13 Land and Soils

13.1 Introduction

This chapter describes the likely significant effects of the proposed scheme on land and soils i.e. soils, geology, and hydrogeology.

Chapter 4, *Description of the Proposed Scheme* provides a full description of the proposed scheme whilst **Chapter 5,** *Construction Strategy* describes the Construction Strategy. The following aspects are particularly relevant to the land and soils assessment:

- Design:
  - The design has considered the potential for significant effects on land, soils and groundwater. Design features of the bridge underpinning and remedial works, channel dredging, debris and gravel traps, flood defences walls and earth embankment and associated drainage works will all have to take into account the particular ground conditions, groundwater regimes and the properties of the underlying soils and groundwaters to ensure that works do not have any potentially significant impacts on lands and soils;
- Construction:
  - Excavations, both above and below the water table, will require special consideration in terms of both the stability of the excavations and the logistics required to facilitate the works, i.e. dewatering. Additionally, disposal of surplus excavated material, including possible contaminated soils and groundwater, must be considered.
- Operation:
  - The proposed development will not have any likely significant impacts on subsoils or bedrock once operational. There will be an ongoing effect on groundwater levels during the operational stage. During operations there will be annual maintenance of the debris trap and gravel trap, and occasional dredging of the river channel, with removal of gravels by WCC. Inspection and any possible repair of scheme infrastructure will be undertaken by WCC.

13.2 Assessment Methodology

13.2.1 General

The following section outlines the legislation, guidelines and data sources considered, and the adopted methodology for preparing this chapter and undertaking the land and soils assessment.

13.2.2 Legislation and Guidance

The following legislation is particularly relevant to the management of groundwater:

- The EU Water Framework Directive (WFD), 2000/60/EC;
- The Groundwater Directive, 2006/118/EC;
- European Communities (Water Policy) Regulations 2014 (S.I. No. 350 of 2014);
- European Communities Environmental Objectives (Groundwater) Regulations 2010 (S.I. No. 9 of 2010), as amended by the European Communities Environmental Objectives (Groundwater) (Amendment) Regulations 2011 (S.I. No. 389 of 2011), the European Communities Environmental Objectives (Groundwater) (Amendment) Regulations 2012 (S.I. No. 149 of 2012) and the European Union Environmental Objectives (Groundwater) (Amendment) Regulations 2016 (S.I. NO. 366 of 2016);
- European Communities (Water Policy) Regulations 2003 (S.I. No. 722 of 2003) as amended by the European Communities (Water Policy) (Amendment) Regulations, 2005 (S.I. No. 413 of 2005);
- European Communities (Water Policy) (Amendment) Regulations, 2008 (S.I. No. 219 of 2008);
- European Communities (Water Policy) (Amendment) Regulations, 2010 (S.I. No. 93 of 2010); and,
- Water Services Acts (2007-2019)

This chapter was prepared cognisant of the following guidance:

- Department of Housing, Planning and Local Government, August 2018. Guidelines for Planning Authorities and An Bord Pleanála on carrying out Environmental Impact Assessment;
- Environmental Protection Agency: Advice Notes on Current Practice in the Preparation of Environmental Impact Statements, (2003) and Draft Revised Notes, 2015;
- OPW ‘Environmental Guidance: Drainage Maintenance and construction’, 2019); and,
- CIRIA C741 Environmental good practice on site guide (4th edition) (2015).

The guidance used for the impact assessment is provided in Section 13.2.8.

13.2.3 Study Area

The study area for the land and soils assessment extends to areas up to 500m outside of the site boundary.

All works and hard measures will take place within the site boundary and the 500m study area captures the extent of the potential influence of the river dredging activities on geology, soils and groundwater during the construction and operation of the scheme. The baseline conditions on a regional scale are also considered, where relevant to the scheme.

For this assessment, the project is divided into five work packages:

- Work package 1 – Arklow Bridge Works. Works include Arklow Bridge underpinning, lowering of floor of bridge by approximately 1.0m, new scour protection slab and remedial works to bridge masonry.
- Work package 2 – Channel dredging. This is proposed over an 850m length of the Avoca River.
- Work package 3 – Debris trap and gravel trap construction, and associated maintenance access.
- Work package 4 – Flood defence walls and drainage along south bank.
- Work package 5 – Flood defence wall and embankment along north bank.

13.2.4 Site Visits and Site Walkover Surveys

A number of site visits to the study area were conducted in the period from 1997 to 2020 and included a visual assessment for any visible survey contamination.

13.2.5 Site Investigation

The following ground investigations were carried out in the scheme area, either for this flood relief scheme or the Arklow Wastewater Treatment Plant (WwTP) project. These are:

- Whiteford Geoservices Ltd on behalf of Arklow Town Council, Arklow Main Drainage Scheme Southside Interceptor Sewers – Site Investigation Works, Report No. 454/05 – dated December 2005;
- Whiteford Geoservices Ltd on behalf of Arklow Town Council, Arklow Bridge – Site Investigation, Report No775.01/08 – dated June 2010;
- A geotechnical ground investigation covering the area of the Alps SWO and stormwater storage tank and the interceptor sewers undertaken August – November 2016;
- Causeway Geotech on behalf of Irish Water, Arklow Sewerage Scheme Marine Outfall Site Investigation – dated 2016 (see Appendix13.1A);
- Causeway Geotech, Avoca River – Marine Sediment Sampling and Analysis – dated January 2018. (see Appendix13.1B);
- Geosolutions on behalf of Wicklow County Council (2019), Hydro-geomorphological Assessment of the Avoca River, Report No.:19006-001-01– dated October 2019;

- Ground Investigation Ireland on behalf of Wicklow County Council, Arklow Town Marsh, Arklow Town, Co. Wicklow - Ground Investigation Report – dated November 2019 (see Appendix13.1C);
- Ground Investigation Ireland on behalf Wicklow County Council, Arklow Bridge, Co. Wicklow – Ground Investigation Report – dated December 2019 (see Appendix13.1D); and,

Ground Investigation Ireland on behalf Wicklow County Council - Sampling and Laboratory Analysis Avoca River and Arklow Town Marsh, July 2020. Report included in Appendix A of the Arklow Flood Relief Scheme Dredge Material Management Study (2020, see Appendix 15.2).These ground investigations were used to characterise the baseline of the subsurface. Site specific details were recorded and included logging of subsoil types, springs, drainage details and ground water levels. In-situ and laboratory testing were carried out. Subsoil deposits and selected exposures / sections were logged according to the British Standard Institute (BSI) BS 5930: 2015 - Code of Practice for Ground Investigations.

Site investigation surveys were conducted where access was possible. Access was granted to private property or council-controlled properties in proposed scheme locations through Wicklow County Council.

A discussion of previous site investigations is included in the Arklow Flood Relief Scheme Dredge Material Management Study, this also helped to inform the baseline (see Appendix 15.2).

The Assessment of proposed dredging on marsh hydrology (2020, Appendix 13.1E) established the relationship between groundwater in Arklow Town Marsh and water levels in the Avoca River estuary.

Ground Investigation data available from other projects

Ground investigation data from previous projects within the study area have been used to characterise the baseline conditions and receiving environment, where relevant. Key documents are:

- Geotech Specialists Limited on behalf of Wicklow County Council (2009). Arklow Water Supply Scheme Contract 5 – Site Investigation for Lamberton Distributions Mains, Report No. KD8096;
- Geotech Specialists Limited on behalf of Wicklow County Council (2011). Arklow Water Supply Scheme Contract 5 – Ground Investigation for Bridgewater Section, Report No. KD8096B;
- RPS Environmental (2005). Soil and Groundwater Investigation Report, Ferrybank, Arklow;
- RPS (2006). Geotechnical Interpretative Report, Ferrybank, Arklow.
- Tobin’s Engineering (2005). SI Report, IFI Tank Farm Site, Arklow;
- Whiteford Geoservices Ltd on behalf of Arklow Town Council (2009) Additional Ground Investigation Works – North Quay, Arklow, Wicklow, Report No. 623/07 – dated May 2007;

- Geotech Specialists Limited on behalf of Wicklow County Council (2009) Arklow Water Supply Scheme Contract 5 – Site Investigation for Lamberton Distribution Mains, report No. KD8096B -dated December 2009;
- Geotech Specialist Limited on behalf of Arklow town Council (2011) Arklow Water Supply Scheme Contract 5 – Ground Investigation for Bridgewater Section, Report No. KD8096B – November 2011;
- Whiteford Geoservices Ltd on behalf of Arklow Town Council (2010) Arklow Main Drainage Scheme – Site Investigation Works, Report No. 775/08 – dated May 2010;
- Whiteford Geoservices Ltd on behalf of Wicklow County Council (2013) Arklow Sewerage Scheme Contract 6 Section 2", Report No. 1337-12 – dated September 2012.

A ground investigation report held by the Geological Survey of Ireland (GSI) for the study area was sourced as follows:

- GSI (2006). Arklow Dock, Report No. 6924.

13.2.6 Consultation

Consultation with the Geological Survey of Ireland (GSI) was undertaken by Arup as part of the EIA Scoping stage. This chapter has been prepared cognisant of feedback provided to Arup by the GSI (dated 9th July 2020) as outlined in Appendix 1.2.

13.2.7 Categorisation of the Baseline Environment

As part of the desktop study that was undertaken to establish the baseline conditions (i.e. soils, geological and hydrogeological environment), the following sources of the information were reviewed:

- Site investigations reports, as outlined in section 13.2.5;
- An Foras Talúntais (1978). Ireland: Peatland Map. An Foras Talúntais Dublin;
- Aerial Photography: Bing Maps and Google Maps (accessed 2020).;
- Department of Communication, Climate Action and the Environment (2018, accessed 2020)). INFOMAR Seabed Mapping;
- Department of Communications, Energy and Natural Resources (2011). State Mining and Prospecting Facilities;
- Environmental Protection Agency (EPA) (2012, accessed 2020)). EPA Maps, Corine Land Cover;
- EPA (accessed 2020). EPA Maps, Water, Water Framework Directive;
- Environmental Protection Agency (EPA) (accessed 2020)). EPA Maps, Environment and Wellbeing, Clean Water and Health;
- EPA. Office of Licensing and Permitting (EPA website, accessed 2020);

- Geological Survey of Ireland (GSI) (accessed 2020) Online map viewer and associated data products. This report contains Irish Public Sector Data (Geological Survey) licensed under a Creative Commons Attribution 4.0 International (CC BY 4.0) licence, including:
  - Quaternary Geology Maps;
  - Bedrock Mapping (1:100K (1:50K data is not available for the scheme area at the time of writing));
  - National Landslide Database;
  - Karst Database;
  - Historic Mine Sites – Inventory and Risk Classification;
  - Groundwater Dataset;
  - Geological Heritage Dataset.
- GSI (2014). Directory of Active Quarries, Pits and Mines in Ireland;
- GSI (2003). Wicklow GWB: Summary of Initial Characterisation; Groundwater Bodies;
- National Parks and Wildlife Service (2018). Proposed / Designated NHA, SPA, SAC Sites;
- Ordnance Survey of Ireland (OSI) (2017). Current and historical Ordnance Survey (OS) maps (1837-1842 and 1888-1913) available for the study area at 1:2,500 and 1:10,560 scales;
- OSI (2017). Aerial photography 1995, 2000, 2005;
- Tietzsch-Tyler D. & Sleeman, A.G (1994. Geology of Carlow-Wexford 1:100 000 scale Bedrock Geology Map Series;
- Teagasc and the Environmental Protection Agency (EPA) (2017). Irish Soil Information System;
- Water Framework Directive (WFD) Ireland (2018). Water Maps; and,
- Wicklow County Council (2018). Planning Departments of Local Authorities, (Section 261, Pits and Quarries Planning and Development Act 2000).

13.2.8 Impact Assessment Methodology

13.2.8.1 Assessment Approach

The following guidance was used in preparation of the impact assessment (IA):

- NRA (2008) ‘Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes’;
- IGI (2013) ‘Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements’;

- EPA (Draft, 2017) 'Guideline of the information to be contained in Environmental Impact Assessment Reports'; and,
- EC (2017) 'Environmental Impact Assessment of Projects Guidance on the preparation of Environmental Impact Assessment Report (Directive 2011/92/EU as amended by 2014/52/EU)'.
- The IGI 'Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements' (IGI 2013) uses the 13-step methodology outlined in **Figure 13.1** below.

Figure 13.1: IGI (2013) Baseline Data Collection and Impact Assessment Methodology

The IA ranking methodology and terminology used in this section is in line with *Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes* (NRA 2008). A summary of the NRA (2008) methodology is provided in IGI (2013). The NRA (2008) IA methodology provides a robust assessment for ranking potential impacts to geology, soil and groundwater and has been successfully adopted for environmental impact assessment outside of road sector projects in Ireland. The process is summarised as follows:

Step 1: Quantify the 'Importance' of a feature for geology, soils and hydrogeology using criteria based on quality, significance, scale, and extent attributes for a feature. Importance is qualified in terms of 'low', 'medium', 'high', or 'very high' (see box 4.1, box 4.2 and box 4.3 in NRA, 2008).

Step 2: Estimate the 'Magnitude' of the impact on the feature from the proposed development using criteria based on degree of loss, change of gain in terms of volume, quality or integrity attributes for a feature. Magnitude of impact is qualified in terms of 'large', 'moderate', 'small', or 'negligible' as well as 'beneficial' or 'adverse' (see box 5.1, box 5.2 and box 5.3 in NRA, 2008).

Step 3: Determine the rating of 'Significance' of the impact using the matrix shown below using the outcome from steps 1 and 2. (see box 5.4 in NRA, 2008, also **Table 13.1**):

Table 13.1 Rating of Significant Environmental Impacts (NRA, 2008)

Importance of attribute	**Magnitude of impact**			
	Negligible	**Small**	**Moderate**	**Large**
Extremely High	Imperceptible	Significant	Profound	Profound
Very high	Imperceptible	Significant/ Moderate	Profound/Significant	Profound
High	Imperceptible	Moderate/Slight	Significant/Moderate	Profound/Significant
Medium	Imperceptible	Slight	Moderate	Significant
Low	Imperceptible	Imperceptible	Slight	Slight/Moderate

The significance ranking is initially determined pre-mitigation (i.e. prior to the introduction of mitigation measures). Residual impacts are ranked based on the assumptions that all mitigation measures are adopted.

