-H5. Peat is underlain by deep till comprised of soft brown very sandy slightly gravelly CLAY. Subsoils in the surrounding area are mapped as till derived from limestones.	Figure 10.4 and 10.110

129. Clonad Bog – Peat depths are greater towards the south-west corner of the site. Industrial milled peat production ceased in 2020 with rehabilitation measures implemented in 2022. Milled peat was previously utilised in the ESB power stations in the Midlands and west. Some of the peat is redder and may be somewhat more acidic or younger. Within the production footprint of Clonad Bog, the majority of the remnant peat is shallow, with less than 1m of peat remaining and much of the eastern production area would be considered to be cutaway. Peat depth is 1.7m on average. Areas of underlying till are exposed in a number of areas. However, deeper peat remains in the south-west corner of the site, where peat depths are between 2m and 5m deep, along the eastern headland adjacent to the local road.

130. No active raised bog occurs in the Construction Working Width at Clonad Bog. An area of deeper degraded raised bog (Non Annex I) is located to the north of an access track which forms the boundary of the Construction Working Width at TWC – 11900 to TWC – 13350. Extensive drainage occurs along the local road and access road. Groundwater levels in the peatland were monitored at the boundary in June to August 2021. Results are included in Appendix A10.15. Groundwater levels were between 0.3m and 0.4m bgl. The site is generally of level topography, with ground slopes ranging from flat to 1/50 gradient (to the horizontal) across the landholding. Image 10.2 is taken at Clonad Bog TWC – 13250 and is representative of the cutover bogs with revegetation occurring in the drainage channels following drain blocking. The peat fields will revegetate as the rehabilitation plans progress.

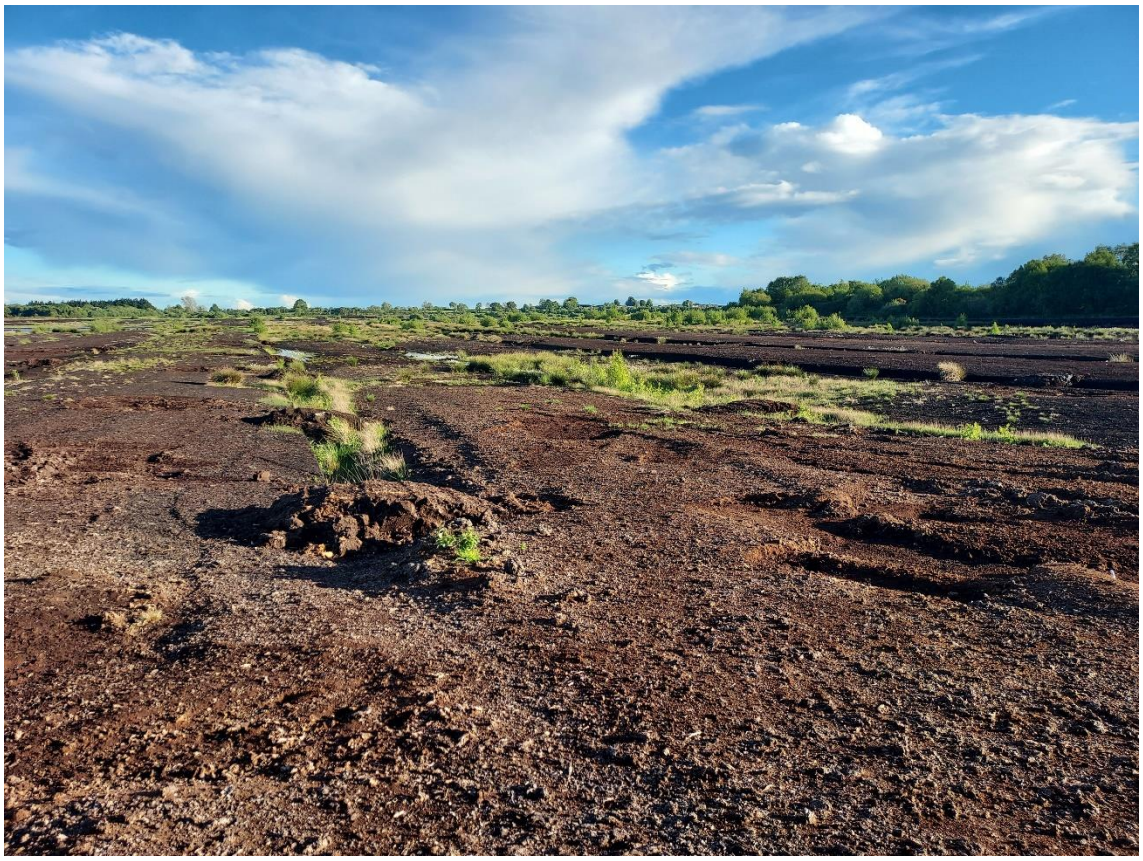

Image 10.2: Clonad Bog Looking South-West

131. Mount Lucas – Peat production at Mount Lucas Bog commenced in the mid-1970s and finished in 2018. Peat depths across the older cutaway section are shallow for the most part (<0.5m), with sections being almost completely cutaway, having exposed subsoils. The average peat depth is 1.5m with deeper peat (2m to 2.8m) along the headlands. Areas of underlying till are exposed in a number of peat drains. No active raised bog occurs in the Construction Working Width at Mount Lucas Bog. An area of deeper degraded raised bog (Non Annex I) (6.3m), is located to the north of an access track which forms the boundary of the Construction Working Width at TWC – 13400. The remnant peat is partially drained due to the presence of a bog railway and access road. Groundwater levels in the peatland were monitored at

the boundary in 2021 and in 2023. Groundwater levels were between 0.3m bgl and 0.55m bgl. The site is generally of level topography, with ground slopes ranging from flat to 1/50 gradient (to the horizontal) across the landholding. A turbary peat bank (<80m) is located outside of the Bord na Móna boundary, adjacent to the existing Bord na Móna rail track. Peat depths to the north of the Bord na Móna boundary are up to >4m in the turbary section (TWC – 17300).

132. Esker – The western section of the bog contains the deepest peat reserves with over 2.5m of peat remaining in some areas to the south of the bog. The eastern section has rather shallower peat depths remaining, with some fen peats exposed. Some of this area is also cutaway, with underlying subsoils now exposed. The peat soils are likely to be underlain with till derived from limestones, as these subsoils are exposed around the margins of the site. The average peat depth is 1.5m with deeper peat (2 to 3.8m) along the southern headland. A short section (<30m) of turbary peat is located outside of the Bord na Móna boundary. Peat depths are up to 4.3m in the turbary section (TWC – 23450) and the south-west portion, where some remaining peat up to 2m deep is present. The subsoils along the southern margin are limestone-based sands and gravels lain down by the Esker River. Grey shelly Marl and till was exposed in some of the spoil taken from the silt ponds at the southern end of the site indicating the presence of marl and till at shallow depths. No remaining active or degraded raised bog occurs within the Construction Working Width. The site is generally of level topography, with ground slopes ranging from flat to 1/100 gradient degrees (to the horizontal) across the landholding.

133. Cloncreen – A windfarm was developed at Cloncreen in 2021/2022. Industrial milled peat production ceased at Cloncreen in 2018 with rehabilitation measures implemented in 2022. The average peat depth is 1.8m with deeper peat (2m to 3m) along the eastern headland. Peats depths at the headland crossed by the Treated Water Pipeline from the BPT to the TPR (TWD – 2400 to TWD – 2800) are between 2-3m deep. Areas of underlying till are exposed in a number of peat drains. No active raised bog or degraded raised bog occurs within the Cloncreen Bog Construction Working Width. The site is generally of level topography, with ground slopes ranging from flat to 1/100 gradient (to the horizontal) across the landholding.

134. Kilcumber Bog is a private peat bog located to the south of the River Figile from TWD – 4200 to TWD – 6400. Peat depths are on average 0.9m and underlain by tills comprising soft to firm grey very sandy SILT. Peats depths at the headland crossed by the Treated Water Pipeline from the BPT to the TPR are 1.5m to 3m deep. Areas of underlying till are exposed in a number of peat drains. No active raised bog or degraded raised bog occurs within the Construction Working Width. The site is generally of level topography, with ground slopes ranging from flat to 1/50 gradient (to the horizontal) across the landholding. The nine-turbine Cushaling Windfarm (https://projects.statkraft.ie/cushaling-wind-farm/) has recently been constructed on the cutaway bog. The pipeline would be located along the adjacent wind farm access road.

135. Codd 1&2/ Sheridans – Peat depths in Codd North are generally less than 1m and underlain by tills. Peat depths at the headlands crossed by the Treated Water Pipeline from the BPT to the TPR (TWD – 6600 to TWD – 8700) are between 1–2.5m deep. Areas of underlying till are exposed in a number of peat drains. No active raised bog or degraded raised bog occurs within the Codd/Sheridan bog. The site is generally of level topography, with ground slopes ranging from flat to 1/50 gradient (to the horizontal) across the landholding. Ballydermot Windfarm (https://www.ballydermotwindfarm.ie) is currently proposed for Codd North and extends to Glashabaun. Industrial milled peat production ceased at Codd in 2020.

136. Glashabaun – Industrial milled peat production ceased at Glashabaun South in 2019/2020. Glashabaun South Bog is separated from Glashabaun North Bog by the Cushaling River corridor. It is contiguous with the Derrybrennan Bog to the north-east. Glashabaun South Bog comprises mostly regenerating cutaway bog and conifer forest. Areas of underlying till are exposed in a number of peat drains. The regenerating bog is mostly dry, heath type vegetation and scrub. A number of deep drains are present on the bog. Peat depths in Glashabaun South are generally greater than 2m and underlain by moderately firm to soft, grey sandy gravelly SILT. Peats depths along the Treated Water Pipeline from the BPT to the TPR (TWD –

9500 to TWD – 12700) are between 1-2.5m deep. No active raised bog or degraded raised bog occurs within the Glashabaun site. The site is of level topography, with ground slopes from flat to 1/50 gradient (to the horizontal) across the landholding.

137. Derrybrennan – A windfarm project is currently (2024) proposed for Derrybrennan. Industrial milled peat production ceased at Derrybrennan in 2020. Derrybrennan Bog comprises mostly regenerating cutaway bog and conifer forest. The regenerating bog is mostly dry, heath type vegetation and scrub. A number of deep drains are present on the bog. The peatland to the north of the Abbeylough River is reclaimed for agricultural use. Peat depths in Derrybrennan are generally less than 2m and underlain by moderately firm to soft, greyish brown CLAY and sandy gravelly SILT. Peat depths along the Treated Water Pipeline from the BPT to the TPR (TWD – 12700 to TWD – 15000) are between 1-2.5m deep. The Grand Canal is located to the north of the Derrybrennan Bog. No active raised bog or degraded raised bog (Annex I) occurs within the Derrybrennan Bog. The site is generally of level topography, with ground slopes ranging from flat to 1/50 gradient (to the horizontal) across the landholding.

138. Timahoe South – The Proposed Project passes along the western boundary of Timahoe South. The bog was used primarily for the industrial exploitation of peat. Industrial production ceased in 1990. Small-scale production for domestic purposes continued at the margins of the commercially cutaway bog until 2020. The peat was removed from the bog via a railway system, with many of the tracks, or sections of them still in place. Peat depths along the Treated Water Pipeline from the BPT to the TPR (TWD – 18900 to TWD – 21550) are between 0.5-2.2m deep. Deeper peat occurs in the peat headlands. Shallow peat to the west of the peatland is currently in agricultural land use. During the initial route selection areas of active raised bog were avoided. No active raised bog or degraded raised bog (Annex I) occurs within the Construction Working Width at Timahoe South. The site is generally of level topography, with ground slopes ranging from flat to 1/50 gradient (to the horizontal) across the landholding.

139. Timahoe North – The Proposed Project passes along the southern and western boundary of Timahoe North. The bog was used primarily for the industrial exploitation of peat. Industrial production ceased in 1990. Small-scale turf cutting for domestic purposes continued outside of the Bord na Móna site. A solar farm was constructed (2022–2024) to the north and north-west of the Proposed Project. The peat was removed from the bog via a railway system, with many of the tracks, or sections of them still in place. Peat depths along the Treated Water Pipeline from the BPT to the TPR (TWD – 21550 to TWD – 23650) are between 1-2.2m deep. Shallow peat to the west of the Bord na Móna peatland is currently in agricultural land use.

140. An area of deeper remnant peat is located to the west of the Timahoe Solar farm access track at TWD – 21550 to TWD – 22200 at Drumachon Bog, Timahoe, County Kildare (Appendix A8.4: Target Habitat Surveys Report). Annex I habitat is located to the north-west of Timahoe South and within the overall Timahoe North Bog. An area of active raised bog is located approximately 280m from the Proposed Project. The active raised bog and Proposed Project are separated by extensive drains along a local road and an access road for the Timahoe 110 kV substation and solar farm. Peatland water levels in the peatland were monitored at the boundary in June to August 2021. Peatland water levels within the Construction Working Width were between 0.3m and 0.4m bgl. The site is generally of level topography, with ground slopes ranging from flat to 1/50 gradient (to the horizontal) across the landholding. An area of degraded raised bog (Non-Annex I) is located at TWC – 21550.

141. Gilltown – The Proposed Project passes through the northern boundary of Gilltown. The bog was used primarily for the industrial exploitation of peat. Industrial production ceased in 2020. The remaining peat is relatively deep to the south and centre of Gilltown Bog. Peat depths along the Treated Water Pipeline from the BPT to the TPR (TWD – 26500 to TWD – 27300) are between 0.3–5.6m deep. Shallow peat to the east of the Bord na Móna bog is currently in agricultural land use. No active raised bog or degraded raised bog (Annex I) occurs within the Construction Working Width. The site is generally of level topography, with ground slopes ranging from flat to 1/50 gradient (to the horizontal) across the landholding.

142. A summary of the peat depths is provided in Table 10.13.

Table 10.13: Peat Depths and Mapped Peat Length (TWA – 0 to TWE – 17500)

Name of Bog[1]	Chainage	Total Length (m)	Inferred Peat Depth (m) [2]	
			Average	Maximum
Peat subsoil in private land #4	TWA – 3550 to TWA – 3575	25	0.2	0.6
Peat subsoil in private land #5	TWA – 3875 to TWA – 4900	850	0.5	2.5
Peat subsoil in private land #6	TWA – 5300 to TWA – 5950	650	0.9	2.1
Peat subsoil in private land #7	TWA – 8675 to TWA – 8675	0	0.0	0.4
Peat subsoil in private land #8	TWA – 9275 to TWA – 9500	225	0.5	0.9
Peat subsoil in private land #9	TWA – 12700 to TWA – 13500	600	1.6	3.2
Peat subsoil in private land #10	TWA – 19225 to TWA – 20300	500	0.3	0.8
Peat subsoil in private land #11	TWA – 20975 to TWA – 21600	625	0.4	0.6
Peat subsoil in private land #12	TWA – 22800 to TWA – 24025	825	0.4	0.8
Peat subsoil in private land #13	TWA – 27625 to TWA – 27925	300	No Data	No Data
Peat subsoil in private land #14	TWB – 6075 to TWB – 6875	800	1.0	2.0
Peat subsoil in private land #15	TWB – 8925 to TWB – 9500	400	0.4	0.7
Peat subsoil in private land #16	TWB – 10825 to TWB – 10950	125	0.5	0.7
Peat subsoil in private land #17	TWB – 12700 to TWB – 12775	75	0.2	0.7
Peat subsoil in private land #18	TWB – 13175 to TWB – 13650	475	0.5	1.1
Peat subsoil in private land #19	TWB – 14000 to TWB – 14275	275	0.4	0.9
Peat subsoil in private land #20	TWB – 14750 to TWB – 15425	675	0.5	0.9
Peat subsoil in private land #21	TWB – 18475 to TWB – 23350	4,075	0.2	1.0
Peat subsoil in private land #22	TWB – 24975 to TWB – 25525	550	0.3	0.9
Peat subsoil in private land #23	TWC – 8750 to TWC – 8925	175	1.0	1.0
Peat subsoil in private land #24	TWC – 9725 to TWC – 10425	700	0.3	0.7
Peat subsoil in private land #25	TWC – 11025 to TWC – 11600	575	0.2	0.8
Clonad Bog	TWC – 11850 to TWC – 13400	1,550	1.5	4.6
Mount Lucas Bog	TWC – 13425 to TWC – 17100	3,575	1.0	2.8
Peat subsoil in private land #26	TWC – 17125 to TWC – 17800	675	2.9	6.2
Peat subsoil in private land #27	TWC – 18825 to TWC – 19100	275	0.4	0.9
Peat subsoil in private land #28	TWC – 19250 to TWC – 20250	1,000	0.3	0.5
Esker Bog	TWC – 20275 to TWC – 21300	1,025	2.4	3.5
Peat subsoil in private land #29	TWC – 21325 to TWC – 23175	1,850	0.8	3.0
Esker Bog	TWC – 23200 to TWC – 23475	275	1.2	2.4
Peat subsoil in private land #30	TWC – 23500 to TWC – 24450	950	2.2	4.9
Peat subsoil in private land #31	TWD – 150 to TWD – 425	275	0.2	0.2
Peat subsoil in private land #32	TWD – 1900 to TWD – 2175	275	0.4	0.8
Cloncreen Bog	TWD – 2450 to TWD – 2900	450	2.2	4.5
Peat subsoil in private land #33	TWD – 2925 to TWD – 6375	3,450	1.0	4.5
Ballydermot Bog	TWD – 6400 to TWD – 14375	7,975	1.6	4.0
Peat subsoil in private land #34	TWD – 14400 to TWD – 16800	800	1.0	3.0
Peat subsoil in private land #35	TWD – 16800 to TWD – 18500	800	0.3	1.0
Peat subsoil in private land #36	TWD – 18500 to TWD – 18900	400	0.3	0.4
Timahoe South Bog	TWD – 18925 to TWD – 21500	2,575	1.0	4.5

Name of Bog[1]	Chainage	Total Length (m)	Inferred Peat Depth (m) [2]	
			Average	Maximum
Timahoe North Bog	TWD – 21525 to TWD – 23900	2,375	2.0	5.5
Timahoe North Bog	TWD – 23925 to TWD – 25225	1,275	0.6	2.5
Peat subsoil in private land #37	TWD – 25425 to TWD – 26475	1,000	1.6	4.1
Gilltown Bog	TWD – 26500 to TWD – 26975	475	3.0	5.6
Gilltown Bog	TWD – 27000 to TWD – 27300	300	1.7	3.0
Peat subsoil in private land #38	TWD – 27325 to TWD – 29325	2000	1.5	4.4

Table notes:

[1] Peat subsoils #1-3 in Table 10.11

[2] Note, peat probe data may overestimate depth of peat where it is underlain by soft tills or lacustrine deposits

143. Alluvial soils are mapped along the surface water features, along the Construction Working Width. In particular, deep alluvial soils are evident along the WTP access road, River Camcor, County Offaly (Figure 10.2), and the River Liffey floodplain, County Kildare (Figure 10.4).

10.3.2.10 38 kV Uprate Works

144. A large range of soils are present along the 38 kV Uprate Works, refer to Figure 10.1. The principal soil groups within the defined study area are:

- AminDW – Deep, well drained mineral soil derived from mainly non-calcareous parent materials
- AminPD – Deep, poorly drained mineral soil derived from mainly acidic parent materials
- MarSed – Marine/Estuarine Sediments.

145. The following soil groups also occur but are less widespread:

- AminSP – Shallow, poorly drained mineral soil derived from mainly acidic parent materials
- AminSPPT – Peaty, shallow poorly drained mineral soil derived from mainly acidic parent materials
- AminSRPT – Shallow, reasonably drained mineral soil derived from mainly acidic parent materials
- AlluvMIN – Mineral Alluvium
- Cut – Cutover peat
- Lac-Alluvium, lacustrine type soil
- Made Ground.

146. Information on the Quaternary (Subsoil) Geology is contained on the GSI website (refer to Figure 10.5 to Figure 10.8). A number of glacio-fluvial terraces are located east of Birdhill and to the west and south of Montpelier/O'Brien's Bridge.

147. With reference to the GSI online mapping, the subsoils within the study area primarily comprise till derived from Devonian sandstones/shales (TDSs), and tills derived from Lower Palaeozoic shales/sandstones (TLPDSs), underlying the 38 kV Uprate Works, as also shown in Figure 10.5.

148. Quaternary deposits such as peat, lacustrine and alluvial soils are also present within the defined study area. East of the River Shannon, areas of cutover peat overlie a mixture of marl and glacial deposits along the defined study area. No blanket peat occurs along the 38 kV route.

10.3.3 Depth to Bedrock

149. To avoid areas of shallow bedrock, the pipeline was routed away from areas of bedrock near the surface. Bedrock at the surface is mapped by the GSI data in a small area (0.3%), at the TPR and surrounding area in County Dublin.

150. Deep subsoil is present at the RWI&PS, WTP, BPS and along the majority of the Treated Water Pipeline in Counties Tipperary, Offaly and Kildare. Based on the GI, shallow bedrock (<2m) is primarily located near the following:

- Nenagh River crossing, Co Tipperary
- Part of the BPT, Co. Tipperary
- East of Killeigh village, County Offaly
- Between the River Liffey and the TPR.

151. The main areas of shallow rock occur to the east of Killeigh village (TWC – 1000 to TWC – 3000) and approximately 4km between the River Liffey (TWE – 11500) and the TPR. Borehole details are included in Appendix A10.1 (Ground Investigations 2018). With the exception of the RWI&PS, the depth to bedrock encountered at the infrastructure sites and Construction Working Width generally correlates with the GSI information on depth to bedrock. A summary of the depth to bedrock is included in Table 10.14.

Table 10.14: Depth to Bedrock at the Infrastructure Sites and Construction Working Width

Infrastructure	Depths	Descriptions	Bedrock Formation/ Notes
RWI&PS	8.4m bgl (RWI-BH015) to 14.5m bgl (RWI-BH016)	Very strong thinly bedded black and dark grey bioclastic fine to coarse-grained LIMESTONE.	Ballysteen Formation
RWRM	>20m bgl	No bedrock encountered – four boreholes to 20m bgl.	Ballysteen Formation
Pipeline WTP to BPT	0.8m bgl (BH-18231B) to 22.6 (BH-5530)	Strong sandstones and limestones. Locally weathered limestones.	Bedrock formation varies – See Table 10.15
BPT	0.3m bgl (BPT-BH002) to 30m bgl (BPT-BH027)	Weathered Limestone rock. Variable rockhead at crag and tail with infilled and weathered limestone. Strong to moderate strong Limestone. Locally very strong grey marbled light grey LIMESTONE.	Waulsortian Limestone Formation
Pipeline BPT to BPS	Generally, bedrock is >5.0m bgl; however, there are 11 rotary borehole locations with depths of less than 3.8m bgl listed hereunder: BH-36920 – 2.3m bgl; BH-36956 – 2.2m bgl; BH-36829 – 3.0m bgl; BH-40004 – 2.5m bgl; BH-41053 – 2.8m bgl; BH-43817 – 1.7m bgl; BH-48795 – 3.6m bgl; BH-49214 – 2.9m bgl; BH-50608A – 3.5m bgl; BH-58414 – 1.2m bgl; BH-61869 – 3.8m bgl	Variable rockhead with infilled and weathered limestone. Shallow rock encountered mainly adjacent to the BPT, at Knockanacree, Co. Tipperary.	Bedrock formation varies – See Table 10.15
BPS	>20.4m bgl	No bedrock encountered – two boreholes completed to 20.0m bgl.	Waulsortian Limestone Formation

Infrastructure	Depths	Descriptions	Bedrock Formation/ Notes
Pipeline BPS to TPR	Generally, bedrock is >5.0m bgl; however, there are locations with depths of less than 4.0m bgl listed hereunder: BH-95064 – 1.9m bgl; BH-95595 – 1.1m bgl; BH-96005 – 2.7m bgl; BH-97104 – 2.7m bgl; BH-166025 – 0.95m bgl; BH-169001 – 2.6m bgl; BH-165317 – 1.7m bgl; BH-149273 – 2.5m bgl; BH-109085 – 3.2m bgl; BH-108988 – 2.5m bgl; BH-150291 – 2.2m bgl; BH-149963 – 3.1m bgl; BH-150291 – 2.7m bgl; BH-165006A – 1.8m bgl; BH-166006 – 1.75m bgl; BH-166025 – 3.0m bgl; BH-166562 – 2.3m bgl; BH-163860 – 2.5m bgl; BH-165890 – 0.9m bgl; BH-165906 – 1.25m bgl; BH-165317 – 2.9m bgl	Shallow rock mainly encountered near the TPR. Predominantly very strong to medium strong, thickly to thinly bedded dark grey fine-grained LIMESTONE.	Bedrock formation varies – See Table 10.15
FCV	2.5m bgl	Very strong to medium strong (to weak where shale), thickly to thinly bedded (to very locally thinly laminated where fissile muddy limestone/shale), grey/dark grey/black, fine-grained, LIMESTONE.	Lucan Formation
TPR	1 to 2m bgl	Very strong to medium strong, thickly to thinly bedded dark grey fine-grained LIMESTONE with subordinate MUDSTONE.	Lucan Formation

152. A small fraction of the surface of the 38 kV Uprate Works area (<2%) comprises bedrock outcrop. Deep subsoils are present along the majority of the 38 kV Uprate Works in Counties Clare, Tipperary and Limerick. Shallow bedrock (<1m) is located between Birdhill, County Tipperary and Montpelier, County Limerick, in localised areas around intermediate polesets (IMPs) 93B, 242 and 249. Depth to bedrock at the Ardnacrusha Substation is 6m.

10.3.4 Bedrock Geology

153. Reference to the relevant GSI geological information indicates that the bedrock geology along the Treated Water Pipeline is varied:

- Geology of Tipperary (Archer *et al*. 1996)
- Geology of Galway/Offaly (Gatley *et al.* 2005)
- Geology of Kildare/ Wicklow (McConnell *et al.* 1994).

154. The published geological maps (GSI 2001a) indicate that the study area is principally underlain by Dinantian Limestones (320–360 million years ago) (refer to Figure 10.9 to Figure 10.12). Undifferentiated Devonian Old Red Sandstones (360–420 million years ago) and Dinantian (early) Sandstones, Shales and Limestones (359–351 million years ago) occur to the east of the WTP.

155. The distribution of geological units along the proposed Construction Working Width is based on published information from the GSI, as shown on Figure 10.9 to Figure 10.12 and summarised in Table 10.15. The composition and the characteristics of the various geological formations are discussed herein.

10.3.4.1 Keeper Hill Formation

156. The Keeper Hill Formation underlies the Birdhill 38 kV Substation and sections of the 38 kV Uprate Works. The Keeper Hill Formation comprises Breccia with locally derived clasts or with a conglomerate which contains abundant angular clasts of the underlying rock type. The basal beds are followed by repeated thinning and fining upward sequences composed of conglomerates and coarse sandstones. The variation in bed thickness, grain size, colour and proportion of sandstone is a feature of the depositional environment (Archer *et al*. 1996).

10.3.4.2 Devonian Old Red Sandstones (Undifferentiated) Formation

157. The Devonian Old Red Sandstone (DORS) Formation underlies the sections of the 38 kV Uprate Works and PSD1. GSI mapping describes the formation as '*Red conglomerate, sandstone & mudstone. Generally, the formation comprises sandstones and conglomerate which contains abundant angular clasts of the underlying rock type*' (Archer *et al*. 1996).

10.3.4.3 Ballysteen Formation

158. The Ballysteen Formation underlies the RWI&PS, WTP and PSD6 sites. The Ballysteen Formation comprises irregularly bedded and nodular bedded argillaceous bioclastic limestones (wackestones and packstones), interbedded with fossiliferous calcareous shales. The Ballysteen Formation becomes increasingly muddy in the upper part of the formation. The Ballysteen Formation is equivalent to the Boston Hill Formation in Counties Kildare and Wicklow (McConnell *et al*. 1994). Based on borehole data from the RWI&PS and the WTP, the underlying bedrock comprises strong to very strong thinly bedded grey and dark grey sparry bioclastic limestones.

10.3.4.4 Waulsortian Limestone

159. The Waulsortian Formation underlies the Ardnacrusha 38 kV Substation, BPT, BPS, CC5, CC6, PSD2, PSD4, PSD5 and PSD10 and sections of the Treated Water Pipeline. The Waulsortian Formation consists of poorly bedded, dense, pale grey micrites and grainstones. The Waulsortian Limestone is variable and can sometimes comprise cherty limestones interbedded with thin shaly bands that display a distinct wavy nodular texture. In the Northern Midlands region, the Waulsortian Formation thins into isolated mud-mounds enveloped by flank facies, which grade into fossiliferous, argillaceous bioclastic grainstones. Borehole data near the BPT site (BH197) confirm the presence of strong to very strong apparently massive grey and light grey sparry fine and coarse-grained Limestone.

10.3.4.5 Terryglass Formation

160. The Terryglass Formation underlies part of CC2 and sections of the Treated Water Pipeline from the WTP to the BPT. The formation generally consists of grey calcarenitic and oolitic limestones. Grain size varies from fine to medium and the limestones are thickly bedded throughout the formation with irregular bedding planes. No exposures were encountered at CC2 and bedrock is greater than 10m bgl to the south of CC2.

10.3.4.6 Lucan Formation (Calp Limestone)

161. The Lucan Formation underlies the TPR, PSD3, PSD4, PSD9, FCV, part of CC2 and sections of the Treated Water Pipeline. The term 'Calp' is used to refer to the various basinal limestone and shales occurring in this formation. The Calp units generally consist of dark grey, fine-grained, impure limestone with interbedded shales and veins of white calcareous spar. The variation in bed thickness, grain size, colour and proportion of shale is a feature of the depositional environment. Borehole data from the TPR site confirms the presence of very strong thinly bedded dark blackish-grey silty fine-grained LIMESTONE thickly interbedded with light grey thinly bedded fine and medium-grained LIMESTONE, with sub-vertical and vertical milky white calcitic veinlets.

10.3.4.7 Edenderry Oolite Member

162. The Edenderry Oolite Member underlies PSD8 and sections of the Treated Water Pipeline from the BPT to the TPR. The oolitic limestones are often devoid of sedimentary structures but sometimes are cross bedded.

