15 Water

15.1 Introduction

This chapter describes the likely significant effects associated with the construction and operation of the proposed development on surface and coastal water quality, the existing hydrological regime, including flood risk and coastal processes. Groundwater features of relevance and hydrogeology have been considered separately in **Chapter 14**.

Chapter 4 provides a full description of the proposed development whilst **Chapter 5** describes the Construction Strategy. The following aspects are particularly relevant to the water assessment:

- Design:
  - Interceptor Sewers and Storm Water Overflows (SWOs);
  - WwTP and outfall design; and
  - Hydrology and flood risk due to permanent sewer encroachment in the Avoca River.
- Construction:
  - Interceptor sewer construction by open cut excavation and tunnelling;
  - WwTP and outfall construction; and
  - Flood risk due to the presence of temporary causeway construction in the Avoca River.
- Operation:
  - Performance of the SWOs;
  - Performance of the treated effluent discharging via the outfall;
  - Operation of the WwTP; and
  - Flood risk during operation of the proposed development

15.2 Assessment Methodology

15.2.1 General

The proposed development includes works within and adjacent to the Avoca River and the Irish Sea therefore, potential direct and indirect effects on surface and coastal waters during construction and operation of the proposed development have been considered herein.

15.2.1.1 Hydrology and Water Quality

The hydrological assessment has considered the likely significant effects of the proposed development on surface watercourses and hydrological features in proximity to the proposed development during construction and operation. This includes in particular, the Avoca River and Estuary, the Irish Sea and the Arklow Town Marsh proposed Natural Heritage Area pNHA (site code 001931 - Refer to **Chapter 11** for further information).

An investigation of the impact of discharges from the proposed treated effluent outfall and the SWO at the WwTP site on coastal water quality (Irish Sea) has also been undertaken. Irish Hydrodata has undertaken this assessment and has prepared a report (Refer to **Appendix 15.2**).

A hydraulic assessment of the proposed interceptor sewer (including the temporary causeway required during construction) and associated encroachment in the river channel has also been undertaken by Hydro Environmental (Refer to **Appendix 15.3**).

A hydraulic model has been prepared for the catchment and has considered the potential impact of any spills associated with SWOs proposed as part of the interceptor sewer network (Refer to **Appendix 15.4**). Infoworks software was used to model the existing and future wastewater collection system and to design the proposed interceptor sewers to achieve the required design parameters. The hydraulic model of the future system (incorporating the proposed interceptor sewers, SWOs and the WwTP) was run with Time Series Rainfall (TSR) event for assessment of spill frequency and volume of discharge via the proposed SWOs at the WwTP, South Quay and at the Alps. SWO performance assessment was carried out to assess its impact on the Avoca River in accordance with the requirements in the Irish Water Standard[1].

15.2.1.2 Coastal Processes

The assessment of coastal processes examines the existing coastal processes in the area and assesses the likely significant effects of the proposed long sea outfall, SWO at the WwTP and the revetment may have on the dynamic coastal system during the construction and operation of the proposed development (Refer to **Appendix 15.5** for further information).

The assessment consists of a desktop study of the site metocean conditions (including metocean, tidal levels, extreme sea level, currents, wind and wave data), ground conditions and environmental constraints, as well as any other relevant historical information and aerial photographs.

Wave propagation from offshore to the proposed locations was also modelled using MIKE21-SW. Sediment transport patterns have been estimated using the CERC formula[2].

[1] Irish Water (2017) Technical Standard: Storm Water Overflows. Document No: IW-TEC-800-03. Revision 1.0 (October 2017)
[2] U.S. Army Corps of Engineers (1984) 'Shore Protection Manual'

15.2.1.3 Flood Risk

As outlined in **Section 15.2.1.1,** hydraulic modelling and two reports have been prepared by Hydro Environmental and Byrne Looby to assess flood risk from the sewer network within Arklow (Refer to **Appendix 15.3 and Appendix 15.4** respectively).

A flood risk assessment (**Appendix 15.6**) has considered the likely significant effects of the proposed development on flood risk at the WwTP site. Flood risk from multiple sources have been considered including coastal/tidal flooding, fluvial flooding, pluvial flooding and groundwater flooding, as well as the potential risk of a breach of the revetment at the WwTP site.

15.2.2 Guidance and Legislation

This assessment has been undertaken with due regard to the overarching EIA guidance (described in **Section 1.4.3 of Chapter 1**).

The following provide the statutory framework for the protection and control of river and transitional/coastal water quality:

- Council Directive 2000/60/EC[3] establishing a framework for Community action in the field of water policy (the WFD)
- European Union Environmental Objectives (Surface Water) (Amendment) Regulations 2015 (S.I. No.386 of 2015) [4]
- European Communities (Quality of Salmonid Waters) Regulations 1998 (S.I. No. 293 of 1998) [5]

Each of these are described in **Sections 15.2.2.1** and the National Planning Guidelines[6] have also been given due regard during the assessment (Refer to **Section 15.2.2.5** for further detail).

15.2.2.1 Water Framework Directive

The WFD aims at improving the water environment in the EU and requires all Member States to protect and improve water quality in all waters so that they achieve good ecological status by 2015 or, at the latest, by 2027.

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[3] Directive 2000/60/EC of the European Parliament and of the Council, as amended by Decision No 2455/2001/EC of the European Parliament and of the Council, Directive 2008/32/EC of the European Parliament and of the Council, Directive 2008/105/EC of the European Parliament and of the Council, Directive 2009/31/EC of the European Parliament and of the Council and Directive 2013/39/EU of the European Parliament and of the Council.
[4] European Communities Environmental Objectives (Surface Waters) Regulations 2009 (SI No 272 of 2009) as amended by the European Communities Environmental Objectives (Surface Waters) (Amendment) Regulations 2012 (SI No. 327 of 2012); and the European Communities Environmental Objectives (Surface Water) (Amendment) Regulations 2015) (SI No 386 of 2015). And defined as "European Communities Environmental Objectives (Surface Waters) Regulations 2009 – 2015"
[5] "European Communities (Quality of Salmonid Waters) Regulations 1988 (SI No 293 of 1988)"
[6] Office of Public Work and Department of the Environment, Heritage and Local Government in (2009) The Planning System and Flood Risk Management Guidelines for Planning Authorities

The WFD has been transposed in Ireland by the European Communities (Water Policy) Regulations 2003 (S.I. No. 722 of 2003)[7]. The WFD applies to rivers, lakes, groundwater, and transitional coastal waters and requires that management plans are prepared on a river basin basis through the specified structured method.

The River Basin Management Plans (RBMPs) have been prepared to protect and improve Ireland's water environment. They are reviewed and updated every six years. The first RBMPs covered the period 2009 to 2014 and identified the waterbodies that may not meet the environmental objectives of the WFD by 2015. The latest RBMPs (for 2018 to 2021) were published in April 2018 and these set out the actions to improve water quality and achieve 'good' ecological status in water bodies (rivers, lakes, estuaries and coastal waters) by 2027.

15.2.2.2 Bathing Water Directive

Council Directive 2006/7/EC concerning the management of bathing water quality and repealing Directive 76/160/EEC (The Bathing Water Directive) aims to improve the protection of bather's health and provides standards for water quality and method of assessment. It is transposed into Irish law as the Bathing Water Regulations, 2008 (SI No. 79 of 2008).

Bathing waters are classed into quality categories, being 'Excellent', 'Good', 'Sufficient' or 'Poor' with a minimum target of 'Sufficient' required to be achieved for all bathing waters.

Local authorities are responsible for bathing water quality in their areas in addition to monitoring bathing water quality and making information available to the public on water quality during the summer season. The EPA publishes a Bathing Water Quality report (latest report in 2017) which assesses compliance with the standards. The 2017 report is based on monitoring covering the 2014 – 2017 period.

15.2.2.3 The European Union Environmental Objectives (Surface Water) (Amendment) Regulations, 2015

The European Union Environmental Objectives (Surface Water) Regulations 2015, as amended, provide a more complete and stringent set of surface water quality regulations which address the requirements of the WFD and Council Directive 2006/11/EC on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community. These regulations specify the conditions and physico-chemical concentrations that should be considered in the assessment of surface water quality.

[7] "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); the 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 the European Communities (Drinking Water) Regulations 2014 (S.I. No 350 of 2014)." And defined as European Communities (Water Policy) Regulations 2003 – 2014.

These regulations also give effect to Council Directive 2008/105/EC on environmental quality standards in the field of water policy.

15.2.2.4 European Communities (Quality of Salmonid Waters) Regulations, 1988

Legislation for salmonid waters was first established under Council Directive 78/659/EEC on the quality of freshwaters needing protection or improvement in order to support fish life (the Freshwater Fish Directive). The Freshwater Fish Directive was subsequently superseded by the European Communities (Quality of Salmonid Waters) Regulations 1988.

The Freshwater Fish Directive defines freshwaters as being waters capable of supporting Salmon (*Salmo Salar*), Trout (*Salmo trutta*), Char (*Salvelinus*) and whitefish (*Coregonus*) and are hereby designated as Salmonid waters.

The surface water quality standards specified across a range of relevant legislation are outlined in **Table 15.1 in Appendix 15.1**.

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

In November 2009, the (then) Department of Environment, Heritage and Local Government and the Office of Public Works jointly published their guidance[6]. The aim of the Guidelines is to ensure that flood risk is neither created nor increased by inappropriate development.

The Guidelines[6] are issued under Section 28 of the Planning and Development Act 2000, as amended and planning authorities and An Bord Pleanála are therefore required to implement these guidelines in carrying out their functions under the Planning Acts. The Guidelines[6] require the planning system to avoid development in areas at risk of flooding, unless the development can be justified on wider sustainability grounds and the risk can be reduced or managed to an acceptable level.