13.3 Baseline Conditions

13.3.1 Introduction

The existing soils, geology and hydrogeology in the study area have been interpreted from desk study information, project-specific site investigations, site investigations for related projects i.e. the Arklow WwTP project and from other site investigations in the same general area as the flood relief scheme.

13.3.2 Regional Overview

The site of the proposed development, as illustrated in **Drawing 1002** of **Appendix 4.1,** *Scheme Drawings* includes the footprint of terrestrial, riverine and estuarine lands within the site boundary. The site boundary of the proposed development is located in Arklow town, entirely within the administrative boundary of Wicklow County Council. The site of the proposed development is predominantly urban in character.

The proposed development is located in the waterfront area of Arklow, with the proposed flood defence walls and embankment and associated drainage located within Arklow Town Marsh and along the south bank of the Avoca River and adjoining streets (see **Drawing Nos. 1001 to 1065** in **Appendix 4.**1 and **Drawing Nos. 300 to 306** in **Appendix 4.2** for more details).

13.3.3 Regional Geomorphology and Topography

Arklow town is located in the catchment of the Avoca River which rises in the Wicklow mountains and flows down to the Irish Sea, entering the harbour mouth in Arklow town.

The topography of the region is dominated by the Wicklow Mountains to the northwest. The topography varies between 800m Ordnance Datum (OD) at Tonelagee to an elevation of almost 0.0mOD in Arklow town.

The landscape principally reflects the erosional and depositional legacy of the last period of glaciation. Glacial erosion of pre-existing topographic features and deposition of thick glacial drift deposits, mainly till (boulder clay), resulted in areas of rather subdued post-glacial topography away from the topographic highs of the Wicklow mountains.

The post-glacial landscape also reflects the effects of fluvial (river) processes that have altered the topography, albeit only to a small extent in this area, since the ice sheet retreat.

The geomorphology of the river is predominantly that of a post glaciation, 'U-shaped' river valley. The topography of the lower Avoca river is generally flat in comparison with the rest of the catchment with topography in the vicinity of the scheme area sloping gently down to the river and further down to the coast. The section of the river as is outflows into the Irish sea and has a calculated average slope of approximately 1 in 500 as a four-meter decrease in river bed elevation can be seen over the final two kilometres of the Avoca river (Gavin and Doherty Geosolutions Ltd 2019) In addition, the proposed development is crossed locally in places by surrounding roads which appear to have been constructed generally on embankment, presumably to lift them out of the flood plain of the river. On either side of the Avoca River, alluvial floodplains are present, which are tens of metres wide in places. The Arklow Town Marsh is present in the scheme area and located northwest of the Arklow Bridge. Arklow Pond is located adjacent to Arklow North Beach, northeast of Arklow Bridge. The hydrological regime of the study area is described in **Chapter 14,** *Water*.

A number of buried meltwater channels are located in the vicinity of the scheme area and roughly follow the path of various streams and part of the Avoca River.

13.3.4 Regional Bedrock Geology

The Lower Palaeozoic succession in the Arklow region consists mostly of slates with large volcanic series, located within a regional syncline fold that has been cut through by numerous thrust-planes with displacements averaging two to three miles (Tremlett 1959; GSI 2020a).

The scheme area is located on the Kilmacrea and Maulin formations. The Kilmacrea Formation is described by the GSI as buff-weathering, grey and black slates and shale with occasional sandstones. The Maulin Foundation is described as dark blue-grey slates and phyllites.

The Kilmacrea Formation dips reported in the vicinity of the site vary from 44º east-north-east to 80º south east. In general, the area is shown to comprise the south eastern limb of a large anticline with a north east to south west trending axis approximately 3km to the north west of the site.

A fault is shown trending generally SSW-NNE running beneath the south-east section of the site, separating the two formations. Details on the bedrock geology underlying the scheme area are provided in **Section 13.3.8.6.**

GSI data indicates that there are no karst features recorded in close proximity to the scheme or the surrounding area (GSI Groundwater Data Viewer, 2020).

13.3.5 Regional Soils and Subsoils

The soils within the study area and wider region are described in the National Soil Survey (NSS). The general soil map of Ireland published by the NSS shows the study area to be underlain by urban soils or made ground. Further north and inland outside of the study area, there are deposits of Irish Sea Till and Glacial Till derived from Lower Palaeozoic Sandstones and Shales.

The till of the study area principally reflects the depositional process of the last glaciation. Typically, during the ice advance, boulder clays were deposited sub-glacially as lodgement till over the eroded bedrock surface, whilst moraine granular deposits were laid down at the glacier margins. Subsequently, with the progressive retreat of the ice sheet from the region, granular fluvio-glacial deposits were laid down in places by melt waters discharging from the front of the glacier.

Boulder Clay is expected to be encountered across the footprint of the proposed development. Made ground is located extensively across the onshore parts of the study area. Details of the soils and sediments underlying the scheme area are provided in **Section 13.3.8.4.**

River alluvium, deposited from historic flooding events, is mapped by the GSI along the banks of the Avoca River and along the Avoca River paleochannel.

Beach sands and gravels are shown along the coast. The GSI data indicates that alluvium underlies Arklow Town Marsh (GSI map viewer, accessed 2020).

13.3.6 Surface Water Bodies

Principal surface water bodies in the scheme area and the hydrological regime are described in **Chapter 14,** *Water*. The site boundary contains sections of the Avoca River and associated quays, and a disused canal in Arklow Town Marsh. Arklow Town Marsh contains standing water intermittently, chiefly during the wetter, winter months or resulting from flood events. Arklow Ponds and the Irish Sea are located within the vicinity of the scheme.

13.3.7 Regional Hydrogeology

The GSI has devised a system for classifying the aquifers in Ireland, based on the hydrogeological characteristics, size and productivity of the groundwater resource, and has developed the National Draft Bedrock Aquifer Map. The three main classifications are: 'Regionally Important Aquifers', 'Locally Important Aquifers' and 'Poor Aquifers'. Each of these three types of aquifer is further subdivided and has a specific range of criteria associated with it such as the transmissivity (m^2/day), productivity, yield and the potential for springs.

The Kilmacrea and Maulin Formations, which underly the study area, have been designated by the GSI as a 'Locally Important Aquifer' - Bedrock which is moderately productive only in Local Zones (LI) (DCCAE, undated report': Wicklow GWB: Summary of Initial Characterisation'). Locally important aquifers in Ireland are generally classed as capable of 'good' well yields 100-400 m^3/d. Poor aquifers would generally have 'moderate' or 'low' well yields - less than 100 m^3/d (GSI website, accessed 2020).

A gravel aquifer which partly underlies the west of the scheme area and extends west-north-west away from the site is designated by the GSI as a Local sand and gravel (Lg) aquifer. This is described by the GSI as an aquifer with a surface area between 1km^2 and 10km^2 which may supply excellent yields but due to its smaller size the amount of recharge available to meet abstractions can be limited.

The Kilmacrea and Maulin formations are part of the Ordovician Metasediments within the Wicklow Groundwater Body. The GSI describe the Ordovician Metasediments as one of the better bedrock aquifers within the groundwater body.

The majority of groundwater flow in the Kilmacrea and Maulin formations takes place mainly in the weathered zone in the upper 3m of the bedrock. The GSI states that deeper groundwater flow can take place in isolated fractures. Pumping tests have been undertaken by the GSI for the Maulin Formation and the Kilmacrea Formation which provided transmissivity values of 30m^2/d to 32m^2/d in these formations. Regional groundwater flow is dominated by the presence of the Avoca River with flow towards this surface water body. Outside of the scheme area, GSI data indicates that there is a Public Supply Source Protection Area at Coolgreany, Co. Wexford, (c. 7 km from Arklow) (GSI 2020). The Coolgreany Borehole No. 2 is the main source for Coolgreany Public Water Supply (PWS).

EPA data indicates that the source is a sand/gravel aquifer and the bedrock map for Coolgreaney PWS indicates the underlying formations are the Ballylane Formation and Oaklands Formation (Dillon and Tobin 2010).

Details on the hydrogeology underlying the scheme area are provided in **Section 13.3.8.8.**

Groundwater Hydrochemistry

Groundwater in the Ordovician bedrock of the Wicklow Groundwater Body, that underlies the study area, is generally soft to moderately soft (20–80 mg/l $CaCO_3$) and has low electrical conductivity (ranging from 130 to 220 µS/cm).

Within the local area, the quality of the groundwater in the LI bedrock aquifer and the Lg gravel aquifer are considered to be heavily influenced by the Irish Sea, creating a brackish environment that is not potable.

13.3.7.1 Sensitive Features

A small number of sensitive features have been identified as they may be dependent on the geology and hydrogeology characteristics including:

- Groundwater abstractions; and
- Groundwater dependent terrestrial ecosystems.

Groundwater abstraction

Groundwater abstraction has been recorded in the scheme area and detail is provided in **Section 13.3.8.9.**

Groundwater dependent terrestrial and hydrological ecosystems

There are no Special Areas of Conservation or Special Protection Areas within the site boundary or in the vicinity of the scheme (see **Chapter 10**, *Biodiversity* and **Appendix 10.5**, *Site Synopses 4 SACs*).

There are two proposed National Heritage Areas (pNHA) sites within 2 km of the study area (see **Chapter 10**, *Biodiversity*). These are the Arklow Sand Dunes (Ref: 001746) located 1.9km to the north of the site and, within the site boundary, Arklow Town Marsh (Ref: 001931), located in the north western part of the site.

The Arklow Town Marsh (discussed in **Chapter 14**, *Water*) is a wetland area located north of the Avoca estuary and within the scheme area (see **Chapter 10,** *Biodiversity*).

Arklow Ponds (discussed in **Chapter 14**, *Water*), and located outside of the scheme area, is not a protected area. However, it is recognised as potential habitat for some bird species (discussed in **Chapter 10**, *Biodiversity*).

13.3.8 Site Specific Environmental Setting

13.3.8.1 Introduction

This section presents the site-specific information available for the proposed development from site investigation and desktop research and also the findings of the site-specific surveys commissioned for the proposed development.

13.3.8.2 Topography/ Bathymetry

Work Package 1: Arklow Bridge Works

Arklow Bridge from South Bank to North Bank

Riverbed levels across Arklow Bridge are generally consistent approaching the upstream piers. The bed levels drop from -0.37mOD to -0.74mOD from South bank before rising to -0.17mOD along North bank.

Bed levels along the centre of the piers range from -0.20mOD to -0.40mOD. There is evidence of scouring of the riverbed 10m downriver of Arklow Bridge.

Work Package 2: Channel Dredging

Upstream of Arklow Bridge to Downstream of Arklow Bridge

Riverbed levels through this section generally fall towards Irish Sea. From the proposed debris trap position, the bed level is practically level, from -1.43m OD at the site for the debris trap to -1.50m OD immediately upstream of Arklow Bridge (approximate length 303m).

The riverbed at Arklow Bridge is at a level of approximately -0.40m OD, a little over a metre higher than the upstream bed level.

The riverbed level downstream of the Arklow bridge falls towards the Irish Sea adjacent to Arklow docks from -1.75m OD to -3.78m OD over a length of 511m.

Discrete, gravel bars ('islands') have built up on the riverbed in the area immediately upriver of Arklow Bridge. In the dynamic fluvial environment the morphology and size of these features are likely to change during tidal cycles and on a seasonal/annual timescale, as material collects upriver of the bridge and as fluvial events occur (e.g. storms and flooding).

The works proposed for this scheme include dredging over approximately 850m length of the riverbed a total of approximately 84,400m^3 of sediment upstream and downstream of Arklow Bridge. The material to be dredged mainly consists of sands and gravels. The nature and destination of the excess material generated by the dredging work is the subject of a Dredge Material Management Study (2020), see **Chapter 15**, *Resource and Waste Management* and **Appendix 15.2**.

Work Package 3: Debris and Gravel Trap

Upstream of Arklow Bridge

At the proposed debris trap position the bed level drops from 1.35m OD on South Bank to a riverbed level of -1.96m OD before rising back to 0.03m OD on North bank (Arklow Town Marsh).

Approximately 900m^3 of riverbed material will be excavated during the construction of the debris and gravel traps (see **Section 5.5.3** of **Chapter 5**, *Construction Strategy,* **Chapter 15**, *Resource and Waste Management* and Dredge Material Management Study, 2020 in **Appendix 15.2**).

Work Package 4: Flood defence wall and associated stormwater drainage along South Bank

Southern Bank Alignment from Chainage 0.0m to Chainage 313.5m (River Lane Car Park to Upstream of Arklow Bridge)

Ground levels through this section are generally level, with a slight fall at a shallow gradient from approximately +3.47m above Ordnance Datum (OD) to +2.47m, over a length of approximately 313.5m. Ground levels are approximately 2m lower where the flood defence wall is located in the river channel. This section can be broken into the following sections:

- Between Ch0m and Ch100m, the ground levels drop from +3.47m OD to +1.29m OD over a length of 100m;
- Between Ch100m and Ch200m, the ground levels drop from +1.29m OD to +0.01m OD in river channel over a length of 100m;
- Between Ch200m and Ch313.5m, the ground levels drop from +0.01m OD to +2.47m OD in river channel over a length of 113.5m;

Southern Bank Alignment from Chainage 0.0m to Chainage 1113.7m (Downstream of Arklow Bridge to Arklow Docks)

Ground levels through this section are generally level, with a slight fall at a shallow gradient from approximately +2.47m above Ordnance Datum (OD) to +2.02m, over a length of approximately 1113.7m. Ground levels are approximately 2.5m lower where the flood defence wall is located in the river channel. This section can be broken into the following sections:

- Between Ch0m and Ch100m, the ground levels drop from +2.47m OD to -1.18m OD in riverbed level over a length of 100m;
- Between Ch100m and Ch200m, the riverbed levels drop from -1.18m OD to -1.21m OD over a length of 100m;
- Between Ch200m and Ch300m, the riverbed levels drop from -1.21m OD to -0.25m OD over a length of 100m;
- Between Ch300m and Ch400m, the ground levels drop from -0.25m OD to +1.36m OD over a length of 100m;
- Between Ch400m and Ch500m, the ground levels drop from +1.29m OD to +1.84m OD over a length of 100m;
- Between Ch500m and Ch600m, the ground levels drop from +1.84m OD to +1.57m OD over a length of 100m;

- Between Ch600m and Ch700m, the ground levels drop from +1.57m OD to +1.77m OD over a length of 100m;
- Between Ch700m and Ch800m, the ground levels drop from +1.77m OD to +1.59m OD over a length of 100m;
- Between Ch800m and Ch900m, the ground levels drop from +1.59m OD to +1.82m OD over a length of 100m;
- Between Ch900m and Ch1000m, the ground levels drop from +1.82m OD to +1.92m OD over a length of 100m;
- Between Ch1000m and Ch1113.7m, the ground levels drop from +1.92m OD to +2.02m OD over a length of 113.7m;

Work Package 5: Flood defence earth embankment, flood defence wall and associated stormwater drainage along North Bank

The ground level falls from +1.72m OD at the north-western end of the site at Chainage 0.00m adjacent to Circle K filling station to +0.56 m OD at Chainage 607.91m which is adjacent to Arklow Bridge. The access gate to Arklow Town Marsh from Arklow Bridge, opposite Ferrybank roundabout, is at +2.49m OD.