163. The mapped rock formations along the RWRMs and Treated Water Pipeline are outlined in Table 10.15.

Table 10.15: Rock Formation Along Pipeline

From Chainage (m)	To Chainage (m)	Formation Name	Description
Twin Raw Water Rising Mains			
RW – 0	RW – 1900	Ballysteen Formation	Dark muddy limestone, shale
Treated Water Pipeline			
TW – 0	TW – 500	Ballysteen Formation	Dark muddy limestone, shale
TW – 500	TW – 1950	Lower Limestone Shale	Sandstone, mudstone & thin limestone
TW – 1950	TW – 3600	Old Red Sandstone (undifferentiated)	Red conglomerate, sandstone & mudstone
TW – 3600	TW – 5700	Lower Limestone Shale	Sandstone, mudstone & thin limestone
TW – 5700	TW – 8450	Ballysteen Formation	Dark muddy limestone, shale
TW – 8450	TW – 12150	Lower Limestone Shale	Sandstone, mudstone & thin limestone
TW – 12150	TW – 12400	Old Red Sandstone (undifferentiated)	Red conglomerate, sandstone & mudstone
TW – 12400	TW – 12600	Lower Limestone Shale	Sandstone, mudstone & thin limestone
TW – 12600	TW – 14300	Old Red Sandstone (undifferentiated)	Red conglomerate, sandstone & mudstone
TW – 14300	TW – 15700	Lower Limestone Shale	Sandstone, mudstone & thin limestone
TW – 15700	TW – 17300	Ballysteen Formation	Dark muddy limestone, shale
TW – 17300	TW – 18050	Ballynash Member	Wavy-bedded cherty limestone, thin shale
TW – 18050	TW – 20050	Waulsortian Limestones	Massive, unbedded lime-mudstone
TW – 20050	TW – 21100	Oldcourt Cherty Limestone Formation	Grey limestone & dark chert
TW – 21100	TW – 21850	Lucan Formation	Dark limestone & shale (Calp)
TW – 21850	TW – 24050	Terryglass Formation	Grey calcarenitic & oolitic limestone
TW – 24050	TW – 24300	Waulsortian Limestones	Massive, unbedded lime-mudstone
TW – 24300	TW – 25150	Lucan Formation	Dark limestone & shale (Calp)
TW – 25150	TW – 25500	Oldcourt Cherty Limestone Formation	Grey limestone & dark chert
TW – 25500	TW – 29400	Lucan Formation	Dark limestone & shale (Calp)
TW – 29400	TW – 32050	Terryglass Formation	Grey calcarenitic & oolitic limestone
TW – 32050	TW – 33100	Lucan Formation	Dark limestone & shale (Calp)
TW – 33100	TWA – 6200	Waulsortian Limestones	Massive, unbedded lime-mudstone
TWA – 6200	TWA – 8850	Ballysteen Formation	Dark muddy limestone, shale
TWA – 8850	TWA – 16050	Waulsortian Limestones	Massive, unbedded lime-mudstone
TWA – 16050	TWA – 17600	Lucan Formation	Dark limestone & shale (Calp)
TWA – 17600	TWA – 20150	Waulsortian Limestones	Massive, unbedded lime-mudstone
TWA – 20150	TWA – 20450	Oldcourt Cherty Limestone Formation	Grey limestone & dark chert
TWA – 20450	TWA – 25950	Lucan Formation	Dark limestone & shale (Calp)
TWA – 25950	TWA – 26950	Oldcourt Cherty Limestone Formation	Grey limestone & dark chert
TWA – 26950	TWB – 800	Lucan Formation	Dark limestone & shale (Calp)
TWB – 800	TWB – 1100	Oldcourt Cherty Limestone Formation	Grey limestone & dark chert
TWB – 1100	TWB – 4100	Waulsortian Limestones	Massive, unbedded lime-mudstone

From Chainage (m)	To Chainage (m)	Formation Name	Description
TWB – 4100	TWB – 5700	Ballysteen Formation	Dark muddy limestone, shale
TWB – 5700	TWB – 7600	Waulsortian Limestones	Massive, unbedded lime-mudstone
TWB – 7600	TWB – 8200	Ballysteen Formation	Dark muddy limestone, shale
TWB – 8200	TWB – 10400	Waulsortian Limestones	Massive, unbedded lime-mudstone
TWB – 10400	TWB – 10900	Ballysteen Formation	Dark muddy limestone, shale
TWB – 10900	TWB – 12350	Waulsortian Limestones	Massive, unbedded lime-mudstone
TWB – 12350	TWB – 14100	Ballysteen Formation	Dark muddy limestone, shale
TWB – 14100	TWB – 15950	Waulsortian Limestones	Massive, unbedded lime-mudstone
TWB – 15950	TWB – 16200	Lucan Formation	Dark limestone & shale (Calp)
TWB – 16200	TWB – 17700	Waulsortian Limestones	Massive, unbedded lime-mudstone
TWB – 17700	TWB – 18850	Allenwood Formation	Thick-bedded limestone, locally peloidal
TWB – 18850	TWB – 21100	Waulsortian Limestones	Massive, unbedded lime-mudstone
TWB – 21100	TWB – 21550	Ballysteen Formation	Dark muddy limestone, shale
TWB – 21550	TWB – 24750	Waulsortian Limestones	Massive, unbedded lime-mudstone
TWB – 24800	TWB – 26900	Ballysteen Formation	Dark muddy limestone, shale
TWB – 26900	TWB – 27850	Waulsortian Limestones	Massive, unbedded lime-mudstone
TWB – 27850	TWC – 11300	Lucan Formation	Dark limestone & shale (Calp)
TWC – 11300	TWC – 11450	Waulsortian Limestones	Massive, unbedded lime-mudstone
TWC – 11450	TWC – 18900	Edenderry Oolite Member	Oolitic limestone
TWC – 18900	TWC – 20000	Waulsortian Limestones	Massive, unbedded lime-mudstone
TWC – 20000	TWD – 3400	Edenderry Oolite Member	Oolitic limestone
TWD – 3400	TWD – 8900	Lucan Formation	Dark limestone & shale (Calp)
TWD – 8900	TWD – 13100	Ballyadams Formation	Crinoidal wackestone/packstone limestone
TWD – 13100	TWD – 15000	Allenwood Formation	Thick-bedded limestone, locally peloidal
TWD – 15000	TWD – 23550	Waulsortian Limestones	Massive, unbedded lime-mudstone
TWD – 23550	TWD – 24000	Allenwood Formation	Thick-bedded limestone, locally peloidal
TWD – 24100	TWE – 1150	Lucan Formation	Dark limestone & shale (Calp)
TWE – 1150	TWE – 1750	Tober Colleen Formation	Calcareous shale, limestone conglomerate
TWE – 1750	TWE – 2700	Waulsortian Limestones	Massive, unbedded lime-mudstone
TWE – 2700	TWE – 6800	Boston Hill Formation	Nodular & muddy limestone & shale
TWE – 6800	TWE – 7950	Waulsortian Limestones	Massive, unbedded lime-mudstone
TWE – 7950	TWE – 8350	Tober Colleen Formation	Calcareous shale, limestone conglomerate
TWE – 8350	End	Lucan Formation	Dark limestone & shale (Calp)

Source: GSI All Ireland bedrock map (GSI 2016)

164. The distribution of geological units is based on published information from the GSI. The borehole data are consistent with the published GSI information. Geological units underlying the Proposed Project are shown in Figure 10.9 to Figure 10.12.

10.3.5 Geomorphology and Geohazards

165. Geomorphology is the study of the landforms which comprise the Earth's surface, the processes which have modified and shaped it in the past and which continue to modify and shape it at the present time (NRA 2009). The geomorphology of the Proposed Project is shown on Figure 10.87 to Figure 10.91.

166. The RWI&PS and WTP sites are located in an area generally characterised as gently rolling drumlin landscape. The GSI Physiographic Unit for the same area is categorised as 'Rolling ice-moulded sediments'. Drumlins take a variety of forms with the majority elongated in the direction of ice flow. Most drumlins in the RWI&PS and WTP sites are composed of glacial tills and a small number are rock-cored. The drumlins in the area of both the RWI&PS and WTP are orientated north to south, indicating the direction of glacial ice flows. A number of crag and tails are located near the BPT and Sharavogue. To the east of the BPT, the frequency of drumlins decreases. Eskers are located at Ardcrony, south of the BPS, Geashill and north of Mount Lucas Bog.

167. Geohazards including karst formations, peat and potential risk of landslides were identified as part of the scoping works and site walkovers, as described in the following section.

10.3.5.1 Fort Henry Embankment

168. The proposed RWI&PS site is located to the north of Fort Henry Embankment, which forms part of the Parteen Basin impoundment. The embankment is classified as a category A dam. While there are no proposed works to the embankment, a geotechnical risk assessment has been conducted identifying the potential risks to the dam during construction and operation of the proposed RWI&PS – refer to Appendix A10.2. The toe of the embankment is approximately 7m from the site boundary at the RWI&PS. It functions as an engineering structure approximately 60m south of the RWI&PS site boundary.

10.3.5.2 Karst

169. Karstification is an important process in Irish hydrogeology. It involves the enlargement of rock fissures when groundwater dissolves the fissure walls as it flows through them. The process can result in significantly enhanced permeability and groundwater flow rates. It occurs in 'purer' limestones. Pure, clean coarse limestone (90–100% calcium carbonate $CaCO_3$) is prone to dissolution by rainfall. The enlargement (by dissolution) of geological discontinuities (joints, fractures, etc.) leads to the formation of a distinctive karst landscape which includes landforms such as closed depressions (dolines), sinkholes, springs, turloughs (seasonal lakes which occur in winter and early spring when the groundwater table rises above the land surface) and caves.

170. Much of the underlying limestone bedrock has the potential for varying degrees of karstification. An assessment of all reported and known karst features in proximity to the route has been conducted based on the following:

- Karst features such as sinkholes, turloughs, caves, etc. GSI database, mapped areas of groundwater flooding or the published geological heritage
- Evidence of karst development in subsoil or bedrock conditions shown in boreholes or geophysical tests, large local variations in depth of bedrock (particularly beneath structures)
- Evidence of surface erosion features based on site reconnaissance.

171. The GSI Groundwater Karst Features database was consulted (GSI 2012). This database holds records of locations and types of reported karst features; however, the database focuses mainly on areas prone to karstification and is incomplete. No karst features were mapped on the infrastructure sites as part of the field survey, review of aerial photography or LiDAR data. Based on a review of the GSI database, no karst features have been mapped by the GSI within 1km of the RWI&PS, WTP, BPT, BPS, FCV and TPR sites. No karst features are mapped by the GSI within the Construction Compounds' boundaries or PSDs. No surficial karst features are identified during the site walkovers within the RWI&PS, WTP, BPT, BPS, TPR Construction Compounds' boundaries or PSDs. No karst features were identified within the study area of the 38 kV Uprate Works. There are nine karst features recorded by the GSI as being located within 2km of the Construction Working Width. These have been mapped in two main clusters, between Chainages TW – 30000 to TW – 35000 and between Chainages TWB – 22200 to TWC – 9000, and

include a variety of features such as springs, swallow holes, and superficial solution features. Notable karst features that have been identified as part of the Proposed Project are discussed below.

172. According to GSI mapping[6] the muddy limestones of the Ballysteen Formation underlie the RWI&PS, WTP and TPR. The Ballysteen Formation is a member of the Dinantian Impure bedded Limestones Rock Unit Group, which are less susceptible to karst solution than pale, pure bedded limestones. According to GSI mapping, both the BPS and BPT sites are underlain by Waulsortian Limestone which is categorised into the Dinantian Pure Unbedded Limestones Rock Unit Group, which are generally susceptible to dissolution; however, no surficial karst features are recorded on the BPT or BPS.

173. The BPT is located to the north of a large crag and tail, a glacial landform consisting of a rock cored hill and tapering ridge, which is produced by selective erosion and deposition beneath an ice sheet. Depth to bedrock changes over short distances at the BPT in particular on the direction of ice flow as detailed in Section 10.3.3 and Appendix A10.4 to Appendix A10.14 (2022 and 2023 Ground Investigations). No surface karst features were identified during the site walkover of the BPT site or the alternative sites in the surrounding area. A 6m wide gravel and clay infilled channel/paleokarst feature is located on the BPT. The term 'paleokarst' is used to describe '*buried, inert and fossilised karst*' (Drew and Jones 2000). Glacial till is present at the surface, obscuring any outcrop of the channel or its infilling sediments. The presence of buried karst in the Waulsortian Limestone is known from literature elsewhere in Ireland (e.g. Murray and Henry 2018), as indicated by infilled fractures in the borehole logs. No open cavities or caves were encountered at the BPT. Borehole logs are included in Appendix A10.1 (Ground Investigations 2018) and Appendix A10.4 to Appendix A10.14 (2022 and 2023 Ground Investigations).

174. The Proposed Project has considered submissions received during the non-statutory public consultation process, which followed the publication of the Final Options Appraisal Report (Irish Water 2016b) and the Environmental Impact Statement Scoping Report (Irish Water 2016a) in respect of a previous iteration of the project design, to the extent that those submissions remain relevant to the Proposed Project. A detailed submission was received from a hydrogeologist on behalf of a group of landowners in the Ardcrony/Ballythomas area of County Tipperary. Concerns raised included the potential for encountering karst and the potential effects on groundwater flow. A number of potential karst features and areas of groundwater flooding were identified through desktop mapping and site walkover surveys in the Ardcrony/Ballythomas area. Walkovers were undertaken by TOBIN staff (John Dillon, Leo Brogan, Michelle Wong) with experience in mapping karst features. Walkovers of a number of sites were undertaken in conjunction with specialist wetland ecologists. Two recorded karst features are located within 0.5km of the Treated Water Pipeline from the WTP to the BPT, namely Ballylusky Swallow Hole and an enclosed depression located to the north-east of Ardcrony/Ballythomas, County Tipperary. Ballylusky Swallow Hole is located 0.5km south of the proposed Treated Water Pipeline from the WTP to the BPT (Chainage TW – 30350), while the enclosed depression is 0.25km to the south of the Treated Water Pipeline from the WTP to the BPT (Chainage TW – 30600). The karst features are located 0.8km east of CC2. Field and desk-based surveys of the features were undertaken as part of site walkover surveys for previous iterations of the project from in 2016 to 2019. The information collected remains valid and relevant for the purposes of assessing the likely significant effects of the Proposed Project. The Treated Water Pipeline avoids areas of groundwater Indicative Flood Hazard. A flood risk assessment is included in Appendix A9.4.

[6] https://www.gsi.ie/en-ie/data-and-maps/Pages/Groundwater.aspx#KarstFeatures

175. Borehole and geophysical data were gathered, with particular attention given to a number of areas including Ardcrony/Ballythomas. Borehole data indicate that no significant karst features were encountered along the Treated Water Pipeline from the WTP to the BPT route. As part of the 2016–2017 site walkover surveys, field and desk-based karst feature mapping was carried out in the Ardcrony/Ballythomas area, TW – 22400 to TW – 31000. Based on a review of the GSI indicative flood mapping, the main areas of groundwater flooding in the Ardcrony/Ballythomas area are shown in Figure 10.13. Rotary core boreholes were installed in June 2017 to determine the depth of subsoil in the Ardcrony/Ballythomas area and assess the quality of the bedrock. A geophysical survey was carried out in May and June 2017. The geophysics survey consisted of EM31 ground conductivity, 2D-Resistivity and seismic refraction (p-wave) measurements. The geophysical survey is an efficient non-intrusive method which informs the subsequent targeted direct investigations. It determines the depth to rock and the overburden thickness to estimate the strength/stiffness/compaction of overburden and the rock quality, to establish the presence of faults and fracture zones and to detect possible karstified rock. GI results are included in Appendices A10.1 and A10.7. The GI works indicated groundwater flow in the Ardcrony/Ballythomas area is by diffuse flow via permeable sand and gravel deposits and fracture/fissure flow. Based on the GI borehole data, no karst features were encountered in boreholes drilled in the Ardcrony/Ballythomas area.

176. Based on the borehole data at Ardcrony/Ballythomas, the bedrock appears competent, dark grey impure limestones, typical of the Lucan Formation. Borehole records from the GSI database indicate poor to moderate yields in the Lucan Formation in the surrounding area. A 24-hour pumping test was completed on BH233 during the optimal summer period in July 2017. The pumping test was undertaken to determine the hydraulic properties of the underlying bedrock aquifer. Groundwater levels in the borehole and in surrounding observation wells, including BH232 and BH234, were recorded for the duration of the test. Limited inflows were encountered in BH233 and the pump test was started at 7.2m^3/day. The specific capacity of BH233, also derived from the pumping test data, is low at 1.2m^3/day/m. No groundwater response was recorded in the adjacent wells. Pumping test results demonstrate the yield of the well is ‘poor’ according to GSI classification and do not indicate karstic groundwater flow at this location. No karst features were encountered in the boreholes at Ardcrony/Ballythomas. Calcium carbonate testing of the bedrock confirms the presence of impure limestones which underlie much of the Ardcrony/Ballythomas area.

177. The Ardcrony/Ballythomas area is modified in terms of drainage and infilling works. Large man-made drains provide an extensive drainage network in this area. Electrical conductivity monitoring was undertaken in the Ardcrony area in February 2016 and March 2018. Conductivity values reflect the geological environment in which the groundwater percolates through and can also be used as an indicator of contamination. The natural background median Electrical Conductivity is 472 microsiemens/ centimetre (µS/cm) in impure limestones in groundwater (EPA 2017). Conductivity values in the groundwater flooded areas were <310µS/cm indicating a surface water influence whereas groundwater conductivities in the limestone are between 680µS/cm and 800µS/cm in the groundwater-fed Ardcrony Stream and Lough Ourna respectively.

10.3.5.3 Peat and Risk of Landslides

178. No peat was identified at the sites proposed for the RWI&PS, WTP, BPT, BPS, FCV or TPR. Localised peaty soils (<0.5m) and peat horizons were encountered along the WTP access road. Peat was mapped along the existing 38 kV line. Extensive areas of peat are identified along the Treated Water Pipeline. Peat areas are shown on Figure 10.5 to Figure 10.8 and on Figure 10.92 to Figure 10.110. As detailed in Section 10.3.2, the peatland areas are predominantly drained, cutover peat with some areas reclaimed as agricultural land.

179. A review of the landslide information on the GSI Irish Landslides Database[7] indicates that the nearest recorded landslide occurred approximately 1.2km north of the BPS 38 kV grid connection (GSI_LS03-0054 the Lisheen landslide of 1900). Physiographic maps are cartographic representations of the broad-scale physical landscape units of a region. The GSI geomorphology maps are shown on Figure 10.87 to Figure 10.91.

180. The GSI has published a 1:50,000 scale Landslide susceptibility mapping. Landslide susceptibility mapping is included on Figure 10.113 to Figure 10.117. There are no landslides recorded within 1km of the Proposed Project. The peatland at Lisheen was subsequently drained and extracted as part of private peat extraction works since the 1960s. No records of instability were recorded post 1960. The proposed grid connection is located in the regional road and there are no proposed works in the Lisheen peatland. Figure 10.113 to Figure 10.117 show the GSI Landslide Susceptibility mapping for the Proposed Project. The Proposed Project is designated as 'Moderately Low' or 'Low' susceptibility.

10.3.6 Contaminated Land

181. An evaluation was undertaken to check if contaminated land sites are present at the RWI&PS, WTP, BPT, BPS, FCV and TPR and Construction Working Width. Data sources on contamination were examined including Section 22 EPA data, EPA Licence data, consultation with local authorities, aerial mapping and potential sources during site walkover surveys. Potential contamination/waste sites are identified on Figure 10.82 to Figure 10.86. Potential contamination sites, waste facilities or historical pits were identified within 1km of the Construction Working Width (refer to Table 10.16). The distance to the nearest infrastructure element was used.

Table 10.16: Potential Contaminated Land Sites Within 1km of the Construction Working Width

Chainage	Approximate Distance (m) and Direction from Nearest Pipeline Section	Description
WTP Access road	0m to Proposed Project boundary, 580m south of WTP	Former building at petrol station to be removed
Chainage TW – 7700 to TW – 8100	250m south-east of Treated Water Pipeline from the WTP to the BPT	Gortmore TMF – Silvermines area
Chainage TW – 36300	800m south of Treated Water Pipeline from the WTP to the BPT	Reclaimed land/historical dump – Cloughjordan historical dump
Chainage TWC – 9000	<50m south-east of Treated Water Pipeline from the BPT to the TPR	Former gravel pit, historical construction and demolition waste area – Geashill
Chainage TWD – 20900	800m south of Treated Water Pipeline from the BPT to the TPR	Drehid Waste Management Facility – existing waste management facility – EPA licence W0201-03 (IED)

Source: OSI Aerial Photos (1995–2005) and historical maps and reports.

182. One small disused petrol station was identified on the R445, at the proposed access road for the WTP (refer to Figure 10.82). The proposed access would cross the Knockadromin Stream (WCX002) at the former petrol station. Two disused pumps and an underground storage tank are surrounded by the Kilmastulla River and Knockadromin Stream (Kilmastulla_050) and the R445. The tanks are located within 1m of the Knockadromin Stream. Site investigations were conducted in May 2021 along the Knockadromin Stream bank and the Kilmastulla River. No oil or oil staining was noted on the Knockadromin Stream. Samples were taken upgradient and downgradient of the former petrol station. Soils and surface water concentrations along the Knockadromin Stream are comparable to natural background metal and hydrocarbon concentrations (Baker *et al.* 2007). Results are included in Appendix A10.15 (Groundwater Levels: Summary of Private Groundwater Supplies 2021-2025).

[7] www.gsi.ie

183. No potential contaminated sites are identified at the RWI&PS, WTP, BPT, BPS, FCV and TPR sites. No potential contaminated sites are identified at Construction Compound or PSD locations. Soils at the infrastructure sites comprise natural topsoil and subsoils as identified in Section 10.3.2. Silvermines (Gortmore) Tailings Management Facility (TMF) is located 200m downgradient of the Construction Working Width. The Gortmore TMF is a large, engineered tailings disposal facility. Since cessation of mining in the 1990s, the TMF was rehabilitated. Historical metal and sulphate contamination occurred at the TMF. Surface water monitoring in the Kilmastulla River indicates that natural attenuation and dilution in the environment results in metals within acceptable surface water concentrations. Rehabilitation works have been completed at various localities in the Silvermines including Gortmore TMF, with works administered by North Tipperary County Council on behalf of the Department of Climate, Energy and the Environment. The rehabilitation work has included capping poorly and non-vegetated areas of the TMF surface; establishing a grassland sward on the capped areas of the TMF; various engineering works on the TMF (e.g. improvements to the surface water drainage system and construction of rockfill buttresses to lessen the slopes of the TMF sidewalls); and remedial works to the TMF's retention ponds and wetlands, so as to improve the quality of waters discharging into adjoining watercourses. Dissolved metal concentrations in the water are above acceptable levels and dilution in the Kilmastulla River brings these to within acceptable limits. The levels of dissolved metal in the surface water, while slightly elevated above background levels, are within drinking water limits downgradient of the TMF (CDM Smith 2019). Concentrations of metal on the banks of the Kilmastulla River are elevated. Samples taken on 21 May 2021 indicated cadmium, lead and zinc concentrations on the banks of the Kilmastulla were elevated at 10.2mg/kg, 893mg/kg and 2,310mg/kg respectively. Conversely, soil metal concentrations for copper were within natural limits. Results from BH51 (Appendix A10.1) are comparable to background agricultural concentrations as shown in Table 10.17.

Table 10.17: Soil Sample Results – Silvermines

Sample	Kilmastulla Bank Sample 0.1km South of WTP Access Road	Soil Concentration Sample (BH51)	Typical Irish Background Soil Concentrations - 5%ile to 95%ile Values (EPA 2007)
Parameter	mg/kg	mg/kg	mg/kg
Arsenic	19.5	9.4	1.4 – 22
Copper	54.3	27	4 – 46
Lead	893	51.4	12-62
Zinc	2,310	74.4	16-145

184. An assessment was undertaken of potentially contaminated land sites located in close proximity (within 1km) to the route of the Proposed Project. The assessment was based on an evaluation of historical Ordnance Survey plans of the sites; LiDAR and OSI aerial photographs[8] of the sites listed in Table 10.18; site walkovers carried out between 2016 and 2021; GI data; EPA information and relevant reports such as the Silvermines remediation plan and monitoring reports.

185. In addition to specific sites, there is a general potential for pollution from agricultural chemicals on present and past agricultural land, and from buried material which may occur anywhere along the Proposed Project. Potential contaminants include hydrocarbons and asbestos. Made ground will be encountered on farm access roads and at public road crossing points. The Treated Water Pipeline from the WTP to the BPT crosses Bord na Móna access roads at Monettia Bog (TWB – 25200) and Mount Lucas Bog (TWC – 17600). Railway tracks within the Bord na Móna sites were constructed mainly on peat; however, the embankments in areas are comprised of reworked soils. Access tracks and hardstanding were recently constructed for the Cushaling Windfarm (TWD – 4500 to TWD – 6200). At Chainage TW – 22500 to TW – 22600, TWC – 21500, TWD – 29100 and TWE – 15600, soils are modified and reworked. Where made

[8] OSI maps - https://www.geohive.ie/

ground is encountered, material will require testing and management in accordance with the Waste Management Act 1996 as amended. No significant agricultural related contamination (fuel spillages or farm waste) was identified during the field surveys or GI. No hydrocarbon odours were identified during the field surveys or GI.

186. No visible contamination was identified at the Birdhill Substation or along the 38 kV Uprate Works.

187. A number of disused quarries and soil excavation works were identified along the Construction Working Width. The excavations were minor and have largely been developed for use in construction activities in the local area. Excavations at TW – 19700, TW – 27800 and TW – 28400 appear to be localised and limited in area/extent. Extraction areas were <1ha in size and 2–4m deep. Based on site walkovers and GI, no evidence of waste or contaminated land was encountered. No evidence of hydrocarbon spills was noted.

188. Geashill historical pit is located to the south of the Construction Working Width at TWC – 9000. The area is a former sand and gravel pit that contains waste/construction and demolition materials used to backfill the area in approximately the 1960s. Mature/semi-mature woodland has become established on the site since with ash and oak at least 30 years old on the Geashill site. No surface water features were noted in the vicinity of the waste disposal area. The nearest surface water feature to the Geashill waste area is Tullamore Stream. The Ballinagar Group Water Scheme (GWS) and Geashill Public Water Scheme (PWS) are located downgradient of the waste area. The waste area is located within the ZoC/SPZ for both abstractions. Two boreholes (BH231 and BH224) were installed in 2018 to the northern boundary of the alleged waste area. TP-102105 and BH-102037 were installed in 2023 at Geashill. No evidence of waste was found from the trial pit or borehole logs in the Construction Working Width. Based on the information available from site walkovers and on-site investigation data, no evidence of historical waste disposal was identified within the Construction Working Width.

189. The Construction Working Width is not located within the SPZ for the Dalgan Springs, as delineated in the Geashill Public Supply – Groundwater Source Protection Zones (GSI 2001b). The GSI prepared the source protection report at the request of Offaly County Council, to delineate SPZs for Geashill spring, outline the principal hydrogeological characteristics of the Geashill area and to assist Offaly County Council in protecting the water supply from contamination.

190. Two boreholes (BH231 and BH224) were installed at the northern boundary of the Geashill waste area, as shown in Figure 10.61. BH046 was installed 50m downgradient of the waste area. No evidence of waste was encountered at these locations. Based on the information available from site walkovers and ground investigation data, no evidence of historical waste disposal was identified within the Construction Working Width.

191. Two groundwater samples were taken in August 2017 from BH046 and BH231 at Geashill, installed as part of the ground investigation programme. The groundwater samples were submitted to ALS Laboratories for analysis of a comprehensive suite of parameters and the results are discussed in the following paragraphs.

10.3.6.1 Interpretation and Discussion of Geashill Groundwater Analytical Results

192. No visual or olfactory evidence of contamination was noted during the sampling of the groundwater monitoring boreholes (BH046 and BH231) at Geashill. No Polychlorinated biphenyls (a persistent organic pollutant) were detected in any of the groundwater samples. Laboratory results are included in Appendix A10.1 (Ground Investigations 2018). Conductivity values ranging from 571µS/cm to 664µS/cm were reported by the laboratory for the groundwater samples. Electrical conductivity can be used as a gross contaminant indicator (EPA 2005). The conductivity values are typical values for groundwater from limestone sand and gravels aquifers (EPA 2017) and do not indicate contamination. The pH ranges between 7.6 and 7.8, which is slightly alkaline and typical of limestone subsoils and bedrock in the area. Laboratory results are included in Appendix A10.1 (Ground Investigations 2018).

193. There are no reported nitrate exceedances above the Drinking Water Regulations[9] Maximum Parametric Values (MPV) of 50mg/l at Geashill. Elevated ammonia levels were noted in BH231 (0.41mg/l), but concentrations were below detection limits in BH046 (<0.3mg/l). The low nitrate concentrations in BH231 and presence of nitrite suggest nitrate-reducing conditions are present in the groundwater at this location. Chloride concentrations range from 25.5 to 26mg/l and do not indicate a significant source of contamination in close proximity to the boreholes. The potassium:sodium (K:Na) ratio is low, at 0.18 to 0.25. A high K:Na ratio >0.35 would suggest a source of organic contamination (e.g. septic tank systems or farmyards, landfills or land spreading of agricultural wastes).

194. The reported metal concentrations are within the corresponding MPVs, with the exception of the nickel detected in the groundwater sample collected from BH046 at Geashill (see Appendix A10.1). Iron concentrations are low and below their respective drinking water MPV. Elevated manganese was detected in BH231. Elevated concentrations of manganese are frequently encountered in the limestone gravels and limestone bedrock. This is likely to reflect reducing conditions in the groundwater. The concentrations of sulphate, potassium, sodium, magnesium and calcium are within normal ranges at Geashill. In summary, a low K:Na ratio, chloride and conductivity values all indicate that there is no contamination from any organic source such as the Geashill waste area.

10.3.7 Current and Historical Mining Sites

195. There are no active mines within the study area of the 38 kV Uprate Works. A number of active prospecting licences are present along the 38 kV Uprate Works in County Tipperary. Lead and zinc deposits are the principal commodities of exploration interest in Ireland. Other commodities that are occasionally associated with midland base metal deposits include silver and barite. Significant mineralisation has also been found in underlying sub-Waulsortian strata at Silvermines, 8km to the east. There are no known economically significant lead and zinc deposits within the area of the 38 kV Uprate Works based on a review of available GSI online Document, Maps and Information Explorer (GOLDMINE) data[10].

196. There are no active mines in the study area of the Proposed Project. The Silvermines mining area is located on the foothills of the Silvermine Mountains in County Tipperary. Mining at Silvermines dates from the 13th century. The Silvermines area has been mined intermittently for lead, zinc, copper, silver, barite and sulphur. The mining sites include Ballygown, Garryard, Gorteenadiha, Magcobar and Shallee, all located to the south and south-east of the Limerick to Dublin Railway. The Ballygown, Garryard, Gorteenadiha, Magcobar and Shallee mining areas are located more than 3km from the Treated Water Pipeline from the WTP to the BPT. The Gortmore TMF is located more than 200m from the proposed Construction Working Width between Chainage TW – 7700 and TW – 8400. No made ground or contamination was recorded in BH51 during the GI works. Metal concentrations at BH51 located 0.25km to the north-west of the TMF (TW – 8000) are within natural background levels, as outlined in Appendix A10.1 (Ground Investigations 2018) and included in Table 10.17.

197. The underground operations by Mogul Mines Ltd. (Mogul) at Garryard, more than 4km to the south-east of the Treated Water Pipeline from the WTP to the BPT, resulted in the generation of significant volumes of fine to coarse-grained sand particles referred to as tailings. Approximately eight million tonnes of such tailings were deposited in a specially constructed and lined, 60ha TMF at Gortmore. Rehabilitation works in 2008/2009 were completed at various localities including Gortmore TMF, with the site work administered by North Tipperary County Council, on behalf of the Department of Communications, Energy and Natural Resources (SRK 2014; and CDM Smith 2019). There is no active or proposed mining in the Construction Working Width. Elevated metals occur in the Kilmastulla River alluvial deposits downgradient of the Silvermines – see Section 10.3.6.

[9] S.I 122 of 2014 as amended

[10] https://secure.decc.gov.ie/goldmine/index.html

198. There are no active mines within the proposed infrastructure sites, 38 kV Uprate Works, RWRMs, PSDs, Construction Compounds (CCs) or Treated Water Pipeline. A number of active prospecting licences are present along the Treated Water Pipeline from the BPT to the TPR in County Offaly and County Kildare. Lead and zinc deposits are the principal commodities of exploration interest in Ireland. Active prospecting licences are located in areas around Kilcormac, Rhode and Castlejordan. There are no known economically significant lead and zinc deposits within the Proposed Project.

10.3.8 Aggregate and Extractive Industries

199. Various datasets were consulted in establishing the economic geology of the study area, including:

- GSI: Aggregate Potential Mapping
- GSI: Mineral localities
- OSI: Aerial mapping (1995 –2024).

200. The Aggregate Potential Mapping (APM) of Ireland as carried out by the GSI Minerals Section is available on the GSI Website[11]. The existence of aggregate potential within the 20m wide Permanent Wayleave could result in a potential loss of available aggregate. The APM indicates the RWI&PS and WTP are underlain by very high potential while the WTP, BPS, FCV and TPR are underlain by low rock aggregate potential. Two active sand and gravel pits are present along the proposed 38 kV Uprate Works, to the south of Montpelier, Co. Tipperary.

201. Based on a review of the GSI mineral data, there are no mapped mineral localities at the RWI&PS, WTP, BPT, BPS, FCV and TPR sites. There are no mapped mineral localities along the Construction Working Width. Further details are provided in Section 10.3.7.

202. Peat was harvested in a number of locations along the Treated Water Pipeline from the BPT to the TPR, primarily County Offaly and County Kildare. In east County Offaly, Bord na Móna has a substantial extent of land subject to former peat harvesting, and the Treated Water Pipeline from the BPT to the TPR would traverse a number of cutover bogs including Mount Lucas, Ballydermot and Timahoe. Areas of private peat cutting occurred at Kilcumber, Co. Kildare, TWD – 4500 and TWD – 6400. Peat cutting in this area has ceased since 2019. Turf cutting occurs on a number of turbary areas along the pipeline including TWC – 17300, TWC – 23550 and TWD – 27100. In areas of Tipperary, Offaly and Kildare, a long history of peat cutting and drainage has converted peatland areas to agriculture and forestry.

203. The Bord na Móna peat activities are regulated by IPC licences issued by the EPA. Peatland rehabilitation has commenced on the cutover bogs and will be undertaken on the Bord na Móna bogs as detailed in EPA Licences P0500-1 (Boora group), P0503-01 (Allen Group) and P0501-01 (Derrygreenagh Group). Table 2.1 in Appendix A5.3 (Methods of Working in Peat) summarises the status of the Bord na Móna rehabilitation plans (including enhanced plans under PCAS). Peat extraction ceased on the Bord na Móna sites in 2019.

204. Peat is mapped in a small number of locations along the 38 kV Uprate Works, primarily in County Tipperary. The shallow peat areas overlie marl, estuarine silts, clays and gravels along the former flood plains of the River Shannon. Peat is present at IMP 83B, refer to Figure 10.93. There is no potential for peat extraction along the 38 kV Uprate Works.

[11] https://dcenr.maps.arcgis.com/apps/webappviewer/index.html?id=ee8c4c285a49413aa6f1344416dc9956

10.3.9 Irish Geological Heritage Sites

205. The GSI has compiled a list of Irish Geological Heritage (IGH) sites proposed for designation as Natural Heritage Areas (pNHAs). The GSI has also determined a secondary list of CGSs, which may be considered for protection at local authority functional control level. CGSs are incorporated into County Development Plans. Information in relation to geological heritage sites is included in Clarke *et al.* (2005), Gallagher *et al.* (2019) and Hennessy *et al*. (2016). There are no geological pNHAs within the Proposed Project.