The Guidelines[6] specifically require the adoption of a Sequential Approach (to Flood Risk Management) of Avoidance, Reduction, Justification and Mitigation and they require the incorporation of Flood Risk Assessment into the process of making decisions on Planning Applications and Planning Appeals. Fundamental to the Guidelines[6] is the introduction of flood risk zoning and the classifications of different types of development having regard to their vulnerability.

The management of flood risk is therefore a key element of any development proposal in an area of potential flood risk and should therefore be addressed as early as possible in the site master planning stage.

15.2.3 Study Area

15.2.3.1 Hydrology and Water Quality

This study area comprises all surface water catchments that could potentially be impacted by the proposed development and is illustrated in Figure 15.1.

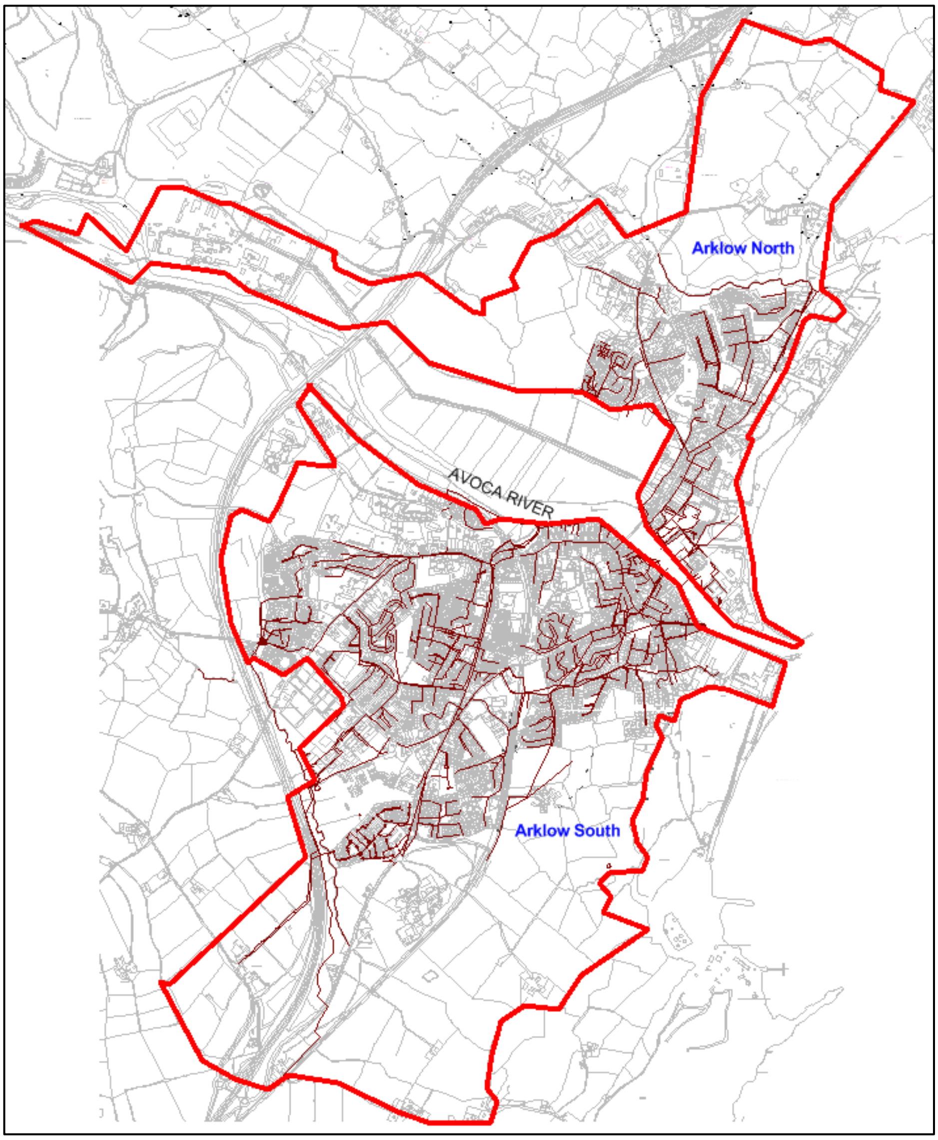

Figure 15.1: Extent of Drainage Catchment impacted by Proposed Development

The study area for the assessment of treated wastewater discharges to the Irish Sea was the Arklow coastal area (Refer to **Appendix 15.2** for further details. The main areas of concern for the assessment were potential impacts on nearby bathing waters, which include Brittas Bay and Clogga, as well as two European sites (Wicklow Head Reef and Blackwater Bank SACs) and the Arklow Town Marsh pNHA.

15.2.3.2 Coastal Processes

The study area for the coastal processes assessment is as illustrated in Figure 15.2, however where further detail is available and relevant on coastal processes in the wider area of interest adjacent to the study area, this has been considered accordingly as part of this assessment. The coastline in the vicinity of the site consists of beaches limited by headlands. Barriers such as headlands accompanied by change in orientation of the adjoining areas suggest limited exchange of sediment between them. The proposed development is located within the Kilmichael Point to Mizen Head area, in a stretch of coastline that is limited to the south by breakwaters which protect the entrance to Arklow harbour, and to the North by the headland located at the north end of the Arklow North Beach. The extent and features of this sub-physiographic unit defined as an Area of Interest are shown in Figure 15.2.

15.2.3.3 Flood Risk

The study area for the Flood Risk Assessment incorporates the planning boundary of the proposed development.

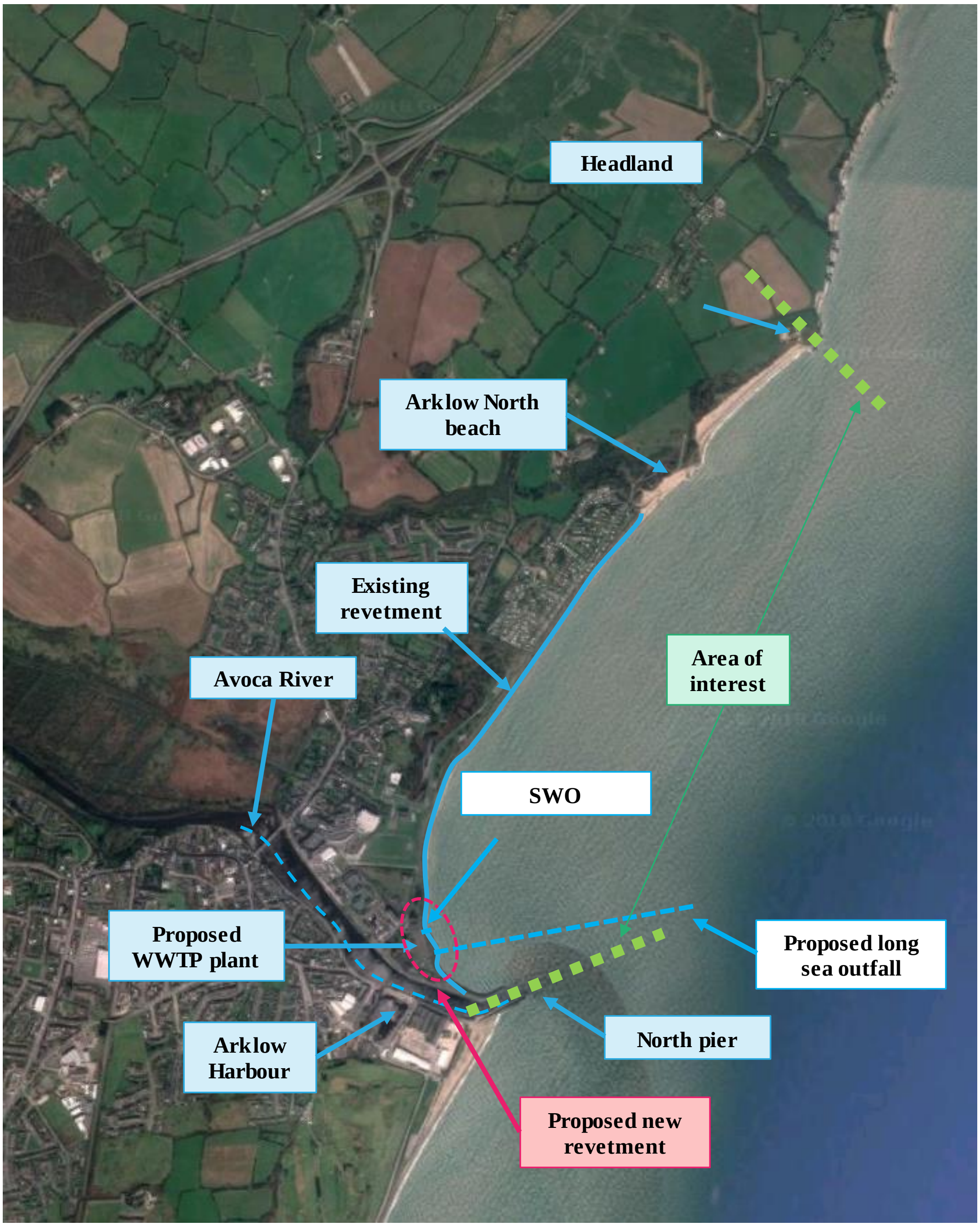

Figure 15.2: Main study area for coastal processes assessment – Extent and features of the Area of Interest

15.2.4 Site Visits

An inspection of the existing revetment was carried out in February 2017 by a chartered senior maritime engineer from Arup. During the inspection visit, the conditions of the structure were assessed and the damage levels evident in different areas of the revetment were investigated.

The topography of the site was studied during a site visit undertaken in April 2018. During the visit, several photographs were taken by members of the project team, which were subsequently used for the assessment.

15.2.5 Consultation

The EPA and Inland Fisheries Ireland were contacted to obtain relevant biological and physico-chemical water quality data for the Avoca River/Estuary.