13.3.8.3 Site History/ Man-made Features

The section presents a high-level overview of the site history and land use. A full description of the site history and historical land use is provided in **Section 11.3 of Chapter 11**, *Archaeological, Architectural and Cultural Heritage*.

Work Package 1: Arklow Bridge Works

A summary of the history of Arklow Bridge is provided in **Table 13.2**. The use of this bridge has remained the same from 1837 until the present day.

Table 13.2: Summary of the relevant information presented on historical maps from 1837 - 2005 for Arklow Bridge.

Source	Date	Land use at the site	Land use in the vicinity of the site
Arklow Bridge			
Map from OSI Web Viewer -	1837-1842	No Change	North: Marsh East: Open Space/ Avoca Harbour South: Residential/ commercial units West: Avoca River/ Residential/ units
Map from OSI Web Viewer -	1888-1913	No Change	North: Marsh East: Open Space/ Avoca Harbour South: Residential/ commercial units West: Avoca River/ Residential/

Source	Date	Land use at the site	Land use in the vicinity of the site
Map from OSI Web Viewer -	1995-2005	No change	North: Marsh/ Residential East: Residential/ commercial units South: Residential/ commercial units West: Avoca River/ Residential/ commercial units

Work Package 2: Channel Dredging

A summary of the Avoca river history, upstream and downstream of the Arklow Bridge, is provided in **Table 13.3**.

Table 13.3: Summary of the relevant information presented on historical maps from 1837 -2005 for Avoca River.

Source	Date	Land use at the site	Land use in the vicinity of the site
Avoca River (Upstream and Downstream of Arklow Bridge)			
Map from OSI Web Viewer	1837-1842	Avoca River	North: Marsh East: Avoca Harbour / Open space South: Residential/ commercial units West: Avoca River/ Open Space
Map from OSI Web Viewer	1888-1913	Avoca River	North: Marsh East: Avoca Harbour/ Open space South: Residential/ commercial units West: Avoca River/ Open Space
Map from OSI Web Viewer	1995-2005	Avoca River	North: Marsh/ Residential / Commercial East: Avoca Harbour/ Residential/ commercial units South: Residential/ commercial units West: Avoca River/ Residential/ commercial units

Work Package 3: Debris and Gravel Trap

A summary of the history of Avoca River, at the debris trap and gravel trap location, is provided in **Table 13.4**.

Table 13.4: Summary of the relevant information presented on historical maps from 1837 -2005 for Avoca River upstream of Arklow Bridge.

Source	Date	Land use at the site	Land use in the vicinity of the site
Avoca River (Upstream of Arklow Bridge)			
Map from OSI Web Viewer	1837-1842	Avoca River	North: Marsh East: Avoca Harbour/ Open space South: Residential/ commercial units West: Open Space

Source	Date	Land use at the site	Land use in the vicinity of the site
Map from OSI Web Viewer	1888-1913	Avoca River	North: Marsh East: Avoca Harbour/ Open space South: Residential/ commercial units West: Open Space
Map from OSI Web Viewer	1995-2005	Avoca River	North: Marsh/ Residential / Commercial East: Avoca Harbour/ residential/ commercial units South: Residential/ commercial units West: Avoca River/ Residential/ commercial units

Work Package 4: Flood defence wall and associated stormwater drainage along South Bank

A summary of the history on the southern side of the Avoca River is provided in **Table 13.5**.

Table 13.5: Summary of the relevant information presented on historical maps from 1838-2005 for the flood defence wall and associated drainage on south bank.

Source	Date	Land use at the site	Land use in the vicinity of the site
Between Ch0.0m and Ch313.7m (River Lane Car Park to Arklow Bridge)			
Map from OSI Web Viewer	1837-1842	Open Land adjacent to river	North: Avoca River East: Avoca River/Arklow Bridge South: Residential/ commercial Units/ Graveyard West: Open land
Map from OSI Web Viewer	1888-1913	Open Land adjacent to river	North: Avoca River East: Avoca River/Arklow Bridge South: Residential/commercial Units/ Graveyard (disused)/Gas Works West: Open land
Maps from OSI Web Viewer	1995-2005	River Lane/River Walk	North: Avoca River East: Avoca River/Arklow Bridge South: Residential/commercial West: Open land
Between Ch0.0m and Ch300.0m (Downstream Arklow Bridge to Pinch Point)			
Map from OSI Web Viewer	1837-1913	In river channel	North: Avoca River East: Avoca River South: Residential/commercial West: Residential/commercial
Map from OSI Web Viewer	1995-2005	In river channel adjacent to South Quay Wall	North: Avoca River East: Avoca River South: Residential/Commercial West: Residential/commercial
Between Ch300.0m and Ch600.0m (Pinch Point* to Arklow Docks)			

Source	Date	Land use at the site	Land use in the vicinity of the site
Map from OSI Web Viewer	1837-1842	Open Land adjacent to river	North: Avoca River East: Avoca River South: Open Land West: Open Land
Map from OSI Web Viewer	1888-1913	No Change	North: Avoca River East: Avoca River South: Boatbuilding Yard West: Open Land
Map from OSI Web Viewer	1995-2005	South Quay Wall	North: Avoca River East: Avoca River South:
Map from OSI Web Viewer	1888-1913	Open land which appears to have been reclaimed	North: Open land East: Kynock Factory and Chemical Works South: Avoca River West: Salvage
Maps from OSI Web Viewer	1995-2005	Road	North: Sports field East: Several long buildings which fit within the footprint of the site belonging to the Wallboard Factory South: Avoca River
*The pinch point is located at the narrowest section of the channel of the Avoca River in the scheme area.			

Work Package 5: Flood defence earth embankment and wall along North Bank

A summary of the site history along the route of the northern flood defences and associated storm water drainage is provided in **Table 13.6**.

Table 13.6: Summary of the relevant information presented on historical maps from 1838-2005 for the flood defences and associated storm water drainage on north bank.

Source	Date	Land use at the site	Land use in the vicinity of the site
Chainage 0.0m to Chainage 607.91m			
Map from OSI Web Viewer	1837-1842	Marsh Land	North: Marsh/ Residential East: Marsh/ Residential South: Avoca River West: Marsh/ Avoca River
Map from OSI Web Viewer	1888-1913	Marsh Land	North: Marsh Land/Residential Properties East: Masonic Hall South: Avoca River West: Marsh

Source	Date	Land use at the site	Land use in the vicinity of the site
Maps from OSI Web Viewer	1995-2000	No change	North: Marsh/Residential Properties East: Residential South: Avoca River West: Marsh
Maps from OSI Web Viewer	2005	No change	North: Marsh/Residential Properties East: Bridgewater Shopping Centre South: Avoca River West: Marsh

13.3.8.4 Bedrock Geology

The GSI bedrock geology map (1:100,000 scale) indicates that the site is underlain predominately by the Ordovician Kilmacrea Formation with the exception of the south-east corner (broadly east of the North Quay Road terminus to the north of the river, and the area east of the South Quay to the south of the river) which is underlain by the Ordovician Maulin Formation(GSI map viewer, accessed December 2020). A description of these formations in provided in **Section 13.3.4** and a figure showing their distribution within the scheme area is provided in **Figure 13.2** in **Appendix 13.2.**

The Maulin Formation is reported as present at the location for SC6.

13.3.8.5 Soils and Sediments

Descriptions of soils from site investigations and laboratory analyses are provided in **Appendix 13.1**.

Teagasc soils data (available through the GSI map viewer, accessed 2020) indicates that soils in the study area general comprise made ground, alluvial mineral soils, and poorly drained, mainly acidic mineral soils. Soils underlying Arklow Golf Links are an exception and reported as marine/estuarine sediments.

Avoca River channel

The sediments from three trial pits and seven foundation inspection pits, located in close proximity to Arklow Bridge, were reported from a SI undertaken by GII in October and November 2019 (GII, 2019a, see Appendix 13.1D). The report states that made ground was encountered at depths of between 1.2m bgl and 1.3m bgl. Made ground was generally described as sandy gravel with many cobbles and quartzite flagstones overlying slightly sandy silt with wooden piles. Granular deposits were also present and typically described as silty sandy gravel with many cobbles.

The sediments from four boreholes carried out in close proximity to Arklow Bridge were reported from a SI undertaken by Causeway Geotech (2017, see BH16, BH17, and BH18 boreholes therein in Appendix 13.1A). The report states that lithologies generally consisted of medium dense gravel overlying stiff clay.

Layers of soft silt/clay were encountered within the gravel. and the depth and thicknesses of these layers varied. The medium dense gravel was generally described as medium dense very sandy slightly silty gravel. The soft silt/clay was generally described very soft silty slightly clayey silt. Sand was fine to coarse. The stiff clay was generally described as very stiff, slightly sandy, slightly gravelly, silty clay.

Sediments adjacent to the south bank of the River Avoca downstream of the Bridge are comprised of black sands or gravels with variable proportions of silty material generally overlying a succession of grey clays and medium dense brown gravels (Causeway Geotech, 2017, see BH01, BH14, and B15 boreholes in Appendix 13.1A).

Sediment upstream of Arklow Bridge are generally composed of grey coarse gravels with low to medium cobble content (see relevant borehole data in Causeway Geotech, 2017 and 2018, see Appendix 13.1A and 13.1B respectively).

The volumes and classification of dredge material to be removed from the riverbed are provided in Chapter 5, *Construction Strategy* and the Appendix 15.2.

South Bank

Between Chainage 0.0m and Chainage 313.5m (River Lane to Arklow Bridge) the top of the bedrock is seen to increase in depth from at surface at the upstream extent to undetected at a level of 15mBGL at Chainage 300.0m. Underlying the made ground, the subsoils are mainly a mixture of medium dense sand and gravels, organic silts and clays and cohesive alluvium. The sands become more prominent towards Chainage 300.0m as the alignment gets closer to the Avoca River estuary.

From Chainage 0.0m (Downstream of Arklow Bridge) - Chainage 300.0m (Pinch point downstream of Arklow Bridge), the bedrock is only reached in a borehole near Chainage 0.0m (Downstream of Arklow Bridge) at a depth of 17.6mBGL. Underlying the made ground, is mainly a mixture of medium dense sand and gravels and cohesive glacial till. A significant thickness of alluvium was found in a borehole dug in the riverbed.

From Chainage 300.0m (Pinch point downstream of Arklow Bridge) to Chainage 1113.7m (Downstream Arklow Docks), the bedrock was not reached in the site investigations carried out along this section of the alignment. Underlying the made ground, is mainly a mixture of medium dense sand and gravels, dense sand and gravels, and cohesive glacial till (Causeway Geotech, 2017 and 2018, see Appendix 13.1A and 13.1B respectively; GSI map viewer data accessed November 2020).

Arklow Town Marsh

Site investigation undertaken in Arklow Town Marsh in 2019 (south of the canal) reported that soils typically comprise 0-1m of organic topsoil, fibrous spongy peats, organic silt, silty pat and sandy very gravelly silt overlying 1-3m of coarse sand clayey fines and silty pseudo-fibrous peat. The results of the SI are reported in GII (2019b).

13.3.8.6 Potential Sources of Contamination

General scheme area

Given the industrial history of the area and previous land use, there is the potential for construction activities to encounter unknown contaminated materials during construction. Potential contamination hotspots are expected to occur within the scheme area based on historic land-use records and previous excavations that have taken place in the vicinity of the scheme, for example:

- Archaeological assessment undertaken for this scheme reports that late 20th century stone rubble and industrial waste has been recorded at depth of up to 1.2-1.4m in areas between the North Pier to an ESB substation at Killiniskyduff. (see **Chapter 11**, *Archaeological, Architectural and Cultural Heritage* for detail).
- contaminated sands (in stratigraphy) have been reported in monitoring undertaken in advance of the Arklow Town Main Drainage Scheme at South Green and Harbour Road (see **Chapter 11**, *Archaeological, Architectural and Cultural Heritage* for detail).

The site compound areas are temporary compounds located on land where there has been no indication, in publicly available reports, of historic land-use or of incidents/events that could have given rise to contamination with the exception of:

- SC 2 which overlies an old and now disused town landfill;
- SC 5 overlies the site of the now disused, Kynoch munitions factory, and,
- SC 6 overlies an area that may have been a dumping site for pottery waste.

Illegal dumping has previously been undertaken in some areas in Arklow Town Marsh. Although materials have been subsequently removed from site by WCC, these could be a potential source of unknown existing contamination of the underlying ground and/or groundwater, if present on the site. The precise location, extent of the dumping and nature of materials that have been present on the site is uncertain and there is no information available at the time of writing to indicated if contamination is present in the area of Arklow Town Marsh, which will be impacted by the scheme.

Dredged material

River Channel

The results of the riverbed material characterisation studies undertaken in 2017 and 2020 indicate that contaminated material is present on the riverbed in the scheme area.

The majority of the material to be dredged is clean inert sands and gravels with a small portion of hazardous and non-hazardous material, found primarily as a thin surface layer of fill material along the south bank of the river.

Sediment testing conducted on river sediments since 2017 indicate the presence of elevated concentrations and exceedances of landfill waste acceptance criteria limits for mineral oil, antimony, molybdenum; chromium, arsenic, cadmium, copper, lead, zinc and PAH in sediments in some locations on the river bed in the scheme area. Some areas to be dredged also have natural slightly elevated chloride levels (see **Appendix 15.2** for detail).

13.3.8.7 Landslides

The GSI's Landslide Susceptibility Classification for the scheme area is Low or inferred to be Low except for areas of moderately low and moderately high risk around New Coomie Lane, Court Househouse, and north of the train tracks adjacent to the Vale Road (R755) and New Commie Lane junction. GSI data indicates that the areas classed as moderately low and moderately high risk do not occur within the site boundary (GSI 2020).