206. The GSI was consulted as part of the route selection process with regard to areas that may have geological and geomorphological importance. No IGH sites are present at the RWI&PS, BPT, BPS, FCV and TPR locations. There are two IGH sites located along the Treated Water Pipeline from the WTP to the BPT, one of which is near the WTP itself. Two IGH sites are located along the Treated Water Pipeline from the BPT to the TPR, with an additional IGH within 200m of the pipeline. All IGH sites are proposed as CGS and detailed in Table 10.18 and shown on Figure 10.18 to Figure 10.22.

Table 10.18: Geological Heritage Areas Along the Construction Working Width

Site Name[12]	Proposed Project Location	Chainage	IGH Theme
Kilmastulla Meltwater Channels (CGS)	Eastern extent of the RWI&PS, RWRMs, WTP and sections of the Treated Water Pipeline from the WTP to the BPT	TW – 0 to TW – 5150	IGH7 Quaternary theme
Ardcrony Esker (CGS)	Treated Water Pipeline from the WTP to the BPT	TW – 27800	IGH7 Quaternary theme
Kinnitty Esker (CGS)[13]	Treated Water Pipeline from the BPT to the TPR crosses the mapped esker between Birr and Kinnitty	TWA – 27350	IGH7 Quaternary theme
Kilcormac Esker (CGS)	Treated Water Pipeline from the BPT to the TPR crosses the mapped esker between Geashill and Ballinagar	TWC – 8900	IGH7 Quaternary theme
Liffey River Oxbow (CGS)	Treated Water Pipeline from the BPT to the TPR – <200m north of the Treated Water Pipeline from the BPT to the TPR	TWE – 10350 to TWE – 10750	IGH14 Fluvial/ Lacustrine Geomorphology theme

207. The Kilmastulla Meltwater Channels CGS comprises a series of deep channels that were formed by meltwater erosion in the wide valley between the Arra and Silvermines Mountains. The channels extend for approximately 7km and into County Limerick, where further channels are recognised around Birdhill. The Kilmastulla CGS covers a large area. There is no evidence of meltwater channels on the WTP site and the meltwater channels appear to correspond with the Kilmastulla River and its floodplain to the south of the Proposed Project. Subsoils within the Kilmastulla Meltwater Channels CGS vary along the pipeline and comprise a series of alluvial deposits (peat, silts, well sorted sand and gravels), which overlie glacial tills. Interlayering of peat and alluvial soils occurs between the WTP and Kilmastulla River.

208. Ardcrony Esker CGS extends as a segmented and bifurcated esker system from Claree Lough (4km east of the Lough Derg shore), eastwards towards Ardcrony, and further south-eastwards to the Limerick-Ballybrophy railway line, a total distance of approximately 12km. The esker is an example of a complex, multi-crested esker ridge which comprises numerous segments or beads. The esker ridges are noticeable as elevated ridges standing proud of the otherwise flat landscape. The esker has a very complex, generally sinuous morphology, and varies from wooded and vegetated ridges, to crests along which roads meander, and broad fans quarried for sand and gravel. A number of gravel extraction pits are evident in the Ardcrony area.

[12] Based on GSI data www.gsi.ie.

[13] Currently categorised as a County Geological Site but may be upgraded to NHA status at a later date.

209. Based on the GI, esker sands and gravels occur in the wider area but appear absent within the Construction Working Width. Natural deposits within the Ardcrony Esker CGS were described in the GI results as firm brown, orange/brown mottled sandy gravelly CLAY, with varying cobbles and boulders. BH-27602 located 0.1km west of the westernmost section of the CGS comprises firm becoming very stiff brown slightly sandy gravelly CLAY, with varying Cobble and boulder content of sandstone and limestone content extending to a depth of 9.7m bgl.

210. Kinnitty Eskers CGS and surrounding sands and gravels include a large accumulation of sands and gravels deposited both under the ice sheet and at its margin as the ice withdrew westwards across east County Offaly, north of the Slieve Bloom Mountains, at the end of the last Ice Age (refer to Figure 10.20). The Kinnitty Eskers and surrounding sands and gravels are formed between the Devonian Old Red Sandstones of the Slieve Bloom Mountains, and the Lower Carboniferous limestones of the lowlands surrounding them (Hennessy *et al*. 2016). Image 10.3 was taken at the location where the Treated Water Pipeline from the BPT to the TPR crosses the CGS. No surface expression of the esker is evident within the CGS boundary at the pipeline crossing. The topographical variation is <2m along this section of the CGS (65–66mAOD). The area within the Construction Working Width represents 0.3% of the Kinnitty Esker CGS.

211. Borehole information (BH-64085) revealed soil deposits within the Kinnitty Esker CGS comprised topsoil overlying soft grey sandy SILT, extending to a depth of 10.5m bgl.

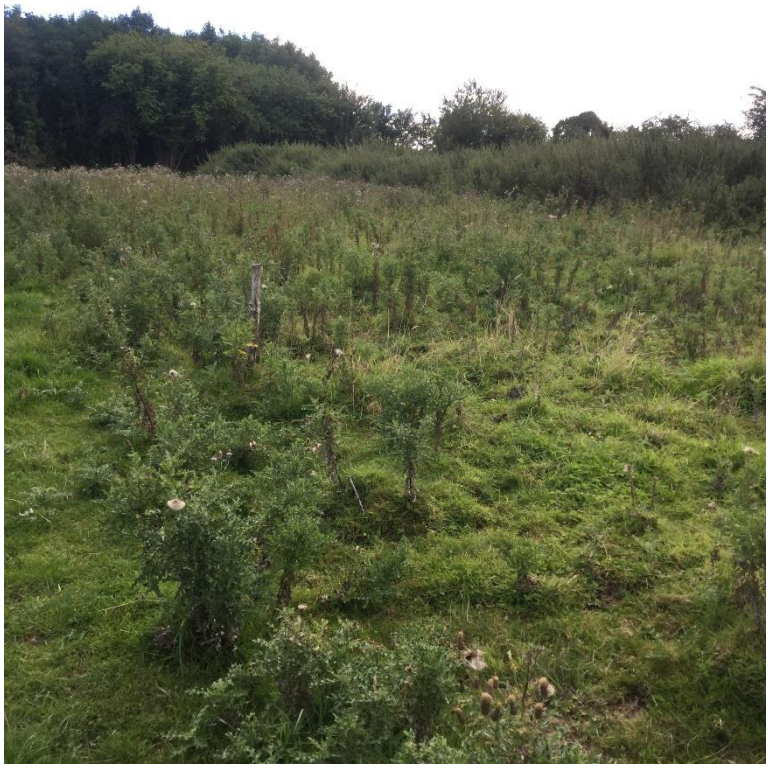

Image 10.3: Pipeline Crossing at Kinnitty CGS

212. Kilcormac Esker CGS and surrounding sands and gravels include an exceptionally large accumulation of sands and gravels deposited both under the ice sheet and at its margin as the ice withdrew westwards across County Offaly at the end of the last Ice Age. The esker forms part of the much larger Killimor-Birr-Fivealley-Kilcormac Esker System, which extends across the Midlands for over a 70km linear extent (refer to Figure 10.20 and Figure 10.21). Sections of the CGS may be designated as NHAs at a later date. Where present, the esker ridges are striking features, standing proud of the flat landscape of till (boulder clay) upon which they were deposited. In many places, the eskers have been surrounded by post-glacial alluvium or peat deposits in the Holocene, following the Ice Age. Image 10.4 was taken at the location where the Treated Water Pipeline from the BPT to the TPR crosses the CGS. No surface expression of

the esker is evident within the CGS boundary at the pipeline crossing. The topographical variation is approximately 2m along this section of the CGS (69–71mAOD). Further to the east of the CGS boundary, the topography rises steeply to approximately 80mAOD, comprising hummocky/esker sand and gravels. The area within the Construction Working Width represents 0.8% of the Kilcormac Esker CGS. Soils at the Kilcormac Esker CGS vary along the pipeline and comprise a series of alluvial deposits (peat, silts, well sorted sand and gravels), along and to the north of the pipeline. To the south of the pipeline, natural deposits were described in the GI results as stiff brown, sandy CLAY overlying dense GRAVEL and SAND with varying cobbles extending to a depth of 7.7m bgl (BH224).

Image 10.4: View of Kilcormac CGS

213. Liffey River Oxbow CGS, situated 3km south-west of Celbridge, displays both an existing oxbow lake as well as a remnant oxbow lake, which are within 300m of one another (Figure 10.22). The oxbow lake CGS is located 150m to the north of TWE – 10500. The geomorphology of the surrounding land adjacent to these fluvial features displays previous pathways that the Liffey had taken (Parkes 2005). The Liffey Oxbow CGS is located 150m to the north of the Treated Water Pipeline from the BPT to the TPR. Borehole data reveal soils within the vicinity of the Liffey River oxbow lake comprise a layer of topsoil overlying interbedded layers of brown silty SAND/grey sandy SILT/ black clayey sandy GRAVEL/ grey silty sandy gravelly CLAY, with occasional cobbles; maximum depth of 15.1m bgl (BH-161516). No works or access tracks would be located in the CGS.

10.3.10 Hydrogeology

214. The hydrogeology baseline in this section addresses groundwater contained below the ground surface, within the soil and bedrock environment

10.3.10.1 Aquifer Classification

215. This section identifies the aquifer types that underlie each infrastructure site and aquifer classes crossed by the Treated Water Pipeline, as classified by GSI. The 38 kV Uprate Works crosses the O'Brien's Bridge and the Silvermines locally important sand and gravels aquifers. Locally important sand and gravel aquifers are mapped between TWA – 27600 to TWB – 600 (Knockbarron, Co. Offaly), TWC – 8700 to BTWC – 9200 (Geashill, Co. Offaly) and TWE – 9800 to TWE – 12000 (River Liffey, Co Dublin). Borehole and PSD data from BH001 (Chainage RW – 700), drilled at this location, do not indicate the presence of sands and gravels at this area. Based on the borehole data, the gravel aquifer is likely to have pinched out and is not present within the RWRM Construction Working Width. No other sand and gravel aquifers are mapped at the RWI&PS, WTP, BPT, BPS, TPR, FCV, RWRMs or along the Treated Water Pipeline.

216. GSI aquifer categories can be used to define the relative importance of aquifers in Ireland. All parts of the national territory have been assigned to one of 10 major aquifer categories (Rkd, Rkc, Rf, Rg, Lk, Lm, Lg, Ll, Pl and Pu), which are intended to describe both resource potential (whether Regionally Important (R), Locally Important (L), or Poor (P)) and groundwater flow type and attenuation potential (through either fissures, karst conduits or intergranular). The GSI aquifer categories are defined in the Groundwater Protection Schemes report (Department of Environment and Local Government (DELG)/EPA/GSI 1999). Bedrock Lithology is detailed in Section 10.3.4. GSI mapping indicates that the bedrock underlying the 38 kV Uprate Works, RWI&PS, WTP, BPT, BPS, FCV and TPR is predominantly categorised as Locally important aquifer, which is Moderately Productive in Local Zones (Ll). Along certain sections of the study area, there are localised areas of Poor bedrock aquifer which is generally unproductive except for Local Zones (Pl) and Regionally important karstified bedrock aquifers dominated by diffuse flow (Rkd). Table 10.19 gives details of the aquifer types at the major infrastructure elements.

Table 10.19: Aquifer Types at Major Infrastructure Elements

Aquifer Code[14]	Aquifer Type	Infrastructure
Ll	Locally important aquifer, which is Moderately Productive only in Local Zones	38 kV – Birdhill 38 kV Substation and 38 kV Uprate Works RWI&PS incl. CC0; WTP incl. CC1; BPT incl. CC3; BPS incl. CC4; CC6, FCV, TPR incl. CC7 Southern section of CC2, CC5 Northern section of PSD1, PSD2 to PSD10
Pl	Poor Aquifer - Bedrock which is Generally Unproductive except for Local Zones	38 kV South-eastern section of PSD1
Lg	Locally important gravel aquifer	38 kV Section of Treated Water Pipeline from the BPT to the TPR
Rkd	Regionally important karstified bedrock aquifers dominated by diffuse flow (Rkd)	38 kV, Northern section of CC2, section of Treated Water Pipeline from the BPT to the TPR

217. The Proposed Project, including the 38 kV Uprate Works, RWI&PS, WTP, BPT, BPS, FCV and TPR locations, is primarily underlain by Dinantian Limestones which are classified as a Locally Important Aquifer, which is Moderately Productive in Local zones (Ll).

218. A summation of the aquifer types along the RWRMs and Treated Water Pipeline is included in Table 10.20. Site investigations encountered limited gravels in these areas as detailed in Appendix A10.1, Appendix A10.9 and Appendix A10.12. The Lg aquifers overlie locally important aquifer which is Moderately Productive only in Local Zones.

[14] Based on GSI data www.gsi.ie

Table 10.20: Aquifer Type Along the Construction Working Width

Aquifer Code[15]	Aquifer Type	% of RWRMs, Treated Water Pipeline Crossing Each Aquifer Type[16]
Pl	Poor Aquifer Bedrock which is generally unproductive except for local zones	6%
Lk	Locally important aquifer which is Moderately Productive. Karstic	2.3%
Ll	Locally important aquifer which is Moderately Productive only in Local Zones	75.7%
Lm	Locally Important Aquifer - Bedrock which is Generally Moderately Productive	10.8%
Lg	Locally important gravel aquifer	2.5%
Rkd	Regionally Important Karstified Aquifer – Diffuse. Bedrock which is Generally Productive	5.2%

10.3.10.2 Groundwater Vulnerability

219. The DELG, EPA and GSI (1999) produced guidelines for Groundwater Vulnerability mapping that aim to represent the intrinsic geological and hydrogeological characteristics that determine how easily groundwater may be contaminated by human activities. Refer to Figure 10.14 to Figure 10.17 for the GSI vulnerability mapping.

220. The Groundwater Vulnerability mapping guidelines allow for the assignment of vulnerability ratings from 'Extreme Vulnerability - rock at or near surface/karst', 'Extreme', 'High', 'Moderate' and 'Low', depending upon variables such as subsoil texture and thickness (Fitzsimons *et al.* 2003).

221. Based on GSI mapping, the Groundwater Vulnerability at the Birdhill 38 kV and Ardnacrusha Substations is classified as 'Moderate'. At IMPs 76, 77, 86, 91, 90A to 94A and 242 to 245, the Groundwater Vulnerability is classified as 'Extreme'. The principal vulnerability classes along the 38 kV Uprate Works are 'High' and 'Moderate'. Where sand and gravels are present, groundwater vulnerability is typically classified as 'High'. As is evident from Table 10.21, areas of 'Moderate' and 'High' Groundwater Vulnerability are the predominant types along the existing Ardnacrusha – Birdhill overhead line (OHL).

Table 10.21: Groundwater Vulnerability Along the Existing Ardnacrusha – Birdhill OHL

Groundwater Vulnerability	Category %
Extreme vulnerability with rock at surface (<1m)	1.5%
Extreme	7%
High	23%
Moderate	62%
Low	6.5%
TOTAL	100%

222. The Groundwater Vulnerability at the RWI&PS and WTP sites is classified as 'Low' to 'Moderate'. At the TPR, the groundwater vulnerability is classified as 'Extreme'. The groundwater vulnerability at the BPT varies from 'Extreme' in the south of the site, to 'Moderate' in the north. Details of the vulnerability categories are shown in Table 10.22.

[15] Based on GSI data https://gsi.geodata.gov.ie/server/rest/services/Groundwater/IE_GSI_Aquifer_Datasets_IE26_ITM/MapServer

[16] Note – Lg gravel aquifers overlie the Ll aquifers and therefore totals are >100%

Table 10.22: Groundwater Vulnerability at Major Infrastructure Elements

Infrastructure	Vulnerability Category and Vulnerability Notes
Birdhill Substation	Moderate
RWI&PS, CC0	Low to Moderate – based on borehole data
WTP, CC1	Low to Moderate – based on borehole data
CC2	Moderate – based on borehole data
BPT, CC3	Extreme to Moderate – borehole data, GSI mapping and geomorphology
BPS, CC4	High to Moderate – borehole data, GSI mapping and geomorphology
TPR, CC7	High/Extreme – borehole data, GSI mapping
CC5	High to Moderate – borehole data, GSI mapping and geomorphology
CC6	High – borehole data, GSI mapping and geomorphology
FCV	High – borehole data
PSD1 – Carrigatogher, County Tipperary	High to Moderate – borehole data, GSI mapping and geomorphology
PSD2 – Toora, County Offaly	Moderate – borehole data, GSI mapping and geomorphology
PSD3 – Boveen, County Offaly	Moderate – borehole data, GSI mapping and geomorphology
PSD4 – Fortel, County Offaly	High to Moderate – borehole data, GSI mapping and geomorphology
PSD5 – Derrinboy, County Offaly	Low – borehole data, GSI mapping and geomorphology
PSD6 – Derryweelan, County Offaly	Moderate – borehole data, GSI mapping and geomorphology
PSD8 – Rathlumber, County Offaly	Low – borehole data, GSI mapping and geomorphology
PSD9 – Graiguepottle, County Kildare	Moderate – borehole data, GSI mapping and geomorphology
PSD10 – Barberstown Lower, County Kildare	High to Moderate – borehole data, GSI mapping and geomorphology

223. The principal vulnerability classes along the Construction Working Width are 'High', 'Moderate' and 'Low'. The groundwater vulnerability at all areas of sand and gravel subsoils is classified as 'High'. As is evident from Table 10.23, groundwater vulnerability typically ranges between 'Moderate' and 'High' with areas of 'Moderate' along the RWRMs, Treated Water Pipeline, based on the GSI groundwater vulnerability mapping and borehole data. Extreme vulnerability areas with rock at, or close to, the surface are denoted as **'X'** on Figure 10.14 to Figure 10.17.

Table 10.23: Groundwater Vulnerability Along the Construction Working Width

Groundwater Vulnerability	%
Extreme vulnerability with rock at surface (<1m) (X)	2.3%
Extreme (E)	3.2%
High (H)	29.4%
Moderate (M)	53.5%
Low (L)	11.6%
TOTAL	100%

Note – % based on GSI and GI data.

10.3.10.3 Groundwater Levels

224. Groundwater levels at the infrastructure sites locations are provided in Table 10.24. Standpipes (50mm uPVC) were installed in selected boreholes at the infrastructure sites, to allow for monitoring of groundwater levels (manual and dataloggers) and taking of water samples. Dataloggers were installed in groundwater monitoring wells on-site to allow for continuous water level measurement over a 12-month period. Permeability tests, by Rising Head/Falling Head method, were carried out in boreholes in accordance with BS 5930:2015.

225. Groundwater levels at the RWI&PS are towards Parteen Basin (<0.001 gradient) and vary seasonally between 0.3 and 1.5m bgl. The main groundwater flow occurs in the upper 4m of soil on the RWI&PS site. Based on the high groundwater levels and flat topography, groundwater flow in the sandy soils is limited. Shallow groundwater flow is towards Parteen Basin but is partially controlled by existing land drains. The potential groundwater throughflow[17] in the sandy soils is 5.0 x $10^{-5}m^3/s$ or $4.3m^3$/day based on the following assumptions and site data:

- 4m (sandy soil depth)
- 70m (cross sectional area)
- Groundwater gradient[18] of 0.001 m/m (SI data – Appendix A10.4)
- A permeability value of 5 x $10^{-4}m^2/s$ (SI data – Appendix A10.4).

Table 10.24: Groundwater Levels at Infrastructure Sites

Location	Groundwater Levels (m bgl)	Notes
RWI&PS	0.3 to 1.5	Main inflows occur in the shallow sand horizons on site. Monitoring undertaken in RWI-BH008, RWI-BH010, RWI-BH013 and RWI-BH016.
WTP	0.3 to >10	Minor seepages occur in the shallow horizons on site. Monitoring undertaken in 18 boreholes included in Appendix A10.6.
BPT	>8 to 15	Monitoring of groundwater levels was undertaken in BPT-BH003, BPT-BH004, BPT-BH006, BPT-BH007, BPT-BH008, BPT-BH031 and BPT-BH032. Monitoring undertaken in the boreholes included in Appendix A10.8. Boreholes were dry with occasional groundwater inflow to BPT-BH031 and BPT-BH032.
BPS	1 to 8	Monitoring of groundwater levels was undertaken in BPS-BH001, BPS-BH004 and BPS-BH012. Monitoring undertaken in the boreholes included in Appendix A10.10. Groundwater levels were between 1m bgl and 8m bgl.
FCV	1.7 to 5	Slow to moderate inflows. Monitoring undertaken in the boreholes included in Appendix A10.9. Groundwater levels were between 1.7 and 5m bgl.
TPR	<1 to 4	Monitoring of groundwater levels was undertaken in TPR-BH003, TPR-BH002, TPR-BH006, TPR-BH008, TPR-BH009, TPR-BH012, TPR-BH013 and TPR-BH014. Monitoring undertaken in the boreholes included in Appendix A10.13. Groundwater levels were between <1 and 4m bgl.

Source: Borehole data (2022), field surveys and GSI data

226. Peatlands along the Treated Water Pipeline were historically drained for peat extraction, turbary or agriculture, thereby altering the peat properties and groundwater/surface water levels. The surface of the Bord na Móna bogs is drained by a network of drains that are typically spaced every 15m. Larger arterial drains connect the field drains and slope gently towards perimeter settlement ponds and surface water outfalls. In areas of shallow peat, much of the land was drained and brought into agricultural production using mole drains. Mole drains are a type of subsurface drainage system used to manage water levels in agricultural fields, including peatlands. The primary purpose of mole drains is to improve drainage and reduce waterlogging, which can enhance soil conditions for agricultural use. Mole drains typically discharge to open drainage channels located on field boundaries. As detailed in Appendix A10.4 to Appendix A10.14 (2022 and 2023 Ground Investigations), groundwater levels in the cutover peats are generally between 0.4m bgl and 2.6m bgl in the peatland areas.

[17] Darcian Flow Q= KIA (permeability x hydraulic gradient x cross sectional area)

[18] Groundwater gradient is dimensionless (dx/dy)

227. A number of partially cutover areas of degraded raised bog are located adjacent to the Treated Water Pipeline from the BPT to the TPR. Locations include Clonad Bog, north of Mount Lucas Bog, east of Esker Bog and Timahoe South Bog. As detailed in Section 10.3.2, the peat soils are cutover or subject to historical drainage. Water level monitoring in the peatland was undertaken in a number of peatland locations in 2021. Results of the monitoring are included in Appendix A10.15. Water levels in the summer were more than 0.3m bgl which indicates that the peat is not active raised bog. The groundwater level monitoring supports and is consistent with the habitat assessment, i.e. degraded raised bog. Water levels throughout the peatland are >0.3m bgl in summer.

228. Where wet or poorly drained soils occur, drainage of land has frequently occurred. Records of individual land drains are limited but include drainage systems such as tile drains, mole drains or French drains. Where they occur along the Treated Water Pipeline, they remove shallow groundwater from the soil, leading to a localised decline in the water table.

10.3.10.4 Groundwater Bodies

229. The GWB is the WFD management unit for groundwater. GWBs are subdivisions of large geographical areas delineated as aquifers. The larger aquifer areas are divided to allow the effective protection of groundwater and linked surface waters[19]. The GWB is defined as a distinct volume of groundwater, including recharge and discharge areas with little flow across the boundaries. Each GWB has been assigned a flow regime, thus these comprise karst aquifers, productive fissured aquifers, poorly productive aquifers, and sand and gravel aquifers.

230. The GWB descriptions are available from the GSI website[20] and the WFD status is obtained from the EPA website[21]. Each of the GWBs underlying the RWI&PS, WTP, BPT, BPS, TPR, Construction Compounds, PSDs, RWRMs and Treated Water Pipeline from the BPT to the TPR are classified as being at 'Good' WFD status, as per the most recent 2019–2024 WFD assessment, as shown in Table 10.25. The RWI&PS, WTP and BPT are underlain by the Nenagh groundwater body. The Nenagh groundwater body comprises low transmissivity and storativity rocks. Each of the GWBs underlying the route of the 38 kV Uprate Works are at 'Good' WFD status. The Silvermines GWB is the only GWB with 'Poor' WFD status (2019–2024), which underlies TW – 6100. The WFD Risk status for each of the GWBs underlying the 38 kV Uprate Works are either 'Not at risk' or are under review. Further detail is provided in the Water Status Impact Assessment Report which has been submitted with the planning application.

231. The majority of the Treated Water Pipeline from the WTP to the BPT is underlain by poorly productive bedrock.

[19] https://www.gsi.ie/en-ie/programmes-and-projects/groundwater/activities/understanding-ireland-groundwater/Pages/Groundwater-bodies.aspx

[20] https://www.gsi.ie/ga-ie/programmes-and-projects/groundwater/activities/understanding-ireland%27s-groundwater/Pages/Groundwater-bodies.aspx

[21] https://gis.epa.ie/EPAMaps/Water

Table 10.25: Summary of Groundwater Bodies

EU_CD Code	Name of GWB	Description	Infrastructure	GWB Status (2019–2024)	Risk Status
IE_SH_G_009	Ardnacrusha	Karstic	38 kV Uprate Works	Good	Not at risk
IE_SH_G_157	Lough Greany	Poorly productive bedrock	38 kV Uprate Works	Good	Not at risk
IE_SH_G_257	O'Brien Bridge Gravels	Gravels	38 kV Uprate Works	Good	Not at risk
IE_SH_G_213	Slieve Phelim	Poorly productive bedrock	38 kV Uprate Works	Good	Not at risk
IE_SH_G_178	Nenagh	Poorly productive bedrock	OHL and Birdhill 38 kV Substation; RWI&PS (incl. CC0); RWRMs; WTP (incl. CC1); BPT (incl. CC3); PSD1; and Treated Water Pipeline from the WTP to the BPT	Good	Not at risk
IE_SH_G_250	Silvermines Gravels	Gravels	OHL, RWRMs, Treated Water Pipeline from the WTP to the BPT	Good	Not at risk
IE_SH_G_248	Silvermines	Poorly productive bedrock	Treated Water Pipeline, from the WTP to the BPT Construction Working Width (TW – 6100)	Poor	Not at risk
IE_SH_G_147	Lismaline	Productive fissured bedrock	CC2, Treated Water Pipeline from the WTP to the BPT	Good	Not at risk
IE_SH_G_205	Shinrone	Poorly productive bedrock	PSD2; PSD3; BPS (incl. CC4); Treated Water Pipeline	Good	Not at risk
IE_SH_G_103	Geashill	Poorly productive bedrock	CC5, PSD4, PSD5, Treated Water Pipeline from the BPT to the TPR	Good	Not at risk
IE_SE_G_107	Portlaoise	Poorly productive bedrock	Treated Water Pipeline from the BPT to the TPR	Good	Not at risk
IE_SE_G_116	Rhode	Productive fissured bedrock	Treated Water Pipeline from the BPT to the TPR	Good	Not at risk
IE_SE_G_048	Cushina	Poorly productive bedrock	PSD6, Treated Water Pipeline from the BPT to the TPR	Good	Not at risk
IE_SE_G_153	Bagenalstown Upper	Karstic	Treated Water Pipeline from the BPT to the TPR	Good	Not at risk
IE_SE_G_077	Kildare	Poorly productive bedrock	CC6, FCV, Treated Water Pipeline from the BPT to the TPR	Good	Not at risk
IE_EA_G_002	Trim	Productive fissured bedrock	Treated Water Pipeline from the BPT to the TPR	Good	At risk
IE_EA_G_008	Dublin	Poorly productive bedrock	PSD9; PSD10; Treated Water Pipeline from the BPT to the TPR; TPR (incl. CC7)	Good	Review

Source: EPA WFD data www.catchment.ie – Accessed October 2025 (Data for the period of 2019–2024)

10.3.10.5 Groundwater Dependent Terrestrial Ecosystem (GWDTE)

232. GWDTEs are defined as habitats that are dependent on groundwater to maintain the environmental supporting conditions required to sustain that habitat and/or species. Groundwater may provide either a direct input, such as in turloughs, fens and petrifying springs or, alternatively, the groundwater may have an indirect influence in maintaining high and stable water levels within the habitat, such as with active raised bogs[22]. GWDTEs are protected habitats which critically depend on groundwater discharges/levels and/or chemistries.

233. The ground conditions in the vicinity of the Proposed Project are considered to be of low ecological sensitivity with no delineated GWDTEs or Natura 2000 sites on or within 1km of the RWI&PS, WTP, BPT, BPS, PSDs, Construction Compounds, FCV and TPR. Based on joint hydrogeological site walkovers and ecological surveys, there are no GWDTEs on the RWRM or Treated Water Pipeline.

234. The nearest SAC bog is Scohaboy Bog located 1.7km north of the BPT. Effects on the existing ground conditions are short term and would be restricted to the Construction Working Width. A number of the GWDTEs are identified within this section and potential impacts are assessed in Section 10.4.2.1 as well as Chapter 8 (Biodiversity). The conceptual GWDTE hydrogeological site model, based on the source–pathway–receptor linkages for the Proposed Project, is discussed below with conceptual cross sections included on Figure 10.135 to Figure 10.149.

235. Some peatlands are considered as GWDTE. Active raised bogs (lagg and high bog), degraded raised bogs still capable of natural regeneration, and Blanket bog flushes are examples of potential peatland GWDTE. There is no blanket bog, lagg zones, active raised bog or degraded raised bogs still capable of natural regeneration located within the Proposed Project; see Chapter 8 (Biodiversity). Partially cutover peatlands are located adjacent to the Treated Water Pipeline from the BPT to the TPR and are assessed in terms of ecology and hydrogeology. Degraded raised bog (Non-Annex I) was recorded at a number of locations – see Section 10.3.2. As detailed in Section 10.3.2, the peat soils are cutover or subject to historical drainage. A small area of the priority Annex I habitat 'Active raised bogs [7110]' was recorded at Drumachon Bog, Timahoe, County Kildare (Appendix A8.4: Target Habitat Surveys Report). This area of active raised bog is located 280m west of the Proposed Project boundary at its closest point and is separated from the Proposed Project by a wooded access track. Drainage ditches and scrub are located either side of the access road.

236. Water level monitoring (Table 10.26) was undertaken in a number of peatland locations in 2021. Solonist Model 601 Standpipe Piezometers were used at these locations and comprise a 3/4" diameter PVC standpipe with push-fit couplings to 1m bgl and 3m bgl. For active raised bog, seasonal fluctuations should not exceed 20cm, and water levels should be within 10cm of the surface, except for very short periods of time (Kelly & Schouten 2002). The pointed tip was pushed into the peat soils and soft sediments. Results of the monitoring are included in Appendix A10.16 and Table 10.26. Based on Appendix A8.4 (Target Habitat Surveys Report) and summer water levels >0.3m bgl, the peat is neither active raised bog nor degraded raised bog capable of regeneration. Sphagnum comprised <10% of all degraded raised bogs identified in the Construction Working Width.

237. Alkaline fens/scrub are located to the east and west of the Treated Water Pipeline from the BPT to the TPR at Killeenbreagh and Lisduff (TWA – 19200). Lisduff Fen is located approximately 0.5km to the west of the Construction Working Width. Big Wood Fen/scrub is located 0.15km to the east of TWA – 19200. Big Wood Fen comprises alkaline fen (Fossitt Habitat Scheme: PF1) adjoined by wet grassland (Fossitt Habitat Scheme: GS4), with scrub (Fossitt Habitat Scheme: WS1) encroaching along the southern and eastern boundaries. The Construction Working Width comprises improved grassland. Big Wood Fen occurs in a topographical depression at the base of Big Wood Hill. While the area is slightly modified by drainage, the lack of gradient ensures the area remains wet/damp throughout the year. A number of soil

[22] EPA (2008). A framework for the assessment of GWDTEs under the WFD.

exposures in the drainage ditches along the Construction Working Width were noted on the boundaries of the site, which comprised firm, light brown slightly sandy very gravelly SILT. The fen area is mapped as an area of cutover peat. The underlying bedrock is a Locally Important Aquifer - Bedrock which is Moderately Productive only in Local Zones (Ll). Recharge to the fen occurs via rainfall and groundwater from Big Wood to the east of the fen. The fen is located upgradient of the Proposed Project and is separated by a deep drain running north-east/south-west and two deep drainage ditches along the local road. To the west of the Treated Water Pipeline from the BPT to the TPR, a number of drainage ditches and small streams occur between the pipeline and the SAC. As mentioned, the Treated Water Pipeline from the BPT to the TPR and associated infrastructure is located approximately 0.5km east of Lisduff Fen SAC. A fast-flowing stream, which flows into the fen at the south end, forms a hydrological/hydrogeological boundary to the east of the SAC and based on the water chemistry and site observation, the streams are fed by surface water runoff and groundwater baseflow. Sharavogue Bog SAC is located a further 3km west and north of the pipeline – TWA – 13000 to TWA – 18500. Further details are included in Chapter 8 (Biodiversity).