The project team met Inland Fisheries Ireland on 16 March 2018 to discuss the proposed development (in conjunction with representatives from the proposed Arklow Flood Relief Scheme who were also present to discuss their proposal given the physical overlap of the two schemes within the river channel). An overview of the proposed development was provided.

The physico-chemical water quality information for the period 2008-2017 and the biological water quality (Q Values[8]) information for the period 1974 to 2015 for the Avoca River was provided by the EPA in April 2018.The transitional/coastal water quality information for the Avoca Estuary for the period 2008 to 2017 was provided by the EPA in May 2018.

The water quality status with regard to fish population based on a fish stock survey conducted in the Avoca Estuary in 2015 by Inland Fisheries Ireland was provided in May 2018.

15.2.6 Categorisation of the Baseline Environment

15.2.6.1 Water Quality

A desktop study of relevant water quality data has been undertaken to obtain information on the existing surface water quality within the study area. The following documentation and sources were reviewed as part of this desktop study:

- Survey information from the EPA on the water quality of the study area has been obtained[9]. Specifically, water quality data was collected from the EPA's monitoring stations on the Avoca River (River water quality status of the Avoca River is recorded at the EPA's river water quality monitoring stations [RSA10A031140 and RSA10A031200] located upstream of the Arklow Bridge). The water quality status of the Avoca Estuary is recorded at the EPA's transitional water quality monitoring stations (AV10, AV20, AV30 and AV40). Figure 15.3 shows the location of the EPA monitoring stations;
- There is a now a national RBMP based on a single national River Basin District for 2018 - 2021 which were published in April 2018 and sets out the actions that Ireland will take to improve water quality and achieve 'good' ecological status in water bodies (rivers, lakes, estuaries and coastal waters) by 2027. The information contained in the RBMP was reviewed in relation to water quality[10];

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[8] Note - Q values are biotic indicators used to express biological water quality that are based on changes in the macroinvertebrate communities of riffle areas brought about by organic pollution. A seriously polluted river is indicated by Q1 while Q5 indicates unpolluted waters of high quality.
[9] EPA(2018), River water quality reports and maps. Available from: https://gis.epa.ie/EPAMaps/ [Accessed: 27 April 2018)]
[10] RBMP . Available from https://www.housing.gov.ie/water/water-quality/river-basin-management-plans/river-basin-management-plan-2018-2021 [Accessed: 10th July 2018)]

- European Communities Environmental Objectives (Surface Water) Regulations 2009-2015 require monitoring of phytoplankton biomass (chlorophyll), phytoplankton composition and macroalgae in transitional and coastal waters**.** However, it is understood from consultation with the EPA that phytoplankton biomass (chlorophyll) and phytoplankton counts only are used to determine the biological quality element in Arklow transitional/coastal waters. (Refer Tables 15.3 and 15.4 in **Appendix 15.1** for further detail). Biological water quality information was obtained from EPA in the form of Q values[11] and chlorophyll concentrations (Phytoplankton Biomass) in Arklow transitional/coastal waters. The rating for the Q values are shown in Table 15.2 in **Appendix 15.1**;
- Reports were also taken from the Irish WFD website[12] in relation to the water quality status of the Avoca Estuary. Information on the WFD Risk status in relation to the Avoca Estuary was also obtained from EPA website (https://gis.epa.ie/EPAMaps/).

Coastal Water Quality

Background water quality for the Arklow coastal area was derived from EPA[13] and Marine Institute[14] monitoring datasets.

[11] EPA (2018) Q value for the Avoca-Vartry hydrometric area. Available from: http://www.epa.ie/QValue/webusers/ [Accessed: May 2018]
[12] www.wfdireland.ie [Accessed: May 2018]
[13] EPA Water Framework Directive monitoring programme for Transitional and Coastal Waters (TraCs), 2017-2016
[14] Marine Institute, Winter nutrient monitoring western Irish Sea, Arklow Transect, June 2018

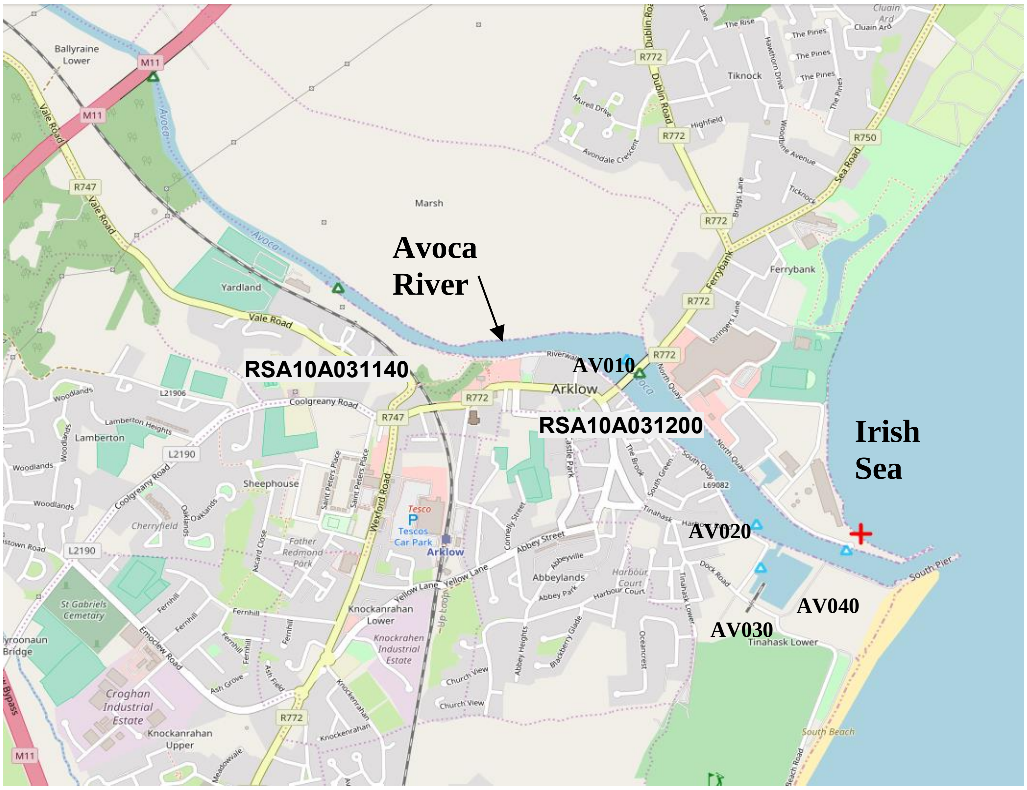

Figure 15.3: Study Area and water quality monitoring stations in Avoca River (extracted from EPA[15]

15.2.6.2 Hydrological Regime

Hydrological Regime

The drainage characteristics of the existing environment were obtained through a desktop study utilising existing topographical surveys to establish the existing drainage routes and storage areas within the study area.

A desktop study was undertaken to establish the baseline information for the study area in relation to flooding and the hydrological regime. Previous flood studies that have been reviewed include the National Preliminary Flood Risk Assessment (PRFA)[16] and the current fluvial flood extent maps[17]. Further, the Strategic Flood Risk Assessment Report produced for Arklow LAP was reviewed with regard to existing and predicted flooding within the study area.

The hydraulic model of the existing and future sewer system was run for various modelling scenarios as per specific recommendations given in the Greater Dublin Strategic Drainage Study (GDSDS) Final Strategy Report[18] for carrying out joint probabilistic flooding assessment of Arklow Sewer Network.

[15] https://gis.epa.ie/EPAMaps/
[16] The National Preliminary Flood Risk Assessment (PFRA) Overview Report (2012)
[17] http://www.floodinfo.ie/map/floodmaps/[Accessed: May 2018]
[18] Greater Dublin Strategic Drainage Study (GDSDS) Final Strategy Report (2005)

The flood simulations undertaken by Hydro Environmental assessed the existing and predicted flood risk due to sewer encroachment and temporary causeway construction in the Avoca River.

15.2.6.3 Coastal processes

A desktop study of relevant data has been undertaken to obtain information on the existing coastal processes within the study area. The following documentation and sources were reviewed as part of this desktop study:

- J.P Byrne & Partners (1990) Coastal Protection Works at North Beach Arklow;
- Byrne, J.P. and Motherway, F.K. (1990) 'Design and construction of coastal protection works at north beach, Arklow, Co Wicklow', Paper presented to a seminar on 'Engineering for Coastal protection' at the Institution of Engineers of Ireland;
- Ordnance Survey Map, 1980. Sheet 40;
- Irish Hydrodata Limited report, 'Arklow WWTP Comparison of marine bathymetric data sets, Irish Hyrdodata 1985 & 1996 vs GSI Informar 2016'
- Reeve, D., Chadwick, A. and Fleming, C. (2004) Coastal engineering: Processes, theory and design practice;
- U.S. Army Corps of Engineers (2002) Coastal Engineering Manual;
- U.S. Army Corps of Engineers (1984) Shore Protection Manual;
- ICPSS report Irish Coastal Protection Strategy Study Phase 2 - South East Coast;
- Irish Hydrodata Limited report (2018), 'Arklow WWTP Investigation of the Impact of Treated Wastewater discharges to the Irish Sea'
- Aerial historical photographs (Google Earth) and historical photographs; and
- Wave modelling as described in Appendix A of **Appendix 15.5.**

A review of the existing ground conditions at the site, both onshore and offshore, from the ground investigations (Refer to **Chapter 14**) and any available historical information, was also undertaken.