13.3.8.8 Site Hydrogeology

A description of the aquifers underlying the scheme area and the hydrogeological regime is provided in **Section 13.3.7**. The aquifer designations in the vicinity of the study area (GSI 2020b) are shown on **Figure 13.3** in **Appendix 13.2**.

Groundwater monitoring was undertaken by GII at Arklow Town Marsh during September-October 2019 (GII 2019b). The highest record groundwater levels in the three boreholes closest to the river from east to west on the marsh (WS08, WS13, WS10) were reported to intrude into fibrous spongy peat, silts underlying peats, and silts underlying sand and topsoil respectively. The highest record groundwater levels in the two boreholes near the central areas of the marsh, and adjacent and south of the canal, respectively, from east to west (WS09 and WS14) were reported to intrude into silt underlying topsoils and pseudo-fibrous peats respectively.

Hydrogeology investigation undertaken by ByrneLooby (2020) indicates that:

- groundwater levels typically lie between the high and low tidally-influenced levels in the river;
- there is a linkage between ground water levels in the marsh and levels in the Avoca River;
- the change in groundwater levels is significantly dampened when compared to the changes in river levels e.g. 15mm to 50mm change in groundwater levels for 400mm to 800mm change in river levels.

Water Framework Directive (WFD) status of groundwater

The Water Framework Directive (WFD) risk status of groundwater bodies underlying the scheme is in review with the relevant statutory bodies. The Ground Waterbody WFD Status 2013-2018 is classified as 'Good' for chemical, overall and quantitative categories in the scheme area, these classifications meet environmental objectives set under the WFD (EPA 2018).

Recharge

The average rainfall between 1984 and 2016 in the study area is approximately 950mm/yr. The average monthly rainfall values for Arklow that have been measured at Ballyrichard House during 1984 to 2016 are summarised in Table 13.7.

Table 13.7: Average Monthly Rainfall (mm) measured at Arklow town during 1984 – 2016.

Years	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1984 – 2016	98	72	62	69	63	68	60	80	68	105	104	101

Recharge is the amount of rainfall that replenishes the aquifer. It is a function of the effective rainfall, the permeability and thickness of the subsoil and the aquifer characteristics.

The GSI recharge map for the study area shows that recharge is approximately between 201mm/annum to 250mm/annum (GSI 2020c). The approximate recharge in the study area is presented in **Figure 13.4** in **Appendix 13.2** .

Aquifer vulnerability

Aquifer vulnerability is a measure of the likelihood with which the groundwater could be contaminated by human activity. Aquifer vulnerability depends on the intrinsic geological and hydrogeological characteristics of the aquifer and any overlying materials.

Aquifer vulnerability is determined by the thickness and permeability of any overlying deposits. For example, bedrock with a thick, low permeability, clay-rich overburden is less vulnerable than bedrock with a thin, high permeability, gravelly overburden.

The vulnerability of the locally important bedrock aquifer under the site has been classified by the GSI as low**.** Aquifer vulnerability is relevant to the LI bedrock aquifer. The vulnerability of the Lg gravel aquifer is likely to be highly dependent on the thickness of the overlying soil and the depth to groundwater.

GSI data indicates that regional groundwater vulnerability in the scheme area and wider vicinity ranges from low to extreme, with area of rock exposed at surface in some places. The majority of the site boundary is reported as located on areas classified as of low or medium vulnerability, however areas of high or extreme vulnerability are identified in the south-west section of the scheme (GSI 2020d), this is shown in **Figure 13.5** in **Appendix 13.2**.

13.3.8.9 Groundwater abstraction

Based on GSI records, up to ten water abstraction boreholes are located within the study area; eight are classed as domestic use and two are classed as industrial use (GSI 2020e) (see **Table 13.8**. below for details). GSI data does not indicate the presence of springs within the study area.

The closest borehole with a high level of location accuracy is located approximately 850m south-west of the scheme site and is for industrial use.

The source, that the groundwater is abstracted from, is not stated but it is likely that it abstracts from the sands and gravels (Lg aquifer) and/or bedrock (LI Aquifer) beneath.

There are no National Federation of Group Water Schemes Zones of Influence within the study area.

The GSI and EPA have delineated certain areas nationwide as Source Protection Areas in order to provide protection for groundwater abstractions and public water supplies. There are no Source Protection Areas located beneath the site or within 2km of the site boundary.

Table 13.8: Summary of known groundwater abstractions within the Land and Soil study area (GSI map viewer, accessed December2020).

GSI Abstraction Name	Abstraction type	Depth of hole (metres)	Depth to rock (metres)	Drill Date	Easting (Irish National Grid reference)	Northing (Irish National Grid reference)	Spatial accuracy of the Grid Reference	County	Source Use	The GSI yield class*	The yield of the source, m^3/day
3217SWW006	Borehole	31.7	9.1	13/12/1961	325260	175310	to within 1km	Wicklow	Domestic use only	Poor	21.8
3217SWW007	Borehole	27.4	3.1	31/08/1963	325150	172640	to within 1km	Wicklow	Domestic use only	Poor	22.0
3217SWW008	Borehole	60.6	2.1	01/11/1970	323770	173210	to within 2km	Wicklow	Domestic use only	Poor	11.0
3217SWW009	Borehole	69.5	9.1	01/11/1970	323770	173280	to within 2km	Wicklow	Domestic use only	Poor	11.0
3217SWW023	Borehole	27.4	3.1	30/08/1962	324710	172310	to within 2km	Wicklow	Domestic use only	Poor	27.0
3217SWW048	Borehole	48.7	21.3	14/03/1983	324600	173400	to within 1km	Wicklow	Industrial use	Moderate	55.0
3217SWW051	Borehole	45.7	20.1	01/11/1996	324950	173850	to within 2km	Wicklow	Domestic use only	Moderate	87.0
3217SWW052	Borehole	53.3	12.0	01/11/1996	324580	173320	to within 1km	Wicklow	Domestic use only	Good	160.0
3217SWW053	Borehole	45.7	3.6	01/11/1996	324560	173250	to within 1km	Wicklow	Domestic use only	Moderate	55.0
3217SWW062	Borehole	9.0	7.5	06/04/1992	324500	172700	to within 20m	Wicklow	Industrial use	Moderate	60.0

GSI Abstraction Name	Abstraction type	Depth of hole (metres)	Depth to rock (metres)	Drill Date	Easting (Irish National Grid reference)	Northing (Irish National Grid reference)	Spatial accuracy of the Grid Reference	County	Source Use	The GSI yield class*	The yield of the source, m^3/day
*The GSI yield class: Excellent (>400m^3/d), Good (100-400m^3/d), Moderate (40-100m^3/d), Poor (<40m^3/d) Data sourced from GSI (2020).											

13.3.9 Technical Limitations

The baseline data described and considered in this assessment includes existing data from earlier investigations within the study area, dedicated field surveys commissioned specifically for the proposed development, and desktop data including information available from relevant statutory bodies (e.g. Geological Survey Ireland). The data collected provides a wide dataset in relation to the soils, geology and hydrogeology within the study area.

The baseline data provides valuable information on the existing soils, geology and hydrogeological environment at point locations within the study area. Between each point the baseline data has been assessed by conservative interpretation.

While soils, geology and hydrogeology can vary, the exploratory locations have been selected following the completion of the comprehensive baseline data collection. This review was completed by studying local geological maps, aerial photography, historic ground investigation and completing site walkovers to provide an understanding of the study area. The location and the spacing of the exploratory locations used as part of the intrusive investigation were chosen in order to gain an understanding of the soils, geology and hydrogeology beneath the site. The findings of the site investigation were generally consistent with those of the desktop study.

Limitations are recognised for the following aspects:

- Groundwater abstraction records for the area are not precisely located and often the location of abstraction sites is only known to within a kilometre. Additionally, is not always clear how old the data regarding recharge, yield, etc, is in GSI records. As a result of this the IA has adopted a precautionary approach based on NRA (2008) guidance in assessing the importance of the aquifers with regards to potential impacts.
- Historical illegal dumping has taken place on Arklow Town Marsh and the nature and location of these activities are not fully known. On this basis, there is the potential for unknown contamination to have been sourced from this material and for any contamination present to have entered soils and/or groundwater.

13.4 Likely Significant Effects

13.4.1 Do Nothing Scenario

In accordance with EC Guidance and after reviewing the baseline data, the ‘do nothing’ scenario (i.e. if nothing is done) was assessed. It is expected that the ‘do nothing’ scenario will result in potential impacts to the land, soils, and groundwater.

Fluvial systems are dynamic environments that give rise to geomorphological changes overtime. In the ‘do nothing’ scenario, sediment levels in the river will likely increase over time with the potential for more deposition in some areas.

It is likely that materials in the river (e.g. gravel) will continue to build-up on the riverbed upstream of the Arklow Bridge overtime, potentially with periodic downstream moment due to large scale flooding events. Scour will also likely continue to take place on the riverbed at Arklow Bridge, potentially eroding riverbed material in this area over time. Both of these actions could increase sedimentation and build-up of sediment on the riverbed further downriver.

Periodical flooding of the marsh would be expected to continue from fluvial and coastal sources. Climate change may lead to increased frequency or intensity of flooding in the long-term and fluvial/coastal flooding events could potentially impact the physico-chemical and structural characteristics of terrestrial soils where overbank flow occurs, depending on the nature, location, frequency and duration of such events and the duration of soil inundation through leaching.

Changes to bedrock geology and hydrogeology are considered to be unlikely to minor.

13.4.2 Assessment of effects during construction

The potential significant impacts on the groundwater, geology, and soils that could occur during the construction of the proposed scheme are:

- Compression of substrata;
- Potential impact on surrounding ground;
- Trafficability of soils;
- Loss of geology and soils;
- Potential impact of dewatering (in-river dewatering; terrestrial dewatering);
- Potential impact on locally important bedrock and/or gravel aquifer;
- Encountering known or unknown existing contamination; and,
- Accidental leaks and spills

Indirect impacts potentially arising from impacts on groundwater level and flow are also discussed, including potential to cause changes in the surface water level in the Avoca River and potential effects to water-users undertaking groundwater abstraction in the vicinity of the scheme. The potential impacts applicable to multiple work packages and locations are described in **Sections 13.4.2.1** to **13.4.2.5** discussed in the relevant work packages below **Section 13.4.2.6 to 13.4.2.10**.

Chapter 15, *Resource and Waste Management* discusses the approximate quantities and destination of materials (mortar and cementitious material, kerbs, paving, etc), including soils and geology, removed or moved during construction and operation phases.

13.4.2.1 Encountering known or unknown existing contamination

There is the potential for encountering known or unknown contamination at the surface or subsurface within the scheme area during construction. Potential impacts to geology, soils, or groundwater could occur through activities where there is

- direct move any contaminated materials on site, if present, during intrusive construction activities or during the movement of vehicles around site; or,
- changes to the subsurface or surface that may create pathways, mobilisation and migration of contamination, if present, during intrusive construction activities.

Potential 'hotspots' where existing contamination may be encountered in land and groundwater have been identified within the scheme area, these are outlined in **Section 13.1.1.1** and in **Appendix 15.2**

Site compounds are to be developed in the locations shown in **Figure 5.3** of **Appendix 5.2** and maintained throughout the construction phase.

The management of surplus excavated material or temporarily stored materials at the site compounds will be determined by the classification of the material and is outlined in **Chapter 5,** *Construction Strategy.* These mitigation measures will prevent disturbance of any existing contamination that may be present at the site compounds. They will also prevent interaction between any existing contamination present on the site compounds and materials stored there and will ensure that contaminate dredge material will not have an impact on the underlying soils or groundwater.

Dredge material will be stored temporarily in site compounds, as described in **Section 5.5.2** in **Chapter 5**, *Construction Strategy*. Contaminated dredge material will be stored in compound SC2. Slightly elevated chloride material will be stored temporarily in SC1 and SC5. There is the potential that the contaminated or slightly elevated chloride dredge material could impact the underlying soils or groundwater in these compounds. Mitigation measures are described in **Section 13.6.1** below. The likely significance of the potential impacts in each work package is described in **Sections 13.4.2.6 to 13.4.2.10**.

13.4.2.2 Accidental leaks and spills

Leakage, accidental discharge or spillage of construction related materials, including fuels and lubricants from vehicles and equipment, on site can cause contamination in geology, soils and groundwater.

The pre-mitigation significance ranking of potential impacts from accidental leaks and spills is dependent on the likelihood of the spill occurring, the physio-chemistry of the material released, the potential duration of the event, the potential volume of release, and the physio-chemical properties of underlying material (e.g. soils and geology). Potential impacts to groundwater also consider the nature of the underlying aquifers, aquifer connectivity and abstraction activities.

Intrusive works during construction can potentially create pathways for any accidental releases in the vicinity of the works to reach the subsurface.

- Accidental leaks and spills could potentially occur within any work package and at any location in the scheme area where there is a potential source material for an accidental release. Potential significant impacts are leaks and spills leading to contamination of groundwater and negatively impacting the aquifer; and,
- leaks and spills leading to contamination of geology and soils.

The significance of this potential, for each work package is discussed **Sections 13.4.2.6** to **13.4.2.10**. Large scale spillage or leak event are considered in **Chapter 18**, *Major Accidents and Disasters*.

13.4.2.3 Runoff from dredge material

Dredge material will be transported from the working area to site compounds for temporary storage. The process is described in **Chapter 5**, *Construction Strategy* and will take place in WP1 and WP2. This process takes into account that the material is expected to dewater during transport and temporary storage, producing sediment laden runoff,

On the basis of the nature of the dredge material (see Appendix 15.2), feasibly liquid runoff could contain hydrocarbons, heavy metals and chloride. If contaminated liquids were introduced to underlying soils during transport or dredge material storage, it could potentially negatively impact soils by reducing their quality and intrinsic value.

The implementation of the designed mitigation described in **Chapter 5,** *Construction Strategy* and additional mitigation measures as outlined in **Chapter 14,** *Water* is considered sufficient to mitigate this potential impact as they include measures to avoid interaction between the dewatering material/liquid and underlying land (including geology and soils).

13.4.2.4 Use of imported materials during construction

Where inert aggregates, materials and soils are imported to site these will be sourced from licensed third parties and will be suitable for use.. Accordingly, it is not anticipated that contaminated material derived for geology or soils will be imported to site. See **Chapter 15**, *Resource and Waste Management* for further detail.