238. Coagh fen area (0.14km east of TWB – 1900) is located on a break in slope at the base of a steep hill to the west of the Tubrid Stream. Water levels in the fen are likely to be maintained by overland surface water runoff and groundwater. No inflow stream to the wetland was detected indicating that it is a spring-fed fen. The soil under the fen is composed of a thin peat layer with mineral soil with calcareous tufa deposits in some areas. The area is approximately 100m x 30m in extent with scattered gorse (*Ulex europaeus*) scrub patches between the fen and the adjacent grazed improved agricultural grassland. The fen area appears to be a remnant of a larger wetland habitat, which has survived in a localised topographical depression. The fen vegetation is located in a slight depression approximately 0.25m deep, in a former drainage channel/drainage ditch. The fen is underlain by 0.3m to 0.4m organic soils overlying silty SAND. The organic soils are deeper towards the Coagh Stream, which forms a hydrological boundary. During the time of survey (8 June 2016, 21 August 2019), ground soils were dry with no evidence of spring inflows and there was no peat based on the site walkover. The shallow topographical depression is likely to contain water during winter or extended wet periods. The site was also surveyed for *Vertigo* species on 16 July 2020. The Coagh site had no habitat suitable for supporting any of the three target *Vertigo* species, due to the vegetation present and the dry substratum. The underlying bedrock is a Locally Important Aquifer - Bedrock which is Moderately Productive only in Local Zone.

239. Coolfin Transition Mire is shallow mire (0.4m to 0.6m deep) and occurs in a topographical depression or basin, 0.14km south of TWB – 7900. While the area is slightly modified by drainage, the lack of gradient ensures the mire remains wet/damp throughout the year. Groundwater levels in the wetland/mire area are between 0.2m and 0.28m bgl. A number of soil exposures were noted on the boundaries of the site comprising firm to stiff, light brown slightly sandy gravelly SILT. Borehole (BH-72683) and Trial Pit (TP-72703) data confirm the presence of Firm grey slightly gravelly, slightly sandy SILT with low cobble content. The primary inflows into the mire occur via rainfall and land drainage to the south. The mire is located in topographical depression (93.7mAOD).

Table 10.26: Wetland/Peatland Piezometer Water Levels

Piezometer ID	Location	Date	Water Level (m bgl)	Date	Water Level (m bgl)
1	Lisduff, Co. Offaly	06/07/2021	0.44	16/08/2021	0.56
2	Island townland, Co. Offaly	22/06/2021	0.23	26/08/2021	0.31
3	Island townland, Co. Offaly	22/06/2021	0.47	26/08/2021	0.55
4	Island townland, Co. Offaly	22/06/2021	0.44	26/08/2021	0.60
5	Mount Lucas, Co. Offaly	22/06/2021	0.21	26/08/2021	0.34
6	Mount Lucas, Co. Offaly	22/06/2021	0.40	26/08/2021	0.52
7	Mount Lucas, Co. Offaly	22/06/2021	0.29	26/08/2021	0.33
8	Timahoe North, Co. Kildare	24/06/2021	0.11	21/08/2021	0.20
9	Timahoe North, Co. Kildare	24/06/2021	0.28	21/08/2021	0.42
10	Timahoe North, Co. Kildare	24/06/2021	0.33	21/08/2021	0.47
11	Timahoe North, Co. Kildare	24/06/2021	0.34	21/08/2021	0.54
12	Coolfin, Co. Offaly	23/06/2021	0.23	20/08/2021	0.34
13	Lisduff, Co. Offaly	06/07/2021	0.36	16/08/2021	0.37

10.3.10.6 Groundwater Supplies

10.3.10.6.1 Public Water Schemes and Group Water Schemes

240. Water usage within the study area of the Proposed Project is primarily supplied by PWSs and GWSs from both groundwater and surface water abstractions. ZoCs and SPZs are delineated for these supplies as illustrated in Figures 10.118 to 10.122.

241. A ZoC is the area surrounding a pumped well that encompasses all areas or features that supply groundwater recharge to the well. It is defined as the area required to support an abstraction from long-term groundwater recharge. SPZs are delineated to protect groundwater abstractions in the ZOCs of groundwater abstractions. ZoCs and SPZs utilise the source–pathway–receptor framework, where the source means the pressures or the sources of contamination; the pathway determines how water moves from a source to a receptor; and the receptor is the spring/borehole abstraction point. The European Union (Good Agricultural Practice and Protection of Waters) Regulations 2022 specifies setback distances or exclusion zones for application of organic fertiliser and soiled water on land in the vicinity of water abstraction points, such as wells, springs, watercourses and lakes. As a consequence, groundwater protection responses have been developed for the following activities:

- Landfills
- Landspreading of organic wastes
- On-site wastewater treatment systems for single houses
- Earth-lined stores
- Out-wintering pads.

242. The purpose of the setback distance is to protect public health by preventing agricultural pollution of drinking water sources. These distances vary from 25m to 200m, depending on the daily abstraction amount or number of people served by the source.

243. A number of ZoCs/SPZs are located within 0.5km of the Proposed Project, as detailed in Table 10.27.

Table 10.27: Abstractions and ZoC/SPZ Within 500m of Proposed Project

Water Supply	Location	Distance from Pipeline to Source Borehole/Spring	Distance to ZoC/SPZ
O'Brien's Bridge PWS	Montpelier Co Tipperary	0.19km from OHL to Well	Uprate of 38 kV within ZoC
Ardcrony GWS	Ardcrony, Co. Tipperary	2.1km north of CC2, 2km north of pipeline	Pipeline and CC2 located partially within ZoC
Killeigh PWS	Newtown, Geashill Co. Offaly	2.4km north of pipeline	Pipeline is located outside of SPZ. SPZ is located 0.1km to the north of pipeline.
Geashill PWS	Dalgan, Geashill, Co. Offaly	0.35km north of pipeline	Pipeline is located outside of SPZ at a distance of 0.16km
Ballinagar GWS	Dalgan, Geashill, Co. Offaly	0.15km south of pipeline	Pipeline is located outside of SPZ at a distance of 0.06km
Mount Lucas	Clonarrow, Mount Lucas, Co. Offaly	0.8km north of low voltage (LV) power line 0.9km west of pipeline	LV power line is located in SPZ. Pipeline is located outside of SPZ.

244. The existing Ardnacrusha – Birdhill OHL passes 350m to the south of O'Brien's Bridge PWS. The O'Brien's Bridge PWS abstracts water via a borehole located in the centre of Montpelier. The IMPs 72B to 76B are located at the southern edge of the ZoC.

245. There is no key infrastructure (Birdhill Substation, RWI&PS, WTP, BPT, BPS, FCV or TPR) within groundwater source ZoCs or SPZs for any PWS or GWS.

246. The Treated Water Pipeline from the WTP to the BPT is located approximately 2km to the south-south-east of the Ardcrony/Ballythomas GWS abstraction point. The Treated Water Pipeline from the WTP to the BPT (TW – 28900 to TW – 29700) and CC2 are located in the Ardcrony GWS ZoC in the townlands of Lisgarriff and Ballylusky, adjacent to the N52 road cutting. Based on borehole data from the GI works, subsoil along the Construction Working Width at this location (BH011) comprises approximately 10m of unsaturated subsoils. Borehole logs are included in Appendix A10.1 (2018 Ground Investigations). Groundwater levels in the area near CC2 are <10m bgl. Well locations are shown on Figure 10.123 to Figure 10.134.

247. The Treated Water Pipeline from the BPT to the TPR passes 0.35km to the north of Geashill PWS abstraction point and 0.15km to the north of Ballinagar GWS abstraction point. Both supplies are sourced from shallow dug wells (<5m deep). High permeability sand and gravels (>1x 10^{-4}m/s) are located to the south and east of the sources. The pipeline is located 150m downgradient of the springs and outside of the Ballinagar ZoC and Geashill SPZ – see Figure 10.120. The Geashill PWS (570m^3/day) and Ballinagar GWS (340m^3/day) are both shallow dug wells and have an average combined abstraction of 910m^3/day. The bedrock aquifer comprises the Upper Impure Limestones which are categorised as Ll aquifer. The PWS/GWS sources are located within the Geashill locally important gravel aquifer; however, no significant gravels were encountered at BH-101953. The remaining known boreholes in the Geashill GWB have Poor to Moderate yields (<430m^3/day)[23].

248. The power connection at Mount Lucas Line Valve is partially located in the ZoC for Mount Lucas GWS. Mount Lucas GWS currently abstracts 120m^3/day from one well abstracting groundwater from limestone bedrock classified as a Locally Important Aquifer that is generally moderately productive (Lm).

[23] GSI (2003). Geashill GWB description.

10.3.10.6.2 Private Water Supplies

249. Along the Treated Water Pipeline, private wells are used by individual landowners. Information on wells was collected by an agronomist in 2017, 2021 and 2024/2025. The well survey data included the type of abstraction, water use and well locations. The well survey was supported by a search of the GSI well database, which shows five wells within 100m of the Treated Water Pipeline. The groundwater wells are used to provide water for dwellings and agricultural use. The GSI does not have a dataset of groundwater abstraction wells. Water level monitoring data of private water supplies in 2020, 2021, 2024 and 2025 are included in Appendix A10.15 (Summary of Private Groundwater Supplies). Groundwater levels vary between 1m and >10m bgl.

10.3.11 Future Baseline

250. The future baseline is set out in this section, while the interaction between the Proposed Project and other plans or projects is assessed in Chapter 21 (Cumulative Effects & Interactions).

251. Existing agricultural areas, such as the WTP, BPT, BPS, FCV and Treated Water Pipeline would continue to operate as agricultural land use with an increase in agricultural output and continual drainage depending on local circumstances. Due to the location of the TPR at Peamount, Co. Dublin, it is likely that the TPR would be developed in the medium term. The TPR site and surrounding lands are zoned for industrial, enterprise, and employment uses.

252. Commercial peat harvesting activities have ceased along the pipeline route since 2019. The Bord na Móna Rehabilitation Plans are progressing at the time of writing as part of their EPA licence conditions. The EPA licence conditions will be implemented on Bord na Móna's EPA licensed sites (P0503-1[24] and P0501-01[25]). Based on the Bord na Móna Rehabilitation plans, the peat production fields will gradually recolonise with vegetation (wetland, heath or scrub) and low lying areas will start to rewet (due to drain blocking). Based on the peatland rehabilitation plans and previous rehabilitation works, the peat extraction areas will naturally re-vegetate in a 10–20 year time period.

253. PCAS provides for the restoration and rehabilitation of approximately 33,000 hectares of Bord na Móna peatlands that were previously harvested. Bord na Móna has implemented PCAS measures[26] on parts of Clonad, Mount Lucas and Cloncreen as part of its enhanced rehabilitation plans and works will be ongoing on these and other bogs. The future baseline scenario on the Bord na Móna sites will comprise a mosaic of wetland, heath, scrub and woodland habitats depending on the various constraints such as topography, surface water and groundwater levels.

254. In order to inform the assessment of the future baseline, a review was undertaken of the current county development plans (Kildare County Council 2023; Laois County Council 2022; Limerick County Council 2023; Offaly County Council 2021; South Dublin County Council 2022; Tipperary County Council 2022), Common Agricultural Policy (Department of Agriculture, Food and the Marine 2023a), Forestry Programme 2023-2027 (Department of Agriculture, Food and the Marine 2023b) and the National Development Plan 2021-2030 (Government of Ireland 2025). The National Development Plan 2021-2030 and the Forestry Programme 2023-2027 outline the policy for and investment to increase forestry cover. Investment is being provided to support the objectives of the National Biodiversity Action Plan 2023-2030 (Department of Housing, Local Government and Heritage 2024), including measures to conserve and restore peatlands and wetlands, combat the spread of invasive alien species, implement Local Biodiversity Action Plans and invest in agri-environment schemes such as Acres.

[24] https://epawebapp.epa.ie/terminalfour/ippc/ippc-view.jsp?regno=P0503-01

[25] https://epawebapp.epa.ie/terminalfour/ippc/ippc-view.jsp?regno=P0501-01

[26] https://www.bnmpcas.ie/

255. Small scale, private turbary activities occur around the margins of the bogs. Only two active turf cutting banks are present at TWC – 17300 and TWC – 23550. The banks are located adjacent to Bord na Móna's Mount Lucas and Esker bogs, Co. Offaly. Where turbary is ongoing, many of the areas are almost exhausted or will cease in the next 15 years. The commercial sale of turf is prohibited since 2022. Regulation 4 of S.I. No. 529 of 2022 prohibits the sale of turf via online sales channels, retail premises or other public places. Any resulting changes are localised in nature and confined to the accessible edges of the bogs. In farmland areas, additional forestry, renewable energy projects, or intensive agriculture may occur.

10.3.12 Receptor Sensitivity

256. Section 10.2 presents the sensitivity criteria of the receiving geology, soils and hydrogeological environment for those receptors which have be carried forward into the impact assessment. As detailed in Section 10.3, potentially sensitive receptors include the soils, degraded raised bogs, geological heritage sites, aquifers and groundwater abstractions.

257. The sensitivity of the existing subsoils and geology were assessed as not economically important and do not have other geological or geomorphological attributes that are of significance on a national scale. The soils present within the Proposed Project are classified as being of low to medium sensitivity on a local scale. The sensitivity of each individual landholding in relation to agriculture is assessed separately in Chapter 11 (Agriculture).

258. The cutover peat within the Proposed Project boundary is substantially modified and degraded, hence the importance/sensitivity of the geological environment is considered to be low. Where degraded raised bog occurs, the sensitivity is classified as medium. No active raised bog or degraded raised bog capable of regeneration occurs within the Proposed Project.

259. A number of geological heritage sites were identified along the RWRM and Treated Water Pipeline; however, no surficial expression of esker, for example, was identified within the Construction Working Width. The sensitivity of the geological heritage sites is considered medium.

260. The sensitivity of the Fort Henry Embankment, which forms part of the Parteen Basin impoundment, south of the RWI&PS, is classified as high due to the embankment classification and function. The toe of the embankment is approximately 7m from the site boundary at the RWI&PS and, moving south it increases gradually in height. It functions as an engineering structure approximately 60m south of the RWI&PS site boundary.

261. The primary risks to hydrogeology arise from potential hydrocarbon spillage and leakages. The hydrogeological quality is of low to medium sensitivity due to the limited groundwater abstraction within the study area of the Proposed Project.

262. The assessment identifies a number of SPZs and water supplies within 500m of the Planning Application Boundary. Receptor sensitivity is low as the infrastructure sites are not located in SPZs and there are no PWS within 1km. There is no GWDTE within 1km of the infrastructure sites.

10.4 Assessment of Effects

263. The following sections present an assessment of the likely significant effects on soils, geology and hydrogeology associated with the Construction and Operational Phases of the Proposed Project with respect to the appraisal methods that have been presented in Section 10.2. Cumulative effects are assessed in Chapter 21 (Cumulative Effects & Interactions). This section presents an assessment in the absence of any mitigation measures, with the exception of embedded mitigation that has been incorporated into the design (e.g. avoiding sensitive features through the siting of the Proposed Project during the optioneering stages). Measures have been proposed in Section 10.5 to prevent or reduce the effects, and the residual effects after the application of mitigation measures are reported in Section 10.6.

10.4.1 'Do Nothing' Scenario

264. The Do Nothing alternative describes the circumstance where no development occurs. Under a 'Do-Nothing' scenario, no likely significant effects arise in respect of soil, geology or hydrogeology. The future baseline is set out in Section 10.3.11. In line with the National Development Plan 2021-2030, continued development will result in changes to land use, in particular, changes in agricultural land use and the continued development near existing urban areas such as regional towns and South Dublin.

265. Peatland rehabilitation is occurring on the Bord na Móna peatlands. Bord na Móna will continue the rehabilitation measures resulting in a higher water table in the peat and an overall increase in wetlands, bog woodland and variety of habitats in the former extraction sites.

266. Ireland's climate is changing in line with global trends, with a temperature increase of, on average, 0.8°C compared with 1900[27]. A research project (Nolan 2024) generated updated simulations for Ireland, using high-resolution regional climate modelling. The results show that mean temperatures are likely to increase by 0.5 to 0.9°C by 2050 with respect to the reference period (1981–2000). Moreover, winters are expected to be wetter and summers drier. An increase in the frequency and intensity of rainfall events is also predicted. Increasing temperatures, droughts and rainfall will alter land use and wetlands and will stress water supplies (Portner *et al.* 2022). The overall changes are not significant with an anticipated reduction in carbon emissions from organic soils and agricultural soils, subject to the implementation of the climate action plan.

10.4.2 Construction Phase

10.4.2.1 Soils and Geology

267. This section should be read in conjunction with the construction methodology as outlined in Chapter 5 (Construction & Commissioning) and Appendix A5.3 (Methods of Working in Peat). The Proposed Project would have potential impacts on the soil, geology and hydrogeology. Effects of the Construction Phase on the surface water environment in relation to silt runoff and effects on watercourses are considered in Chapter 9 (Water). Likely significant effects on individual landholdings are assessed in Chapter 11 (Agriculture).

268. Soils and geology effects relate to soil compaction, loss of soils, changes in land use, geomorphology and geohazards, contamination, loss of extractive material and effects on IGH sites. Hydrogeology considers effects on groundwater flow, groundwater quality, and GWDTEs. The following sections describe the likely significant effects for each of these matters. Effects are adverse unless otherwise stated. A summary of the likely significant effects for each infrastructure element is included in Section 10.4.4.

10.4.2.1.1 Soil Compaction

269. The movement of construction traffic within the Proposed Project could cause localised compaction of the topsoil and subsoils, leading to changes in the hydrogeological regime. Soil compaction effects relate to areas of temporary construction that do not form part of the permanent infrastructure. Soil compaction may occur in areas used during the Construction Phase such as the 38 kV Uprate Works, Construction Compounds, PSDs, RWRMs and Treated Water Pipeline. Land use change at the RWI&PS, WTP, BPT, BPS, FCV and TPR is addressed separately in Section 10.4.2.1.2.

270. Site clearance and preparation works for the installation of the access routes have the potential to impact soil quality. Potential impacts identified include:

- Over-compaction of agricultural soils caused by the use of heavy machinery onsite

[27] https://www.epa.ie/environment-and-you/climate-change/what-impact-will-climate-change-have-for-ireland/

- Over-compaction of agricultural soils caused by storage of construction equipment at the site
- Structural deterioration of soil materials during excavation, soil handling, storage and replacement
- Homogenisation and loss of characteristic horizons during excavation, storage and replacement.

271. These direct impacts on soil quality also have potential indirect impacts on soil fertility and drainage. The impacts of compaction are likely to be localised but can result in reduced soil permeability and infiltration. The majority of soils present within the Proposed Project were classified as being of low sensitivity due to the short term work, and soils would be reused as part of the development. The Proposed Project would require the short term removal of soil from agricultural use within the Construction Working Width. Likely significant effects on individual landholdings are assessed in Chapter 11 (Agriculture).

272. The soil compaction effects are predicted to be localised. The majority of the construction areas are located on improved agricultural land. The magnitude of potential impacts is defined by a series of factors including the spatial extent of any interaction, the likelihood, quality (positive or negative), duration, frequency, and reversibility of a potential impact.

273. Based on the criteria set out in Section 10.2, pre-mitigation magnitude of potential impacts are:

- Negative – soils and peat would be altered
- Certain – lands will be locally altered during the construction works
- Temporary to long term – Construction Phase will vary depending on the infrastructure sites and pipelines. For example, the construction period for the WTP, BPT and TPR is five years. The pipeline trenchless crossings is 10–12 weeks, and 2–4 weeks for open trench locations. Detailed timelines are set out in Chapter 5 (Construction & Commissioning). Long term effects include the compaction of degraded raised bog areas.

274. The sensitivity of the soil (excluding peat) receptors in the study area is considered to be low and the magnitude of impact is assessed as low to medium. Therefore, as per the matrix in Table 10.6, the potential effect is Not Significant to Slight (Not Significant). Mitigation measures in relation to soil compaction are addressed in Section 10.5.2.1.1.

275. Peat material would be excavated as part of the Construction Phase. Construction in peat areas would cause rutting and compaction of peat deposits, altering the peat structure with potential effects on the hydrogeological regime in the Construction Working Width. Peat within the Construction Working Width primarily comprises drained/altered peatland, either in agricultural land use or cutover peat as a result of the previous private and industrial extraction.

276. The area of degraded raised bogs is limited to 1.1 hectares, or 0.09% of habitats within the Proposed Project (Appendix A8.4: Target Habitat Surveys Report). A total of 0.4ha of the 1.1 hectares of the degraded raised bog relates to turbary / turf banks. Within the Construction Working Width, soils within Bord na Móna ownership will be reused in line with their rehabilitation plans. The magnitude of impact is assessed as medium for >1ha degraded raised bog. The sensitivity of the drained peat material in the study area is considered to be low (cutover peat) to medium (degraded raised bog) as outlined in Section 10.3.12. As per the matrix in Table 10.6, the effect would be temporary, Not Significant/Slight (Not Significant) for cutover peat, to Moderate (Significant) for the areas of degraded raised bog.

277. Degraded raised bog as well as other peat soils will be reprofiled post construction. As the degraded raised bog is reinstated following the installation of the pipe, there is a long term, low magnitude of impact. As per the matrix in Table 10.6, the potential effect reduces to long term, Not Significant/Slight (Not Significant) for degraded raised bog and Not Significant/Slight (Not Significant) for cutover peatland.

10.4.2.1.2 Loss of Soils – Land Use Change

278. The Construction Phase of the Proposed Project would alter the land use with excavations required for the RWI&PS, WTP, BPT, BPS, FCV, TPR and Construction Working Width. The land required for the infrastructure sites would be acquired on a permanent basis. The land would be fenced off and removed from agricultural production from the Construction Phase onwards. Permanent effects are addressed in Section 10.4.3. Land within the Construction Working Width would be utilised during the Construction Phase and reinstated to the original land use post construction. Potential farm-scale Construction Phase impacts on land are addressed in Chapter 11 (Agriculture).

279. Land use change would occur in areas used during the Construction Phase such as the 38 kV Uprate Works, Construction Compounds, PSDs and pipelines along the Construction Working Width. The extent of the Construction Phase excavations required for the RWRMs and Treated Water Pipeline vary, depending on the precise geological conditions that are encountered during works. The Construction Working Width is in general 50m in width. Exceptions to this are areas where it has been narrowed locally to avoid areas such as watercourses or archaeological features, or in areas where it has been widened due to a greater land extent being required to facilitate certain construction activities. Activities and areas which require widening of the Construction Working Width are detailed in Chapter 5 (Construction & Commissioning). Examples include:

- Access and egress to the public road network
- Construction of trenchless crossings for High Voltage power lines, railway, road and watercourse crossings
- Areas required for surface water management.

280. The construction effect on degraded raised bog (Non Annex I) is predicted to be localised. As detailed in Appendix A5.3 (Methods of Working in Peat), the peat in the Construction Working Width will be recontoured and surficial vegetation reinstated following the construction period. The construction areas are located on improved agricultural land and cutover peatlands. Peat would be displaced by the Proposed Project, and as noted in Section 10.2.7, Method 4 would have slightly greater effects in terms of disturbance to peat layers and volume of peat excavated for temporary storage. Based on the criteria set out in Section 10.2, pre-mitigation magnitude of potential impact is assessed as low to medium.

- Temporary to long term – construction of pipeline sections would be carried out in a <24-month period, peat will be reinstated or reused within the Construction Working Width. Soil loss at the infrastructure sites would be long term
- Negative – effects will occur during the Construction Phase
- The Construction Phase is likely to change existing baseline conditions
- Certain – peatlands and soils would be altered during the Construction Phase.

281. The construction works are expected to last for an estimated duration of five years in total and less than two years in any pipeline area. The works would consist of the installation of an underground pipeline along the length of the RWRM and Treated Water Pipeline. The lands which are temporarily removed from agricultural production would be fenced on both sides with appropriate stock-proof fencing. The lands present within the development area were classified as being of low (majority of areas) to medium (degraded raised bog – non Annex I) sensitivity, see Chapter 8 (Biodiversity).

282. Based on the site walkover, groundwater monitoring and ecological assessment, there are no active raised bogs along the Construction Working Width. No active raised bog was identified as part of the ecological surveys – see Chapter 8 (Biodiversity). A number of partially cutover, degraded raised bogs are located adjacent to the Treated Water Pipeline from the BPT to the TPR. Degraded raised bog not capable of regeneration (Non Annex I) is located at Island/Clonad, County Offaly (TWC – 13400); Mount Lucas, County Offaly (TWC – 17200 to TWC – 17300); Esker, County Offaly (TWC – 23550); and Timahoe, County Kildare (TWD – 21550).

283. As detailed in Section 10.3.2 and Appendix A5.3 (Methods of Working in Peat), the peat is cutover or subject to historical drainage. Water levels in the summer were more than 0.3m bgl in the three bogs, which indicates that the peat is not active raised bog. The peat has undergone degradation by historical drainage with humification of the peat areas (where drainage of peatland results in an increase in oxygen levels which results in the breakdown of plant material in the peat). While the areas are not active raised bogs the sensitivity to peat loss is considered medium at these locations.

284. The sensitivity in the study area is considered to be low (agricultural land and cutover peat) to medium (degraded raised bog). The peatlands are modified with no active raised bog (Annex I) encountered in the Construction Working Width as detailed in Chapter 8 (Biodiversity). The areas of degraded raised bogs are limited to non-Annex I areas (i.e. not capable of regeneration), with a total of 1.1ha. As a consequence, the magnitude is assessed as low to medium and the potential effect is Not Significant/Slight (Not Significant) for well drained soils to cutover peat, and Moderate (Significant) for degraded raised bog (Non Annex I) as per Table 10.6.

285. As the degraded raised bog and cutover peat is placed over the pipe following the installation, there is a long term, low magnitude of impact due to the altering of peat during the Construction Phase. As per the matrix in Table 10.6, the potential effect reduces to long term, Not Significant/Slight (Not Significant) for degraded raised bog and Slight (Not Significant) for cutover peatland.

10.4.2.1.3 Geomorphology and Geohazards

286. Geohazards occur when potentially hazardous earth processes and features interact with people and the environment. In the context of the Proposed Project the primary potential geohazards are at Parteen Basin (Fort Henry) embankment, peat areas and karst features.

Fort Henry Embankment

287. The Fort Henry Embankment is located to the south of the RWI&PS. The proposed works are located near the Ardnacrusha hydroelectric scheme, constructed from 1923 to 1929 by Siemens. The Ardnacrusha scheme involved the construction of a 12km long headrace canal and reservoir embankments called the Fort Henry and Ardclooney embankments. These embankments are owned and managed by the ESB and are classified as Category A dams, where a failure of the dams could result in loss of life. The embankment is therefore classified as high sensitivity. The height of the embankment is low (<1m) to the south of the RWI&PS but increases in height further south towards the Ardnacrusha Generating Station. Ground investigation works were carried out on the RWI&PS for previous iterations of the project in 2019 and again in 2022. The information collected remains valid and relevant for the purposes of assessing the likely significant effects of the Proposed Project. The overburden consists of dense sands and gravels in the upper 4m to 6.5m, with stiff to very stiff glacial till overlying Limestone bedrock. Bedrock is present between 18mAOD and 23mAOD at the RWI&PS (8.4m to 14.6m bgl). No karst features were observed in the geophysical survey or rock cores.

288. Potential risks to the dam during construction and operation of the proposed RWI&PS were assessed, and the design includes embedded measures to mitigate those risks. Existing ground levels would be maintained to the south of the RWI&PS site. Where construction occurs to the north of the embankment, secant piling would be installed for the Raw Water Intake as part of the embedded mitigation. Further information is included in Section 10.5.1 and 10.5.2. The magnitude of impact is assessed as low due to the proposed design and distanced to the embankment.

289. The sensitivity of the embankment is considered to be high and the magnitude of the geohazard impact is assessed as negligible. Given the sensitivity, the potential pre-mitigation effect is Not Significant (as per Table 10.6).

Karst

290. The Proposed Project was assessed in terms of the loss of surface karst solution features such as swallow holes or enclosed depressions. Potential karst features were avoided as part of the embedded mitigation. The pipeline route was selected to avoid known karst features. Karst can also provide constructability issues for engineering works associated with major infrastructure. These potential impacts mainly arise from the occurrence of underground cavities/paleokarst features which may lead to subsequent subsidence where there is inadequate support for structures. Drilling returns did not encounter significant open karst cavities/voids during the GI. No limestone pavement or surficial karst features were recorded at the infrastructure sites. No karst landforms/features were identified at the RWI&PS, WTP, BPT, BPS, FCV or TPR. No surficial karst features were identified based on the site walkovers, oblique aerial photography or LiDAR data. Weathered limestone or paleokarst features were identified at depth at the BPT. The intrusive ground investigation (i.e. rotary cored boreholes) shows variation in engineering rockhead (i.e. described as a rock to BS 5930 (BSI 2015) and Solid Core Recovery >50%) below the proposed BPT (See Appendix A10.8). The variation in rock head could potentially result in differential settlement. Construction methods are identified in Chapter 5 (Construction & Commissioning) to address settlement. Methods proposed include spread foundations, grouting and compaction. Where grouting is utilised, there is a potential loss of cementitious material to the groundwater.

291. No significant karst features were identified during the site walkover surveys within the Construction Working Width, with karst features identified within 200m of the pipeline in the Ardcrony/Ballythomas area. While karst features were not identified at ground surface within the Construction Working Width, the potential for karst features exists along the Treated Water Pipeline. The Construction Environmental Management Plan (CEMP) (Appendix A5.1) contains methods for dealing with karst features during construction.

292. The magnitude of impact is assessed as low due to the limited potential for effects. The sensitivity of the karst is considered to be negligible to medium as no surficial karst features were identified at the infrastructure site or along the Construction Working Width. Pre-mitigation, the potential effect in relation to karst stability is Not Significant to Slight (Not Significant) (as per Table 10.6).

Peat and Landslide Potential

293. There is a potential risk that localised ground movement may occur. The GSI Landslide Susceptibility mapping for the Proposed Project indicates ‘Moderately Low’ or ‘Low’ susceptibility. The GSI landslide assessment only accounts for the current site topographic and hydrological conditions and is not intended to be used in isolation to determine actual on-site risk. Peat depths along the pipeline are generally less than 1m and subject to land improvement, i.e. drainage. As set out in Appendix A5.3 (Methods of Working in Peat), where peat is present, peat depths are <1m in 55% of the identified areas. The Proposed Project could alter peat in the short term. Excavations are typically 4–6m deep and represent an alteration to the local topography in the short term.

294. Due to the relatively flat (0 to <2% slope), drained cutaway nature of the peatlands, the risk of a regional scale landslide is low. No evidence of historical or current peat instability was noted on the peat areas within the Construction Working Width. It is noted that the former peat extraction areas within the Construction Working Width are cut to very steep angles with few signs of instability. Localised peat stability would require management as set out in Appendix A5.3 (Methods of Working in Peat). An assessment of peat stability has been undertaken with embedded mitigation measures to address localised stability issues as outlined in Appendix A5.3 (Methods of Working in Peat). For example, in sections of construction where there would be deep peat, or where slacker side slopes cannot be adopted, the Contractor would adopt a trench box / temporary sheet piled coffer dam (this would be installed using a vibratory plate method) in order to retain the side slopes. This can have an effect on the local stability of the material however the magnitude is considered low.

295. The sensitivity is considered to be low to negligible and the magnitude of impact is assessed as low. The pre-mitigation potential effect in relation to peatland stability is Not Significant to Not Significant/Slight (Not Significant) (as per Table 10.6).

10.4.2.1.4 Soil and Geology Contamination

296. The significance of effects associated with contaminated land has been evaluated based on guidelines in C552 - Contaminated Land Risk Assessment, A Guide to Good Practice (CIRIA 2001); and LCRM (UK Environment Agency 2020). No significant potential contamination risk was identified along the Construction Working Width. The potentially contaminated land sites identified outside of the Construction Working Width do not pose a significant risk of contamination or a constraint to the Proposed Project. Potential contamination may be encountered during the installation of electrical cable ducting laid within the public road network. If contamination is encountered, appropriate mitigation measures will be applied (Section 10.5.2.1.4).

297. Sites with potential for contaminated land (Birdhill petrol station forecourt area and underground tanks) in proximity to the Proposed Project would not be disturbed by the Construction Phase. Soils and surface water concentrations at the WTP access road are comparable to natural background metal and hydrocarbon concentrations. Results are included in Appendix A10.3 (Petrol Station Assessment). Existing above ground structures at the petrol station would be removed as part of the Proposed Project. Excavations at WCW003, WCW004 and TW – 6100 may encounter elevated soil metals near the banks of the Kilmastulla River, due to historical mining upgradient at Silvermines. Results for ongoing monitoring at Silvermines indicates a low solubility of heavy metals, due in part to a neutral water pH. Excavation of soils with high metals may mobilise metals in the soil and groundwater. Given the medium sensitivity of the soil receptor and low magnitude of impact, the significance of effect is considered Slight (Not Significant) as per Table 10.6 (effects matrix).

298. It has been conservatively estimated for the assessment that of the 1,626,950 tonnes of excavated soil and stone, excavated rock and imported rocks and stone likely to be generated, approximately 32,539 tonnes of this material would be contaminated (this equates to 2%, and is based on indicative benchmarks within the BRE SmartWaste tool), and potentially classified as hazardous. Details in relation to waste are discussed further in Chapter 19 (Resource & Waste Management). If contamination is encountered, appropriate mitigation measures will be incorporated (Section 10.5.2.1.4). Given the medium sensitivity of the soils and geology receptor and the low magnitude of impact, the significance of effect would be Slight (Not Significant) as per Table 10.6.