15.2.6.4 Flood Risk

A desktop study was undertaken to establish the baseline information for the study area in relation to flood risk. The information with respect to flood risk considered various flood studies including the National Preliminary Flood Risk Assessment (PRFA)[19], the Irish Coastal Protection Strategy Study (ICPSS)[20] and the Eastern Catchment Flood Risk Assessment and Management Study (Eastern CFRAM)

[19] The National Preliminary Flood Risk Assessment (PFRA) Overview Report (2012)
[20] ICPSS documents: https://www.opw.ie/en/flood-risk-management/floodanderosionmapping/icpss/ [Accessed: May 2018]

flood maps and reports[21]. The Strategic Flood Risk Assessment Report produced as part of the Arklow LAP was also reviewed with regard to existing and predicted flooding within the study area.

The baseline assessment of the coastal revetment protecting the site has been categorised based on a review of the following:

- The results of the revetment inspection discussed in **Sections 15.2.1 and 15.2.3**.
- Observations and photographs taken during the site visit discussed in **Section 15.2.3.**

15.2.7 Impact Assessment Methodology

15.2.7.1 Hydrological Regime and Drainage

The assessment considers the proposed development and how relevant aspects have the potential to change the physical characteristics and thus the drainage and flood characteristics of the study area. The assessment specifically considers how any change interacts with the drainage network and how significant the change is in the context of the relevant legislation.

The baseline data (particularly the topography) has been used to establish drainage characteristics within the study area. The proposed development has been assessed to ascertain if there would be any likely significant effects on the natural drainage and the sewer network within the study area. Hydraulic modelling of the sewer network was carried out in Infoworks software program to assess the performance of the existing sewer network for flooding. Details of the hydraulic assessment are described in **Section 15.2.7.4** with further detail in available in **Appendices 15.3 and 15.4**.

15.2.7.2 Water Quality

Surface Water Quality

Surface water quality has been assessed by determining the baseline as described in **Section 15.2.5.1**, reviewing the data and establishing the likely significant effects as a result of the proposed development based on the parameters outlined in the legislation (Refer to **Section 15.2.2**). To achieve this, the proposed development has been reviewed in detail and considered to assess the likely significant effects on surface water quality. The assessment specifically considers how any change interacts with the receiving waters and how significant is the change in the context of the relevant legislation.

[21] Eastern CFRAM reports and maps available to download from: http://www.floodinfo.ie/ [Accessed: May 2018]

Inland Fisheries Ireland information and guidance[22] was also used in the assessment of construction effects on surface water quality.

Coastal Water Quality

The likely significant effects of the proposed discharges from the long sea outfall and SWO at the WwTP on coastal water quality were assessed using various calculations and hydraulic modelling methods. These included:

- Initial dilution simulations of the outfall diffuser;
- Water circulation modelling;
- Contaminant dispersion modelling.

A jet type model was used to simulate the effluent stream issuing from the diffuser and to estimate the near-field dilutions at the immediate discharge location. Water movements in the wider area were simulated with a 2D-hydrodynamic model driven by tidal forcing. A contaminant simulation model, driven by hydrodynamics was used to evaluate the location-specific impacts of discharges within the mid- and far-field areas. **Appendix 15.2** provides further details of the assessment methodology.

In terms of applicable water quality standards, given that none of the local waterbodies are designated 'sensitive', the minimum design parameters for the plant used in the assessment were those in Table 15.1

Table 15.1: Minimum WwTP Design Standards (Source: Urban Wastewater Treatment Regulations)

Parameters	**Final Effluent Concentration**	**Minimum Percentage Reduction on Source Effluent**
BOD5	25mg/l O2	70 - 90
COD	125mg/l O2	75
SS	35 mg/l	90

The target water quality standards for various environments are listed in Table 15.2 and Table 15.3. The parameters that are most relevant to the proposed outfall are e.coli, intestinal enterococci (IE), dissolved inorganic nitrogen (DIN) and biochemical oxygen demand (BOD). Concentrations for other parameters such as orthophosphate (PO4) and total ammonia (TA) are not specified for coastal waters but are included here for completeness.

Under the European Union Environmental Objectives (Surface Water) (Amendment) Regulations 2015 (S.I. No.386 of 2015)[4], the DIN target must be achieved at the edge of the mixing zone. A regulatory method for determining the extent of the mixing zone is not defined. It is required to be restricted to the proximity of the discharge and be proportionate.

[22] Inland Fisheries Ireland (2016) Guidelines on Protection of Fisheries During Construction Works in and Adjacent to Waters

Various non-binding guidelines for the assessment of discharges have been developed under the EC Common Implementation Strategy for the Water Framework Directive. The general approaches for identifying mixing zones[23] are followed. The design objective of 'High Status' is used to delineate the mixing zone extent.

Table 15.2: Target water quality standards for surface waters (SI 272/2009, SI 386/2015)

Parameter	Transitional Waters	Coastal Waters
BOD (mg O2/l)	<4.0 (Good Status, 95%ile)	Not Specified
Dissolved Oxygen (DO) (% sat)	Summer (95%ile) 80%<DO<120% (35psu) 70%<DO<130% (0psu)	Summer (95%ile) 80%<DO<120% (35psu)
Suspended Solids (SS) (mg/l)	Not Specified	Not Specified
Total Ammonia (mg N/l)	Not Specified	Not Specified
PO4 (mg P/l)	0.06mg/l (0-17psu) median 0.04mg/l (34psu) median	Not Specified
Dissolved Inorganic Nitrogen DIN (mg N/l)	Good Status <2.6mg/l(0psu) median Good Status <0.25mg/l(34.5psu) median High Status <0.17mg/l(34.5psu) median	

Table 15.3: Target bacterial water quality standards for bathing waters

	Bathing Waters Target	Regulation/Code
E.coli	<250 cfu/100ml (Excellent Quality)	Bathing Waters: SI 79/2008, 2006/7/EC Based on 95%ile evaluation
Intestinal enterococci (IE)	<100 cfu/100 ml (Excellent Quality)	

Only three of these target values are of particular significance for the marine outfall. These are e.coli, IE and DIN. The relatively high levels of bacterial contamination in the treated effluent mean that e.coli and IE are usually the most critical parameters in outfall evaluation when bathing areas are located nearby.

There are no standardised decay times for these two parameters as they vary substantially with environmental stress factors including ambient solar radiation, season and water clarity. Typically a conservative e.coli decay time of 12 hours and an IE decay time of 24 hours are used in the industry.

While it is acknowledged that the WwTP will likely comprise two phases (in terms of the process installation), the assessment has considered the full design capacity (36,000PE). Tables 3.8 and 3.9 of **Appendix 15.2** set out the water quality standards that will be achieved in the final effluent and the SWO design standards, respectively.

[23] EC (2009) Technical Guidelines for the Identification of Mixing Zones pursuant to Art.4(4) of the Directive 2008/105/EC.

15.2.7.3 Coastal Processes

The coastal processes assessment uses the desk based study of the historical evolution of the coastline within the study area, previous studies undertaken, as well as the wave modelling and empirical formulae (see **Appendix 15.5**) to assess the likely significant effects of the proposed outfall, revetment and the SWO at the WwTP site on coastal processes.

The impact assessment methodology has categorised the likely significant effects during construction and operation of the proposed development in accordance with the overarching EIA guidance (described in **Section 1.4.3 of Chapter 1).**

15.2.7.4 Flood Risk

Flood risk has been assessed by determining the baseline conditions (fluvial and coastal flood extents) and establishing the likely significant impact of the proposed development on flood risk.

For the site of the WwTP a desktop study is sufficient to assessment the likely significant effects of the proposed development. For the interceptor sewers however, detailed hydraulic modelling has been undertaken in order to assess in detail the impact of construction of the interceptor sewers on flood risk. (Refer to **Appendix 15.3** and **Appendix 15.4**). This information was then used to identify the likely significant effects that the proposed development may have on flood risk along the routes of the interceptor sewers.

The baseline data has been used to establish flood routes, levels and storage areas within the study area. A detailed hydraulic modelling exercise of the Arklow sewerage network incorporating the proposed development was carried out to determine the flooding impacts (Refer to **Appendix 15.4**).

The hydraulic assessment of the existing sewer system of Arklow was carried out to assess baseline existing flooding risk. The hydraulic assessment results indicate that the existing wastewater network in Arklow is significantly under capacity and is predicted to flood at more than 100 locations with flood volumes greater than 25m^3 for a 1 in 30-year storm event. The assessment of the spill volumes shows that approximately 7,566m^3 of raw wastewater is predicted to spill via the existing outfalls into the Avoca River during Dry Weather Flow (DWF).

The above information was then used to identify the likely significant effects that the proposed development may have on flooding in the study area.

15.3 Baseline Conditions

15.3.1 Introduction

The study area is located in the Arklow catchment, in Arklow town, which is located at the mouth of the Avoca River. Arklow Municipal District has a population of 26,185[24] while the urban settlement had a population of 13,163[25].

The key water features in the study area include:

- Avoca River;
- Arklow Estuary;
- Arklow Town Marsh pNHA; and
- Irish Sea.

15.3.2 Hydrology and Water Quality

15.3.2.1 Hydrological Regime

The main hydrological feature within the study area is the Avoca River as shown on Figure 15.4. The Avoca River is the longest river in County Wicklow and it's catchment covers an area of approx. 650km² on the eastern flanks of the Wicklow Mountains. The Avoca River discharges into the Irish Sea in Arklow town.

The main tributaries of the Avoca River, that join the river upstream of Arklow, include the Aughrim, Avonbeg and Avonmore Rivers as shown in Figure 15.5.

The study area drains directly into the Avoca River as overland flow and also via the Aughrim and Avonbeg rivers, their associated tributaries and other manmade drains and/or surface water outfalls within the Avoca catchment. The construction of major motorways and significant residential development throughout Arklow and Aughrim towns has significantly modified the natural drainage characteristics of the catchment of the Avoca River. Figure 15.4 illustrates the catchment of the Avoca River.