13.4.2.5 Dewatering activities during construction

Dewatering activities will take place in all work packages to either create a temporary in-river working area or during excavation works, as described in **Chapter 5**. Dewatering will typically be achieved by using a series of sumps and submersible pumps. Discharge from the dewatering process will be passed to a suitably sized propriety sediment removal system before discharge to the Avoca River or other water course.

The potential significant impacts of dewatering with the scheme area are:

- subsurface changes to soils and sediments that induce movement and settlement of surrounding ground.

Based on the descriptions set out in Chapter 5 – Construction Strategy and the relatively small and local nature of the dewatering, it is considered to be unlikely that there will be any potential significant impacts of dewatering relating to:

- changes to groundwater level and flow direction leading to changes to ground conditions;
- changes to groundwater level and flow direction leading to reduced yield in wells; and,
- changes to groundwater level and flow leading to reduction in water level in the River Avoca.

One or more of these effects could occur within the work packages and are discussed, where relevant, in the following sections. It is noted that ByrneLooby (2020) states that peak groundwater levels are likely to be influenced by the river dredging by a maximum of 100mm.

Due to the volume of soils, sediments, and overburden in the scheme area and the proposed construction methodology it is considered unlikely that intrusive works, such as piling and excavation, will impinge into the locally important bedrock aquifer.

13.4.2.6 Work Package 1: Proposed Arklow Bridge Works

Section 5.5.1 of **Chapter 5**, *Construction Strategy* describes the construction strategy for WP1. The proposed likely significant potential impacts for WP1 are listed below:

Compression of substrata

Construction of project measures creating compression of substrata may result in increased loading on underlying lithologies which could affect the existing characteristics of underlying and surrounding geology and soils during:

- construction and use of in-channel access roads at locations: RA1 RA2 RA6 and RA7;
- use of a bund,
- the underpinning of the bridge abutment and piers; and,
- reconstruction of the scour protection slab at the new riverbed level.

During the underpinning of the bridge abutment and piers and reconstruction of the scour protection slab the importance of this impact is considered ‘Low’ and the Magnitude of impact is considered ‘small, adverse’ due to the likely low extent of the potential impacts (i.e. located within the working area and immediate vicinity), the limited size of the in-river working area, and the underlying ground conditions.

Potential impacts from underpinning of the bridge abutment and piers and reconstructing the scour protection slab may be 'long term' to 'permanent' in duration but it is noted that works being undertaken to lower the riverbed are at an existing bridge and are unlikely to contribute significant additional loading. Consequently, the significance rating of this potential impact to geology and soils is considered to be 'imperceptible'.

During the construction and use of in-channel access roads and the use of the bund the importance of the attribute is considered 'Low' and the magnitude of impact is considered 'small, adverse'. The potential impact is likely to be temporary in duration as the access roads and bund will be removed at the end of each summer work period and re-established, where necessary, at the commencement of the following summer work period over successive years. The potential impact is likely to be low in extent i.e. located within the working area and immediate vicinity. Consequently, the overall significance rating of this potential impact to geology and soils is considered to be 'imperceptible''.

Potential impact on surrounding ground

Piling and excavation have the potential to induce movement and settlement of surrounding ground and the potential to impact on adjacent assets during:

- construction of river access road;
- the underpinning of the bridge abutment and piers;
- temporary or permanent relocation underground of overhead cables adjacent to river access locations on South Quay and River Walk; and,
- construction for sewer outfalls which are to be extended to the riverside of the bunds and haul roads.

The importance of the attribute is considered 'low' and the magnitude of this impact is considered 'small, adverse' due to the properties of the underlying material (medium dense and dense sand and gravels) and the potential impacts would likely be temporary to short-term and likely to be low in extent i.e. located within the working area and immediate vicinity. Consequently, the significance rating of this potential impact to geology and soils is considered to be 'imperceptible'.

Trafficability of soils

Heavy equipment and heavily loaded large earthmoving vehicles will travel through the scheme area potentially causing unwanted compaction and disturbance/erosion of natural ground on any unfinished road surfaces works during:

- construction and use of temporary in-channel access roads at locations: RA1, RA2, RA6, and RA7; and
- use of the dewatered riverbed as a temporary working area during the underpinning of the bridge abutment and piers and reconstruction of the scour protection slab.

The importance of the attribute is considered 'low' and the magnitude of this impact is considered 'small, adverse' due to the small volumes of traffic, short term duration of the potential impact due to seasonal working, and the likely low extent of potential impacts (i.e. being limited to haul routes and site working areas). River assess roads will be constructed from suitable hard materials and the riverbed surface is comprised of medium dense and dense sands and gravels. Consequently, the significance rating of this potential impact to geology and soils is considered to be 'imperceptible'.

Loss of geology and soils

Bunds will be required to isolate work areas from the river and from high tides. These could be formed from permeable material with an impermeable liner such as heavy-duty polythene, precast concrete blocks with an impermeable liner, or 1 1-tonne sandbags to form the core of the bund. They will also be used for construction traffic to access the work areas.

Material introduced to the rivers for use as a bund could be eroded and effectively lost. Where bunds are formed from granular material, the importance of the attribute is considered 'low' and the magnitude of impact is considered 'small, adverse' due to the short term duration of the potential impact due to seasonal working and the nature of the material used to construct the bund. Furthermore, the materials used to construct the bund will be imported to site and suitable for purpose. Bunds will be constructed from inert material and water ingress from tidal event is likely to be small. The material will be removed from the river and reused in seasonal working. Consequently, the significance rating of this potential impact to geology and soils is considered to be 'imperceptible'.

Sediments (6,500m^3) of will be removed from the riverbed during the lowering for the scour slab. The loss of this material will occur on a local scale and the change will be permanent. It is not anticipated that *insitu* bedrock lithology would be removed. The use of bunds during in-river works is anticipated to temporarily prevent localised erosion on the riverbed (e.g. through scour) on working areas during works. The importance of the feature is considered 'low' due to the materials having a low quality, significance or value on a local scale, e.g. the sediments are not an economically extractable mineral resource or source of fertile topsoil. The magnitude of impact is considered 'moderate adverse' due to the requirement to excavate a moderate volume of materials in a localised area. Consequently, the significance rating of this potential impact to geology and soils is considered to be 'slight'.

In river dewatering

The potential effects of dewatering activities during construction are described in **Section 13.4.2.5**. The Avoca River is in continuity with the groundwater in the sand and gravels throughout the study area and water levels in the river are likely to be partly dependent on water levels in the aquifer, albeit to a lesser extent than the tidal influence on river levels

To enable in-river working, a bund and dewatering process, as described in **Section 5.5.1.5** of **Chapter 5,** *Construction Strategy* will be used to create a temporary working area in the river to allow for underpinning of the bridge abutments and reconstruction of the scour protection slab works.

Dewatering may cause changes to the groundwater level and flow direction leading to an indirect negative impact to yield volume in abstractions. However, the relatively small volume of dewatering and its local nature is not expected to cause any impact in the project area. The importance of the attribute is considered 'medium' and the magnitude of potential impact is considered 'negligible' due to the presence of a locally important aquifer (classed as 'Bedrock which is Moderately Productive only in Local Zones') underlying or in close proximity the scheme area and a small scale gravel aquifer within the western part of the scheme area, the presence of abstractions with predominantly 'moderate' or 'low' abstraction yields within the scheme area, and the likely small-scale and temporary impacts of limited dewatering works to groundwater levels and flow. Consequently, the significance rating of this potential impact to groundwater and indirect impact to abstraction is to be 'imperceptible'.

Dewatering may cause changes to groundwater level and flow direction leading to the indirect negative potential impact of reduction in water level in the Avoca River. However, the relatively small volume of dewatering and its local nature is not expected to cause any impact to water level in the Avoca River. The importance of the feature is considered 'medium' and the magnitude of impact is considered 'negligible' due to the presence of a locally important aquifer underlying the scheme area and a small-scale gravel aquifer in the western part of the scheme area, to the likely small-scale and temporary impacts of limited dewatering works to groundwater levels and flow. The scheme is located adjacent to the outflow from the catchment into the Irish Sea and the hydrology of the wider catchment has greater influence on water levels in the Avoca River than groundwater in the scheme area. Consequently, the significance rating of this potential impact to groundwater and indirect impact water level in the River Avoca is considered to be 'imperceptible'.

Dewatering during underpinning of the bridge abutment and piers may cause subsurface changes that could induce movement and settlement of surrounding ground leading to the indirect negative potential impact to the stability of sensitive structures. Mitigation with regards to ground stability is designed into **Chapter 4 – Proposed Scheme** and chiefly comprises the grouting works at Arklow Bridge. Appropriate dewatering methodologies must be used and monitoring for settlement will take place (see **Chapter 5**, *Construction Strategy* for details on the mitigation measures).

Terrestrial dewatering

The potential impacts of dewatering activities during construction are described in **Section 13.4.2.5**.

Due to the relatively high-water table in the area (approximately 2m below ground level), dewatering works may be required for intrusive works during:

- temporarily or permanently relocation underground of overhead cables adjacent to river access locations on South Quay and River Walk; and,
- construction for sewer outfalls which are to be extended to outside of the flood defence wall.

The importance of this potential impact is considered 'low' and the magnitude of this potential impact is considered 'negligible'' due to the small and local extent of excavation and likely relatively low permeability of the underlying materials it is anticipated that limited pumping of water may be required. The duration of the potential impact is likely to be short term. Consequently, the significance rating of the potential impacts that may occur due to changes to groundwater flow and level (as outlined in **Section 13.4.2.5**) is considered to be 'imperceptible'.

Accidental leaks and spills

The potential impacts of accidental leaks and spills are described in **Section 13.4.2.2.**

The riverbed is a natural surface composed of gravelly material, with argillaceous material present at the surface in some areas downriver of the bridge. Should leaks and spills occur on porous and permeable material (such as clean gravels), or within proximity of intrusive works, there is the potential that contamination could intersect groundwater. The importance of the feature is considered 'medium' and the magnitude of impact for works in and out of the river is considered 'small, adverse' due to the low volume of vehicles in the in river working area, the nature of the materials on the riverbed and underlying ground conditions, the short-term duration of works and the small scale of the working area in the river. Consequently, the significance rating of the potential impact to geology and groundwater is considered to be 'slight'.

Encountering known or unknown existing contamination

The potential effects of encountering known, or unknown existing contamination are discussed in **Section 13.4.2.1**.

The importance of the feature is considered 'medium' and the magnitude of impact is considered 'small adverse' due to the nature of the sediments, limited excavation and short term duration of works with intrusive works limited to defined areas within working areas on the river bed. Consequently, the overall significance rating of the potential impact is considered to be 'slight'.

Summary the Potential Impacts

Table 13.9 summarises the potential significant impacts during WP1.

Table 13.9: Summary of potential impacts on geology, soils and groundwater in Work Package 1

Feature	Importance		Magnitude of Impact		Significance of Impact
	Ranking	Criteria*	Ranking	Criteria *	
Compression of substrata	Low	Attribute has a low-quality, significance or value on a local scale.	Small, Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	Imperceptible
Potential impact on surrounding ground (during piling and excavation)	Low	Attribute has a low-quality, significance or value on a local scale..	Small adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	Imperceptible
Trafficability of soils	Low	Attribute has a low-quality, significance or value on a local scale.	Small adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	Imperceptible
Loss of geology and soils (bund)	Low	Attribute has a low-quality, significance or value on a local scale.	Small adverse	Results in minor impact on integrity of attribute or loss of small part of	Imperceptible
Loss of geology and soils (sediments)	Low	Attribute has a low-quality, significance or value on a local scale.	Moderate adverse	Results in impact on integrity of attribute or loss of part of attribute	Slight
In river dewatering	Medium	Attribute has a medium quality or value on a local scale	Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	Imperceptible
Terrestrial dewatering	Low	Attribute has a low-quality, significance or value on a local scale.	Small adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	Imperceptible
Accidental leaks and spills	Medium	Attribute has a medium quality or value on a local scale.	Small adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	Slight

Feature	Importance		Magnitude of Impact		Significance of Impact
	Ranking	Criteria*	Ranking	Criteria *	
Encountering known or unknown existing contamination	Medium	Attribute has a medium quality, significance or value on a local-scale	Small adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	Slight
*A description of the justification is provided in the text in this section.					

13.4.2.7 Work Package 2: Proposed Channel Dredging

Section 5.5.2 describes the construction methodology for the channel dredging works. The likely significant potential construction impacts of WP2 are listed below.

Compression of substrata

During enabling work existing inert river gravels from within the footprint of the designated siteworks boundary will be used, where available, to form temporary haul roads in the river. Otherwise, suitable material will be imported for the purpose. The temporary haul roads will be removed as the dredging progresses.

The construction works that cause compression of substrata may result in increased loading on underlying lithologies, which could affect the existing characteristics of underlying and surrounding geology and soils .

The importance of the attribute is considered ‘low’ and the magnitude of potential impact is considered ‘small, adverse’ due to the nature of the underlying geology and material, the likely low extent (i.e. located within the working and immediate vicinity) of potential impacts and small scale and short-term duration of works. Consequently, the significance rating of this potential impact on geology and soils is considered to be ‘imperceptible’.

Potential impact on surrounding ground

Excavation has the potential to induce movement and settlement of surrounding ground and the potential to impact on adjacent assets during:

- construction of river access: RA1, RA2, RA3, RA4, and RA8;
- construction access being built for SC1, SC 2, SC3, SC5 and SC6; and,
- dredging of material in the channel of the Avoca River.

During the construction of the river accesses, site compounds accesses and in-river temporary haul road, the importance of the attribute is considered 'low' and the magnitude of potential impact is considered 'small, adverse' due to the nature of the underlying geology and soils, the likely low extent (i.e. located within the working and immediate vicinity) of potential impacts and small scale and short-term duration of works. Consequently, the significance rating of this potential impact on geology and soils is considered to be imperceptible'.

Removal of materials during dredging of the Avoca River channel may induce a stress on the existing ground with the potential to induce movement and settlement of surrounding ground. The importance of the feature is considered 'low' and the magnitude of impact is considered 'small, adverse' due to the relatively small volume of material removed, the nature of the underlying material, the short-term duration of works, and the potential impacts would likely be located in the working area and immediate vicinity. Consequently, the significance rating of this potential impact to geology and soils is considered to be 'imperceptible'.