299. The use of concrete to form structural elements of the substations and infrastructure site locations has the potential to generate alkaline runoff, which has the potential to discharge to groundwater potentially affecting the water quality. During the Construction Phase, machinery on-site would include hydrocarbon powered trucks, excavators and mobile cranes. The potential impacts from the Proposed Project could derive from accidental spillages of fuels, oils and solvents, which could affect the soil and groundwater quality, if allowed to infiltrate to ground during the Construction Phase.

300. Based on the criteria set out in Section 10.2, the magnitude of the potential contamination impacts on receptors are:

- Negative – effects will likely reduce the quality
- The effects are localised and short-term – construction is carried out over an estimated 5-year period
- Reversible – i.e. potential effects can be mitigated and managed.

301. Soil and geology receptor sensitivity is medium based on the localised temporary excavations and proposed reuse. Given the medium sensitivity of the soil receptors and low magnitude of impact, the significance of effect is considered Slight (Not Significant), as per Table 10.6 (effects matrix).

10.4.2.1.5 Aggregate and Extractive Industries

302. The Proposed Project could result in a loss of available aggregate within the Construction Working Width during the Construction Phase. Two active sand and gravel pits are present along the proposed 38 kV Uprate Works. Both extract sand and gravel from pits to the south of Montpelier, Co. Tipperary; however, there are no excavations at present underneath the powerlines. An existing wayleave agreement is in place for the 38 kV powerline.

303. There are no active quarries or mines within the remaining Proposed Project elements. Areas where rock is close to the surface have higher potential for extractive industries and any future extraction is addressed in the Operational Phase – Section 10.4.3.1.5. Shallow bedrock is encountered in a number of areas as identified in Section 10.3.3, including near the Nenagh River crossing (WCX016), the BPT, east of Killeigh village County Offaly; and between the River Liffey (WCX073) and the TPR. Site investigation work in the form of geophysical surveys and boreholes within the RWI&PS site, indicate that limestone rock is present at >8m bgl.

304. Peat extraction has ceased on all Bord na Móna bogs and industrial peat extraction sites. Bord na Móna has committed to rehabilitation of the peatlands within the EPA licensed boundaries. The subsoils permanently removed in the peat areas are not economically important. Excavations would not reach or expose the underlying bedrock aquifer, which is more than 8m bgl in the peatland areas. No significant extractable material exists on the cutover peatland sites as rehabilitation is proposed in the Bord na Móna sites. As peat extraction has ceased there is no potential significant effects on peat extraction sites.

305. The Proposed Project would remove turbary (total of 0.4ha) within an 80m turbary bank at TWC – 17300 and a 20m turbary bank at TWC – 23550. As turf cutting is active is a potential effects on the turf bank sites.

306. Based on the criteria set out in Section 10.2, the magnitude of the potential impacts are:

- Negative – effects will likely reduce the extractive potential
- The effects are not likely to change existing baseline conditions
- Uncertain – the presence of infrastructure would locally limit the potential for extraction; however, the potential extraction areas at existing pits is limited
- Short term – construction is carried out across a 24-month to 5-year period.

307. Receptor sensitivity in the Proposed Project is low as there are no active quarries or mines within the Proposed Project. Given the low to negligible sensitivity of the extractive receptors and low to negligible magnitude of impact, the significance of effect is considered Imperceptible to Not Significant/Slight (Not Significant)**,** as per Table 10.6 (effects matrix).

10.4.2.1.6 Geological Heritage Sites

308. There are no Geological Heritage Sites within 2km of the 38 kV Uprate Works, BPT, BPS, FCV or TPR based on a review of the baseline data and consultation with the GSI, detailed under Section 10.2.5. There would therefore be no likely significant effects on geological heritage sites as a result of constructing these infrastructure elements (effects would be Imperceptible).

309. There is potential for direct impact on the Kilmastulla Meltwater Channels, Ardcrony Esker, Kilcormac Esker and Kinnitty Esker CGSs and potential indirect impact on the Liffey Oxbow CGS. The Kilmastulla Meltwater Channels covers a large area in Tipperary and encompasses an area from the eastern extent of the RWI&PS, the RWRMs, the WTP and Treated Water Pipeline from the WTP to the BPT as shown on Figure 10.18. There is no surface expression of Kilmastulla Meltwater Channels along the Treated Water Pipeline from the WTP to the BPT.

310. The geological features of interest at three CGS sites are eskers. As detailed in Section 10.3.9, an esker is a long, narrow, ridge composed of stratified sand and gravel. The alignment crosses the mapped Ardcrony, Kilcormac and Kinnitty Esker CGS sites; however, there is no surficial expression of the esker system at each location. There is limited evidence from the GI undertaken at each location outside of the current CGS boundaries. Quarrying may have removed the original features at these locations. No excavations are proposed within the Liffey Oxbow CGS. The magnitude of impact is considered negligible to low and long term. The CGSs are considered to be medium sensitivity sites as they are a CGS but with no surficial expression where the Construction Working Width crosses the CGS. The significance of effect is therefore considered Slight (Not Significant) on the Ardcrony Esker CGS, Kilmastulla Meltwater Channels CGS, Kilcormac Esker CGS and the Kinnitty Esker CGS. The Liffey Oxbow CGS has medium sensitivity; however, the magnitude is considered negligible as there are no direct effects, therefore the significance of effect is considered Not Significant as per Table 10.6.

10.4.2.2 Hydrogeology

311. The Proposed Project has the potential to impact locally on groundwater flow and quality. The principal effects include a reduction in groundwater level and modification in groundwater flow as a result of dewatering; and deterioration in groundwater quality as a result of suspended solids runoff and contaminant (oils and chemicals) spills/leaks during the Construction Phase. The evaluation of the significance of potential effects on groundwater is based on the source–pathway–receptor approach and is determined from a combination of the magnitude of any impact and sensitivity of the receptor.

10.4.2.2.1 Groundwater Flow Effects – Temporary Dewatering

312. Temporary dewatering is required to manage groundwater, facilitating dry working conditions in excavations. Dewatering methods would vary depending on ground conditions and includes sump pumping, wellpoint dewatering, drainage channels, depending on site conditions and project requirements. Dewatering methods are detailed in CIRIA C750 (CIRIA 2016).

313. No significant groundwater flow effects would occur as a result of the 38 kV Uprate Works due to the limited excavations required for the uprate works.

Infrastructure Sites

314. The RWI&PS, WTP, BPT, BPS, FCV and TPR are not located in a groundwater ZoC or SPZ (refer to Figure 10.118 to Figure 10.122). Groundwater may be encountered in excavations. Where excavations encounter groundwater, such inflows would be pumped, resulting in short-term localised drawdown of the water table. Temporary effects would be restricted to the temporary period of pumping, i.e. typically two weeks or less than three months in the case of trenchless technology. Drawdown effects decrease exponentially away from the excavation.

315. The deepest excavation occurs at the RWI&PS where the water table is shallow. Groundwater levels at the RWI&PS are almost flat (<0.001 gradient) but vary seasonally between 0.3m and 1.5m bgl. Based on the high groundwater levels and flat topography, groundwater flow in the sandy soils is limited. Groundwater is encountered in the saturated sandy upper horizon and groundwater levels are above the Parteen Basin surface water level. Based on embedded mitigation, i.e. proposed design (secant or sheet piling), and permeability testing of the underlying clay horizon and bedrock, dewatering would be limited at the RWI&PS. Piling will be utilised to exclude the permeable sand and gravel horizons. The calculated discharge volumes would be <15m^3/hr. Calculations are included in Appendix A10.16.

316. Groundwater levels at the WTP varied seasonally and across the site. Groundwater levels are between 0.3m and >10m bgl. Soils at the WTP comprise low to moderate permeability tills based on the site walkovers, geological logs and in situ falling head permeability tests. No significant dewatering would be required at the WTP; however, minor inflows would occur as the excavation progresses.

317. Limited excavations (<0.5m) are required at the construction compounds. The majority of construction compounds are also associated with the infrastructure sites. CC2 is located in the Ardcrony groundwater supply ZoC. Groundwater flow is not affected at CC2 as the compound is >10m above the water table.

318. The subsoils underlying the BPT are variable and comprise silty GRAVEL and stiff, brown, slightly sandy slightly gravelly SILT. Groundwater levels at the BPT are >8m bgl. Proposed excavations at the BPT are <5m. No significant dewatering would be required at the BPT; however, minor inflows may occur in the proposed excavations.

319. The subsoils underlying the BPS are variable till deposits comprising silty GRAVEL and stiff, brown, slightly sandy gravelly SILT. Groundwater levels at the BPS vary seasonally between 1m bgl and 8m bgl. The proposed excavation is 4m bgl. Based on the site-specific borehole data and low/moderate permeability data (c.2 x 10^{-7}m/s), the dewatering requirements would be limited at the BPS and depend on the timing of excavations. Based on proposed design (sheet piling) and site-specific borehole data, the requirement to pump would be limited at the BPS due to timing of Construction Phase.

320. Groundwater levels at the FCV vary seasonally and are between 1.7m bgl and 5m bgl. Excavations (<4m) are required at the FCV and consequently dewatering would be required. Minor inflows may occur in the proposed excavations.

321. Groundwater levels at the TPR vary seasonally and are between 1m bgl and 4m bgl. No significant excavations (<2m) are required at the TPR and consequently dewatering would be limited at the TPR; however, minor inflows may occur in the proposed excavations.

322. The construction of the Proposed Project would influence existing runoff and groundwater recharge patterns locally across and around the hardstanding areas. As part of the embedded measures detailed in the Surface Water Management Plan (SWMP) (Annex A of Appendix A5.1: CEMP), rainwater falling on the construction sites would be intercepted and discharged through the stormwater infrastructure and directed to Sustainable Drainage Systems (SuDS) water management infrastructure. From here, the water is discharged to the local streams via settlement ponds. This would result in a localised reduction in recharge over a <24-month period.

323. Based on the criteria set out in Section 10.2, the magnitude of the potential impact is considered to be:

- Negative – dewatering would locally alter groundwater level during the construction period
- The effects are not likely to significantly change existing baseline conditions
- Certain – dewatering would be required by the Construction Phase
- Temporary to Short term – construction areas would be required for a 6 to 24-month period
- Reversible – i.e. potential effects can be mitigated and managed.

324. Receptor sensitivity is low as the infrastructure sites are not located in SPZs and there are no PWS within 1km. Individual components, e.g. the RWI&PS, would be affected in the short term. Given the low sensitivity of the receptors and low magnitude of impact, the significance of effect is considered Not Significant/Slight (Not Significant)**,** as per Table 10.6 (effects matrix).

Treated Water Pipeline

325. The RWRM and Treated Water Pipeline are not located within 0.1km of any GWS/PWS or the inner source protection of public groundwater supply schemes – refer to Figure 10.118 to Figure 10.122.

326. The need for dewatering to construct the pipeline would vary along the Construction Working Width and precise locations would be confirmed at the Construction Phase. As detailed in Section 5.24 of Chapter 5 (Construction & Commissioning), before trenching commences, dewatering of groundwater may be required to ensure safe working conditions. The excavation of peat, subsoils and rock below the

groundwater table would interrupt the hydrogeological conditions in the affected area. During construction, this would involve changes to runoff and groundwater recharge, as well as groundwater lowering from seepage into open excavations.

327. The main trench excavation would be predominantly open cut and carried out with plant, such as excavators, appropriate to the identified soils and ground conditions. Before trenching commences, dewatering of groundwater may be required to ensure safe working conditions. The trenching operation would only be conducted once the pipeline installation and backfill crew are ready to install the pipe in that location, in order to minimise the time the trench is open. Water pumped from the excavations may contain suspended solids and contaminants. In the absence of any treatment, the disposal of this water to ground or to the surface water system could cause deterioration in water quality of the receiving system.

328. Private dwellings with groundwater wells occur along the pipeline. Based on consultation with landowners, there are no direct impacts on wells within the Construction Working Width. However, there is the potential for indirect impacts on private wells due to groundwater drawdown in excavations. This is assessed below.

329. The pipeline would be laid at a minimum depth of cover of 1.2m above the crown of the pipe and maximum depths of excavation are generally 6m. However, at trenchless crossings the depth of cover would exceed these depths as required by the local site conditions/constraints. Temporary effects would be restricted to the temporary period of pumping, i.e. typically less than two weeks or less than three months in the case of trenchless technology. Drawdown effects decrease exponentially away from the excavation.

330. When a trench is temporarily pumped, the water drawn into it leaves behind a dewatered area (i.e. a cone of depression or influence). The shape of the cone and the rate at which it expands depends on the coefficients of transmissivity and depth of excavation. The initial dewatering stage is derived from storage. However, as pumping continues, the cone enlarges and continues to do so until it intercepts a source of recharge (replenishment) that would produce all of the water demanded by the pump (steady state). In terms of dewatering, the short-term pumping, shallow excavations and underlying geology limit the potential for impact. The pipeline would be predominantly routed through deep subsoils, locally important and poorly productive aquifers. It is known that hard rock aquifers or fractured rock aquifers pose difficulties in characterising and predicting aquifer parameters. This is due to the inherently heterogeneous nature of fractured rock aquifers and the length scales of heterogeneity and the length scale of measurement. Realistic transmissivity and permeability values are provided for each of the aquifer categories and the Rock Unit Groups in the Irish parameter database (Kelly *et al.* 2015)[28]. Based on the Irish aquifer database, the upper range of transmissivity values for the underlying aquifers varies due to heterogeneity but are generally less than 150m^2/day. A pumping test at Ardcrony, for example, indicated a transmissivity of <50m^2/day. The volume of water and the radius of influence (R_o) is first estimated by the empirical Sichardt Formula for radial flow:

- $R_o = C\ (H - h_w)\sqrt{K}$

Where,

- C = empirical calibration factor usually taken as 3,000 when units are (m) for drawdown and (m/s) for permeability
- H = initial aquifer piezometric or phreatic level
- h_w = piezometric or phreatic level in the equivalent well
- K = permeability.

[28] Kelly, C., Hunter Williams, T., Misstear, B.M., Motherway, K. (2015). Irish Aquifer Properties – A reference manual and guide. Prepared on behalf of the Geological Survey of Ireland and the Environmental Protection Agency.

331. Assuming a drawdown of 5m, where static water levels are 1m bgl, the empirical steady state estimate calculates the 0m drawdown at <150m. The excavations are not likely to reach steady state due to the short period required for trenching at any one location. Further calculations for the Treated Water Pipeline are included in Appendix A10.16. Based on the well surveys, there are five wells within 50m of the Pipeline Construction Working Width. Where wells are located within 50m of the Treated Water Pipeline, temporary adverse effects can occur in terms of altering groundwater levels.

332. Trenchless construction involves tunnelling beneath a feature rather than using a conventional open-cut method which can cause a greater environmental impact or disruption. Typically, trenchless crossings are proposed underneath major crossings, for example major roads, railways, canals or watercourses. The proposed trenchless construction may have Construction Phase effects on groundwater flow and quality. Details of the trenchless construction are given in Chapter 5 (Construction & Commissioning).

333. Where local concerns were raised during consultation at Ballythomas/Ardcrony in County Tipperary, dewatering is not anticipated in relation to groundwater as the Treated Water Pipeline from the WTP to the BPT would be installed during the dry season and above the water table. Groundwater levels at this location are 5m bgl to 8m bgl outside of the winter season. The groundwater levels at Ardcrony are below the anticipated invert level of the Treated Water Pipeline from the WTP to the BPT.

334. Dewatering to the north of the Geashill PWS/Ballinagar GWS would be required to enable the installation of the Treated Water Pipeline from the BPT to the TPR at Chainage TWC – 8900. While the proposed trench would be located downgradient of the Geashill/Ballinagar water supplies and outside of the ZoC, dewatering would be required to a depth of 8m with potential to alter groundwater flow/quantity at the Ballinagar GWS. In relation to effects on the Geashill PWS/Ballinagar GWS, to the east of the Geashill to Ballinagar road it is evident from BH213 and BH224 that groundwater levels are below the Treated Water Pipeline from the BPT to the TPR. No significant groundwater effects are anticipated where the pipeline is located outside of the delineated ZoCs/SPZs such as Killeigh SPZ – see Figure 10.118 to 10.122 for reference.

335. Dewatering would be required in a number of cutover and cutaway peatland areas. As part of the embedded mitigation measures, groundwater and surface water encountered would be discharged to settlement ponds and topographical depressions in the cutover peat areas – refer to Appendix A5.3 (Methods of Working in Peat). The trenching operation would only be conducted once the pipeline installation and backfill crew are ready to install the pipe in that location, in order to minimise the time the trench is open.

336. Records of individual land drains are limited but include farm scale drainage systems such as tile drains, mole drains or French drains that occur within the Construction Working Width. Where land drains occur along the Treated Water Pipeline, they remove shallow groundwater from the soil, leading to a localised decline in the water table. Disconnection of the land drains would be undertaken during the construction of the Treated Water Pipeline.

337. Based on the criteria set out in Section 10.2, the magnitude of the potential impact is considered to be:

- Low to medium magnitude
- Negative – construction activity could reduce the groundwater flow
- Temporary to short term – construction is carried out across a 24-month period but less than two months in any area
- Certain to likely – dewatering would be required by the Construction Phase
- Reversible – i.e. potential effects can be mitigated and managed.

338. Groundwater sensitivity is low (individual well) to medium (PWS/GWS) along the Construction Working Width. Therefore, in the absence of mitigation measures, a Not Significant/Slight (Not Significant) to Moderate (Significant) effect is assessed during the Construction Phase. Moderate, short-term effects could occur at Ballinagar GWS at approximate Chainage TWC – 8900 and therefore mitigation is required.

10.4.2.2.2 Groundwater Quality Effects

339. Spillages of fuels or chemicals represent a pollution risk to groundwater. The potential effect of spillages is the contamination of groundwater. Accidental spillages of chemicals and hazardous material may occur during the Construction Phase. The following have been assessed:

- Spillages or leakages from construction traffic and machinery
- Spillages during refuelling
- Spillages associated with the use of concrete
- Spillages/loss of drilling fluids.

340. The significance of effects associated with contaminated land has been evaluated based on guidelines in C552 - Contaminated Land Risk Assessment, A Guide to Good Practice (CIRIA 2001); and LCRM (UK Environment Agency 2020). Potential for contaminated land has been identified along the Proposed Project; however, no groundwater contamination was encountered at the infrastructure sites.

341. Groundwater quality issues associated with peat drainage include elevated levels of suspended solids, ammonia, phosphorus and dissolved organic carbon (DOC). In water bodies draining excavated peat areas, these elevations have been observed and compared to lowered levels following the rewetting of peatlands (An Fóram Uisce 2021). The approach to the management of water during the construction of the pipeline in peat areas is broadly similar to that described in the SWMP (Annex A of Appendix A5.1: CEMP), for silty water control. However, the potential water quality issues associated with the construction of the pipeline through peat areas are slightly different to those along the rest of the route, therefore additional measures are required and detailed in the SWMP.

342. No PWS or GWS are located within 200m of the construction compounds or PSDs. Two IMPs are located within O'Briens Bridge PWS ZoC. Construction Compound CC2 is located 2.1km from Ardcrony GWS but within the mapped Ardcrony ZoC. CC2 is underlain by circa 10m unsaturated subsoils. The ESB connection at Mount Lucas is located in the ZoC catchment for Mount Lucas GWS. New polesets and overhead lines would deliver power from the connection point on the ESBN network to the Line Valve sites.

343. Based on the criteria set out in Section 10.2, the magnitude of the potential impact is:

- Negative – effects would likely reduce the quality of the groundwater quality during construction due to the potential for localised contamination
- The effects would change existing baseline conditions
- Unlikely – due to the limited works (O'Briens Bridge, Mount Lucas) and implementation of design measures and embedded mitigation including oil interceptors at infrastructure sites
- Temporary to Short term – construction is carried out across a 24-month period at Ardcrony GWS, O'Brien's Bridge PWS and Mount Lucas GWS
- Reversible – i.e. potential effects can be mitigated and managed.

344. Groundwater quality sensitivity is medium based on the distance to the water supplies (O'Brien's Bridge PWS, Ardcrony GWS, Mount Lucas GWS) and the appraisal methodology set out in Section 10.2.6 and Section 10.3.12. There are no proposed wastewater discharges to groundwater at CC2, Mount Lucas or O'Brien's Bridge. Surface water discharges will be treated as detailed in the SWMP and therefore have no effect on groundwater. In areas outside of ZoCs, the sensitivity is low. For low sensitivity receptors and

low magnitude of impact, the significance of effect is considered Not Significant. Given the medium sensitivity of the receptors (Ardcrony GWS, O'Brien's Bridge PWS and Mount Lucas GWS) and low magnitude of impact, the significance of effect is considered Not Significant to Slight (Not Significant).

345. In the context of this chapter, accidental spillage of fuels or chemicals represent a pollution risk to groundwater. Groundwater also represents a pathway to the surface water receptor, which is addressed in Chapter 9 (Water). Any minor leaks would be attenuated in the subsurface environment by processes of adsorption, dilution and degradation processes.

346. Trenchless crossing construction technique is an embedded mitigation for the crossing of larger watercourses, canals and significant infrastructure such as roads and railways. Where trenchless construction is used it poses a potential groundwater contamination risk. Furthermore, during construction of the trenchless crossings, there is potential for a 'breakout' of bentonite clay, i.e. drilling fluid/mud. This is, in effect, very fine suspended solids, i.e. clay. If a pathway exists, and in the absence of control measures or mitigation, this could enter water bodies and result in a temporary increase in sediment load. Trenchless construction would be employed at eleven major watercourse crossings (Chapter 5: Construction & Commissioning). The remaining watercourses that intersect the route of the Treated Water Pipeline and associated infrastructure would be crossed via open cut techniques (Chapter 5: Construction & Commissioning) and the impacts associated with this are discussed in Chapter 9 (Water). As inert materials would be utilised in the trenchless technology, the magnitude of impact on groundwater is low.

347. Given the medium sensitivity of receptors and the low magnitude of impact, the significance of effect of trenchless crossings on groundwater quality is Slight (Not Significant)**.** Effects on surface water are outlined in Chapter 9 (Water).

348. Construction Compounds and PSDs would require welfare facilities; this would necessitate a method of collecting the wastewater generated. Wherever practicable, Construction Compounds and PSDs would not have a direct connection to local sewers but would be serviced by means of a wastewater storage tank, which would be regularly emptied by means of a suction tanker by an appointed Contractor(s). In the absence of control or mitigation measures, there is a potential for pollution of water bodies with other substances such as oils, chemicals and wastewater due to accidental spillage which could impact on groundwater. Given the medium sensitivity of receptors and low magnitude of impact, the significance of effect is considered Slight (Not Significant).

10.4.2.2.3 Potential Effects on Groundwater Dependent Terrestrial Ecosystems

349. Habitats dependent on hydrogeological characteristics include GWTDE receptors that are dependent on emergent groundwater.

350. Excavation of soil and bedrock during the Construction Phase of the Proposed Project may cause localised disruption and interruption to groundwater flow. Interruption of groundwater flow could potentially reduce the supply of groundwater to GWDTEs, if present, thereby causing an alteration/change in the quality or quantity of, and/or the physical or biological characteristics of the GWDTE. Contamination of groundwater could also cause physical or chemical contamination to the GWDTE.

351. The footprint of the 38 kV Uprate Works overlaps with one European site, the Lower River Shannon SAC. No qualifying GWDTE habitats or species were identified within the lands upon which existing and new polesets are proposed. Additionally, the 38 kV Uprate Works would not include any instream or bankside works. No significant effects on the qualifying interests of this SAC are therefore anticipated. Only minimal earthworks would be carried out during the construction of the 38 kV Uprate Works, such as the replacement of polesets. Therefore, there is no potential for significant interference with groundwater supply or quality and as such no potential for significant effects (effects would be Imperceptible).

352. There are no GWDTE at the RWI&PS, WTP, BPT, BPS, FCV or TPR and therefore no direct effects. Parteen Basin is an artificial water body regulated by the ESB. No springs occur on the shoreline at the proposed abstraction point. Therefore, there is no potential for effects on GWDTEs (effects would be Imperceptible).

353. GWDTE were identified during the ecological site walkover of the Treated Water Pipeline in Counties Tipperary and Offaly. These include the Coolfin Transition Mire and Coagh fen as detailed in Section 10.3.10. There are no direct or indirect effects on the Coolfin mire or Coagh fen GWDTE. Where potential GWDTEs occur within 0.2km of the pipeline, they are discussed further below.

354. Coagh fen area (0.14km east of TWB – 1900) is located on a break in slope at the base of a steep hill and to the west of the Tubrid Stream. Water levels in the fen are likely to be maintained by overland surface water runoff and groundwater. No inflow stream to the wetland was detected indicating that it is a spring-fed fen. The soil under the fen is composed of a thin peat layer with mineral soil with shallow (0.05m) calcareous tufa deposits in some areas. The area is approximately 100m x 30m in extent with scattered gorse (*Ulex europaeus*) scrub patches between the fen and the adjacent grazed improved agricultural grassland. The fen area is a remnant of a larger wetland habitat, which has survived in a localised topographical depression. The fen vegetation is located in a slight depression of approximately 0.25m deep, in a former drainage channel/drainage ditch. Coagh fen is underlain by 0.3m to 0.4m organic soils and silty SAND. Coagh Stream, which forms a hydrological boundary, is located 100m to the west of the Treated Water Pipeline from the BPT to the TPR. Water levels in the fen are maintained by overland surface water runoff and groundwater seepages. During the time of survey, ground soils were moist to dry with no spring inflows. No peat was encountered during the site walkover. The underlying bedrock is a Locally Important Aquifer - Bedrock which is Moderately Productive only in Local Zone. Surface water or groundwater discharged to the Tubrid Stream from the Construction Working Width would not directly or indirect affect the fen area. There are no plausible effects on the fen as a result of the temporary Construction Phase.

355. Coolfin Transition Mire is shallow mire (0.4m to 0.6m deep) and occurs in a topographical depression, 0.14km south of TWB – 7900. While the area is slightly modified by drainage, the lack of gradient ensures the mire remains wet/damp throughout the year. Groundwater levels in the wetland/mire area are between 0.2m and 0.28m bgl in the summer and the area is flooded during the winter period. A number of soil exposures noted on the boundaries of the site comprised firm to stiff, light brown slightly sandy gravelly SILT. The primary input into the mire occurs via rainfall and land drainage to the south. The ZoC to the transitional mire is from the south and south-east and there are no construction works proposed within the ZoC. Dewatering along the Treated Water Pipeline from the BPT to the TPR would be temporary and based on the underlying geology, there is no potential for direct or indirect significant effects on the transitional mire.

356. A number of partially cutover areas of degraded raised bog (Non Annex I) are crossed by the Treated Water Pipeline from the BPT to the TPR. Locations include Island/Clonad, Mount Lucas and Timahoe. As detailed in Section 10.3.2, the peat soils are cutover or subject to historical drainage. Water level monitoring in the peatland was undertaken in a number of peatland locations in 2021. Results of the monitoring are included in Appendix A10.15. Water levels in the summer were more than 0.3m bgl which indicates that the peat is not active raised bog. The groundwater level monitoring supports and is consistent with the habitat assessment, i.e. degraded raised bog. Water levels throughout the peatland are >0.3m in summer. Based on the peatland setting, habitat surveys and groundwater results, there are no peatland GWDTEs. Further details on the peatland habitats are included in Chapter 8 (Biodiversity).

357. Conceptual site models/ cross sections of potential GWDTEs/peatlands including Coagh, Island/Clonad bog, Mount Lucas bog and Timahoe North bog and river crossings, are included on Figure 10.135 to Figure 10.149. Based on the criteria set out in Section 10.2, the magnitude of impacts are:

    - Negative – effects may reduce the groundwater quality

- There are no direct effects on GWDTEs; based on the geological setting, the indirect effects are not likely to significantly change existing baseline conditions
- Unlikely – effects are unlikely to occur
- Temporary to short term – construction is carried out between 6 and 24-month period
- Reversible – i.e. potential effects can be mitigated and managed.

358. Receptor sensitivity along the Treated Water Pipeline is medium to high. Given the medium to high sensitivity of the receptors and negligible magnitude of impact, the significance of effect is considered Slight (Not Significant) as per Table 10.6 (effects matrix).

10.4.3 Operational Phase

10.4.3.1 Soils and Geology

359. Due to the nature of the distribution network, there would be machinery periodically at the Birdhill and RWI&PS Substations and potentially at poleset locations to carry out maintenance and repairs. See Appendix A4.1 (Operational Strategy).

10.4.3.1.1 Soil Compaction

360. There would be no likely significant effects on soils, subsoils or bedrock during the Operational Phase of the 38 kV Uprate Works and infrastructure sites because no excavations are required.

361. There would be no likely significant effects on soil compaction during the Operational Phase of the Proposed Project. Limited access is required within the 20m wide Permanent Wayleave for the RWRMs and Treated Water Pipeline. Soil compaction results in an increase in bulk density and reduction in biological activity, porosity and permeability. Due to limited activity during the operational phase, the potential magnitude of impact is negligible, unlikely and long term. Given the low sensitivity of receptors and negligible magnitude of impact, the significance of effect is considered Not Significant.

10.4.3.1.2 Loss of Soils – Land Use Change

362. According to the EPA (2022) EIAR Guidelines in referencing and describing ‘land’ it is clarified that the amended EIA Directive introduces ‘land’ as a prescribed environmental factor; ‘Recital 9’ gives context to this addition, showing that it relates to the issue of ‘land take’. Potential farm-scale impacts on land are addressed in Chapter 11 (Agriculture). Where effects are associated with the Construction Phase, these are addressed in Section 10.4.2.1.

363. Operation of the pipeline infrastructure would not result in the disruption of agricultural land apart from those areas where permanent inline features are located. The results of the assessment for the infrastructure sites at individual farm level are included in Chapter 11 (Agriculture). Due to limited activity during the operational phase, the potential magnitude of impact is negligible, unlikely and long term. Given the negligible sensitivity and negligible magnitude of impact, the effect is considered Imperceptible (Not Significant).

364. Given the negligible sensitivity of receptors and negligible magnitude of impact, the significance of effect on loss of soil is considered Imperceptible (Not Significant) at the RWI&PS, WTP, BPT, BPS, FCV, TPR and 38 kV Uprate Works.

10.4.3.1.3 Geomorphology and Geohazards

365. There would be no likely significant effects on geomorphology and geohazards during the Operational Phase of the Proposed Project. There are no significant Operational Phase excavations as a result of the Proposed Project. Due to limited activity during the operational phase, the potential magnitude of impact is negligible to low, unlikely and long term. The sensitivity of receptors is considered negligible to high (Fort Henry) and with negligible to low magnitude of impact, the significance of effect is considered Imperceptible to Not Significant/Slight (Not Significant). A summary of effect is provided in Table 10.30 and Table 10.35.

10.4.3.1.4 Contamination

366. There are no operational discharges to ground for the 38 kV Uprate Works. The pre-mitigation effects on the soils and geology are considered Imperceptible (Not Significant) for the Operational Phase of the 38 kV Uprate Works.

367. There is potential for ongoing contamination from increased personnel movement within and surrounding infrastructure due to ongoing maintenance and repair works at:

- The RWI&PS, WTP, BPT, BPS, FCV and TPR
- Maintenance and repair activities at Line Valve, Air Valve and Washout Valve sites
- Pollution risk from spills (during cleaning and maintenance and repair works) from machinery and associated infrastructure into surface and or groundwater
- Pollution risk from leaks and emergency or non-emergency discharges of treated water from pipeline into surface and/or groundwater.

368. Due to the nature of the Proposed Project, there would be machinery at the six infrastructure sites. This could lead to occasional accidental hydrocarbon emissions, which could potentially cause contamination if they enter the soil and bedrock environment. The proposed design includes the use of oil interceptors at the infrastructure sites as noted in Section 10.5 and detailed in Chapter 5 (Construction & Commissioning). Due to limited activity during the operational phase, the potential magnitude of impact is low to negligible, unlikely and long term. The sensitivity is considered low to medium and magnitude is low to negligible. Potential effects are considered to be Not Significant/Slight to Slight (Not Significant).

10.4.3.1.5 Aggregate and Extractive Industries

369. As there are no permitted quarries adjacent to the proposed infrastructure, there would only be a very small loss of potential aggregate reserves within the 20m wide Permanent Wayleave. The Proposed Project would sterilise future extraction within the 20m wide Permanent Wayleave.

370. Industrial peat extraction has ceased since 2019 as required and therefore the Proposed Project would not sterilise any future industrial peat extraction.

371. The Proposed Project would remove turbary within the 20m wide Permanent Wayleave, as a result of the construction activity. The Construction Phase would have permanently altered and removed the turbary bank at TWC – 17300 and TWC – 23550. The potential effects are therefore addressed in Section 10.4.2.

372. Due to limited activity during the operational phase, the potential magnitude of impact is low, unlikely and long term. Due to the low sensitivity and low magnitude of impact, the effect is expected to be Not Significant/Slight (Not Significant).

10.4.3.1.6 Geological Heritage

373. The magnitude of impact on the geological heritage sites (Kilmastulla CGS and three CGS along the pipeline) is considered to be low to negligible. Given the medium sensitivity of receptors and low to negligible magnitude of impact, the significance of effect is considered Slight (Not Significant).