[24] Arklow and Environs Local Area Plan 2018 - 2024
[25] Central Statistics Office - census.SWO.ie/sapmap

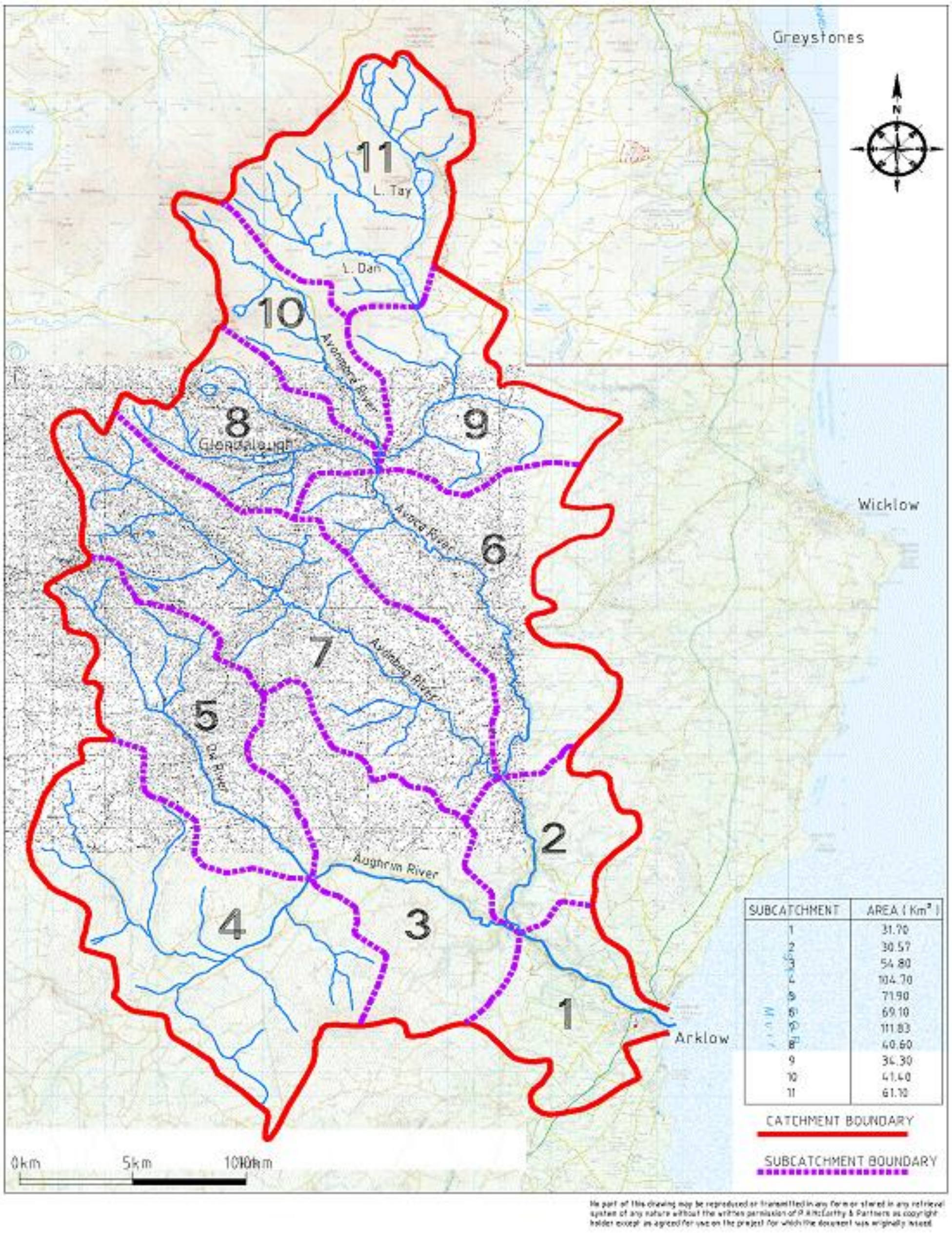

Figure 15.4: Avoca River Catchment

Figure 15.5: Catchment Area and main tributaries of Avoca River

Arklow is divided by the Avoca River, which is crossed by the Arklow Bridge, a stone arch bridge linking the southern of the town with the northern part, called Ferrybank.

Ferrybank is predominantly residential in nature with a large recreational amenity and a wetland wildfowl park at Arklow Town Marsh which is the primary ecological feature that is designated as a proposed natural heritage area (pNHA). Arklow Town Marsh is located to the north of the river channel, extending upstream from Arklow Bridge to within 235m of the M11 flyover. It should be noted that Ferrybank is impacted by fluvial rather than tidal flooding. Flooding occurs in Ferrybank when floodwater exits the Arklow Town Marsh.

The Avoca Estuary is a relatively small, narrow estuary that runs from Pearse Park Yard located near the Alps to Arklow Bay. The river channel (which is part of the Avoca Estuary) is within the Arklow Town Marsh pNHA. The estuary primarily consists of sea walls, boat moorings and piers. The estuary upstream of the Arklow Bridge has steep banks and is heavily wooded with large trees on both banks. The estuary covers an area of 0.17km². Downstream of Arklow Bridge (along the North Quay and South Quay) is prone to tidal flooding. This area experiences periodic flooding from significant tidal events.

It should be noted that water quality in the Avoca Estuary is currently impacted by the discharge of untreated wastewater via 19 existing SWOs and/or outfalls located along the northern and southern sides of the river channel within the study area.

As noted in **Sections 1.4.2 of Chapter 1** and **Section 2.3.1 of Chapter 2**, the practice of discharging untreated wastewater to the Avoca River is not compliant with the obligations of the UWWT Directive[26] and the proposed development is being progressed to address this issue.

Coastal regime

The general bathymetry for the Arklow area is available on the Admiralty chart of the area (See Figure 2.1a in **Appendix 15.2**). The nearshore coastal area was surveyed in 2016 by the Geological Survey of Ireland under the Infomar programme[27] and shows that there are no major differences between the older Admiralty and the more recent Infomar datasets in the vicinity of the proposed development. However, some erosion has taken place locally adjacent to the shoreline, as documented in **Section 15.3.3**.

Tidal ranges are small and the tidal elevation curves are somewhat complex due to the proximity of a degenerate amphidrome near Courtown[28]. Predicted water levels at Arklow (based on a 2015 representative year – See **Appendix 15.2** for further detail) indicate a highest predicted tide level over the year of 0.58m OD while the lowest level is -0.85m OD.

The oceanography at the site, based on previous Irish Hydrodata studies (see **Appendix 15.2** for further detail) can be described as energetic with strong tidal currents, brief slack waters, large tidal excursions and good dispersive characteristics. Durations of slack water at the site are limited, as confirmed by drogue surveys undertaken by Irish Hydrodata in September 2017 (see **Appendix 15.2** for further detail).

15.3.2.2 Water Quality

Surface Water Quality

<u>Avoca River</u>

The quality of surface waters in Ireland is examined regularly by the EPA to monitor performance against a number of biological parameters. The EPA's trophic status assessment compares the compliance of individual parameters against a set of criteria indicative of trophic state. These criteria fall into three different categories which broadly capture the cause-effect relationship of the eutrophication process, namely nutrient enrichment, accelerated plant growth, and disturbance to the level of dissolved oxygen normally present. Each water body assessed is categorised as either eutrophic, potentially eutrophic, intermediate or unpolluted with respect to nutrient enrichment.

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[26] Council Directive 91/271/EEC, as amended by Commission Directive 98/15/EC, Regulation (EC) No 1882/2003 of the European Parliament and of the Council, Regulation (EC) No 1137/2008 of the European Parliament and of the Council and Council Directive 2013/64/EU
[27] GSI Informar data, 2016
[28] Admiralty, 1980, Chart 5058, Co-tidal and Co-range Lines for the British Isles and adjacent waters.

The Avoca River/Estuary falls under 'Transitional Waters' and was given 'Moderate' water quality status by the EPA in the last reporting period 2010 - 2015.

It should be noted that 55 out of the 80 monitored transitional water bodies (69%) were classified at moderate or worse status during 2010 – 2015[29], with 25 (31%) at high or good status. Four water bodies were classified as bad status.

The Q values (i.e. biological quality rating as described in detail in **Section 15.2.6.1**) for the Avoca River within the study area are summarised below (Refer to Table 15.5 in **Appendix 15.1** for further detail):

- The Q value for the Avoca River was '1' in 1990 at Arklow Bridge River Monitoring Station (Station No. RS10A031200) which indicates serious pollution of the river. There has not been any biological quality survey undertaken since 1990 at this monitoring station.
- The river monitoring stations upstream of Arklow Bridge at Shelton Abbey (Station No RS10A031000) and at the footbridge 500m downstream of the Aughrim River and just upstream of the Avoca River confluence (Station No RS10A030900) were last surveyed in 1986 and 1994. The respective monitoring stations were given Q values of 2 and 1 in 1994 indicating serious pollution of the Avoca River at this location.
- The only monitoring station that has been regularly surveyed is at the Avoca Bridge (Station No RS10A030700) which is approximately 10.5km upstream of the Arklow Bridge and 2.6km downstream of the Avoca Mines. A Q value of 3 was determined during the latest survey in 2015. This Q value indicates that the Avoca River is moderately polluted at this location.

The latest Biological River Quality Surveys Report[30] indicates that the paucity of pollution macroinvertebrate fauna continues to indicate poor ecological conditions with toxic effects due to acid mine drainage at Avoca Bridge in July 2015. Further detail on the baseline aquatic ecology conditions is provided in **Section 11.3 of Chapter 11**.

The surface water quality of the Avoca River within the study area was found to have a Q value of less than 4 which is classed as 'polluted' and determined as 'unsatisfactory' condition by the EPA. This indicates significant interferences with beneficial or potential beneficial uses of the Avoca River due to the pollution, in part, caused by discharge of untreated wastewater into the Avoca River within Arklow town via the existing 19 SWOs and/or outfalls.