Removal of materials during dredging of the Avoca River channel may induce changes to groundwater levels in Arklow Town Marsh. It likely that peak ground water levels will be influenced by the river dredging by up to a maximum of 100mm. The importance of the feature is considered 'very high' on the basis of its status as a pNhA and the magnitude of impact is considered 'negligible' due to the presence of an underlying locally important bedrock aquifer, the limited extent and small scale of the potential impact, and the nature of the underlying material, Consequently, the significance rating of the potential impact to groundwater is considered to be 'imperceptible'.

Trafficability of soils

The description of impact is as for WP1, as discussed in **Section 13.4.2.6**. Within WP2, river assess roads will be constructed from suitable hard materials, temporary haul roads will be constructed in the river and adjacent to the banks. The riverbed surface is comprised of medium dense and dense sands and gravels.

Potential impacts may occur during:

- Movement of project vehicles and equipment between site compounds;
- construction of river access: RA1, RA2, RA3 and RA8;
- construction access being built for SC1, SC 2, SC5 and SC6; and,
- dredging of material in the channel of the Avoca River.

The importance of the attribute is considered 'Small' and the magnitude of impact is considered 'Small, Adverse' due to the high volume of traffic, use of existing roads with finished surfaces outside of the river, use of temporary haul roads within the river, the short term duration of the potential impact due to seasonal working, and the likely low extent of potential impacts, i.e. likely limited to haul routes and site working areas. Consequently, the significance rating of this potential impact to geology and soils is considered to be 'Slight'.

Loss of geology and soils

Removal of material from the channel of the Avoca River during dredging may lead to increased erosion of the channel and banks. River dredging is proposed over a c. 850 m length of the channel and the general depth of dredging will typically vary from approximately 1.2m at the channel edge to zero. Dredging at a number of high points will extend to 2.6m depth. The average depth of dredging will be 0.4m.

The importance of the attribute is considered 'low' due to the materials having a low quality, significance or value on a local scale, e.g. the sediments are not an economically extractable mineral resource or source of fertile topsoil. The magnitude of impact is considered 'moderate adverse' due to the requirement to excavate a moderate volume of materials (c. 77,382 m^3) in a localised area. Consequently, the significance rating of this potential impact to geology and soils is considered to be 'slight'.

Material Chapter 15, *Resource and Waste Management* provides detail on the impacts associated with the management of the dredged material during construction and maintenance period. The processes of onsite transport and temporary storage of dredged material at site compounds, and designed-in mitigation, are described in **Chapter 5***, Construction Strategy*.

Accidental leaks and spills

The description of the potential impacts and the impact assessment is as for WP1 (see **Section 13.4.2.6**), as discussed in **Section 13.4.2.2.** The ranking considers that the volume of traffic is higher than anticipated for WP1. It also considers that SC1 is located with, and on the boundary off, Arklow Marsh and assess will be via existing roads.

Encountering known or unknown existing contamination

The description of potential impact is discussed in **Section 13.4.2.1**.

Contaminated/chlorinated material on the riverbed is a recognized potential source of contamination when it is removed from the channel. The classification, transport, storage of dredged material at site compounds, reuse of suitable dredged material and export of dredged material from the site is discussed in **Chapter 15**, *Resource and Waste Management*. Inert and suitable dredge material removed from the Avoca River in WP2 may be utilised as infill in other Work Packages (see **Chapter 5,** *Construction Strategy*). Contamination encountering during dredging may be introduced to other locations within the scheme area during movement of dredge material and storage of this material outside of the river channel. Prior to mitigation, the importance of the feature is considered 'high' and the magnitude of impact is considered 'moderate, adverse' due to the presence of known contamination in sediments on the river bed, the nature of contamination, the volume of material to be dredged, the use of multiple site compounds across the site to store materials, and the proximity of a site storage compound (SC1) receiving dredged material to Arklow Town Marsh. Consequently, the significance rating of the potential impact is considered to be 'significant /moderate'.

Summary of the Potential Impacts

Table 13.10 summarises the potential significant impacts during WP2.

Table 13.10: Summary of potential impacts on geology, soils and groundwater in Work Package 2

Feature	Importance		Magnitude of Impact		Significance of Impact
	Ranking	Criteria*	Ranking	Criteria*	
Compression of substrata	Low	Attribute has a low-quality, significance or value on a local scale.	Small, Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute.	Imperceptible
Potential impact on surrounding ground (geology and soils)	Very high	Attribute has a high quality, significance or value on a regional or national scale	Small, Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute.	Imperceptible
Potential impact on surrounding ground (geology and soils)	Medium	Attribute has a medium quality, significance or value on a local scale	Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	Imperceptible
Trafficability of soils	Low	Attribute has a low-quality, significance or value on a local scale.	Small adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	Imperceptible
Loss of geology and soils	Low	Attribute has a low-quality, significance or value on a local scale.	Moderate adverse	Results in impact on integrity of attribute or loss of part of attribute	Slight
Accidental leaks and spills	Medium	Attribute has a medium quality or value on a local scale. Presence of Locally Important Aquifer.	Small adverse	Results in minor impact on integrity of attribute or loss of small part of attribute.	Slight

Feature	Importance		Magnitude of Impact		Significance of Impact
	Ranking	Criteria*	Ranking	Criteria*	
Encountering known or unknown existing contamination	High	Degree or extent of sediment contamination in the river is significant on a local scale	Moderate adverse	Results in impact on integrity of attribute or loss of part of attribute	Significant /Moderate'
*A description of the justification is provided in the text in this section.					

13.4.2.8 Work Package 3: Proposed Debris & Gravel Traps

Section 5.5.3 of **Chapter 5** describes the construction methodology for WP3. The proposed likely significant potential impacts are listed below for WP3.

Compression of substrata

A temporary haul road will be constructed from the site compound SC4 to the riverbank and on to RA4 to facilitate construction traffic. A temporary construction road will be constructed in the riverbed from RA4 downstream to the location of the debris trap and then across the river to the north bank.

Foundation works have the potential to induce a stress on the existing riverbed which has the potential to induce movement and settlement of surrounding ground. The description of the potential impact and the impact assessment is the same as for WP2 (see **Section 13.4.2.7**), with lower volumes of traffic occurring in WP3.

Trafficability of soils

Accessways developed in this work package are described in **Chapter 5,** *Construction Strategy*.

The description of the potential impact and the impact assessment is as for WP1 (see **Section 13.4.2.6**), with low volumes of traffic occurring in WP3.

Loss of geology and soils

The debris trap will be located approximately 320m upstream of Arklow Bridge. The gravel trap will be located approximately 10m upstream of the debris trap.

The gravel trap will be constructed by excavation and lowering riverbed floor level by 1m to the required profile, working from north to south. The description of the potential impact and the impact assessment, associated with removal of the riverbed material, is as for WP2 (see **Section 13.4.2.7**).

Bunds will be required to isolate work areas from the river during construction of the debris trap and gravel trap. Material introduced to the river could be eroded and effectively lost.

The description of the potential impact is as for WP1 (see **Section 13.4.2.6**). The importance of the attribute is considered 'low' and the magnitude of impact is considered 'negligible' due to the short term duration of the potential impact due to seasonal working, the nature of the material, and relative scale of works and low volume of material to be removed. Consequently, the significance rating of this potential impact to geology and soils is considered to be 'imperceptible'.

In river dewatering

During development of the debris trap a bund will be formed around the northern half of the debris trap to facilitate construction. On completion of the northern half of the debris trap, the bund will be removed and used to form a bund around the southern half of the debris trap. Each bund will be dewatered to facilitate the works. The works will be small scale and short term in duration.

The description of the potential impacts and the impact assessment is as for WP1 (see **Section 13.4.2.6**).

Encountering known or unknown existing contamination

The description of potential impact is as for WP1 (see **Section 13.4.2.5**) and as discussed in **Section 13.4.2.1**. The importance of the feature is considered 'medium' and the magnitude of impact is considered 'small adverse' due to the nature of the river sediments, and the relatively small scale and short term duration of the works . Consequently, the significance rating of the potential impact to groundwater is considered to be 'imperceptible'.

Accidental leaks and spills

The description of the potential impacts and the impact assessment is as for WP1 (see **Section 13.4.2.6**), as discussed in **Section 13.4.2.2**. The locally important gravel aquafer may be present, in addition to the locally important bedrock aquafer within the working area.

Summary of the Potential Impacts

Table 13.11 summarises the potential significant impacts during WP3.

Table 13.11: Summary of potential impacts on geology, soils and groundwater in Work Package 3

Feature	Importance		Magnitude of Impact		Significance of Impact
	Ranking	Criteria*	Ranking	Criteria*	
Compression of substrata	Low	Attribute has a low-quality, significance or value on a local scale.	Small, Adverse	Results in minor impact on integrity of attribute.	Imperceptible
Trafficability of soils	Low	Attribute has a low-quality, significance or value on a local scale.	Small adverse	Results in minor impact on integrity of attribute.	Imperceptible

Feature	Importance		Magnitude of Impact		Significance of Impact
	Ranking	Criteria*	Ranking	Criteria*	
Loss of geology and soils	Low	Attribute has a low-quality, significance or value on a local scale.	Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	Imperceptible
In river dewatering	Medium	Attribute has a medium quality or value on a local scale	Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	Imperceptible
Encountering known or unknown existing contamination	Medium	Attribute has a medium quality or value on a local scale	Small adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	Slight
Accidental leaks and spills	Medium	Attribute has a medium quality or value on a local scale. Presence of Locally Important Aquifer.	Small adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	Slight
*A description of the justification is provided in the text in this section.					

13.4.2.9 Work Package 4: Proposed Flood Defence Walls and Drainage along South Bank

Section 5.5.4 of **Chapter 5** describes the construction methodology for WP4. The proposed likely significant potential impacts for WP4 are:

Compression of substrata

To facilitate construction of the sheet piled wall along River Walk and South Quay, a temporary causeway will be built in the river to provide a working platform. The causeway will initially be built to facilitate works along River Walk. Upon completion of works at that location, the material will be excavated and reused to build a causeway along South Quay.

Construction of the temporary causeway may result in increased loading on underlying lithologies, while this feature is in place, which could affect the existing characteristics of underlying and surrounding geology and soils during its emplacement. The importance of the attribute is considered 'low' and the magnitude of potential impact is considered 'small, adverse' due to the nature of the underlying ground conditions, the likely low extent (i.e. located within the working and immediate vicinity) of potential impacts. It is anticipated that soils will be under a similar loading after construction compared to existing loading conditions. Consequently, the significance rating of the potential impact on geology and soils is considered to be 'imperceptible'.

Potential impact on surrounding ground

Pile driving and excavation have the potential to induce movement and settlement of surrounding ground and the potential to impact on adjacent material assets, such as buildings, during construction. WP4 comprises:

- Installation of sheet piles during construction of flood defences. The sheet pile wall will be formed by vibrating steel sheets into the ground using a piling hammer or similar.
- Construction of reinforced concrete walls during construction of flood defences. Preparation of the foundation works will include excavation to formation level only.
- Construction of stormwater drainage network using the open cut method and construction of three submersible pumping station stations using standard excavation techniques though soil.
- Construction of a temporary accesses to the site compounds SC4 and SC6.
- Removal of overhead electricity cables along South Quay and Harbour Road and placement underground.

The importance of the attribute is considered 'medium' and the magnitude of potential impact is considered 'small, adverse' due to underlying ground conditions, the likely low extent (i.e. located within the working and immediate vicinity) of potential impacts and the short-term duration of works. Consequently, the significance rating of the potential impact on geology and soils is considered to be 'imperceptible'.

Trafficability of soils

Accessways developed in this work package are the construction and use of a temporary haul road and causeway. The description of the potential impact and impact assessment is as for WP1 (see **Section 13.4.2.6**), with low volumes of traffic occurring in WP4 and the presence of the temporary accessways being short term in duration.

Loss of geology and soils;

There will be excavation of soil and overburden along the line of the flood defence walls from Ch0.0m to Ch313.5m upstream of Arklow bridge and Ch0.0m to Ch1113.5m downstream of Arklow Bridge during construction of the proposed flood defence walls and stormwater drainage network.

It is anticipated that a small volume of soft soils will be excavated during pipelaying in the construction of the stormwater sewer network. The importance of the attribute is considered 'low' and the magnitude of potential impact is considered 'small, adverse' due to the nature of the material being excavated, limited volume of material being excavated, the limited extent of works to the working area. Consequently, the significance rating of the impact on potential geology and soils is considered to be 'imperceptible'.

Terrestrial dewatering

Dewatering activities during the construction of sewers will involve:

- Sheet piles will be used to provide groundwater cut off for the construction of the interceptor sewer for the WwTP Project and dewatering will typically be achieved by using a series of sumps and submersible pumps. To reduce the amount of dewatering required at any given time, it is likely that the contractor will construct the sewer in sections.
- To form the trench for the stormwater drainage, the overburden will be excavated, and a drag box or trench box will be installed as the excavation progresses. The excavation areas will be sized accordingly to accommodate the trench box/ drag box. The use of trench box/ drag box will minimise the working area by providing stability to the upper sides of the excavation.

Due to the relatively high-water table in the area (approximately 2m below ground level), dewatering works will be required at some locations. Dewatering will typically be achieved by using a series of sumps and submersible pumps. Discharge from the dewatering process will be passed through a suitably sized settlement pond or a proprietary silt removal system located within the working area, before discharge to the Avoca River or the local storm sewer network.

The description of potential impacts and impact assessment is as for 'Terrestrial dewatering' in WP1 (see **Section 13.4.2.6**)

Impacts to bedrock aquifer

Hard landscaping as part of the public realm works could potentially negatively impact aquifer recharge through long-term sealing of surfaces and reducing rainwater infiltration to ground. However, no current permeable areas will be changed to impermeable areas and all of the proposed hard landscaping will be immediately adjacent to the Avoca River so surface water runoff will immediately flow to the river which is directly connected to the aquifer.

The importance of the attribute is considered 'medium' and the magnitude of impact is considered 'negligible' due the present of a local important aquifer underlying or in the vicinity of the works and the likely small scale of the impact on a local scale. Consequently, the significance rating of the potential impact to groundwater is considered to be 'imperceptible'.