10.4.3.2 Hydrogeology

10.4.3.2.1 Groundwater Flow Effects

374. The construction of the infrastructure sites could reduce groundwater recharge within the permanent footprint and associated hardstanding areas. Rainwater would be captured by the stormwater system at the RWI&PS, WTP, BPT, BPS, FCV and TPR. Hence, there is no net loss of water that discharges to the surface water system. Infiltration rates at the RWI&PS and WTP site are low and no significant alteration is predicted. Surface water captured at the BPT would be allowed to infiltrate back to ground.

375. During the Operational Phase, there is a potential for preferential flow along the pipeline backfill material. Conversely there is a potential for reduced flow where lower permeability materials are used. The potential for flow along pipelines is slight due to the small cross-sectional area, groundwater conditions and frequent changes in elevation. Along sections of the Treated Water Pipeline where gradients increase, drainage along the pipeline could occur within the bedding material. For example, Ardcrony/Ballythomas, or in areas of species-rich grasslands/wetlands, bedding material could act as a preferential pathway for the transference of groundwater. The construction methodology identifies steel pipes that require minimal granular material. Backfilling would be achieved by using the native excavated material as backfill around the pipe. The potential for preferential pathways is quantified based on the following scenario, assuming high permeability backfill (1 x 10^{-4}m/s), extensive granular backfill (1m^2) and steep slopes (1/10), drainage along the pipeline is in the order of 0.6l/min or 0.8m^3/day.

376. Construction works can lead to reduced permeability where compaction occurs. The effects of compaction are likely to be localised and short term but can result in reduced soil permeability and rainfall infiltration beyond the Construction Phase.

377. The construction of the Proposed Project would influence existing runoff and groundwater recharge patterns locally across and around the hardstanding areas. As part of the embedded drainage design measures detailed in Chapter 4 (Project Description), rainwater falling on the infrastructure sites would be intercepted and discharged through the stormwater infrastructure and directed to SuDS water management infrastructure.

378. To evaluate the hydrologic barrier effect of the RWRMs and Treated Water Pipeline, a literature review was undertaken. There is a potential to raise groundwater levels where flow is perpendicular to pipelines. Attard *et al.* (2016) details the potential for impact of underground structures on the flow of groundwater. The Attard *et al.* paper deals with various boundary conditions (Dirichlet, Cauchy and Neumann) imposed by deep foundations and tunnels. Infiltration/exfiltration from sewers and impacts on groundwater quality are detailed in hydrogeology papers, including Boukhemacha (2015)[29], Lerner and Barrett (1996)[30], Karpf and Krebs (2004)[31] and Karpf and Krebs (2011)[32]. Changes to the groundwater levels arose mainly from infiltration and exfiltration. As the pipeline is sealed, it cannot itself become a drain, as a sewer or tunnel could. There is no operational reason to depress groundwater level in long term operation, as one might

[29] Boukhemacha, MA, Gogu CR, Serpescu I, Gaitanaru D, Bica I (2015) A hydrogeological conceptual approach to study urban groundwater flow in Bucharest City, Romania. Hydrogeol J 23:437–450
[30] Lerner DN, Barrett MH (1996) Urban groundwater issues in The United Kingdom. Hydrogeol J 4:80–89
[31] Karpf C, Krebs P (2004) Sewers as drainage systems-quantification of groundwater infiltration. In: Proceedings of NOVATECH 2004 Sustainable Techniques and Strategies in Urban Water Management, vol 2, Lyon, France, June 2004, pp 969–975
[32] Karpf C, Krebs P (2011) Quantification of groundwater infiltration and surface water inflows in urban sewer networks based on a multiple model approach. Water Res 45:3129–3136

need to do with a tunnel. Marinos and Kavvadas (1997) calculated values for various scenarios for tunnels. Scenarios assessed in Marinos and Kavvadas, (1997) included 6m and 10m diameter tunnels up to 10m below ground level. Based on the gradients similar to the pipeline and a 6m tunnel and 6m deep, the groundwater rise upgradient is 2% to 5% of the diameter of the pipeline. Variations in the upgradient and downgradient were based on the various assumptions including infinite aquifer extent and limited aquifer depth. Various scenarios were reviewed using the typical gradients and a range of potential hydraulic conductivity values for sediments, trench backfill and underlying geology. All scenarios resulted in a change between 1% and 10% of the pipe diameter. Variations in the groundwater level of 0.1m does not constitute a significant effect on the hydrogeological environment. These calculations are further reduced where the pipeline is entirely below the groundwater table. Where land drainage pipes are intercepted and not replaced, the potential for water level increase or localised ponding occurs due to the disconnection of the land drainage. The minor alteration of groundwater levels locally is a not significant effect and the sensitivity is low.

379. The magnitude of impact is considered negligible, unlikely and long term. Given the negligible to low sensitivity of the receptor and negligible magnitude of impact, the significance of effect is considered Imperceptible to Not Significant (Not Significant).

10.4.3.2.2 Groundwater Quality Effects

380. Foul wastewater generated by operating staff at all of the infrastructure sites (except the TPR, where foul water drainage is not required due to existing facilities) would be tankered from wastewater collection tanks to a licensed Wastewater Treatment Plant (WwTP).

381. There are no stormwater discharges to ground with the exception of the BPT due to the low infiltration rates. An infiltration basin would be utilised at the BPT to manage storm water runoff from roofs and hardstanding. The construction of soakaway chambers and filter drains to disperse surface water in a controlled manner. In addition, the proposed site layout would include an infiltration basin which would be used for control of any surface water runoff. The soakaway design would include a minimum of 1m of engineered material across the base of the basin.

382. Drainage from the RWI&PS, WTP, BPS, FCV and TPR site paved areas are designed to incorporate SuDS principles to limit discharges from the site to the equivalent greenfield site flow rate. This includes provision of filter drains to act as attenuation/infiltration devices and would disperse surface and stormwater in a controlled manner to the soakaway.

383. Two IMPs are located within Montpelier/O'Brien's Bridge PWS ZoC. Timber polesets are pressure treated with creosote to the relevant national and international standards[33]. Creosote is a complex mixture of substances made up of Polycyclic Aromatic Hydrocarbon (PAH) compounds. Poles are impregnated with creosote with overnight vacuum and allowed to dry following treatment. The PAHs component of creosote has a low solubility. Creosote components are slowly released from treated wood products by oil exudation, rainwater leaching and by volatilisation of the lighter fractions (Henningsson 1983). The U.S. Department of Agriculture (1980) and Jernlås (2012)[34] reported that the components of creosote were not detected in soil samples taken to a depth of six inches within 0.05m–0.6m from treated poles, as a result of low solubility and biotransformation of mobilised components by soil microorganisms.

[33] Commission Implementing Regulation (EU) 2022/1950 of 14 October 2022 renewing the approval of creosote as an active substance for use in biocidal products of product-type 8 in accordance with Regulation (EU) No 528/2012 of the European Parliament and of the Council - https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32022R1950

[34] Jernlås (2012). Status Report on Soil Contamination in the Proximity of Creosote-Treated In Service Utility Poles in Sweden,

384. There are no proposed process or wastewater discharges to ground as a result of the Proposed Project. Washout Valves are used during the Testing and Commissioning Phase and very infrequently to enable maintenance. Discharge occurs primarily to the surface water and is assessed in Chapter 9 (Water). There are 40 washout locations where no sufficiently sized watercourse is available within 100m of the Washout Valve, therefore the water would be discharged to the adjacent land and would be allowed to soakaway taking into consideration local conditions at that time (there are two additional washouts that are part of Line Valves that would discharge to land, however, these would only be used during the Testing and Commissioning Phase – see Appendix A5.2: Commissioning Strategy). Water would only be discharged to land where it is appropriate to do so. At some of these locations, the adjacent land is used for agriculture, while the remaining locations are in peatland. Appendix A4.1 (Operational Strategy) provides further detail of the washout design flow for each washout. No discharge would occur during a flood event. There would be no discharge within 50m of a karst feature. Discharged water would percolate back to ground or via overland flow to the existing drainage. Where discharge occurs to land, water would be dechlorinated prior to discharge and allowed to infiltrate into the ground. Corrosion of the steel pipeline could occur over the long term. Potential effects include increased maintenance or loss of water.

385. Given the negligible to medium sensitivity of receptors and negligible to low magnitude of impact, the significance of effect is considered Imperceptible to Slight (Not Significant) for groundwater quality effects. The BPT would have a Slight (Not Significant) effect due to the low magnitude of impact and medium sensitivity.

10.4.3.2.3 GWDTE

386. The RWI&PS, WTP, BPT, BPS, FVC and TPR are not located within 1km of a GWDTE. The Operational Phase would not therefore have a significant effect on sensitive locations such as GWDTEs (effects would be Imperceptible). As there are no significant effects at the RWI&PS, WTP, BPT, BPS, FCV and TPR, no additional mitigation is required at these locations. Where GWDTE occur along the Treated Water Pipeline, based on a high sensitivity of the receptor and negligible magnitude of impact, the significance of effect is considered Slight (Not Significant).

387. Mitigation measures are proposed in sensitive areas (see Section 10.5.2).

10.4.4 Summary of Pre Mitigation Potential Effects

388. Table 10.28 and Table 10.29 outline the Construction Phase effects of the Proposed Project on soils, geology and hydrogeology, prior to the implementation of mitigation measures. Table 10.30 and Table 10.31 outline the Operational Phase effects of the Proposed Project on soils, geology and hydrogeology, prior to the implementation of mitigation measures. Effects on streams such as the Kilmastulla River are addressed in Chapter 9 (Water). In the absence of mitigation measures, there is the potential for significant short-term effects (Moderate or above), during the Construction Phase from the following:

- Compaction at degraded raised bog (Non Annex I) areas along the pipeline route
- Loss of degraded raised bog (Non Annex I) in areas along the pipeline route
- Potential temporary groundwater flow effects from dewatering during installation of the Treated Water Pipeline at Ballinagar GWS.

389. No likely significant effects have been identified for the Operational Phase.

Table 10.28: Summary of Potential Construction Phase Effects for the Proposed Project (Pre Mitigation) – Soils and Geology

Environmental Attribute (Soils & Geology)	Construction Phase						
	38 kV Uprate Works	RWI&PS and WTP Site	BPT	BPS	TPR	Construction Compounds and Pipe Storage Depots	RWRMs, Treated Water Pipeline, FCV
Soil Compaction	Potential compaction along access tracks – Not Significant/Slight (Not Significant), short term	Not Significant/Slight (Not Significant), short term	Not Significant/Slight (Not Significant), short term	Not Significant/Slight (Not Significant), short term	Not Significant/Slight (Not Significant), short term	Potential compaction – Slight (Not Significant), short term	Potential compaction of soft sediments along the Construction Working Width – Not Significant/Slight (Not Significant), short-term to long term, localised effects. Potential for Moderate (Significant) temporary effects at degraded raised bog (Non Annex I) locations. Long term effects are Not Significant/Slight (Not Significant).
Loss of soils/Land use change	Not Significant, long-term	Not Significant/Slight (Not Significant), long-term	Not Significant/Slight (Not Significant), long-term	Not Significant/Slight (Not Significant), long-term	Not Significant/Slight (Not Significant), long-term	Not Significant/Slight (Not Significant), temporary to short-term	Temporary loss of soils during the Construction Phase – Slight (Not Significant), temporary effects. Potential for Moderate short term (Significant) effects at degraded raised bog locations. Long term effects are Not Significant/Slight (Not Significant).
Soil Contamination	Limited works required to upgrade 38 kV line. Potential minor contamination during Construction Phase. Slight (Not Significant)/Not Significant, temporary to short term	Former petrol station located near access to WTP. High sensitivity due to Kilmastulla River. Potential minor contamination during Construction Phase. Slight (Not Significant), short term	Greenfield site. Potential minor contamination during Construction Phase. Slight (Not Significant), short term	Greenfield site. No contamination identified. Potential minor contamination during Construction Phase. Slight (Not Significant), short term	Greenfield site. No contamination identified. Potential minor contamination during Construction Phase. Slight (Not Significant), short term	Greenfield site. No contamination identified. Potential minor contamination during Construction Phase. Slight (Not Significant), short term	No contaminated sites located within Construction Working Width. Potential minor contamination along pipeline route. Slight (Not Significant), temporary to short term
Aggregate and Extractive Industries	Not Significant/Slight (Not Significant), temporary to short term	Not Significant, short term	Not Significant/Slight (Not Significant), short term	Not Significant, short term	Not Significant, short term	Imperceptible to Not Significant/Slight (Not Significant), short term	Imperceptible to Not Significant/Slight (Not Significant), temporary to short term
Geohazards: – Fort Henry Embankment	N/A	No alteration to Fort Henry Embankment – Not Significant, temporary to short term	N/A	N/A	N/A	N/A	N/A
Geohazards: – Peat and landslide potential	Not Significant/Slight (Not Significant), temporary to short term	Not Significant, short term	Not Significant, short term	Not Significant, short term	Not Significant, short term	Not Significant/Slight (Not Significant), short term	Peat and soft sediments along route alignment. Not Significant/Slight (Not Significant), temporary to short term
Geohazards: – Surface karst features	Not Significant, temporary to short term	Not Significant, short term	No karst landforms/ features within 0.2km of the BPT site. Weathered/ karstified rock at the BPT but no surficial expressions. Not Significant/Slight (Not Significant), short term	Not Significant, short term	Not Significant, short term	Slight (Not Significant), short term	No karst feature within the Construction Working Width – karst features in surrounding areas. Slight (Not Significant), temporary to short term
Geological heritage sites: CGSs	Imperceptible (Not Significant) - No Geological heritage sites	Kilmastulla Meltwater Channels – Slight (Not Significant), long term	Imperceptible (Not Significant) - No Geological heritage sites	Imperceptible (Not Significant) - No Geological heritage sites	Imperceptible (Not Significant) - No Geological heritage sites	Imperceptible (Not Significant) - No Geological heritage sites	Three IGH sites along the Treated Water Pipeline. Slight (Not Significant), long term

Table 10.29: Summary of Potential Construction Phase Effects for the Proposed Project (Pre Mitigation) – Hydrogeology

Environmental Attribute (Hydrogeology)	Construction Phase						
	38 kV Uprate Works	RWI&PS and WTP Site	BPT	BPS	TPR	Construction Compounds and Pipe Storage Depots	RWRMs, Treated Water Pipeline, FCV
Groundwater flow effects	Not Significant/Slight (Not Significant), temporary to short term	Not Significant/Slight (Not Significant), short term	Not Significant/Slight (Not Significant), short term	Not Significant/Slight (Not Significant), short term	Not Significant/Slight (Not Significant), short term	Construction Compound CC2 located at edge of Ardcrony GWS ZoC. No Groundwater supplies within 100m of the Construction Compounds or PSDs. Not Significant/Slight (Not Significant) short-term effects.	Treated Water Pipeline located outside of Ballinagar GWS ZoC at approximate Chainage TWC – 8900. Moderate (Significant), temporary to short-term effects. One spring within the Construction Working Width and five domestic wells/shallow wells within 50m corridor. Not Significant/Slight (Not Significant), temporary to short-term effects.
Groundwater quality effects	Potential for slight contamination during Construction Phase. Slight (Not Significant), temporary to short term.	Potential groundwater quality effects during the Construction Phase for a period of less than six months. Slight (Not Significant), short term.	Potential groundwater quality effects during the Construction Phase for a period of less than six months. Slight (Not Significant), short term.	Potential groundwater quality effects during the Construction Phase for a period of less than six months. Slight (Not Significant), short term.	Potential groundwater quality effects during the Construction Phase for a period of less than six months. Slight (Not Significant), short term.	Potential groundwater quality effects during the Construction Phase for a period of less than six months. Slight (Not Significant), short-term effects.	CC2 located in Ardcrony ZoC with spring 3km to the north. Proposed LV connection located within ZoC for Mount Lucas GWS. Potential groundwater quality effects during the Construction Phase. Slight (Not Significant), temporary to short term effects.
GWDTE	Imperceptible (Not Significant)	Imperceptible (Not Significant)	Imperceptible (Not Significant)	Imperceptible (Not Significant)	Imperceptible (Not Significant)	Imperceptible (Not Significant)	No direct effects. Potential effects during the Construction Phase for a period of less than six months at any location. Slight (Not Significant), temporary to short term.

Table 10.30: Summary of Potential Operational Phase Effects for the Proposed Project (Pre Mitigation) – Soils and Geology

Environmental Attribute	Operational Phase					
(Soils & Geology)	38 kV Uprate Works	RWI&PS and WTP Site	BPT	BPS	TPR	RWRMs, Treated Water Pipeline, FCV
Soil Compaction	Not Significant, long term	Not Significant, long term	Not Significant, long term	Not Significant, long term	Not Significant, long term	Not Significant, long term
Loss of soils/Land use change	Imperceptible (Not Significant)	Imperceptible (Not Significant)	Imperceptible (Not Significant)	Imperceptible (Not Significant)	Imperceptible (Not Significant)	Imperceptible (Not Significant)
Soil Contamination	Imperceptible (Not Significant)	Potential minor contamination from machinery and maintenance. Slight (Not Significant), unlikely long-term effects from operational works	Potential minor contamination from machinery and maintenance. Slight (Not Significant), unlikely long-term effects from operational works	Potential minor contamination from machinery and maintenance. Slight (Not Significant), unlikely long-term effects from operational works	Potential minor contamination from machinery and maintenance. Slight (Not Significant), unlikely long-term effects from operational works	Potential minor contamination along pipeline route, Not Significant/Slight (Not Significant) localised, long-term
Aggregate and Extractive Industries	Operational pit adjacent to the existing and proposed infrastructure and would result in a very small loss of potential aggregate reserves – Not Significant/Slight (Not Significant) and long term	Imperceptible (Not Significant)	Imperceptible (Not Significant)	Imperceptible (Not Significant)	Imperceptible (Not Significant)	No permitted quarries adjacent to the proposed infrastructure and would result in a very small loss of potential aggregate reserves –Not Significant/Slight (Not Significant) and long term
Geohazards: – Fort Henry Embankment	N/A	Fort Henry Embankment – Not Significant, long term.	N/A	N/A	N/A	N/A
Geohazards: – Peat and landslide potential	Not Significant/Slight (Not Significant), long term	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant/Slight (Not Significant), long term
Geohazards: – Surface karst features	Imperceptible (Not Significant)	Imperceptible (Not Significant)	Not Significant/Slight (Not Significant), long term	Imperceptible (Not Significant)	Imperceptible (Not Significant)	Not Significant/Slight (Not Significant), long term

Environmental Attribute	Operational Phase					
(Soils & Geology)	38 kV Uprate Works	RWI&PS and WTP Site	BPT	BPS	TPR	RWRMs, Treated Water Pipeline, FCV
Geological heritage sites	No Geological heritage sites - Imperceptible (Not Significant)	Slight (Not Significant) effect on Kilmastulla Meltwater Channels CGS, long term	No Geological heritage sites - Imperceptible (Not Significant)	No Geological heritage sites - Imperceptible (Not Significant)	No Geological heritage sites - Imperceptible (Not Significant)	Three IGH sites along the Treated Water Pipeline. Slight (Not Significant) effect on CGSs, long term

Table 10.31: Summary of Potential Operational Phase Effects for the Proposed Project (Pre Mitigation) – Hydrogeology

Environmental Attribute	Operational Phase					
(Hydrogeology)	38 kV Uprate Works	RWI&PS and WTP Site	BPT	BPS	TPR	RWRMs, Treated Water Pipeline, FCV
Groundwater flow effects	Imperceptible (Not Significant)	Imperceptible (Not Significant)	No SPZs or ZoCs in close proximity. No significant works during the Operational Phase. Not Significant, long term	Imperceptible (Not Significant)	Imperceptible (Not Significant)	Not Significant, long term. Imperceptible (Not Significant at FCV)
Groundwater quality effects	No significant groundwater quality effects. Imperceptible (Not Significant)	No significant groundwater quality effects. Imperceptible (Not Significant)	No groundwater supplies within 100m of the BPT. Infiltration is not likely to result in significant effects. Slight (Not Significant), long term	No significant groundwater quality effects. Imperceptible (Not Significant)	No significant groundwater quality effects. Imperceptible (Not Significant)	No significant groundwater quality effects. Not Significant, long term
GWDTE	Imperceptible (Not Significant)	Imperceptible (Not Significant)	Imperceptible (Not Significant)	Imperceptible (Not Significant)	Imperceptible (Not Significant)	Slight (Not Significant), long term

10.5 Mitigation and Monitoring Measures

10.5.1 Embedded Mitigation

390. The environment team has worked in close collaboration with the infrastructure design team to avoid or reduce environmental effects through the Proposed Project design. This is referred to as embedded (or design) mitigation. Embedded mitigation is inherent to the Proposed Project design and forms part of the project description and construction methodology described in Chapters 4 and 5 of the EIAR. As such, embedded mitigation is considered in the assessment of pre-mitigation effects in Section 10.4. Chapter 3 of the EIAR details the reasonable alternatives that have been considered throughout the design development of the Proposed Project, including the environmental factors which have influenced the decision making.

391. In the event of approval being granted for the Proposed Project and prior to commencement of works, the appointed Contractor(s) will implement the CEMP (Appendix A5.1) which forms part of the embedded mitigation.

392. A Soils Management Plan (SMP) and a Construction Waste and By-Product Management Plan (CWBMP) have been prepared for the Proposed Project, see Appendix A5.1. The SMP sets out the means by which topsoil and subsoils will be excavated and stored during the Construction Phase of the Proposed Project prior to reprofiling following construction activities. The SMP is presented in Annex B of Appendix A5.1 (CEMP). Excavated material, including topsoil, will be reused or removed as detailed in Chapter 19 (Resource & Waste Management). Peat will be retained within the Construction Working Width and reused as part of the Construction Phase works. Where peat occurs on the Bord na Móna sites, there is an agreement in principle to retain peat on Bord na Móna lands.

393. A SWMP is included as Annex A of Appendix A5.1. It details bespoke (where required) and generic control and mitigation measures for avoiding, preventing or reducing any significant adverse effects on the surface water and groundwater environment during construction, as identified in Chapter 9 (Water) and associated technical appendices.

394. Drainage design is incorporated into the Construction Working Width development – see Chapter 5 (Construction & Commissioning) and the SWMP (Annex A of Appendix A5.1). Existing drainage will be maintained where applicable, or temporary solutions implemented during the Construction Phase. Appropriate permanent solutions will be in place on completion of the Proposed Project. Existing drainage lines may be rerouted using a drainage trenching machine during the Construction Phase. After the installation of the RWRMs and Treated Water Pipeline, the backfill will be compacted in layers up to the underside of the severed drains which are to be reconnected. The replacement drains will extend on each side of the trench for a suitable distance to ensure a properly supported connection can be made (1m or more).

395. Embedded measures include the identification of areas at risk of spillage, such as vehicle maintenance areas and hazardous substance stores (including fuel, oils, drilling fluids and chemicals) being bunded and carefully sited to minimise the risk of hazardous substances entering the groundwater. Additionally, the bunded areas will have impermeable bases to limit the potential for migration of contaminants into groundwater following any leakage/spillage. Bunds used to store fuel, oil and other hazardous substances will have a 110% capacity.

396. Embedded mitigation measures relevant to the assessment of soils, geology and hydrogeology are set out below. Where additional mitigation measures are proposed, these are detailed in Section 10.5.2. Additional mitigation includes measures that are not incorporated in the design of the Proposed Project and require further activity to secure the required outcome of avoiding or reducing impacts. Embedded mitigation measures will include the following:

- Secant piling will be installed within the RWI&PS. The installation of the secant piling will help stabilise the excavation and will reduce groundwater flows into the excavation
- Topsoil will be stored, sloped and weatherproofed in areas of the site where disturbance will be least, pending final landscaping
- Once the topsoil and a portion of the subsoil have been suitably stockpiled, further grading or benching of the remaining ground level may occur to give a level surface and working platform along the side of the pipeline trench. These may include weather monitoring, topsoil wrapping, emergency procedures and fuel storage constraints
- The stockpiles will be protected during construction activities and kept free from the passage of vehicles and plant. No rubbish will be left on the topsoil stockpile and first layer of subsoil stockpile. The stockpiles will not be stored under overhead services or over underground services. The topsoil stockpile and first layer of subsoil stockpile will be kept free of weeds by by cutting techniques such as mowing and strimming to prevent seed dispersion
- Soil stripping will be carried out during favourable weather conditions when the soil is drier and more friable. Soil handling will be avoided during periods of persistent rainfall
- Banksmen will watch over the stockpiles of topsoil and subsoil to ensure that mixing of the two does not occur and that material does not get pushed outside the Construction Working Width. Stockpiles will have a maximum height of 2m. Stockpiles will be built neatly and well-shaped to ensure, as far as possible, they are weatherproof
- A minimum separation distance of at least 1m will be kept between heaps of topsoil and subsoil to prevent cross contamination. Other measures may be implemented to improve the protection of spoil heaps from construction activities, wind/water erosion or for weed management
- Topsoil removed from the banks of watercourses and ditches will be stockpiled separately. Gaps will be left at intervals along the topsoil and subsoil heaps to permit the maintenance of public rights of way, surface water management and beneath all overhead cables
- Use of grouting or ground improvement where differential settlement may occur (notably the BPT site).

397. The following measures will be put in place by the appointed Contractor(s) across the entire Proposed Project with regard to stockpiling of material:

- Management of stockpiles to prevent siltation through runoff during rainstorms will be required and may include the following:
  - Allowing the establishment of vegetation on the exposed soil
  - Providing silt fences at the toe of the stockpile to mitigate runoff during rain events
  - Surrounding stockpiles with cut-off ditches to contain runoff
  - Directing any runoff to the site drainage system and to a settlement pond (or other) treatment systems
  - Providing bunds or another form of diversion to keep runoff from entering the stockpile area.
- Surface water runoff from hardstanding areas will be managed using SuDS measures including infiltration to ground. Further details of this are provided in Chapter 4 (Proposed Project Description). Access roads and other paved areas are designed to incorporate SuDS principles as recommended by the SuDS Manual C753 (CIRIA 2015a), to limit discharges to the equivalent greenfield flow rate
- Storage of potentially polluting materials in fully bunded tanks and controlling/reducing runoff from hardstanding areas. Bunding will be to EPA (2004b) Guidance

- Management of reinstatement of the Construction Working Width within the Bord na Móna peatlands to pre-construction conditions in line with the existing rehabilitation plans or enhanced PCAS rehabilitation plans. Where rehabilitation plan or enhanced PCAS measures are already completed within the Construction Working Width, similar measures will be undertaken to align with the rehabilitation/PCAS requirements, i.e. raising water level to within 0.1m of the surface. Close liaison and coordination with Bord na Móna will be required for all works through their peatland areas in particular the management of peat during the Construction Phase. Peat excavated during the pipeline construction will be utilised for reinstatement over the pipeline and within the Bord na Móna lands
- Where there are no rehabilitation plans (e.g. outside Bord na Móna lands), the land / peat would be reinstated to pre-construction conditions This would be on the basis of the conditions which existed on site prior to the construction of the Proposed Project including the material, habitat and surface water management measures that were on site before the works commenced.
- The aim of the reinstatement of the Construction Working Width is
  - To get the post-construction conditions back to the pre-construction conditions in terms of the material, surface water management measures and water level
  - Not to inhibit the longer term delivery of the Rehabilitation Plans / Enhanced Rehabilitation Plans.
- Suitable surplus excavated peat materials would be used in partnership with Bord Na Móna to supplement the approved Rehabilitation Plans / Enhanced Rehabilitation Plans.

398. Management of runoff during the Construction Phase, occurring adjacent to or within water bodies, will follow the Control of Water Pollution from Linear Construction Projects technical guidance (CIRIA 2006) in order to minimise effects to these sites.

399. Use of trenchless crossing is an embedded mitigation for the crossing of larger watercourses and canals and also to cross significant infrastructure such as roads and railways. Trenchless construction will be employed at eleven major watercourse crossings (Chapter 5: Construction & Commissioning). Trenchless techniques will be used at major crossings and is an excavation method that installs the pipe behind the tunnel face shield by pushing, or 'jacking', pipes from a drive shaft or jacking platform. In some locations the shafts and tunnel drive will be below the natural groundwater level, so a system of water management (using a settlement pond and discharge to land drain) will be installed to provide a suitably safe and relatively dry working environment within the excavation. The launch and reception sites will contain site compounds. The temporary launch and reception shafts will be backfilled. The top of the segmental shaft lining and the collar will be broken down to at least 1m to 2m bgl. The lining in the shafts will be modified on completion to allow natural groundwater movement.

400. To minimise any impact on the underlying sub-surface strata, all oils and solvents used during the Construction Phase will be stored within specially constructed dedicated bunded areas. Refuelling of construction vehicles and the addition of hydraulic oils to vehicles, will take place in a designated area of the site, away from surface water gullies or drains. Spill kits and hydrocarbon adsorbent packs will be stored in this area and operators will be fully trained in the use of this equipment. Designated areas of the PSDs and Construction Compounds will have impervious pavement and be graded to a fuel/oil separator for collection of any surface water runoff contaminants.

401. Accidental spillages of chemicals and hazardous material may occur during the Construction Phase. Any vehicles used during the Construction Phase will be maintained on a weekly basis and checked daily to ensure any damage or leaks are corrected. Precautions will be taken in line with Appendix A5.1 (CEMP) and the SWMP, to avoid spillages. These will comprise, where appropriate:

- Use of secondary containment, e.g. bunds around oil storage tanks
- Use of drip trays around mobile plant

- Supervising all deliveries and refuelling activities
- Designating and using specific impermeable refuelling areas isolated from surface water drains
- Having an emergency/accidental spillage plan in place.

402. Any vehicles used during the Operational Phase will be regularly maintained and checked to ensure any damage or leaks are corrected.

403. All fuel will be stored in bunded areas. The bund capacity will be sufficient to accommodate 110% of the largest tank's maximum capacity or 25% of the total maximum capacities of all tanks, whichever is the greater.

404. Oil and chemical storage areas will be bunded and oil interceptors installed as part of the surface water drainage system. Surface water runoff from hardstanding areas will be managed using SuDS measures including infiltration to ground. Further details of this are provided in Chapter 4 (Proposed Project Description). Access roads and other paved areas are designed to incorporate SuDS principles as recommended by the SuDS Manual C753 (CIRIA 2015a), to limit discharges to the equivalent greenfield site flow rate. The surface water drainage and its operation are described in more detail in Appendix A4.1 (Operational Strategy).

10.5.1.1 Methods of Working in Peat

405. Sections of the Treated Water Pipeline are located in areas of cutaway bog with much of the peat on site being drained and flat to gently sloping lands. The peatlands are cutover with no active raised bog (Annex I) encountered in the Construction Working Width as detailed in Chapter 8 (Biodiversity). There is approximately 53km of the pipeline construction which would be within areas identified as peat soils. Four main construction methods were developed (see Appendix A5.3: Methods of Working in Peat).

406. Each technique will require the construction of a suitable stable access road for heavy plant across the peat and is summarised as follows:

- Method 0 applies to areas of <0.5m (16.3km in total)
- Method 1 applies to areas with peat 0.5–1.0m depth (14.0km in total)
- Method 2 applies to areas with peat >1m and <2.5m depth (15.7km in total)
- Method 3 applies to areas with peat >2.5m and <4.5m depth (5.7km in total)
- Method 4 (piling) applies to areas with peat >4.5m depth (1.1km in total).

407. The construction methods are described in Section 6 of Appendix A5.3 (Methods of Working in Peat).

408. For areas of peat less than 0.5m in depth (16.3km in total), soils will be handled in the same manner as for the rest of the pipeline route. The topsoil, including any sections of shallow peat, will be removed down to firm ground which would then form the base for the pipe trench. The shallow extents of peat would not provide any construction constraints and both the excavation of the pipe trench and construction of the pipe will proceed as in non-peat areas.

409. Method 1 is reflective of the shallow peat depths observed for substantial sections of peat areas. The peat will be removed down to firm ground which will then form the base for both the Temporary Construction Road and the pipe trench. Only when the pipe string was ready, will a trench be dug just long enough to receive it with the aim being to dig the minimum amount of peat for the shortest feasible time. The substrata below the peat will be exposed with the peat being temporarily placed beside the excavation. The substrata will then be excavated and graded as necessary, to achieve the correct rise or fall of the pipeline, as per the long section gradient requirements. Saddle bags filled with rocks or concrete collars will then be placed over the pipeline adjacent to the joint, sufficient to prevent flotation. The substrate

material will then be placed and compacted as side fill and surround up to the original level of the substrata. Finally, the excavated peat will be replaced around and over the pipe up to the original ground level.

410. Methods 2 to 4 all use a 'floating road'. The difference between Methods 2 to 4 is whether support would be required for the pipeline. For Method 2 it would not, because suitable ground below the peat would provide the support. In comparison, for Method 3 and Method 4 there would be the installation of stone pillars or concrete piles, respectively, at intervals along the length of the pipeline to provide sufficient support in the poor ground conditions. Methods 3 and 4 would also result in additional permanent infrastructure in the form of stone pillars (Method 3) or piled supports (Method 4) below the pipeline.

10.5.2 Specific Mitigation and Monitoring Measures

411. Specific mitigation measures are proposed to prevent or reduce significant adverse effects. Where appropriate, consideration has been given to the appropriateness of monitoring measures, the purpose of which is to check that the mitigation measures required to prevent or reduce significant adverse effects are delivered and perform as intended, in accordance with the requirements of the EIA Directive.