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[29] EPA Water Quality in Ireland (2010 -2015) - http://www.epa.ie/pubs/reports/water/waterqua/Water%20Quality%20in%20Ireland%202010-2015.pdf

[30] EPA River Quality Surveys: Biological - http://www.epa.ie/QValue/webusers/PDFS/HA10.pdf?Submit=Get+Results – [Accessed 27th April 2018]

In contrast, the main tributaries to the Avoca River – the Aughrim, Avonbeg and Avonmore Rivers which lie outside the study area were given Q values of 4-5 indicating that these rivers are mostly 'unpolluted' and generally in 'satisfactory' condition with respect to beneficial uses.

As noted in **Section 15.2.6.1**, chlorophyll (phytoplankton biomass) and phytoplankton counts have been used to determine the Phytoplankton Biological Quality Element.
The EPA has indicated that in the last assessment (2010-2015) for the Avoca/Arklow Estuary the Phytoplankton Biological Quality Element was assessed as 'High'. This indicates that the estimated values in Avoca Estuary for Biological Quality elements can generally be designated as high ecological status (Refer to **Section 11.3 of Chapter 11** for further details on aquatic ecology).

The EPA's physio-chemical data from the 2013-2015 sampling periods for monitoring points immediately upstream and within the study area are shown in Tables 15.6 - 15.10 in **Appendix 15.1**. The locations of all stations where water quality is monitored are shown in Figure 15.3. In summary, the majority of the parameters are in compliance with the surface water quality standards. Parameters that are above the standards are highlighted in bold in Tables 15.6 – 15.10 in **Appendix 15.1**.

Overall the physio-chemical parameters indicate compliance with the European Communities Environmental Objectives (Surface Water) Regulations 2015[4], with the exception of BOD_5 and Ammonia Total values which were found to be above the limits outlined in these regulations.

<u>WFD Status & Risk</u>

The study area is located within the national river basin district under the RBMP 2018 – 2021.

The most recent water quality status report[31] on the Avoca Estuary showed the following (Refer to Table 1 in **Appendix 15.1** for further detail):

- The overall WFD status of the Avoca River within the study area was 'Moderate' (Refer to Figure 15.6);
- The Avoca Estuary was given 'At risk' status;
- Ecological status for the Avoca Estuary was classed as 'Unassigned' due to insufficient information;
- Chemical surface water status was classed as 'Failing to achieve good';
- Hydro-morphological status was specified as 'Moderate'; and
- A stretch of the Avoca River within the study area fails the Specific Pollutant Conditions.

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[31] Transitional Waterbody WFD Status 2010-2015 IE_EA_150_0100 https://gis.epa.ie/EPAMaps/ [Accessed 3rd May 2018]

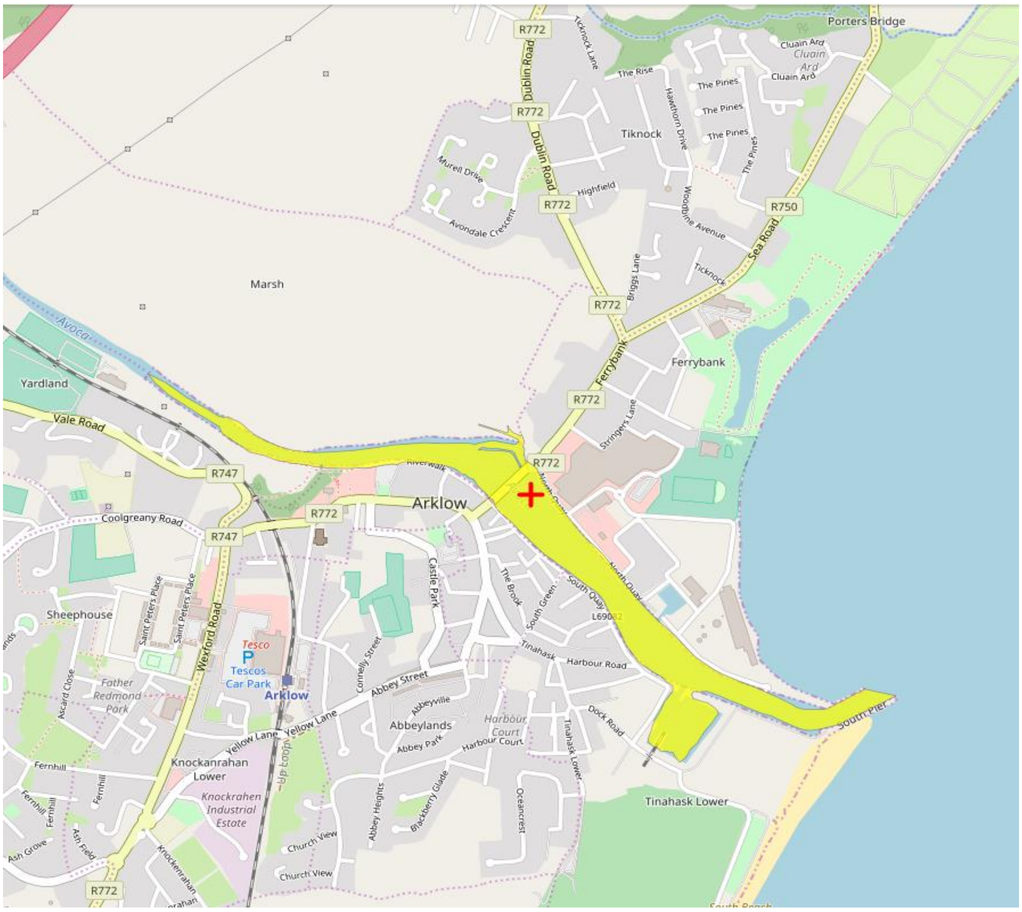

Figure 15.6: Avoca Estuary Water Quality Status – Moderate, WFD (extracted from EPA[15])

Whilst the ecological status was 'unassigned', the Avoca Estuary has been assigned a draft ecological status classification of 'good' (EQR=0.68) based on the fish populations present during a 2015 fish stock survey[32] carried out at sites on the Avoca Estuary by Central Fisheries Board and the Eastern Regional Fisheries Board.

The risk report for the Avoca River[33] identified that the surface water quality is at risk from diffusion contamination, particularly pollutants from road washing activities. The report also specified that at present there is no hydrological risk or morphological risk to the Avoca River. Table 15.4 outlines the WFD's water quality data for the Avoca Estuary.

[32] WFD Fish Stock Survey of Transitional Waters in the Eastern River Basin District – Avoca Estuary 2015

[33] Transitional Waterbodies RiskIE_EA_150_0100 https://gis.epa.ie/EPAMaps/ [Accessed 3rd May 2018]

Table 15.4: WFD Status of the Avoca Estuary 2010 – 2015 (Source: EPA[34])

European_Code	**IE_EA_150_0100**	**Comment**
Name	Avoca Estuary	-
Status	Moderate	-
Period_for_WFD_Status	SW 2010-2015	This data is from the period 2010 - 2015
Bio_Status	Good	Good status indicates that macro invertebrate and fish quality elements assessed were in compliance with WFD standards
Chemical_SW_Status	Failing to achieve good	Chemical status is assessed by compliance with environmental standards for priority substances and priority hazardous substances such as metals, pesticides etc Avoca Estuary is one of the 21% of river water bodies that failed to achieve their chemical status objective during this period.
Dissolved_ Oxygen_ Saturation	Good	Low DO affects aquatic life & organisms that live in the sediments. A good status of DO in Avoca River indicates it supports aquatic life
Fish Status	Good	Good Fish status indicates that fish species composition and abundance corresponds with little anthropogenic disturbance
General Conditions	Good	Good status of general conditions includes oxygenation & nutrient conditions, thermal conditions, transparency salinity
Hydromorphological_Conditions	Bad	Good hydromorphological conditions support aquatic ecosystems (i.e. hydromorphological elements such as water flow and substrate provide physical habitat for biota such as fish, invertebrates and aquatic macrophytes). However, it was classed as Bad for Avoca River which indicates that waterflow and substrate provided are not adequate.
Nutrient Conditions	Good	Monitoring of phosphorus (P) and nitrogen (N) nutrients causing eutrophication, is undertaken by the EPA. A good nutrient condition indicates there is no eutrophication of Avoca river
Other_Nutrient_Conditions	Good	Nutrients other than phosphorus (ortho Phosphate) and nitrogen (Nitrate & Ammonia) were found to be within reference conditions values

[34] EPA Transitional Waterbody WFD Status 2010-2015 IE_EA_150_0100 https://gis.epa.ie/EPAMaps/ [Accessed 3rd May 2018]

European_Code	**IE_EA_150_0100**	**Comment**
Other_Oxygenation_Conditions	High	Oxygenation conditions other than BOD and DO were found to be meet reference conditions values to be classed as High
Oxygenation_Conditions	Good	Oxygenation conditions are classified as Good based on being 99% confident that relevant water quality standards in SI 272 of 2009 are exceeded
Phytoplankton_Status	High	Measure of phytoplankton biomass as concentration of chlorophyll a in µg/l. Degradation in ecological status measured by increase in chlorophyll concentrations assessed against a salinity related threshold.
Specific_Pollutant_Conditions	Fail	All priority substances plus other pollutant substances discharged in significant quantities are measured. An assessment of dangerous substances in Water Framework Directive Transitional and Coastal Waters indicates that face value comparison against standards set out in Schedule 5, Table 10 of SI 272 of 2009 is not met by Avoca Estuary
Supporting_Chemistry_Conditions	Moderate	The values for Supporting Physico-Chemical elements should not exceed levels established so as to ensure: (a) The functioning of ecosystem; and (b) The achievement of the values specified for the biological quality elements. Avoca River is given moderate status as it fails on the supporting physico-chemical quality elements.