Encountering known or unknown existing contamination

The importance of the feature is considered 'medium' and the magnitude of impact is considered 'small adverse' due to the presence of contaminated sediments in the river and the use of a causeway to create an in-river working area and so avoiding direct trafficking over any contaminated sediments. Works will be short term and intrusive works will be limited to defined working areas Consequently, the significance rating of the potential impact is considered to be 'slight'. Suitable inert materials will be used for infill during construction and hard and soft landscaping in public realm works.

Accidental leaks and spills

The description of the potential impacts and the impact assessment is as for WP1 (see **Section 13.4.2.6**), as discussed in **Section 13.4.2.2**. The in-river working area will be located on a causeway so accidental leaks and spills directly to a dewater river-bed are considered unlikely.

Summary of the Potential Impacts

Table 13.12 summarises the potential significant impacts during WP4.

Table 13.12: Summary of potential impacts on geology, soils and groundwater in Work Package 4

Feature	Importance		Magnitude of Impact		Significance of Impact
	Ranking	Criteria*	Ranking	Criteria*	
Compression of substrata	Low	Attribute has a low-quality, significance or value on a local scale.	Small, Adverse	Results in minor impact on integrity of attribute.	Imperceptible
Potential impact on surrounding ground	Low	Attribute has a low-quality, significance or value on a local scale.	Small, Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	Imperceptible
Trafficability of soils	Low	Attribute has a low-quality, significance or value on a local scale.	Small adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	Imperceptible

Feature	Importance		Magnitude of Impact		Significance of Impact
	Ranking	Criteria*	Ranking	Criteria*	
Loss of geology and soils	Low	Attribute has a low-quality, significance or value on a local scale.	Small, Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	Imperceptible
Terrestrial dewatering	Low	Attribute has a low-quality, significance or value on a local scale.	Small adverse	Results in minor impact on integrity of attribute or loss of small part of attribute.	Imperceptible
Impacts to bedrock aquifer	Medium	Attribute has a medium quality or value on a local scale (Locally Important Aquifer)	Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	Imperceptible
Accidental leaks and spills	Medium	Attribute has a medium quality or value on a local scale. Presence of Locally Important Aquifer.	Small adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	Slight
Encountering known or unknown existing contamination	Medium	Attribute has a medium quality or value on a local scale	Small adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	Slight
*A description of the justification is provided in the text in this section.					

13.4.2.10 Work Package 5: Proposed Flood Defence Earth Embankment and Wall and Drainage along North Bank

Section 5.5.4 of **Chapter 5** describes the construction methodology for the for WP5. The proposed likely significant potential impacts are listed below for WP5.

Compression of substrata

The installation of the earthen embankment may result in increased loading on underlying lithologies which could affect the existing characteristics of underlying and surrounding geology and soils. The importance of the attribute is considered 'low' and the magnitude of potential impact is considered 'small, adverse'. Consequently, the significance rating of the potential impact on geology and soils is considered to be 'imperceptible'.

There is considered to be a low risk of landslides/bog movement in Arklow Town Marsh on the basis of the topography in the area and selected construction strategy, i.e. peats will be removed from the area underlying the embankment installation and adjacent roads will be suitability constructed (see **Chapter 5**, *Construction strategy* for details). It is noted the GSI's Landslide Susceptibility Classification for the area of Arklow Town Marsh is inferred to be Low.

Potential impact on surrounding ground

Pile driving and excavation have the potential to induce movement and settlement of surrounding ground and the potential to impact on adjacent material assets e.g. buildings and infrastructure during:

- Construction of new flood defence earthen embankment with a land drain at the toe of embankment;
- Installation of sheet piles including reinforced concrete retaining wall;
- Diversion of the existing drainage channel which connects the canal to the Avoca River westwards to facilitate the construction of the wall and embankment; and,
- Relocation of utilities and services with assets repositioned and placed underground and diversion of underground cables running from Arklow Town Marsh to Ferrybank
- Realignment of the existing channel

Soft soils will be removed during excavation, where appropriate, and suitable material will be used for construction. The description of the potential impacts and the impact assessment is as for WP4 (see **Section 13.4.2.9**).

Trafficability of soils

The description of the potential impact is as for WP1 (see **Section 13.4.2.6**).

Within Arklow Town Marsh the importance of the attribute is considered 'high' on the basis that Arklow Marsh is a pNHA and the relative volume of soft organic soil underlying site on a local scale. The magnitude of potential impact is considered 'small, adverse' due to the presence of soft soils in Arklow Town Marsh, limited extent of the working area, and the small volume of traffic. Consequently, the significance rating of the potential impact on geology and soils is considered to be 'Moderate/Slight'. A temporary haul road will be developed in the marsh that will limit tracking on soils in the marsh.

Where established roads (e.g. Ferrybank and the Dublin Road) are used as haul routes for dredge material it is anticipated the significance rating of the potential impact on geology and soils is considered to be 'imperceptible' and in line with the ranking for WP2 (see **Section 13.4.2.7**) with a lower volume of traffic anticipated for WP5.

Loss of geology and soils;

Soils will be excavated during the preparation for foundation and relocation of assets underground or movement of underground cables.

During the construction of foundations works will consist of clearing vegetation, grubbing, to remove stumps and large roots to approximately a 1m depth, and stripping to remove sod, topsoil, boulders, organic materials, and other unsuitable materials. During enabling and intrusive works soils, where these occur, will be removed, stored during the works, and reinstated. Highly compressible soils occurring in a thin surface layers or isolated pockets will be removed. Inert fill will be used during construction, where appropriate. Soft landscaping in the form of the placing of soil, levelling and grass-seeding will be undertaken and topsoils will be reinstated with the original material.

The importance of the attribute is considered 'medium' and the magnitude of potential impact is considered 'small, adverse' due to the nature of the material being excavated, limited volume of material being excavated and the limited extent of works to the working area. Consequently, the significance rating of the impact on potential soils is considered to be 'slight'.

Impacts to geology are considered to be unlikely as bedrock will not be reached during excavation.

Terrestrial dewatering

Dewatering of excavation may occur during construction of the reinforced concrete flood defence wall. During construction of the embankment, where cut off or drainage trenches extend below the water table, a dewatering will be necessary to properly prepare the foundation and to compact the first lifts of embankment fill. All water removed in dewatering will be disposed through sediment settlement tanks.

The impact assessment is as for 'Terrestrial dewatering' in WP1 (see **Section 13.4.2.6**).

Impacts to bedrock aquifer

Landscaping along the flood defence works will be constructed using conventional methods. Hard landscaping works could potentially negatively impact aquifer recharge through long-term sealing of surfaces and reducing rainwater infiltration to ground. The impacts assessment, significance and justification are as for WP4 (see **Section 13.4.2.9**).

Encountering known or unknown existing contamination

For works outside of Arklow Town Marsh the impacts assessment, significance and justification is as for WP4 (see **Section 13.4.2.9**).

Inert materials will be used in construction (see **Section 13.4.2.4**). Suitable dredge material will be used for construction of the core of the earthen embankment.

Accidental leaks and spills

The description of potential impacts and impact assessment is as for WP1 (see **Section 13.4.2.6**), as discussed in **Section 13.4.2.2**.

Summary of the Potential Impacts

Table 13.13 summarises the potential significant impacts during WP5.

Table 13.13: Summary of potential impacts on geology, soils and groundwater in Work Package 5

Feature	Importance		Magnitude of Impact		Significance of Impact
	Ranking	Criteria*	Ranking	Criteria*	
Compression of substrata	Low	Attribute has a low-quality, significance or value on a local scale.	Small, Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute.	Imperceptible
Potential impact on surrounding ground	Low	Attribute has a low-quality, significance or value on a local scale.	Small, Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	Imperceptible
Trafficability of soils	High	Attribute has a high quality, significance or value on a local scale	Small adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	Moderate/Slight
Loss of geology and soils	Medium	Attribute has a Medium-quality significance of value on a local scale.	Small, Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	Slight
Terrestrial dewatering	Low	Attribute has a low-quality, significance or value on a local scale.	Small adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	Imperceptible

Feature	Importance		Magnitude of Impact		Significance of Impact
	Ranking	Criteria*	Ranking	Criteria*	
Impacts to bedrock aquifer	Medium	Attribute has a medium quality or value on a local scale (Locally Important Aquifer)	Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	Imperceptible
Accidental leaks and spills	High	Attribute has a medium quality or value on a local scale. Presence of Locally Important Aquifer.	Small adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	Slight
Encountering known or unknown existing contamination	Medium	Attribute has a medium quality or value on a local scale	Small adverse	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity.	Slight
*A description of the justification is provided in the text in this section.					

13.4.3 Assessment of effects during operation and maintenance

The operational phase of the proposed development will have an overall neutral long-term impact on land and soils.

13.4.3.1 Land and soil

There are considered to be no likely significant impacts to geology, soils and groundwater arising from the following regular maintenance activities (as listed in **Section 4.6.2** of **Chapter 4**, *Proposed Development*) regarding riverbank vegetation, and stormwater drainage system including pumping stations and non-return valves.

There are considered to be no likely significant impacts to geology, soils and groundwater arising from maintenance and repair carried out on the following listed items: demountable flood defence barriers, flood gate, flood defence walls including glass panels, flood defence embankment, bridge piers and abutments, scour protection slab; Public Realm, and roosting platforms for birds upstream of Arklow Bridge, bat tubes in the flood defence walls and bat tubes and nest boxes on Arklow Bridge.

Maintenance of the gravel and debris traps

Routine maintenance of the debris and gravel traps with be undertaken periodically with excavators and dump trucks using a river access with permanent and temporary sections. Works will be temporary. Due to the small scale of works the potential impact of these work are considered to be imperceptible.

Some sediments on the riverbed of Arklow River are known to be contaminated. Although some of this material will be removed during the construction phase of the scheme and underlying material covered with clean fill (see **Chapter 5**, *Construction Strategy* for further detail), there is the potential that inert material that collects on the riverbed could become contaminated over time through third-party activities (e.g. wash down of heavy metals from historical mines located outside of the scheme area, higher up in the river catchment). Accordingly, material removed from the river during operations will need to be classified to determine its fate in line with national legislation (see **Chapter 15**, *Resource and Waste Management* for details).

Maintenance of the river channel,

The Avoca River channel will be maintained through dredging if sediment builds up over time. Material removed from the river during operations will need to be classified to determine its disposal route in line with national legislation (see **Chapter 15**, *Resource and Waste Management* for details).

Installed infrastructure

Once installed, the sheet piles and stormwater sewerage network pipes are considered unlikely to cause long term negative impact to groundwater flow due to their limited extent on the surface (i.e. volume of wall) and/or limited extent into sediments.

The installed stormwater sewerage network pipes will convey storm water collected from the hard surfaces inland to the Avoca River. Consequently, there is a risk of a leak from the storm water drainage potentially impacting on groundwater quality. The importance of the attribute is considered ‘medium’ and the magnitude of potential impact is considered ‘negligible’ due to the presence of an underlying aquifer, the nature of the underlying materials and the location of the pumps. Consequently, the significance rating of the impact on potential groundwater is considered to be ‘imperceptible’. The infrastructure will be designed and constructed in accordance with industry best practice.

13.4.3.2 Marsh Hydrogeology

No likely significant impacts on the hydrogeology of the Marsh are anticipated during the operational phase of the scheme. The construction of the flood defence walls, and earth embankments will result in higher water levels within the channel during flood events. This may result in a short-term localised reversal in groundwater hydraulic gradients. However, the high-water levels in the watercourse will occur over a limited time period and the impact on groundwater is considered to be low. There may also be localised impacts on groundwater levels in the immediate vicinity of the proposed flood walls and embankments.

There are no measures being put in place in the development of the scheme that would foreseeably result in groundwater cut off between Arklow Town Marsh and Arklow Ponds during operation of the scheme.

13.5 Cumulative Effects

It is considered unlikely that there would be significant cumulative effects to land, soils or hydrogeology during construction or operations of this scheme arising from interaction with third-party projects with planning or in planning process or maybe imminent at the time of writing and based on the information publicly available through planning portals[1]. However, it is noted that in many cases, limited details are available for the third-party projects with regards to detailed construction strategies or programmes and this may cause limitations to foreseeing any potential indirect impacts, cumulative impacts, or impact interactions that may arise.

There will be interaction with the Arklow Wastewater Treatment Plant project during construction (see **Chapter 2**, *Background and Need for the Scheme,* **Chapter 4***, Project Description,* and **Section 5.2.3** of **Chapter 5,** *Construction Strategy*). Common works (outlined in **Section 5.2.3**) will be carried out by whichever scheme commences first and, therefore, it is not anticipated these would give rise to cumulative impacts.

Cumulative impacts may arise from the use of common works areas though increase vehicle tracking and any adjacent excavation works during construction. However, construction strategy design and the inclusion of measures to address likely significant impacts potentially arising from activities in common areas, such as trafficability of soils and loss of soils and geology (albeit addressed under slightly different terminology) have been considered in the EIARs for both schemes. The Office of Public Works and Wicklow County Council will endeavour to minimise the in-combination effect of both schemes. A memorandum of understanding agreement has been signed by both project promoters, see **Appendix 2.1** for details. This potential for cumulative effects has been addressed in **Chapter 20**, *Cumulative Impacts and Interaction of Effects.*

[1] The following applications number were considered: 1615, 15857, 16248, 16414, 18316, 19750, 20426, 20469, 181170, 201285, and SI201801 (Arklow Waste Water Treatment Plant Project). Also 'Parade Ground, Arklow (Part 8)' (no application number), Arklow OGI Case reference: PL27 .306662, the following foreshore application numbers: FS005762, FS006241, FS006506, FS006862, FS007045, and FS007049

13.6 Mitigation Measures and Monitoring

13.6.1 Mitigation

13.6.1.1 Mitigation During Construction

General

As outlined in **Section 5.5 of Chapter 5** and in the CEMP (Refer to **Appendix 5.1**), the adopted construction techniques will comply with the requirements of statutory bodies (inspections by the Health and Safety Authority and the Office of Public Works inspections and compliance with Employer's Requirements).

Mitigation measures for erosion and sediment control are primarily addressed in **Chapter 14**, *Water*. Mitigation measures for accidental leaks and spills are in the CEMP (Refer to **Appendix 5.1**).