412. Monitoring measures for soils, geology and hydrogeology will confirm the implementation of conditions and/or planning agreements and audit predicted effects against the actual situation. The monitoring measures are incorporated into CEMP (Appendix A5.1). Groundwater monitoring in the Bord na Móna peatlands is shown on Figures 10.150 to 10.162.

10.5.2.1 Construction Phase

413. Measures to reduce the effect of the Proposed Project on local soil and geology are the reuse of in situ material and importation of additional material from local sources. Details of the construction of the RWRMs, Treated Water Pipeline and associated infrastructure can be found in Chapter 5 (Construction & Commissioning). In addition to setting out the proposed construction works, Chapter 5 (Construction & Commissioning) includes details on commissioning works necessary for assuring that systems and components meet the operational requirements for service. A list of all mitigation measures is provided in the Register of Environmental Actions and Commitments within the CEMP (Annex G of Appendix A5.1).

10.5.2.1.1 Soil Compaction

414. Measures to reduce the impact of the proposed Low Voltage, Medium Voltage and 38 kV Uprate Works on local geology include reuse of in situ material and importation of additional material from local sources. The placement of polesets has avoided areas of intact peat, therefore the hydrology of peat masses in the general vicinity of the works would not be affected. The majority of the IMP locations, with the exception of the proposed interpoles, are already in place. Access for the 38 kV Uprate Works will be achieved using wide-tracked, low ground pressure vehicles to minimise damage in soft ground/peat areas. In very wet land (saturated soils/high water table), bog mats (wooden, rubber) or aluminium road panels will be installed to mitigate any possible damage to the highly valued terrain in the vicinity of the proposed works. In very poor, soft, boggy and/or undulating land, stone roads may need to be constructed. In such instances geotextile reinforcement will be placed on the surface and stone placed on top and compacted to form the track. It is noted, however, that it is not anticipated that stone roads will be required for the 38 kV Uprate Works.

415. Existing trackways, where available, will be used to access construction sites. If required, an additional layer of clean 200mm – 600mm stone aggregate will be laid on top of the existing trackway to reinforce the trackway for construction vehicle access. Geotextile membrane is generally placed beneath the stone layer. Silt fencing will be erected by fixing posts at intervals to act as a silt curtain along the edge of the trackway, if trackways are located within 20m from identified watercourses. Removal of stone post

construction is carried out in a sequential manner from the construction site to the access point off the public road network. Silt fencing will remain in place until the operation is completed.

416. The method of access, whether developing stoned trackways on geo-grid or laying surface protection materials such as bog mats or tracking across ground, is dependent on the nature of the works to be undertaken at each site, the local ground conditions and the ecologically sensitive nature of the area. As far as is practicable, existing private tracks will be utilised in the access routes.

417. Excavated soil and subsoil will be stored adjacent to the excavation area and set back a minimum distance of 5m from rivers/streams/drains or any identified surface water feature. Excavated material will be reused in situ. Typically, $2m^3$ of soil/rock will be excavated at each IMP location with approximately $30m^3$ of soil/rock excavated from angle structures. In the event material is unsuitable for reuse by landowners, subsoil will be reused as by-product material or disposed of at a licensed/permitted facility in accordance with the Waste Management Act 1996 (as amended) and associated regulations.

418. Once all construction works are complete, the Temporary Construction Roads and the construction areas which have been disturbed around the towers during the tower foundation installation and tower erection phases will be reinstated.

419. Temporary Construction Roads will be constructed within the Construction Working Width to facilitate the movement of plant, labour and materials. These roads are formed by stripping the topsoil and upper level of subsoil across the Temporary Construction Road to its full depth, as determined by Uisce Éireann's Agronomist. Records will be kept of the depths stripped in each of the parcels of land that the Construction Working Width passes through. Topsoil typically has a depth of between 150mm to 400mm across the site area depending on the rooting depth of the plants growing there. Every care will be taken to prevent topsoil and subsoil mixing. The upper level of subsoil will be stripped and stockpiled in separate stockpiles positioned within designated areas within the Construction Working Width.

420. The Temporary Construction Roads will be constructed in one of two ways depending upon the ground conditions encountered:

- Directly on the formation layer – the construction traffic will travel directly on top of the lower level of subsoil. This will be the greatest extent of the Temporary Construction Road required for the pipeline
- Geogrid mattress and stone – for poor ground to ensure stability of operations.

421. To enable the pipe to be laid in poor ground conditions, including peat, the Temporary Construction Road will incorporate a coarse stone (e.g. 75mm grading), up to approximately 1m deep, overlain on a geogrid mattress to prevent material sinking into the soil below. Further information can be found in Appendix A5.3 (Methods of Working in Peat).

422. Temporary Construction Roads will be removed on completion of the works.

10.5.2.1.2 Soil Loss

423. The vast majority of excavated material would consist of subsoil and naturally excavated soils and rock. All surplus waste arising during the Construction Phase will be managed and recovered/disposed of in accordance with the provisions of the Waste Management Act 1996 (as amended) and subsequent amendments and regulations and any of the relevant Waste Management Plans. A CWBMP (Annex C of Appendix A5.1: CEMP) will be implemented to minimise waste and ensure correct handling and disposal of construction waste streams in accordance with the Best Practice Guidelines for the Preparation of Resource and Waste Management Plans for Construction and Demolition Projects (EPA 2021). Based on site walkovers, ground investigation data and sampling results, it is anticipated that the excavated materials would predominantly comprise natural uncontaminated soils.

424. All topsoil to a depth determined by Uisce Éireann's Agronomist/LLO will be kept separate and stockpiled to one side of the working strip on unstripped lands. The top layer of subsoil over the trench and the haulage area of the Construction Working Width will also be stripped to a depth determined by Uisce Éireann's Agronomist and stored separately to the topsoil.

425. Uisce Éireann is committed to limiting the volume of waste soils generated as part of the Proposed Project. By its nature, excavation activities impact on the geological environment. The Proposed Project will have a surplus of approximately 589,800m^3 excavated material. Soil/subsoil material will be reused within each element; the majority being reused directly during its excavation. Materials required for the WTP are anticipated to be imported from elsewhere on the Proposed Project. The remainder of the material will utilise waste permit/waste licence sites as detailed in Chapter 19 (Resource & Waste Management).

426. Suitable excavated material will be re-used on-site in cut and fill operations and reprofiling the site. This material will be selected and managed for storage, and consolidated properly at the correct moisture content, and soils at source will be verified as free of contamination arising from any previous land use, before being re-used. This will allow for surplus excavated material from construction on the WTP site to be effectively managed, as the quantities of excavated material and imported material will balance the fill material required to make up finished levels on site, and site landscaping. It is expected that all excavated material arising on the WTP site will be re-used there.

427. The Proposed Project will use Regulation 27[35] (by-product) or Regulation 28 (end-of-waste) mechanisms where possible to reuse or recover materials off-site and has set a commitment of zero recoverable waste to landfill (see Chapter 19: Resource & Waste Management). The Regulation 27 notification will be by a site-specific use risk assessment that will assess the risk of the proposed soils re-use at the proposed end point. The risk assessment process allows mitigating factors concerning the re-use of the material to be highlighted or addressed prior to the movement and placement of the soils at the end user site.

428. Where no suitable location is available for soil / surplus excavated material within the Construction Working Width it will be removed from site. Its removal and reuse/recycling/recovery/disposal will be carried out in accordance with the Waste Management Act 1996 (as amended), the Waste Management (Collection Permit) Regulations 2007 (as amended) and the Waste Management (Facility Permit & Registration) Regulations 2007 (as amended).

429. Bord na Móna has identified over 33,000 hectares of cutover and cutaway peatlands for enhanced rehabilitation under the PCAS scheme. The Treated Water Pipeline from the BPT to the TPR is partially located in PCAS bogs such as Clonad Bog, Mount Lucas Bog, Esker Bog and Cloncreen Bog. At Mount Lucas, the proposed route of the Treated Water Pipeline has been refined since the Rehabilitation Plan was developed. This has been done in order to reduce the potential effects on degraded raised bog north of the bog. This has arisen from the recommendations of the EIAR process. Bord Na Mona's approval has been obtained to traverse Mount Lucas as set out in the Strategic Infrastructure Development Planning Application. The EPA are responsible for the IPC licence and rehabilitation plan for this site. National Parks and Wildlife Service are responsible for the Enhanced Rehabilitation Plan for this site and they have been consulted on the proposed alignment and the reasons for it. Uisce Éireann will support Bord na Móna to rehabilitate the original proposed route including the implementation of additional water management measures and/or habitat creation. This would be subject to a separate consenting process and would be as agreed with Bord na Móna.

[35] European Communities (Waste Directive) Regulations 2011, as amended.

430. Following the Construction Phase, it is proposed to reprofile areas within the Construction Working Width by a combination of drain blocking, peat field re-profiling, cell-bunding, wetland creation and seeding or targeting bare peat such as headlands. These measures are outlined in Appendix A5.3 (Methods of Working in Peat).

431. Bord na Móna's rehabilitation measures will raise groundwater levels in the Bord na Móna peatlands. It is anticipated that the combination of rehabilitation measures and natural colonisation will quickly support the development of pioneer vegetation. As set out in Appendix A5.3, the Proposed Project will not inhibit the longer term delivery of the Rehabilitation Plans/Enhanced Rehabilitation Plans. The future baseline scenario on the Bord Na Móna sites post rehabilitation will likely comprise a mosaic of wetland, wet peatland, heath, scrub and woodland habitats depending on the various constraints such as topography, surface water and groundwater levels, as detailed in Chapter 8 (Biodiversity). It is proposed to monitor water levels in the peatlands as detailed on Figures 10.150 to 10.162.

10.5.2.1.3 Geomorphology and Geohazards

432. The significance of potential effects associated with the geomorphology along the extent of the Construction Working Width has been evaluated based on the proposed magnitude of excavation and soil/subsoil and bedrock alteration required along the Proposed Project extent. No significant effects were identified, therefore mitigation measures in relation to geomorphology are not required.

433. The proposed RWI&PS site is adjacent to the Fort Henry Embankment, which forms part of the Parteen Basin impoundment. The embankment is a Category A dam, where breach of the dam may result in loss of life. Design measures have been put in place to mitigate those risks. The risk assessment concludes that with appropriate ground investigation, design and construction monitoring, the risks identified can be mitigated effectively to ensure that the dam safety is not compromised by the Proposed Project. During site preparation works, the Planning Application Boundary adjacent to Fort Henry Embankment (which ESB have requested be excluded from temporary or permanent works), will be permanently fenced off. Piezometers will be installed, in agreement with ESB, to monitor groundwater levels pre-construction, during construction and post construction. Piezometers will be connected individually to a Modem (data) logger. The data can be transferred over a mobile phone network to a shared platform for various stakeholders.

434. The geophysical and borehole records suggest that the overburden will consist of firm to stiff deposits, which will reduce the pressures on the retaining wall. The GI suggests that rock will not be encountered in the majority of the local excavation with up to 4m of rock to be removed at the base of the RWI&PS excavation (see Appendix A10.2 and Appendix A10.4). The rock may be locally higher at the south-eastern corner of the pumping hall, according to the interpretation of the rockhead from the geophysical survey and information from borehole RWIBH015. The installation of secant piles will ensure that the retaining wall is founded on competent limestone. Any water ingress will likely be dominated by channels in the limestone as opposed to the widespread influx of water through weathered rock and overburden. Consequently, the dewatering of the rock is likely to consist of groundwater pumping with sealing of inflows as required. The use of ground anchors will minimise the wall deflections and ensure that the excavation is open. The anchors will be installed into the bedrock and will typically be inclined at 45 degrees. However, it is considered that there will be an imperceptible effect on the performance of the embankment by the installation of ground anchors.

435. In the event voids or karst features are encountered during the Construction Phase, a geotechnical risk assessment will be completed. Engineering design solutions to assess the need for basal reinforcement will be provided as required during construction to deal with ground instability. Solutions to areas of weak rock include the use of geotextiles and pipeline supports.

436. Engineering large structures in karst landscapes has become a relatively common occurrence in Ireland. For example, large motorway bridges have been safely constructed in more active karst landscapes (Madden and O'Hara 2016, Rutty & Jennings 2012). Routine mitigation is outlined in EIAR Chapter 5 (Construction & Commissioning) and the CEMP (Appendix A5.1) and will be implemented at detailed design stage to reduce settlement risk. A karst protocol will be employed during construction and involves a series of steps and methodologies to ensure stability in karst areas. The karst feature inspection protocol is documented by Madden and O'Hara (2016). Ground stabilisation measures to be employed include compaction, grouting/stabilisation, geotextile or utilising raft foundations. Where weathered limestone or karst is encountered at formation level, the feature will be mapped in detail. Each feature and associated mitigation measure will be documented and included in the safety file for the Proposed Project. The stabilisation measures will be approved by a geotechnical engineer. Where infilling or grouting is undertaken (such as proposed at the BPT), works will be supervised by a suitably qualified hydrogeologist to ensure there is no effect on groundwater.

437. Due to the relatively flat (<2% slope) and the drained cutover peatlands, the risk of a regional scale landslide is low. Localised peat stability will require management as set out in the Appendix A5.3 (Methods of Working in Peat). Mitigation measures will be put in place during the construction of the Proposed Project, to reduce the likelihood of an excavation collapsing. Possible mitigation measures include stepping or battering back of excavations to a safe angle (as determined through a slope stability assessment by a competent temporary works designer) or construction of a temporary sheet pile wall or rock fill to support the peat during construction.

438. Excavation works will be monitored by a suitably qualified and experienced geotechnical engineer or engineering geologist. A geotechnical risk register will be maintained for the Proposed Project. The earthworks will not be scheduled to be carried out during severe weather conditions as detailed in the SWMP (Annex A of Appendix A5.1).

439. Mitigation measures to be implemented in peat areas at construction stage may include but are not limited to:

- The adoption of the following construction approach:
  - Work in dry weather conditions as far as reasonably practicable with earthworks planned for summer months and movement of machinery to be suspended during heavy rainfall / high water levels (other than as required to respond to a potential incident).
  - Interceptor drains on the perimeter of the Construction Working Width and dewatering of the excavation for the pipeline, will be used as part of the temporary drainage plan in areas of peat and / or land with high ground water r table to create ‘dry’ conditions as far as reasonably practicable, (definition of ‘dry’ as per (CIRIA 2001))
  - Slacken side slopes on the batter of the trench excavation as informed by peat probes / further Ground Investigation undertaken as part of the preparation of the construction phase. This is to be as determined through a detailed slope stability assessment by a competent temporary works designer and is to be set out in construction Method Statement for each section of pipeline construction within peat soils
  - Utilise land within the Construction Working Width upstream and downstream of the section of pipeline being constructed for activities which there is flexibility over their location such as the temporary stock piling of material and drainage ponds. This would be done to maximise the land available at the section of pipeline being built that could be utilised in slackening side slopes
  - For sections of construction where there would be deep peat and/or dewatering proves not to be effective, or slacker side slopes cannot be adopted the contractor would adopt a trench box / temporary sheet piled coffer dam (this would be installed using a vibratory plate method / press piling) in order to retain the side slopes

  - Each section of excavation is to be left open for as short a period of time as reasonably practicable.
- Limiting stockpiling of materials in any specific areas
- No stockpiling in areas of degraded raised bog
- Excavated material to be removed to designated deposition areas
- Implementation of monitoring regime for peat movement
- Frequent monitoring and inspection during construction and operation of access roads and temporary peat storage areas
- If required, additional site investigations inclusive of in situ testing and laboratory testing in specific risk areas on the site
- Client's Geotechnical Engineer/Site Geotechnical Supervisor to approve the method statement
- Approved Contractor to provide toolbox talks and on-site supervision prior to and during the works
- Daily sign-off by supervising staff on completed works
- Implementation of emergency plan and unforeseen event plan by the approved Contractor.

10.5.2.1.4 Contamination

440. There is a potential to encounter contamination, or for construction activity to result in contamination. It is considered that the vast majority of excavated material will consist of subsoil and naturally excavated soils and rock. All construction waste arising from the Construction Phase will be stored, managed, recovered/disposed of in accordance with the provisions of the Waste Management Act 1996 (as amended) and subsequent amendments and regulations; and any of the relevant local authorities' Waste Management Plans (refer to Chapter 5: Construction & Commissioning). A CWBPMP, as set out in Annex C of Appendix A5.1, will be implemented to minimise waste and ensure correct handling and disposal of construction waste, in accordance with the Best Practice Guidelines for the Preparation of Resource and Waste Management Plans for Construction and Demolition Projects (EPA 2021). Excess soils/subsoils will be disposed of at licensed/permitted waste management facilities. Excess steel pipe/off cuts will be disposed of/recovered offsite at a licensed facility. All waste material will require the necessary waste permits and documentation as part of the construction programme and the CWBPMP.

441. Potential for contaminated land has been assessed along the Proposed Project. However, no significant potential contamination risk was identified at the RWI&PS, WTP, BPT, BPS, TPR or along the Construction Working Width. Where contaminated soils/materials are discovered, these areas of ground will be isolated, tested for contamination in accordance with Council Decision of 19 December 2002 establishing criteria and procedures for the acceptance of waste at landfills pursuant to Article 16 of and Annex II to the Landfill Directive 1999/31/EC (as amended) (2003/33/EC), and pending the results of laboratory testing, will be excavated and exported off-site by an appropriately Permitted Waste Contractor. Chemical testing will determine the appropriate treatment/disposal to a Permitted/Licensed Waste Facility.

442. A disused petrol station is located on the southern bank of the Knockadromin Stream which is a tributary of the Kilmastulla River. It is proposed to remove above-ground structures from the petrol station site to allow construction of the access road junction and provide the required safe sightline distances. The proposed works include cleaning out and backfilling the tanks with either sand and cement or foam concrete.

443. Key infrastructure works will be designed to be watertight. This includes the storage tanks and storage containers at the WTP. The design of reinforced concrete structures to be water-retaining and the use of bunds around any chemicals and oil storage areas will reduce the risk of any leaks or accidental spillages. Potential effects, as a result of silt-laden groundwater discharges from excavations, will be avoided by control of water pollution from construction sites in accordance with the guidelines of C741 Environmental good practice on site (CIRIA 2015b).

444. The pipelines will be constructed in a manner that will reduce the potential for preferential pathways between the potential source hazards and the receptors. The construction methodology identifies steel pipes that require minimal granular material. Backfilling will be achieved by using the native excavated material as backfill around the pipe. Clay stanks will be placed where any significant contamination is identified or in areas where preferential drainage may occur (i.e. low permeability horizons).

445. Management of drilling fluid during the Construction Phase of the Proposed Project will be the responsibility of the appointed Contractor. Spent bentonite will require reuse or disposal at the end of the trenchless technology process. If an alternative use for this material is not identified, it will be disposed of in an appropriately licensed facility. A number of measures to mitigate potential effects associated with the trenchless drilling are listed below:

- The drilling fluid/bentonite will be non-toxic and naturally biodegradable (i.e. Clear Bore Drilling Fluid or similar will be used)
- Silt fencing will be embedded into the local soils to ensure all site water is captured and filtered
- The area around the bentonite batching, pumping and recycling plant will be bunded using Terram geotextile (as it will clog) and sandbags in order to contain any spillages
- Drilling fluid returns will be contained within a sealed tank/sump to prevent migration from the works area
- Spills of drilling fluid will be cleaned up immediately and stored in an adequately sized skip before being taken off-site
- Any sediment-laden water from the works area will not be discharged directly to the ground or surface waters
- Daily monitoring of the compound works area, the water treatment and pumping system will be completed by a suitably qualified person during the Construction Phase. All necessary preventative measures will be implemented to ensure no entrained sediment or deleterious matter is discharged
- On completion of the works, the ground surface disturbed during the site preparation works and at the entry and exit pits will be carefully reinstated at the earliest opportunity to prevent soil erosion
- The drilling process/pressure will be constantly monitored to detect any possible leaks or breakouts into the surrounding geology. This will be gauged by observation and by monitoring the pumping rates and pressures. If any signs of breakout occur, then drilling will be immediately stopped
- Any drilling fluid material will be contained and removed off-site
- The drilling location will be reviewed before recommencing with a higher viscosity drilling fluid mix.

10.5.2.1.5 Aggregate and Extractive Industries

446. The Proposed Project is not located near existing or proposed quarries or mines. The Treated Water Pipeline from the BPT to the TPR may affect future development within the 20m wide Permanent Wayleave. There are no additional measures proposed.

10.5.2.1.6 Geological Heritage Sites

447. The Construction Working Width crosses four proposed CGSs, namely the Kilmastulla Meltwater Channels CGS, Ardcrony Esker CGS, Kinnitty Esker CGS and the Kilcormac Esker CGS. There is no proposed construction in the Kilmastulla River channel with the exception of two washout valves between TW – 2500 and TW – 3500 (WCW003 and WCW004). No significant effects were identified in consultation with the GSI. The GSI will be notified by the appointed Contractor about any significant new geological feature that is uncovered within the Proposed Project footprint. Information from the GI works will be provided to the GSI to aid in the delineation and characterisation of the CGS.

448. The mitigation measures proposed for the Kilmastulla Meltwater Channels, Ardcrony, Kilcormac and Kinnitty CGS include the following:

- Continued consultation with the GSI
- GI data to be provided to the GSI
- Limiting excavation by only excavating the required footprint
- Limiting construction in the Kilmastulla River Channel
- The GSI will be notified by the appointed Contractor about any significant new section/feature that is exposed within the construction footprint.

10.5.2.1.7 Hydrogeology

449. There are no PWS wells within 200m of the RWI&PS, WTP, BPT, BPS, FCV or TPR. Five private wells were identified within 50m of the Treated Water Pipeline. Additional rounds of well surveys will be undertaken pre-construction. Where dewatering is required along the Construction Working Width, dewatering will be undertaken in accordance with C750 Groundwater Control: design and practice second edition (CIRIA 2016). Mitigation measures include:

- Limiting the period of open excavations and therefore dewatering requirement
- Suitable groundwater control scheme to minimise drawdown or pore water pressure reductions, i.e. sheet or secant piles
- Selection and placement of settlement tanks, settlement lagoons or lamella tanks for removal of suspended solids
- Monitoring of water supplies location and, if necessary, replacement or augmentation of affected water supplies.

450. Excavations for angle towers for the 38 kV Uprate Works are less than 3m deep. Foundations will be undertaken over a two-day period. There are no identified wells within 50m of the angle towers and no likely significant effects.

451. At the location of the proposed WTP, temporary dewatering will occur based on the construction design and groundwater levels. The site is underlain by low permeability tills and there are no groundwater wells within 200m of the WTP. No additional groundwater mitigation measures are required for the WTP.

452. At the location of the proposed BPT, temporary dewatering is not anticipated based on the construction design and groundwater levels (Appendix A10.1: Ground Investigations 2018; and Appendix A10.4 to Appendix A10.14 2022 and 2023 Ground Investigations). No additional groundwater mitigation measures are required for the BPT.

453. The TPR site is classified as having high to extreme groundwater vulnerability. There are no planned discharges to groundwater and any risk to groundwater quality will be the result of accidental spillages of hazardous materials. However, there are no groundwater supplies within 200m of the TPR and the aquifer is 'poorly productive' with low attribute importance. No additional groundwater mitigation measures are required for the TPR.

454. Along sections of the Treated Water Pipeline, at species-rich grasslands/wetlands (see Chapter 8: Biodiversity), sensitive wetlands, peatlands or on steep gradients, puddle clay stanks or low permeability material will be used as an impermeable barrier to the free movement of water. This is undertaken to prevent the (higher permeability) bedding material being used as a conduit for the transference of groundwater. These are placed perpendicular to the pipe to a height of at least the depth of the granular material and to the full width of the trench excavated, in the order of 200mm thickness and are keyed into the sides of the trench. At a localised level, stanks are constructed at field boundaries or every 50m to contain the groundwater within the holding of the landowner.

455. When a trench is temporarily pumped, the dewatering induces a cone of depression. The shape of the cone and the rate at which it expands depends on the depth, coefficients of transmissivity and storage of the aquifer. Calculations on the temporary dewatering are included in Appendix A10.16.

456. During the phased excavations along the pipeline, water will enter the trench by direct rainfall and via groundwater seepage once the groundwater table is intercepted. The water will be pumped out in advance of pipelaying. Quantities pumped will vary depending on the rainfall conditions and the geology that is intersected. As detailed in Appendix A10.4 to Appendix A10.14, material underlying the peatland area is predominantly gravelly SILT and silty GRAVELS with water level varying between 0.4m bgl and 2m bgl. Dewatering will be undertaken for short periods (typically days but less than one month) at any one location and adapted to account for the prevailing conditions.

457. Direct disposal to watercourses of arisings from excavations and from groundwater dewatering activities will not be allowed. Water will be managed and treated in accordance with the SWMP (Annex A of Appendix A5.1: CEMP). Dewatering volumes will vary depending on factors such as depth of excavation, soil/bedrock permeability and the phasing of the excavation works. The deepest excavation occurs at the RWI&PS. Based on the proposed piling design, inflows from the permeable sand and gravel horizons will be excluded. The calculated discharge volumes will be <15m^3/hr. Dewatering will be required for a period of two to three months until the excavation is completed and sealed. No significant dewatering is required for the WTP, BPT, BPS, FCV or TPR. Dewatering requirements vary along the pipeline but is only required for short periods i.e. two weeks to four months. Due to the shallow excavations and low water table, dewatering will not be required in many areas.

458. Where weathered limestone or karst is encountered at formation level, the feature will be mapped in detail. Each feature and associated mitigation measure will be documented and included in the safety file for the Proposed Project. Where infilling or grouting is undertaken, works will be supervised by a suitably qualified hydrogeologist to ensure there is no effect on groundwater.

459. The proposed Treated Water Pipeline will be located 0.15km downgradient of the Ballinagar Group Water Scheme (GWS) and 0.35km downgradient of the Geashill PWS (TWC – 8800 to TWC – 8950). The proposed pipeline is not located within the Ballinagar SPZ or Geashill ZoC. The potential (pre-mitigation measures) for the estimated drawdown, as a result of the temporary works, is in the range of 0.1 to 0.2m at the springs, at steady state conditions, i.e. long-term pumping. Details are provided in Appendix A10.16. Drawdown away from the dewatering does not instantly reach steady state and is a function of time. Drawdown due to a groundwater abstraction will continue to spread until recharge is sufficient to balance the abstraction rate.

460. The short-term works (less than 12 weeks) will limit potential drawdown at the Geashill/Ballinagar supplies. The groundwater will be monitored upgradient of the water supply. Monitoring will be undertaken at the Geashill and Ballinagar water supplies along with the existing monitoring wells. Additional well surveys will be undertaken pre-construction. Trigger values will be established in terms of pH, conductivity, and water levels upgradient of the proposed works. Where concentrations exceed the natural variation in the parameters, the following mitigation will be implemented:

- Sheet piling at trenchless crossing shaft to limit groundwater inflows to the south of the Construction Working Width
- Limiting the period of excavation. The trenching operation is only conducted once the pipeline installation and backfill crew are ready to install the pipeline in that location, in order to minimise the duration that the trench is open
- Alternative water source to the existing Ballinagar GWS for the duration of the temporary excavation works. Alternative water sources include tankering or a connection to the Geashill PWS.

461. The main water parameters in terms of groundwater quality and levels are outlined in the monitoring schedule (see Table 10.32).

Table 10.32: Groundwater Monitoring Schedule

Phase	Location	Pre-Construction	Construction	Post-Construction
Monitoring Period		Three months	Five years on a phased basis	Three months
Groundwater level monitoring	Monitoring of private wells within 100m of the pipeline, Fort Henry, monitoring of Ardcrony GWS, Geashill PWS and Ballinagar GWS. Monitoring of groundwater levels in rehabilitation plan/PCAS peatlands and degraded raised bog areas. Monitoring in rehabilitation plan/PCAS bogs every 200m along Construction Working Width.	Continuous monitoring with dataloggers	Continuous monitoring with dataloggers	Continuous monitoring with dataloggers
Frequency Groundwater Sampling Parameters	Ardcrony GWS, Geashill PWS and Ballinagar GWS.	Monthly pH, electrical conductivity, temperature (handheld meter). Chloride, mineral oil, pH, total ammonia	Weekly pH, electrical conductivity, temperature (handheld meter). Molybdate reactive phosphorus, nitrate, mineral oil, Monitoring during clearance phase and construction works.	Quarterly pH, electrical conductivity, temperature (handheld meter). Chloride, mineral oil
Reporting	As part of SWMP	Pre-construction report. Report limits/ values for Construction Phase water monitoring.	Monthly and quarterly monitoring report. Results screened against pre-Construction Phase water monitoring results.	Final monitoring reporting. Results screened against Construction Phase surface water monitoring results.

10.5.2.2 Operational Phase

462. Mitigation measures for the Operational Phase are outlined in Sections 10.5.2.2.1 to Section 10.5.2.2.6.

10.5.2.2.1 Soil Compaction

463. It is considered that the Operational Phase would not have significant effects on soil compaction. No additional mitigation measures are required.

10.5.2.2.2 Soil Loss

464. It is considered that the Operational Phase would not have significant effects on soil loss. There are no significant excavations or change of land use proposed during the Operational Phase. No additional mitigation measures are required.

10.5.2.2.3 Geomorphology and Geohazards

465. It is considered that the Operational Phase would not have significant effects on geohazards. Permanent ground movement and groundwater level monitoring at the RWI&PS will be undertaken, incorporated into the operation and maintenance of the Fort Henry Embankment. Monitoring will be in accordance with the Dam Surveillance Guide (International Commission on Large Dams 2018). Maintenance includes periodic calibration of instruments, cleaning, repair or replacement/upgrading. Performance monitoring will be carried out regularly by qualified geotechnical professionals, whose training is kept up to date and who can interpret monitoring data.

10.5.2.2.4 Contamination

466. Chemicals will be stored throughout the Proposed Project site locations in compliance with the handling instructions provided with the Material Safety Data Sheets (MSDSs) and in compliance with the Safety, Health and Welfare at Work (Chemical Agents) Regulations 2001 (as amended) and the Safety, Health and Welfare at Work (Construction) Regulations 2013 (as amended). This includes separation of incompatible chemicals, provision of adequate fire-fighting equipment, spill containment and other safety facilities.

467. For each chemical, an MSDS will be available, as well as an assessment of the hazards associated with the chemical (to personnel, for storage and for emergency response). The MSDSs will be available at the various places where chemicals are required to be used and centralised with the Safety Officer on board.

468. Chemicals will be stored in drums or smaller containers and be suitably bunded to contain any leaks or spills. The design of reinforced concrete structures will be water-retaining and the use of bunds around any chemicals and oil storage areas will reduce the risk of any leaks or accidental spillages.

469. During the Operational Phase, there are potential sources of groundwater contamination from the hardstanding areas. However, as a result of the design of site oil and chemical storage and drainage systems, there would be no significant adverse effects.

470. There will be no wastewater from welfare facilities discharged; it will be contained and removed to an authorised facility, or for recovery by tanker at appropriate intervals. The holding tank will be alarmed to alert when emptying is required, for disposal in a licensed manner via a licensed facility.

10.5.2.2.5 Aggregate and Extractive Industries

471. The Proposed Project is not located near existing or proposed quarries or mines. No additional mitigation is required.

10.5.2.2.6 Hydrogeology

472. As part of the embedded mitigation outlined in Section 10.5.1, oil and chemical storage areas will be bunded and oil interceptors installed. Where infiltration basins are used for roadside drainage such as the BPT, there will be a consistent unsaturated 1m of appropriate material, either natural or man-made subsoil material, beneath the invert level of the discharge. The proposed infiltration basin at the BPT will be in accordance with Road Drainage and the Water Environment (Transport Infrastructure Ireland 2015) to promote treatment and reduce potential sediment losses to the groundwater.

473. Washout Valves are located at every low point along the pipeline. During pipeline operation, it is very rare that these valves would be used as sections will only infrequently need to be drained down. They will generally only be required for emptying sections of the pipeline where necessary for emergency repairs or possibly for cleaning programmes every 20 to 30 years. Even then, the Washout Valves will only be used to drain short sections of pipeline, which cannot otherwise be drained to either end of the pipeline section due to the topography. Embedded mitigation (dechlorination) is part of the project design.

474. For the purposes of this assessment, certain design requirements (see Chapter 5: Construction & Commissioning) have been committed to, as follows:

- Planned repair and maintenance will only occur in low flow periods
- Line Valves have been sited where possible at a field boundary and adjacent to the public road to facilitate plant access and repair and maintenance. The pipeline arrangement at the Line Valve is designed to maximise the potential to pump treated water around the Line Valves to sections not being maintained. This reduces the quantity of water to be discharged to the environment
- Washout Valves will be provided at low points along the Proposed Pipeline and would discharge through an outlet chamber to allow for the provision of dechlorination chemicals prior to discharge. Washout valves with a permanent outfall have been designed to minimise the impact of the discharge by proposing a suitable orientation and appropriate engineering design to dissipate the energy from the discharge. They will also include the construction of a chamber to facilitate the use of dechlorination media
- Any water that is discharged will be fit for release through provision of appropriate treatment. This usually takes the form of a mobile treatment unit such as a ‘Siltbuster’ which can be used for both solids removal (during commissioning only) and dechlorination by chemical dosing with sodium thiosulphate
- Washout chambers will be located in concrete chambers with locked manhole covers.