Coastal Water Quality

In terms of background coastal water quality, the available data for both the Avoca estuary and coastal waters in the vicinity are provided in Table 15.5, Table 15.6 and Table 15.7.

Table 15.5: Coastal background water quality data (2007 – 2016)

Station No	Sample Depth	Salinity	TON mg/l N	NH_3 mg/l N	DIN mg/l N	BOD mg/l	Season
AV110	0.0	33.22	0.16	0.014	0.174	1.0	Winter
AV110	9.7	33.25	0.15	0.022	0.172	1.0	Winter
AV110	0.0	34.14	0.01	0.016	0.026	1.0	Summer
AV110	9.7	34.17	0.01	0.021	0.031	1.0	Summer
AV120	0.0	28.87	0.21	0.122	0.332	1.0	Summer
AV120	9.8	34.15	0.01	0.023	0.033	1.0	Summer
AV130	0.0	32.93	0.19	0.016	0.206	1.0	Winter
AV130	10.1	33.20	0.15	0.018	0.168	1.0	Winter
AV130	0.0	30.78	0.02	0.017	0.037	1.0	Summer
AV130	6.4	34.12	0.02	0.050	0.07	1.0	Summer
AV150	0.0	33.38	0.14	0.014	0.154	1.0	Winter
AV150	18.0	33.39	0.14	0.022	0.162	1.0	Winter
AV150	0.0	34.14	0.02	0.014	0.034		Summer
AV150	15.0	34.19	0.02	0.012	0.032		Summer
AV160	0.0	33.25	0.14	0.022	0.162		Winter
AV160	13.5	33.36	0.14	0.014	0.154		Winter
Average			0.10	0.026	0.122	1.0	
Median		33.37	0.14	0.017	0.154	1.0	

Table 15.6: Avoca Estuary background water quality data (Station Av010) (2007 – 2016)

Sample Depth	‰	TON mg/l N	NH3 mg/l N	B.O.D. mg/l O2	DIN mg/l N	PO4 µg/l P
0	0.03	2.50	0.05	1.0	2.55	25
0	0.04	2.60	0.03	3.0	2.63	12
0	0.25	2.60	0.03	3.0	2.63	12
0	0.02	0.99	0.05	1.0	1.04	33
0	0.02	1.20	0.08	1.0	1.28	2.5
0	0.03	1.30	0.08	1.0	1.38	6
0	0.03	1.30	0.08	1.0	1.38	6
0	0.04	1.90	0.10	1.0	2	24
0	0.07	2.80	0.14	1.0	2.94	5
0	0.18	2.20	0.20	2.0	2.4	8.4

Sample Depth	‰	TON mg/l N	NH3 mg/l N	B.O.D. mg/l O2	DIN mg/l N	PO4 µg/l P
3	1.28	2.10	0.12		2.22	6.1
3	0.04	1.70	0.14	1.0	1.84	12
0	0.04	1.82	0.055	0.5	1.875	2.5
0	0.03	1.02	0.095	0.5	1.115	5
0	0.06	1.5	0.132	0.5	1.632	7
2.6	0.11	1.49	0.129	0.5	1.619	5
0	2.03	1.43	0.196	1.2	1.626	10
0	2.16	1.36	0.245	1.4	1.605	11
Average	0.36	1.77	0.11	1.21	1.87	10.69
Median	0.04	1.60	0.10	1.00	1.74	7.70

Table 15.7: Clogga Beach and Brittas Bay South bacterial water quality data (2016-2017)

Clogga Beach			Brittas Bay South		
Date	**e.coli/100ml**	**IE/100ml**	**Date**	**e.coli/100ml**	**IE/100ml**
04/09/2017	98	35	04/09/2017	243	25
21/08/2017	160	92	21/08/2017	51	<10
14/08/2017	110	<10	14/08/2017	52	<10
31/07/2017	52	53	31/07/2017	10	10
17/07/2017	<10	<10	17/07/2017	41	<10
03/07/2017	10	<10	03/07/2017	10	<10
19/06/2017	10	<10	26/06/2017	63	13
12/06/2017	20	23	19/06/2017	<10	<10
22/05/2017	<10	10	12/06/2017	20	<10
05/09/2016	605	240	22/05/2017	<10	<10
22/08/2016	10	68	05/09/2016	20	<10
08/08/2016	187	20	22/08/2016	10	12
25/07/2016	122	20	08/08/2016	51	14
11/07/2016	122	73	25/07/2016	10	<10
04/07/2016	<10	<10	11/07/2016	183	53
27/06/2016	<10	<10	04/07/2016	20	<10
13/06/2016	20	<10	27/06/2016	<10	<10
30/05/2016	31	<10	20/06/2016	20	11

The median background values are summarised as follows:

<u>Coastal locations AV110 to AV160 (Refer to Table 15.5):</u>

- DIN = 0.154mg/l N;

- A = 0.017mg/l N

Corresponding values for the estuary location AV010 (Refer to Table 15.6):

- DIN = 1.74mg/l N;
- TA = 0.1mg/l N.

Whilst the median DIN in the Marine Institute data for the sites shoreward of the Arklow Bank is 0.156mg/l N.

Bacterial sampling data is available for both Clogga beach to the south and Brittas Bay beach to the north. Data for the bathing seasons in 2016 and 2017 are listed in Table 15.7. Both beaches are assigned Excellent Status in terms of the Bathing Quality Regulations (e.coli <250 cfu/100ml, IE <100 cfu/100ml).

The calculated 95%ile values based on the last 4 years of sampling data for Clogga are e.coli = 185cfu/100ml and IE = 79 cfu/100ml and for Brittas e.coli = 173 cfu/100ml and IE = 68 cfu/100ml respectively. There is some appreciable overall variation in this data and the results may be impacted either by the existing Arklow town discharges or also possible contamination from more local licensed outfalls.

15.3.3 Coastal Processes

A detailed description of the existing coastal processes in the study area is provided in **Appendix 15.5**. A summary of the main conclusions with regard to the baseline coastal processes is as follows:

- The existing structures (i.e. existing revetment and harbour entrance at the mouth of the Avoca River) influence coastal processes in the study area. The construction of the revetment (in 1972 and subsequent upgrade in 1990) caused the coastline in the study area to be rigidized over a length of approximately 900m as demonstrated by Irish Hydrodata[35].
- Whilst the coastline has been fixed for a number of years, there is evidence of an ongoing natural loss of seabed material as the previously existing beach (in front of the revetment at the WwTP site) is no longer visible. Seabed lowering between 1985 and 2016 in front of the revetment at the WwTP site ranges between 0.5m and 2m. This value in addition to the 30-year difference between the two surveys, suggests that the sediment transport processes in this specific area are limited.
- In areas to the north of the WwTP site, seabed erosion continues to approximately 400m offshore (to a depth of approximately 6m). Beyond this point, the seabed remained relatively stable between the survey dates.

[35] Irish Hydrodata Limited report, 'Arklow WWTP Comparison of marine bathymetric data sets, Irish Hydrodata 1985 & 1996 vs GSI Informar 2016'

Seabed lowering is shown to be higher towards the north, which could be explained by the shelter, provided by the north pier at the entrance, to the southern end of the revetment (i.e. area adjoining the WwTP site).

- The predominant direction of offshore waves along the coastline are north-east and south-east. The main longshore drift of sediments moves from South to North in the study area. Therefore, the two piers (which form the entrance of the Arklow harbour mouth) act as a barrier to sediment transport from the south. Hence, accretion of sediment is expected to be occurring to the south of the study area (south of the entrance to Arklow Harbour) with further loss of sediments likely in the north.
- The existence of the harbour entrance provides shelter to the existing revetment at the WwTP site from wave action from the second quadrant directions (i.e. south to east south-east). This shelter means that the stretch of the revetment to be upgraded is more protected from wave action from the directions coming from the second quadrant (i.e. east-southeast to south) than the remainder of the existing revetment to the north of the WwTP site.
- The stable coastline created by the revetment also means that there is a very limited sediment source existing in the Area of Interest apart from the seabed material and the unprotected areas to the north.
- Based on the results from the desk study and wave model (Refer to Appendix A within **Appendix 15.5**), and considering a return period of five years and climate change, it could be expected that the surf zone, where most of the sediment transport occurs in this scenario due to wave breaking and currents, would be limited offshore to the bathymetric line of -6.5m CD. For annual average conditions, the extent of the surf zone is limited to shallower waters, closer to the coastline.

15.3.4 Flood Risk

Arklow has experienced recurring flooding events in the past, some of which have resulted in damage to property. The largest flood event recorded in the study area was in August 1986 resulting from extreme meteorological conditions commonly referred to as ‘Hurricane Charlie’. The following major flooding events have occurred between 1989 and 2015 - December 1989, November 2000, February 2002, October 2004, October 2005, January 2010, January 2013 and December 2015.

Information on historical flooding events was obtained by reviewing the OPW’s flood database[36]. In total 18 flood events have been recorded in Arklow town since 1986, of which 15 were recorded on the southern side of the Avoca River in Arklow town (Refer to Figure 15.7). Recurring flooding was reported on several sites to the south of the river channel including along South Quay. The Arklow Flood Relief Scheme, is proposed to address this flooding risk.