During construction, the following generic measures will be used to avoid or reduce the significance of potential impacts:

Encountering known or unknown existing contamination

- The historical illegal dumping of waste on Arklow Town Marsh has been recovered by WCC.
    - Should any further illegal dumping take place on the site these materials will be removed by WCC prior to works commencing.
    - A site investigation to determine the quality of soils and groundwater within the working area in Arklow Town Marsh will be conducted prior to intrusive works to determine if soil or groundwater contamination is present in the working area.
- During enabling works, a suitable geotextile membrane with be installed at all site compounds where historical land use indicates potential contamination may be present, to avoid interaction with overlying storage materials or equipment. At SC1 topsoil will be stripped and a suitable geotextile membrane will be installed and overlaid with hardcore. Intrusive works will not take place on SC2 and SC5, a suitable geotextile liner will be installed and overlaid with hardcore. SC3 is the site of a demolished house and is partly hard cored. Topsoil will be stripped from the western side of the property and a suitable geotextile membrane will be installed and overlaid with hardcore. SC4 is located on an existing carpark. SC5 is a semi-derelict site with a largely hardcore base, a suitable geotextile liner will be installed in an area of soft soils on the site compound. At SC6 topsoil will be stripped and a suitable geotextile membrane will be installed and overlaid with hardcore.

- A bund system, as described in **Section 5.4.3** of **Chapter 5**, *Construction Strategy,* will be installed at site compounds SC1, SC2, SC5 and SC6 to contain stored dredge materials so it is not anticipated that there will be interaction between materials stored at site compounds and any underlying existing contamination, if present. All hazardous material will be stored in bunded site compounds.

If contamination is encountered in geology, soils or groundwater, suitable measures will be put in place to avoid mobilising the contamination based on the most appropriate industry best practice guidance for contaminated land management. These measures, should they be required, will be documented in the soil management plant and revised as needed.

Accidental leaks and spills

A contingency plan for accidental leaks and spillages is included in the CEMP and will be further developed by the contractor prior to the commencement of the works and regularly updated during construction. This contingency plan identifies the actions to be taken in the event of a pollution incident in accordance with the CIRIA guidance 741 *Environmental good practice on site*, and includes:

- Containment measures;
- Emergency discharge routes;
- List of appropriate equipment and clean-up materials;
- Maintenance schedule for equipment;
- Details of trained staff, location and provision for 24-hour cover;
- Details of staff responsibilities;
- Notification procedures to inform the EPA or Environmental Department of the Wicklow County Council;
- Audit and review schedule;
- Telephone numbers of NPWS and IFI; and
- List of specialist pollution clean-up companies and their telephone numbers.

The plan must include adequate measures and processes to ensure that any spillages will be immediately contained, and that contaminated soil will be removed from the proposed development and properly disposed at a suitable facility.

Measure to avoid and reduce the risks of minor leaks and spill are set out in the CEMP (**Appendix 5.1**), as are good housekeeping measures which also contribute to avoiding leaks and spills. These include:

- Potential pollutants will be adequately secured against vandalism and will be provided with proper containment according to the relevant codes of practice.
- Vehicles and equipment will be maintained by a suitably trained person and checked on a regular basis.

- Daily vehicle and equipment checks will include a visual assessment for oil or lubricant leaks prior to use.
- Vehicles will be parked on hardstanding areas overnight or when not in use, as applicable.
- Vehicles will minimise tracking over natural, exposed or unfinished surfaces, where practicable.
- Vehicles will not track over recently reinstated soils.
- Drip trays will be placed underneath any standing machinery to prevent pollution by oil/fuel leaks during refuelling. Where practicable, cleaning and refuelling of vehicles and machinery will be carried out on an impermeable surface in one designated area well away from any watercourse or drainage.
- Good housekeeping in line with industry best practises (e.g. CIRIA) will be adhered to including daily site clean-ups, use of disposal bins, etc.).
- Discharges from dredge material stored in site compounds are not considered an accidental leak or spill and the construction strategy contains measures designed to avoid and reduce any potential negative impacts to underlying soils and land, including through use of geotextile lines and bunds, as appropriate, at site compounds and the adoption of a procedure of temporary halts of loaded haulage vehicles on slopes within an appropriate vicinity of the river source to allow for drainage to remain within the source area, thus minimising movement of discharge across the site.

Use of imported materials during construction

See **Chapter 15**, *Resource and Waste Management***.**

Compression of Substrata

All WPs:

- Ground settlements will be controlled through the selection of a foundation type and method of construction which are suitable for the particular ground conditions,
- Excavations shall be kept to a minimum, using shoring or trench boxes where appropriate. For more extensive excavations, a temporary works designer will be appointed to design excavation support measures in accordance with all relevant guidelines and standards.

WP5: The potential impact of the installation would likely to be localised to the vicinity of the footprint of the embankment and works would be temporary. Soft soils will be removed during construction of the foundation to create a stable base and a geotextile membrane will be placed over the formation to strengthen the foundation. During construction of foundations, stump holes will be filled and compacted by power-driven hand tampers. Additionally, if a silty or clayey foundation soil has a high-water table and high degree of saturation, the surface will be compacted using lightweight compaction equipment.

This activity will be confined to the footprint of the embankment and will take place after stripping and storage of topsoil. The embankment will be constructed of suitable, compacted materials to ensure stability.

Potential impact on surrounding ground

Ground settlements will be controlled through the selection of a foundation type and method of construction which are suitable for the particular ground conditions:.

WP1: Mitigation measure for ground stability during intrusive works is designed into **Chapter 5**, *Construction Strategy* and chiefly comprises the grouting works at Arklow Bridge and the temporary works design.

During WP4 and WP5, at some locations existing walls will be retained for flood defence walls, where practicable – Refer to **Chapter 4**.

Appropriate dewatering methodologies must be used (see **Chapter 5**, *Construction Strategy* for further detail).

Trafficability of soils

During all WPs:

- Significant project vehicle and equipment movements will be along agreed predetermined routes along existing national, regional and local routes. Where compaction occurs due to truck movements and other construction activities on unfinished surfaces, remediation works will be undertaken to reinstate the ground to a condition if at least equal quality to the original surface.
- Vehicles will minimise tracking over natural or unfinished surfaces, where practicable.
- Vehicles will not track over recently reinstated soils, should these be present.
- River access will be constructed of a suitable hard material such as hardcore
- Heavy vehicles and equipment will be parked on hardstanding areas overnight or when not in use, as applicable.
- Where practicable, compaction of any soil or subsoil which is to remain in situ in the works area will be avoided.
- Care will be taken to ensure that the side slope surfaces of bunds and haul roads are stable to minimise erosion.

In WP1, the river access may be developed on top of the bund to minimise the extent of potential impacts and reduce the overall effects, if practicable.

In WP2, where suitable, inert dredge material may be used as infill material in construction of the embankment during WP5.

Loss of geology and soils

All WPs:

- A soil management plan is included in the CEMP and will be developed further by the contractor prior to the commencement of the works and updated, as required, during construction. This plan identifies the actions that will be taken to avoid reducing the quantity of soils present on the site. Measure will include:
  - Topsoils and subsoils will not be mixed
  - Soil stockpiles will be covered with suitable materials
  - Vehicles will not track over recently reinstated soils, should these be present.
- Care will be taken to ensure that the side slope surfaces are stable to minimise erosion. This will be achieved through the selection of suitable material and adoption of an appropriate side slopes. If there is insufficient space to allow for a suitable side slopes, supports to sides will be provided by precast concrete traffic barriers.
- Suitable inert material will be used as infill, wherever this is required,
- Where possible excavated material will not be stockpiled within 10m of the Avoca River or the channel in the Arklow Town Marsh. Where this measure is not implementable, then specific silt control measures will be implemented as part of the detailed method statement for site works in each specific area (refer to **Chapter 5**, Construction Strategy for detail).
- Precautions will be taken to minimise the runoff of soils into watercourses through the implementation of erosion and sediment control measures as set out in the **Chapter 14**, Water.
- Soil and materials will be transported in appropriate dump trucks to minimise the loss of material in transport.
- Earthworks operations will be carried out such that surfaces will be designed with adequate falls, profiling and drainage to promote safe runoff and prevent ponding and flooding.
- Soils removed during excavation activities will be reinstated where possible.

During all Work Package with in-river work areas:

- Bunding of any in-river working areas with be used to minimise the loss of riverbed or bank sediments
- Bunds will be formed of suitable inert materials. These will generally be formed from permeable material with an impermeable liner such as heavy-duty polythene or sandbags.

During WP 4 and WP5:

- All excavated material will, where possible, be reused as construction fill. The appointed contractor will ensure acceptability of the material for reuse for the proposed development with appropriate handling, processing and segregation of the material.
- This material will have to be shown to be suitable for such use and subject to appropriate control and testing according to the Earthworks Specification(s). These excavated soil materials will be stockpiled locally within the working area where possible, using an appropriate method to minimise the impacts of weathering. Care will be taken in reworking this material to minimise dust generation, groundwater infiltration and generation of runoff. Any surplus suitable material excavated, that is not required elsewhere for the proposed development, will shall be used for other projects where possible, subject to appropriate approvals/notifications.
- It is anticipated that excavated topsoil will be reused in soft landscaping, where practicable.
- Water for disposal will be pumped to sedimentation tank before discharge to canal or river.

Potential impact of dewatering - in river dewatering

An appropriate dewatering methodology will be selected for works. This will consider the risk of any ground instability arising from dewater activities to potentially sensitive receptors in proximity to the works area. Arklow Bridge will be considered a sensitive receptor in WP1. Sensitive structures are comprised of material assets and would typically include but not be limited to, nearby buildings, highways, and protected structures.

During WP1 and WP3:

- Discharge from the dewatering process will be passed through a proprietary silt removal system located within the working area where possible, before discharge to the Avoca River.
- Industry best practices will be followed in the use of bunds.

During WP 3 there will be two stages of stage development in the construction of the debris trap, where on completion of the northern half of the debris trap, the bund material will be removed and used to form a bund around the southern half of the debris trap.

For mitigation measures for potential impact on surrounding ground from dewatering, refer to subsection '**Potential impact on surrounding ground'.**

Potential impact of dewatering - terrestrial dewatering

An appropriate dewatering methodology will be selected for works. This will consider the risk of any ground instability arising from dewater activities to potentially sensitive receptors in proximity to the works area. Sensitive structures would typically include but not be limited to, nearby buildings, highways and protected structures such as Arklow Bridge.

During WP1, WP3, and WP4:

- Discharge from the dewatering process will be passed to a proprietary silt removal system located within the working area before discharge to the Avoca River.

For mitigation measures for potential impact on surrounding ground from dewatering, refer to subsection '**Potential impact on surrounding ground'.**

Potential impact on bedrock aquifer.

Mitigation not proposed as impact is considered to be negligible.

13.6.1.2 Mitigation During Operation

Mitigation measures, proposed for the construction phase, will be implemented for maintenance operations, where relevant.

Maintenance of debris trap and gravel trap

WCC will adhere to OPW guidance (Brew and Gilligan 2019) to ensure due care is taken during debris and gravel trap clearance and periodic routine dredging prior to works commencing. Suitable permanent river access measures will be developed during construction for river access.

WCC will undertake appropriate testing of materials prior to their removal from the river to determine the physio-chemical properties of material and classify the material so it can be identified as suitable for reuse or disposed of at an appropriate facility (see **Section 15.4.3** of **Chapter 15,** *Resource and Waste Management* for detail on the management of general construction waste during operations).

13.6.2 Monitoring

13.6.2.1 Monitoring During Construction

Excavations in made ground will be monitored by an appropriately qualified person to ensure that any contaminated material is identified, segregated and disposed of appropriately. Any identified hotspots shall be segregated and stored in an area where there is no possibility of runoff generation or infiltration to ground or surface water drainage. Care will be taken to ensure that the hotspot does not cross-contaminate clean soils elsewhere.

Any excavation shall be monitored during earthworks to ensure the stability of side slopes and to ensure that the soils excavated for disposal are consistent with the descriptions and classifications according to the waste acceptance criteria testing carried out as part of the site investigations. Refer to **Chapter 15**, *Resource and Waste Management*.

Monitoring for settlement will take place during in all work packages, refer to Chapter 5, Construction Strategy for details.

13.6.2.2 Monitoring During Operation

Mitigation measures, proposed for the construction phase, will be implemented for maintenance operations, where relevant.

Maintenance of debris trap and gravel trap

Appropriate testing of dredged material to identify potential contamination will be undertaken prior to dredging and at suitable intervals during dredging.

Installed infrastructure

Ongoing routine inspection of the infrastructure for leaks will be carried out during operation.

13.7 Residual Effects

With the implementation of the proposed mitigation measures and monitoring, the effect of the proposed development on land and soils is considered to be of negligible magnitude and imperceptible significance during construction and operation.

13.7.1 Residual effects during construction

The significance ranking of 'imperceptible' is the lowest ranking available in the NRA (2008) impacts assessment methodology. The majority of potential impacts are considered to be of 'imperceptible' significant prior to mitigation. The residual effects during construction are considered for the following features that rank of greater significance than 'imperceptible' prior to mitigation.

Trafficability of soils

It is anticipated that the mitigation measures will reduce the 'magnitude' of the potential impact ranking to 'negligible' and the residual significance ranking of the potential impact will be 'imperceptible'.

Loss of geology and soils

It is anticipated that the mitigation measures will reduce the 'magnitude' of the potential impact ranking to 'negligible' and the residual significance ranking of the potential impact would be 'imperceptible'. The residual significance remains 'slight' for loss of geology and soils where dredge is permanently removed from the river bed.

Accidental leaks and spills

Mitigation measures are proposed to reduce the risk of leaks or spills occurring by adopting measures to avoid leaks or spills occurring and/or to reduce the degree of the potential impact should leaks or spills occur. It is anticipated that the mitigation measures would reduce the magnitude of attribute to 'negligible' during all work packages and the residual significance ranking of the potential impact would be 'imperceptible'.

This considers the risk of normal 'day-to-day' activities and minor incidents and does not include major accidents which are discussed in **Chapter 18,** *Major Accidents*.

Encountering known or unknown existing contamination

Mitigation measures are proposed to reduce the likelihood of encountering and/or disturbing contamination, and accidently transporting contamination across of beyond the scheme area. It is anticipated that the mitigation measures would reduce the 'magnitude' of the potential impact ranking to 'negligible' for all work packages and the residual significance ranking of the potential impact would be 'imperceptible'.

13.7.2 Residual effects during operation

Neutral residual effects are anticipated during operation, with periodical localised and short-term dredging used to prevent the continual accumulation of materials at the gravel trap and debris trap during maintenance activities.

The residual significance ranking of the potential impacts would likely be 'imperceptible' to 'slight' and in line with Work Package 3.

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