475. To prevent corrosion of the steel pipe, internal and external protective coatings are applied. In addition, a remotely monitored impressed-current Cathodic Protection system will be installed. The Cathodic Protection will be continuously monitored by a Supervisory Control and Data Acquisition (SCADA) system. This alerts the operators of changes in system current which may indicate possible damage to the pipe coatings and that may, in the long run, cause localised corrosion.

476. The pipelines will be constructed in a manner that will reduce the potential for preferential pathways. The construction methodology identifies steel pipes that require minimal granular material. Backfilling will be achieved by using the native excavated material as backfill around the pipe. Clay stanks will be placed where any significant contamination is identified or in areas where preferential drainage may occur (i.e. low permeability horizons). Sensitive ecological receptors are detailed in Chapter 8 (Biodiversity).

10.6 Residual Effects

477. A summary of the residual effects, after the application of mitigation measures set out in Section 10.5, is provided in Table 10.33 to Table 10.36.

Table 10.33: Summary of Residual Construction Phase Effects on Soils and Geology

Environmental Attribute	Pre Mitigation			Post Mitigation	
(Soils & Geology)	Sensitivity	Magnitude	Significance	Magnitude	Residual Significance
Soil Compaction					
38 kV Uprate Works	Low	Low	Not Significant/Slight (Not Significant)	Low	Not Significant/Slight (Not Significant)
RWI&PS and WTP Site	Low	Low	Not Significant/Slight (Not Significant)	Negligible	Not Significant
BPT	Low	Low	Not Significant/Slight (Not Significant)	Negligible	Not Significant
BPS	Low	Low	Not Significant/Slight (Not Significant)	Negligible	Not Significant
FCV	Low	Low	Not Significant/Slight (Not Significant)	Negligible	Not Significant
TPR	Low	Low	Not Significant/Slight (Not Significant)	Negligible	Not Significant
Construction Compounds and Pipe Storage Depots	Low	Low to medium	Slight (Not Significant)	Low	Not Significant/Slight (Not Significant)
RWRMs, Treated Water Pipeline	Low for majority of the pipeline, medium sensitivity for degraded raised bog (Non Annex I)	Low (i.e. cutover peat) to medium (degraded raised bog (Non Annex I))	Not Significant/Slight (Not Significant) (cutover peat) to Moderate (Significant) (degraded raised bog (Non Annex I))	Low (i.e. cutover peat) to medium (degraded raised bog (Non Annex I))	Not Significant/Slight (Not Significant) for cutover peat, to Moderate (Significant) for degraded raised bog (Non Annex I) in the short-term. Long term effects are Not Significant/Slight (Not Significant).
Loss of soils/Land use change					
38 kV Uprate Works	Low	Negligible	Not Significant	Negligible	Not Significant
RWI&PS and WTP Site	Low	Low	Not Significant/Slight (Not Significant)	Low	Slight /Not Significant (Not Significant)
BPT	Low	Low	Not Significant/Slight (Not Significant)	Negligible	Not Significant
BPS	Low	Low	Not Significant/Slight (Not Significant)	Negligible	Not Significant
FCV	Low	Low	Not Significant/Slight (Not Significant)	Negligible	Not Significant
TPR	Low	Low	Not Significant/Slight (Not Significant)	Negligible	Not Significant
Construction Compounds and Pipe Storage Depots	Low	Low	Not Significant/Slight (Not Significant)	Negligible	Not Significant

Environmental Attribute	Pre Mitigation			Post Mitigation	
(Soils & Geology)	Sensitivity	Magnitude	Significance	Magnitude	Residual Significance
RWRMs, Treated Water Pipeline	Low for majority of the pipeline, medium sensitivity for degraded raised bog (Non Annex I)	Low (i.e. cutover peat) to medium (degraded raised bog (Non Annex I))	Slight (Not Significant) (cutover peat) to Moderate (Significant) (degraded raised bog (Non Annex I))	Low (i.e. cutover peat) to medium (degraded raised bog (Non Annex I))	Slight /Not Significant (Not Significant) for cutover peat, to Moderate (Significant) for degraded raised bog (Non Annex I) in the short-term. Long term effects are Not Significant/Slight (Not Significant).
Contamination					
38 kV Uprate Works	Medium	Low	Slight (Not Significant)	Low	Not Significant/Slight (Not Significant)
RWI&PS and WTP Site	Medium	Low	Slight (Not Significant)	Negligible	Not Significant
BPT	Medium	Low	Slight (Not Significant)	Negligible	Not Significant
BPS	Medium	Low	Slight (Not Significant)	Negligible	Not Significant
FCV	Medium	Low	Slight (Not Significant)	Negligible	Not Significant
TPR	Medium	Low	Slight (Not Significant)	Negligible	Not Significant
Construction Compounds and Pipe Storage Depots	Medium	Low	Slight (Not Significant)	Negligible	Not Significant
RWRMs, Treated Water Pipeline	Medium	Low	Slight (Not Significant)	Negligible	Not Significant
Aggregate and Extractive Industries					
38 kV Uprate Works	Low	Low	Not Significant/Slight (Not Significant)	Low	Not Significant/Slight (Not Significant)
RWI&PS and WTP Site	Low	Negligible	Not Significant	Negligible	Not Significant
BPT	Low	Low	Not Significant/Slight (Not Significant)	Low	Not Significant/Slight (Not Significant)
BPS	Low	Negligible	Not Significant	Negligible	Not Significant
FCV	Low	Negligible	Not Significant	Negligible	Not Significant
TPR	Low	Negligible	Not Significant	Negligible	Not Significant
Construction Compounds and Pipe Storage Depots	Low to Negligible	Low to Negligible	Imperceptible to Not Significant/Slight (Not Significant)	Low to Negligible	Imperceptible to Not Significant/Slight (Not Significant)

Environmental Attribute	Pre Mitigation			Post Mitigation	
(Soils & Geology)	Sensitivity	Magnitude	Significance	Magnitude	Residual Significance
RWRMs, Treated Water Pipeline	Low to Negligible	Low to Negligible	Imperceptible to Not Significant/Slight (Not Significant)	Low to Negligible	Imperceptible to Not Significant/Slight (Not Significant)
Geohazards: Fort Henry Embankment					
RWI&PS	High	Negligible	Not Significant	Negligible	Not Significant
Geohazards: Peat and landslide potential					
38 kV Uprate Works	Low	Low	Not Significant/Slight (Not Significant)	Negligible	Not Significant
RWI&PS and WTP Site	Negligible	Low	Not Significant	Negligible	Imperceptible (Not Significant)
BPT	Negligible	Low	Not Significant	Negligible	Imperceptible (Not Significant)
BPS	Negligible	Low	Not Significant	Negligible	Imperceptible (Not Significant)
FCV	Negligible	Low	Not Significant	Negligible	Imperceptible (Not Significant)
TPR	Negligible	Low	Not Significant	Negligible	Imperceptible (Not Significant)
Construction Compounds and Pipe Storage Depots	Low	Low	Not Significant/Slight (Not Significant)	Negligible	Not Significant
RWRMs, Treated Water Pipeline	Low	Low	Not Significant/Slight (Not Significant)	Negligible	Not Significant
Geohazards: Surface karst features					
38 kV Uprate Works	Negligible	Low	Not Significant	Negligible	Imperceptible (Not Significant)
RWI&PS and WTP Site	Negligible	Low	Not Significant	Negligible	Imperceptible (Not Significant)
BPT	Low	Low	Not Significant/Slight (Not Significant)	Negligible	Not Significant
BPS	Negligible	Low	Not Significant	Negligible	Imperceptible (Not Significant)
FCV	Negligible	Low	Not Significant	Negligible	Imperceptible (Not Significant)
TPR	Negligible	Low	Not Significant	Negligible	Imperceptible (Not Significant)
Construction Compounds and Pipe Storage Depots	Medium	Low	Slight (Not Significant)	Negligible	Not Significant/Slight (Not Significant)
RWRMs, Treated Water Pipeline	Medium	Low	Slight (Not Significant)	Negligible	Not Significant/Slight (Not Significant)

Environmental Attribute	Pre Mitigation			Post Mitigation	
(Soils & Geology)	Sensitivity	Magnitude	Significance	Magnitude	Residual Significance
Geological Heritage sites					
38 kV Uprate Works	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
RWI&PS and WTP Site	Medium	Low	Slight (Not Significant)	Negligible	Not Significant
BPT	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
BPS	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
FCV	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
TPR	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
Construction Compounds and Pipe Storage Depots	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
RWRMs, Treated Water Pipeline	Medium (for CGS sites)	Low	Slight (Not Significant)	Negligible	Not Significant

Table 10.34: Summary of Residual Construction Phase Effects on Hydrogeology

Environmental Attribute	Pre Mitigation			Post Mitigation	
(Hydrogeology)	Sensitivity	Magnitude	Significance	Magnitude	Residual Significance
Groundwater flow effects					
38 kV Uprate Works	Low	Low	Not Significant/Slight (Not Significant)	Negligible	Not Significant
RWI&PS and WTP Site	Low	Low	Not significant/Slight (Not Significant)	Negligible	Not Significant
BPT	Low	Low	Not significant/Slight (Not Significant)	Negligible	Not Significant
BPS	Low	Low	Not significant/Slight (Not Significant)	Negligible	Not Significant
FCV	Low	Low	Not significant/Slight (Not Significant)	Negligible	Not Significant
TPR	Low	Low	Not significant/Slight (Not Significant)	Negligible	Not Significant
Construction Compounds and Pipe Storage Depots	Low	Low	Not significant/Slight (Not Significant)	Negligible	Not Significant
RWRMs, Treated Water Pipeline	Low to medium	Low to medium	Not Significant/Slight (Not significant) to Moderate (Significant)	Low	Slight (Not Significant)
Groundwater quality effects					
38 kV Uprate Works	Medium	Low	Slight (Not Significant)	Negligible	Not Significant
RWI&PS and WTP Site	Medium	Low	Slight (Not Significant)	Negligible	Not Significant
BPT	Medium	Low	Slight (Not Significant)	Negligible	Not Significant
BPS	Medium	Low	Slight (Not Significant)	Negligible	Not Significant
FCV	Medium	Low	Slight (Not Significant)	Negligible	Not Significant
TPR	Medium	Low	Slight (Not Significant)	Negligible	Not Significant
Construction Compounds and Pipe Storage Depots	Medium	Low	Slight (Not Significant)	Negligible	Not Significant
RWRMs, Treated Water Pipeline	Medium	Low	Slight (Not Significant)	Negligible	Not Significant

Environmental Attribute	Pre Mitigation			Post Mitigation	
(Hydrogeology)	Sensitivity	Magnitude	Significance	Magnitude	Residual Significance
GWDTE					
38 kV Uprate Works	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
RWI&PS and WTP Site	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
BPT	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
BPS	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
FCV	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
TPR	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
Construction Compounds and Pipe Storage Depots	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
RWRMs, Treated Water Pipeline	Medium to High	Negligible	Slight (Not Significant)	Negligible	Not Significant

Table 10.35: Summary of Residual Operational Phase Effects on Soils and Geology

Environmental Attribute	Pre Mitigation			Post Mitigation	
(Soils & Geology)	Sensitivity	Magnitude	Significance	Magnitude	Residual Significance
Compaction					
38 kV Uprate Works	Low	Negligible	Not Significant	Negligible	Not Significant
RWI&PS and WTP Site	Low	Negligible	Not Significant	Negligible	Not Significant
BPT	Low	Negligible	Not Significant	Negligible	Not Significant
BPS	Low	Negligible	Not Significant	Negligible	Not Significant
FCV	Low	Negligible	Not Significant	Negligible	Not Significant
TPR	Low	Negligible	Not Significant	Negligible	Not Significant
RWRMs, Treated Water Pipeline	Low	Negligible	Not Significant	Negligible	Not Significant
Loss of soils/Land use change					
38 kV Uprate Works	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
RWI&PS and WTP Site	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
BPT	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
BPS	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
FCV	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
TPR	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
RWRMs, Treated Water Pipeline	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
Contamination					
38 kV Uprate Works	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
RWI&PS and WTP Site	Medium	Low	Slight (Not Significant)	Negligible	Not Significant
BPT	Medium	Low	Slight (Not Significant)	Negligible	Not Significant

Environmental Attribute	Pre Mitigation			Post Mitigation	
(Soils & Geology)	Sensitivity	Magnitude	Significance	Magnitude	Residual Significance
BPS	Medium	Low	Slight (Not Significant)	Negligible	Not Significant
FCV	Medium	Low	Slight (Not Significant)	Negligible	Not Significant
TPR	Medium	Low	Slight (Not Significant)	Negligible	Not Significant
RWRMs, Treated Water Pipeline	Medium	Negligible	Not Significant/Slight (Not Significant)	Negligible	Not Significant
Aggregate and Extractive Industries					
38 kV Uprate Works	Low	Low	Not significant/Slight (Not Significant)	Low	Not significant/Slight (Not Significant)
RWI&PS and WTP Site	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
BPT	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
BPS	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
FCV	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
TPR	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
RWRMs, Treated Water Pipeline	Low	Low	Not significant/Slight (Not Significant)	Low	Not significant/Slight (Not Significant)
Geohazards: Fort Henry Embankment					
RWI&PS	High	Negligible	Not Significant	Negligible	Not Significant
Geohazards: Peat and landslide potential					
38 kV Uprate Works	Low	Low	Not significant/Slight (Not Significant)	Negligible	Not Significant
RWI&PS and WTP Site	Negligible	Low	Not significant	Negligible	Imperceptible (Not Significant)
BPT	Negligible	Low	Not significant	Negligible	Imperceptible (Not Significant)
BPS	Negligible	Low	Not significant	Negligible	Imperceptible (Not Significant)

Environmental Attribute	Pre Mitigation			Post Mitigation	
(Soils & Geology)	Sensitivity	Magnitude	Significance	Magnitude	Residual Significance
FCV	Negligible	Low	Not significant	Negligible	Imperceptible (Not Significant)
TPR	Negligible	Low	Not significant	Negligible	Imperceptible (Not Significant)
RWRMs, Treated Water Pipeline	Low	Low	Not significant/Slight (Not Significant)	Negligible	Not Significant
Geohazards: Surface karst features					
38 kV Uprate Works	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
RWI&PS and WTP Site	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
BPT	Low	Low	Not significant/Slight (Not Significant)	Negligible	Not Significant
BPS	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
FCV	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
TPR	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
RWRMs, Treated Water Pipeline	Low	Low	Not significant/Slight (Not Significant)	Negligible	Not Significant
Geological heritage sites					
38 kV Uprate Works	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
RWI&PS and WTP Site	Medium	Low	Slight (Not Significant)	Negligible	Not Significant
BPT	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
BPS	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)

Environmental Attribute	Pre Mitigation			Post Mitigation	
(Soils & Geology)	Sensitivity	Magnitude	Significance	Magnitude	Residual Significance
FCV	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
TPR	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible(Not Significant)
RWRMs, Treated Water Pipeline	Medium	Low	Slight (Not Significant)	Negligible	Not Significant

Table 10.36: Summary of Residual Operational Phase Effects on Hydrogeology

Environmental Attribute	Pre Mitigation			Post Mitigation	
(Hydrogeology)	Sensitivity	Magnitude	Significance	Magnitude	Residual Significance
Groundwater flow effects					
38 kV Uprate Works	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
RWI&PS and WTP Site	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
BPT	Low	Negligible	Not Significant	Negligible	Not Significant
BPS	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
FCV	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
TPR	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
RWRMs, Treated Water Pipeline	Low	Negligible	Not Significant	Negligible	Not Significant
Groundwater quality effects					
38 kV Uprate Works	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
RWI&PS and WTP Site	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
BPT	Medium	Low	Slight (Not Significant)	Negligible	Not Significant
BPS	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
FCV	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
TPR	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
RWRMs, Treated Water Pipeline	Low	Negligible	Not Significant	Negligible	Not Significant

Environmental Attribute	Pre Mitigation			Post Mitigation	
(Hydrogeology)	Sensitivity	Magnitude	Significance	Magnitude	Residual Significance
GWDTE					
38 kV Uprate Works	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
RWI&PS and WTP Site	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
BPT	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
BPS	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
FCV	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
TPR	Negligible	Negligible	Imperceptible (Not Significant)	Negligible	Imperceptible (Not Significant)
RWRMs, Treated Water Pipeline	Medium to High	Negligible	Slight (Not Significant)	Negligible	Slight (Not Significant)

10.6.1 Residual Effects on Construction Phase

478. There would be no likely significant effects for the majority of soils, geology and hydrogeology receptors. As identified in Section 10.4.2, in the absence of mitigation measures, there is the potential for significant short-term effects (Moderate effects) during the Construction Phase from the following:

- Compaction at degraded raised bog (Non Annex I) areas along the pipeline route
- Loss of degraded raised bog (Non Annex I) in areas along the pipeline route
- Potential temporary groundwater flow effects from dewatering during installation of the Treated Water Pipeline at Ballinagar GWS.

479. With regard to Ballinagar GWS, mitigation measures set out in Section 10.5.2.1, including monitoring and implementing additional measures if trigger values are exceeded, would reduce the effect to Slight (Not Significant). There would therefore be no likely significant residual effects on groundwater flow from dewatering during installation of the Treated Water Pipeline at Ballinagar GWS during the Construction Phase.

480. With regard to the areas of degraded raised bog (none of which are active raised bog or degraded raised bog capable of regeneration), it is not possible to mitigate the effect on loss of peat or peat compaction in the short term. There would therefore be a Moderate (Significant), short term, negative residual effect. However, it is not proposed to remove peat from the Proposed Project, as all peat will be used along the pipeline and any surplus provided to Bord na Móna for reuse within their peatland rehabilitation schemes. Therefore, although there would be a short term likely significant residual effect on degraded raised bog, this would be limited to the Construction Phase as the degraded raised bog would be reinstated following the installation of the pipe. As a result, the long term residual effect reduces to Not Significant/Slight (Not Significant).

10.6.2 Residual Effects in the Operational Phase

481. No likely significant effects were identified during the Operational Phase on soils, geology and hydrogeology receptors, therefore no specific mitigation is required. Design mitigation, such as measures to contain chemicals and manage accidental spills, and design measures to control rare washout discharges, would reduce effects further. There are therefore no likely significant residual effects during operation.

10.7 References

An Foras Talúntais (1966). Soils of Co. Limerick.

An Foras Talúntais (1970). Soils of Co. Kildare.

An Foras Talúntais (1971). Soils of County Clare.

An Foras Talúntais (1980). General Soil Map of Ireland.

An Foras Talúntais (1993). Soils of Tipperary, North Riding.

An Foras Talúntais (2003). Soils of Co. Offaly.

An Fóram Uisce (2021). Optimising Water Quality Returns from Peatland Management while Delivering Co-Benefits for Climate and Biodiversity.

Archer, J.B., Sleeman, A.G., and Smith, D.C. (1996). Geology of Tipperary. Bedrock Geology 1:100,000 map series, Sheet 18, Geological Survey Ireland.

Attard, G., Winiarskli, T., Rossier, Y., Eisenlohr, L. (2016). Review: Impact of underground structures on the flow of urban groundwater. Hydrogeol J 24(01):5-19.

Baker, G., Crean, D., and Moran, S. (2007). Establishing Natural Background Levels for Groundwater Quality in Ireland. GSI Groundwater Newsletter No. 46

Boukhemacha, M.A., Gogu C.R., Serpescu, I., Gaitanaru, D., Bica, I. (2015). A hydrogeological conceptual approach to study urban groundwater flow in Bucharest City, Romania. Hydrogeol J 23:437–450.

Bord na Móna (2021a). Clonad Cutaway Bog Decommissioning and Rehabilitation Plan 2021 https://www.bnmpcas.ie

Bord na Móna (2021b). Esker Cutaway Bog Decommissioning and Rehabilitation Plan 2021.

Bord na Móna (2021c). Mount Lucas Cutaway Bog Decommissioning and Rehabilitation Plan 2021.

Bord na Móna (2022a). Gilltown Cutaway Bog Decommissioning and Rehabilitation Plan 2022.

Bord na Móna (2022b). Cloncreen Cutaway Bog Decommissioning and Rehabilitation Plan 2022.

Bord na Móna (2022c). Timahoe South Cutaway Bog Decommissioning and Rehabilitation Plan 2022.

Bord na Móna (2022d). Timahoe North Cutaway Bog Decommissioning and Rehabilitation Plan 2022.

British Standards Institution (2015). Code of Practice for Site Investigations (BS 5930:2015 +A1:2020).

CDM Smith (2019). Environmental Monitoring Services at the Former Mining Areas of Silvermines (Co. Tipperary) and Avoca (Co. Wicklow) Silvermines Data Report.

Clarke, A., Parkes, M., Gatley, S. (2005). Geological Heritage of Kildare Geological Survey Ireland, Dublin

Construction Industry Research and Information Association (2001). C552 Contaminated Land Risk Assessment, A Guide to Good Practice.

Construction Industry Research and Information Association (2006). C648 Control of water pollution from linear construction projects. Technical guidance

Construction Industry Research and Information Association (2015a). C753 SuDS Manual

Construction Industry Research and Information Association (2015b). C741 Environmental good practice on site

Construction Industry Research and Information Association (2016). C750 Groundwater Control: design and practice, second edition

Department of Agriculture, Food and the Marine (2023a). Common Agriculture Policy Strategic Plan 2023-2027.

Department of Agriculture, Food and the Marine (2023b). Forestry Programme 2023-2027.

Department of Housing, Local Government and Heritage (2024). Ireland's 4th National Biodiversity Action Plan 2023–2030.

Department of Housing, Planning and Local Government (2018). Guidelines for Planning Authorities and An Bord Pleanála on carrying out Environmental Impact Assessment.

DELG/EPA/GSI (1999). Groundwater Protection Schemes. Department of the Environment and Local Government, Environmental Protection Agency, and Geological Survey Ireland.Drew, D. P., Jones, G. Ll. (2000). Post-Carboniferous, pre-Quaternary karstification in Ireland. Proc. Geol.Assn., 111, 345-353.

Environment Agency, UK (2020). Land Contamination Risk Management (LCRM).

Environmental Protection Agency (2004a). Final Report of Expert Group for Silvermines County Tipperary Lead and Other Relevant Metals.

Environmental Protection Agency (2004b). IPC Guidance Note on Storage and Transfer of Materials for Scheduled Activities.

Environmental Protection Agency (2005). Towards setting Guideline values for the Protection of Groundwater in Ireland - EPA Strive Report 2005-WRM-01

Environmental Protection Agency (2007). Soil Geochemical Atlas of Ireland

Environmental Protection Agency (2008). A framework for the assessment of GWDTEs under the WFD.

Environmental Protection Agency (2017). Natural Background Levels for Chemical Parameters in Irish Groundwater - EPA Strive Report 2007-FS-WQ-16-S4

Environmental Protection Agency (2021). Best Practice Guidelines for the Preparation of Resource & Waste Management Plans for Construction and Demolition Projects. Available from https://www.epa.ie/publications/circular-economy/resources/CDWasteGuidelines.pdf. Accessed October 2025.

Environmental Protection Agency (2022). Guidelines on the Information to be Contained in Environmental Impact Assessment Reports.

Environmental Protection Agency and Geological Survey Ireland (2009). Historic Mine Sites - Inventory and Risk Classification.

European Commission (2017). Environmental Impact Assessment of Projects - Guidance on the preparation of the Environmental Impact Assessment Report (Directive 2011/92/EU as amended by 2014/52/EU)

Fitzsimons, V., Daly, D., and Deakin, J. (2003). GSI Guidelines for Assessment and Mapping of Groundwater Vulnerability to Contamination. Geological Survey Ireland.

Fossitt, J.A. (2000). A Guide to Habitats in Ireland.

Gallagher, V., Meehan, R., Parkes, M., Hennessy, R., and Power, S. (2019). The Geological Heritage of County Tipperary - An audit of County Geological Sites in County Tipperary.

Gatley, S., Somerville, I., Morris, J.H., Sleeman, A.G., and Emo, G. (2005). Geology of Galway-Offaly. A geological description of Galway-Offaly and adjacent parts of Westmeath, Tipperary, Offaly, Clare and Roscommon to accompany the bedrock geology 1:100,000 scale map series, Sheet 15, Galway-Offaly. Geological Survey Ireland.

Geological Survey Ireland (n.d.) Groundwater bodies: Summary of Initial Characterisation. www.gsi.ie

Geological Survey Ireland (2001a). 1:100,000 scale Sheet No. 13-18

Geological Survey Ireland (2001b). Geashill Public Supply – Groundwater Source Protection Zones. Available from http://www.gsi.ie. Accessed October 2025.

Geological Survey Ireland (2003). Geashill GWB description.

Geological Survey Ireland (2006). Criteria used in aquifer classification. Available from: http://www.gsi.ie/Programmes/Groundwater/Aquifer+Classification.htm. Accessed October 2025.

Geological Survey Ireland. (2012). Groundwater Karst Data Ireland. Scale 1:100,000. Geological Survey of Ireland, Dublin, Ireland. Updated, 2021. Available with associated metadata from: www.gsi.ie

Geological Survey Ireland. (2013). Quaternary Sediments 1:50,000 Ireland (ROI) ITM. Geological Survey of Ireland, Dublin, Ireland. Updated, 2021. Available with associated metadata from: www.gsi.ie, Accessed October 2025.

Geological Survey Ireland (2016). Bedrock Geology 1:100,000 Ireland (ROI) ITM. Geological Survey of Ireland, Dublin, Ireland. Updated 2022. Available with associated metadata from: www.gsi.ie, Accessed October 2025.

Geological Survey Ireland (GSI) (2023). Geological Survey Ireland Spatial Resources, Department of the Environment, Climate and Communications. Available at: https://dcenr.maps.arcgis.com/apps/MapSeries/index.html?appid=a30af518e87a4c0ab2fbde2aaac3c228. Accessed October 2025.

Geological Survey Ireland (2024). Groundwater bodies: Summary of Initial Characterisation. Available from (Groundwater bodies).

Government of Ireland (2025). National Development Plan Review 2025l.

Historical Geological 6 inch:1mile maps

Historic Mine Sites – Inventory and Risk Classification (EPA & GSI)

Historical OSI 6” and 25” maps

Hennessy, R., Meehan, R., Parkes, M., Gallagher, V., and Gatley, S. (2014). The Geological Heritage of South Dublin County An audit of County Geological Sites in South Dublin County. Geological Survey Ireland, Dublin.

Hennessy, R., Meehan, R., Parkes, M., Gallagher, V., and Gatley, S. (2016). The Geological Heritage of Offaly County. An audit of County Geological Sites in Offaly County. Geological Survey Ireland, Dublin.

Henningsson, B. (1983). Environmental protection and health risks in connection with the use of creosote. Holz als Roh- und Werkstoff. 41:471–475.

Institute of Geologists of Ireland (2013). Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements.

International Commission on Large Dams (2018). Dam Surveillance Guide.

Irish Water (2016a). Water Supply Project Eastern and Midlands Region Environmental Impact Statement Scoping Report.

Irish Water (2016b). Final Options Appraisal Report.

Jacobs TOBIN (2022). Water Supply Project Eastern and Midlands Region – Public and Stakeholder Participation Report.

Jernlås, R. (2012). Status Report on Soil Contamination in the Proximity of Creosote-Treated In Service Utility Poles in Sweden.

Karpf, C., Krebs, P. (2004). Sewers as drainage systems-quantification of groundwater infiltration. In: Proceedings of NOVATECH 2004 Sustainable Techniques and Strategies in Urban Water Management, vol 1 Lyon, France, June 2004, pp 969–975.

Karpf, C., Krebs, P. (2011). Quantification of groundwater infiltration and surface water inflows in urban sewer networks based on a multiple model approach. Water Res 45:3129–3136.

Kelly, C. (2001). Killeigh and Meelaghans Group Water Schemes – Groundwater Source Protection Zones. Geological Survey Ireland. Available from http://www.gsi.ie. Accessed October 2025.

Kelly, C., Hunter Williams, T., Misstear, B.M., Motherway, K., (2015). Irish Aquifer Properties – A reference manual and guide. Prepared on behalf of the Geological Survey of Ireland and the Environmental Protection Agency.

Kelly, L., Schouten, M. (2002). Vegetation. In: M. Schouten, ed. Conservation and Restoration of Raised Bogs: Geological, Hydrological and Ecological Studies. Department of Environment and Local Government, Dublin, Ireland/ Staatabosbeheer, The Netherlands, pp. 110-169.

Kildare County Council (2023). County Development Plan 2023 – 2029 (as varied).

Laois County Council (2022). County Development Plan 2021 – 2027 (as varied).

Lerner, D.N., Barrett, M.H. (1996). Urban groundwater issues in The United Kingdom. Hydrogeol J 4:80–89.

Limerick County Council (2023). Limerick County Development Plan 2022 – 2028 (as varied).

Madden and Hara (2016). The Treatment of Karst Features Encountered during Road Construction in County Galway.

Marinos, P.G., Kavvadas, M.J. (1997). Effects of shallow tunnels on the groundwater table levels.

McConnell, B., Philcox, M.E., Sleeman, A. G., Stanley, G., Flegg, A.M., Daly, E.P. and Warren, W.P. (1994). Geology of Kildare - Wicklow. A geological description to accompany the Bedrock Geology 1:100,000 map Series, Sheet 16, Kildare - Wicklow. Edited by B. McConnell, Geological Survey Ireland.

Mitchell, F. (2009). The Holocene. In: Holland, C.H. and Sanders, I.H. (Editors) The Geology of Ireland.

Mitchell, F., Delaney, C. (1997). The Quaternary of the Irish Midlands. Irish Association for Quaternary Studies (IQUA) Field Guide Number 21.

Mitchell, G.F., Ryan, M. (1998). Reading the Irish Landscape.

Murray, J., Henry, T. (2018). Waulsortian Limestone: Geology and Hydrogeology. Proceedings of the 2018 Annual Conference of the Irish Group of the International Association of Hydrogeologists. Tullamore, April 2018.

National Roads Authority. (2009). Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes.

Nolan, P. (2024). Updated High-resolution Climate Projections for Ireland. Environmental Protection Agency Research Report No. 471.

Offaly County Council (2021). Offaly County Development Plan 2021 – 2027 (as varied).

Ordnance Survey of Ireland (n.d.). Aerial Photographs. Available from: https://www.arcgis.com/apps/webappviewer/index.html?id=3ae19cc156bf4706a929304bf8fcc4f6. Accessed October 2025.

Ordnance Survey of Ireland (n.d.). 1:50,000 scale maps, Sheets 35, 42, 43, 49 and 50.

Ordnance Survey Ireland (n.d.). Historical OSI 6 inch map. Available: https://www.arcgis.com/apps/webappviewer/index.html?id=3ae19cc156bf4706a929304bf8fcc4f6. Accessed October 2025.

Ordnance Survey Ireland (n.d.). Historic and 25 inch map. Available: https://www.arcgis.com/apps/webappviewer/index.html?id=3ae19cc156bf4706a929304bf8fcc4f6. Accessed October 2025.

Parkes, M., Hennessy, R., Meehan, R., Gallagher, V., and Gatley, S. (2016). The Geological Heritage of County Laois An audit of County Geological Sites in County Laois.

Parkes, M., Sheehan-Clarke, A. (2005). The Geological Heritage of County Kildare, An audit of County Geological Sites in Kildare.

Pörtner, Hans-O, Roberts, D.C., Adams, H., Adler, C., Aldunce, P., Ali, E., Begum, R.A., Betts, R., Kerr, R.B., Biesbroek, R. (2022). Climate change 2022: Impacts, adaptation and vulnerability. IPCC Geneva, Switzerland.

Rutty, P., Jennings, P. (2012). Investigation, design and construction in karst. GSI Roads Conference, 2012

South Dublin County Council (2022). County Development Plan 2022 – 2028 (as varied).

SRK (2014). Management and Rehabilitation of the Silvermines Area.

Teagasc (2006). Soils map of Ireland. Produced as part of the EPA / Teagasc Soils and Subsoils Mapping Project, Teagasc, Kinsealy, Dublin.

Tedd, K.M., Coxon, C.E., Misstear, B.D.R., Daly, D., Craig, M., Mannix, A. and Hunter Williams, N.H. (2014). An integrated pressure and pathway approach to the spatial analysis of groundwater nitrate: a case study from the southeast of Ireland.

Tedd, K., Misstear, B.D.R., Coxon, C., Daly, D., Hunter Williams, N.H., Craig, M. and Mannix, M. (2011). Review of groundwater level data in the South-eastern River basin District. EPA STRIVE Programme 2007-2013. Environmental Protection Agency.

Tipperary County Council (2022). Tipperary County Development Plan 2022-2028 (as varied). Local Authorities (County Development Plans)

Transport Infrastructure Ireland (2015). DN-DNG-03065 Road Drainage and the Water Environment (including Amendment No.1).

Uisce Éireann (2023). Water Supply Project Eastern and Midlands Region EIA Scoping Methodology Report.

U.S. Department of Agriculture (1980). The biologic and economic assessment of pentachlorophenol, inorganic arsenicals, creosote, vol. 1. Wood Preservatives. pp. 193–227. Technical Bulletin No. 1658-1.