[36] OPW Floodmaps http://www.floodmaps.ie/View/Default.aspx [Accessed May 2018]

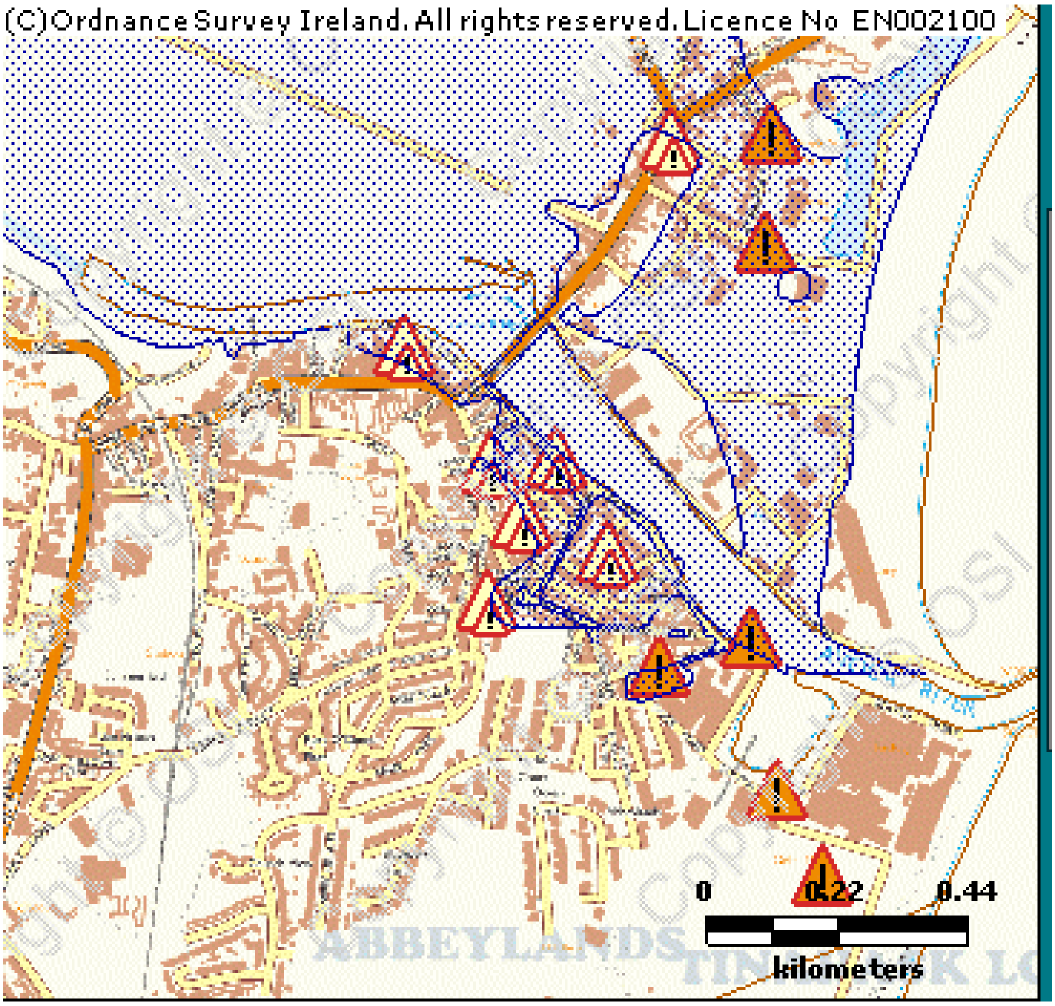

Figure 15.7: Flood events recorded on OPW Flood database (Source: OPW[37]

The WwTP site is not within the historic floodplain. The risk of fluvial flooding to the site of the WwTP is low. The risk of coastal flooding to the WwTP site is also considered to be low (Refer to **Appendix 15.6** for further detail).

Groundwater levels recorded at the site indicate that the groundwater table is circa 2m below ground level. The risk of groundwater flooding to the site is therefore considered to be low. The risk of pluvial flooding to the site is also considered to be low (refer to **Appendix 15.6** for further detail).

The area north of the site of the proposed WwTP is protected from coastal inundation by an embankment. In the event of a breach however the flood risk to the site is considered to be low (Refer to **Appendix 15.6**).

The site of the proposed WwTP is therefore classified as Flood Zone C and a Justification Test for the development is therefore not required.

[37] http://www.floodmaps.ie/

Interceptor Sewers

A hydraulic and flood risk assessment of the proposed interceptor sewer pipe encroachment of the Avoca River channel at Arklow was carried out by Hydro Environmental Ltd (Refer **Appendix 15.3**).

The design flow rates have been derived from the Flood Studies Report (FSR) ungauged catchment characteristic Index Flood Method. Table 15.8 provides the estimated design flood flows in the Avoca River with and without climate change allowance.

The design flood event for the fluvial flood impact assessment is the combined 200-year event represented by the 100 year river flood and the 0.35 year tide (which is the critical combination of fluvial and tidal event). The design flow includes the OPW factors of safety in respect to factorial errors of the Flood Study estimation method.

Table 15.8: Summary of design flood flows with and without climate change

Return Period	Design Flow m^3/s (no climate change allowance)	Design Flow m^3/s (with climate change allowance**)	Design Flow with SFE* m^3/s (no climate change allowance)
2	231	277	340
5	322	386	473
10	381	457	560
25	457	548	672
50	512	614	753
100	568	682	835
200	627	752	922
1000	698	838	1026

*SFE is the standard factorial error of the regression equation used (SFE = 1.47)

** Climate Change Allowance – 20% increase in Flow Rate

15.4 Likely Significant Effects

15.4.1 Do-Nothing Scenario

The do-nothing scenario refers to what would happen if the proposed development was not implemented and appropriate wastewater treatment was not provided in Arklow town. As outlined in **Chapters 1 and 2**, the need for wastewater treatment provision in Arklow town has been well documented in national, regional and local policy as well as legal cases.

The UWWT Directive and the transposing Urban Wastewater Treatment Regulations, 2001, as amended set standards to be met in the collection and treatment of wastewater as well as the monitoring requirements for wastewater discharges from urban areas.

The Directive and the Regulations require that secondary or equivalent treatment is provided for wastewater generated in urban areas such as Arklow. Furthermore, the Water Framework Directive (WFD) sets objectives to reduce the discharge of pollutants to waters, to prevent deterioration in water quality and achieve ‘Good Status’ in all waters over time.

The European Commission is currently taking a case against Ireland at the Court of Justice of the European Union (ECJ) for its failure to ensure that urban wastewater in 38 agglomerations (of which Arklow is one such named agglomeration) is adequately collected and treated to prevent serious risks to human health and the environment. Indeed, the referral decision also raises additional concerns about the failure to ensure that a correct operating licence has been issued for the treatment plants serving the agglomerations of Arklow and Castlebridge.

Notwithstanding the legislative requirements, the provision of appropriate treatment of wastewater in Arklow is required to improve water quality in the Avoca River and enable further development in Arklow town, which is currently constrained by the absence of treatment.

For those reasons, the ‘do-nothing’ scenario was considered to have negative effects with regards to water.

15.4.2 Assessment of Effects during Construction

15.4.2.1 Hydrology and Water Quality

Hydrology

The construction activities associated with the enabling works (as described in detail in **Chapter 5**), including the diversion of utilities and services could have a significant effect on the drainage characteristic of the study area. The existing surface water drainage network that currently discharges into the Avoca River will therefore require diversions/temporary pumping during construction. Further, activities such as stockpiling, hoarding etc can also block overland drainage flow paths, which can result in potential flood risk.

Some construction activities that have the potential to impact the hydrological regime include:

- Temporary stockpiling of material at working areas;
- The erection of hoarding around working areas;
- The release of grouting and cement materials;
- Wash water from dust suppression sprays; and
- Spillage of fuel and lubricants from maintenance of construction vehicles and mechanical equipment.

The construction activities outlined above have the potential to alter the hydrological regime temporarily in the study area. This would be considered a significant short term negative effect.

Drainage

The construction activities associated with the enabling works (as described in detail in **Chapter 5**), includes diversion of existing combined/surface water sewers currently that discharge via outfalls into the Avoca River. These sewer diversions could have a potential short-term significant negative effect on the drainage characteristics by blocking or interfering with existing surface water drains that discharge into the Avoca River during construction of the interceptor sewers.

Water Quality

There are numerous substances used on construction sites that are potential pollutants to water bodies that could affect surface water quality. Runoff from the working areas during construction may contain increased sediment loads, suspended solids and contaminants. This is typical on construction sites and working areas of this nature.

The key construction works involved in the proposed development are open-cut excavation works for the interceptor sewers, revetment upgrade, long sea outfall, SWOs and WwTP construction as well as tunnelling works. A summary of potential pollutants of relevance to water quality is provided below:

- Potential sources of pollution from site drainage include runoff and erosion from site excavation, earthworks from construction of the temporary causeway and upgraded revetment, underpinning of the bridge, open cut construction of the sewers etc. and associated stockpiles;
- The release of bentonite slurries, concrete washings and other grouting materials via the discharge of construction runoff and storm water from tunnelling working areas; and
- Other major pollutants present include fuels, lubricants, cement, mortar, silt and soils required for plant and equipment on site.
- The washing of construction vehicles and equipment also pose a pollution risk to watercourses in the area if undertaken in inappropriate locations and in the absence of effective management and mitigation.
- Any accidental spillages of fuel and/or discharge of oil from leaks in vehicles or fuel tanks.
- In addition, surface water run-off from surface construction activities has the potential to be contaminated and pose a significant risk to all watercourses as these sites will be exposed to rainfall which has the potential to produce silt laden run-off.

As described in detail in **Section 5.3.6 of Chapter 5**, the interceptor sewers will be constructed using a combination of both open cut and tunnelling techniques. Further, the deep excavations for the proposed launch and reception shafts for tunnelling works and the inlet works sump and SWO at the WwTP will require dewatering which will need to be appropriately disposed of to prevent pollution of the Avoca River. This will be a short term significant negative effect.

Potential effects of tunnelling if not effectively managed and controlled could include discharge of a plume with suspended materials. There is a possibility of suspended sediment plumes or contaminated run off from tunnelling operations including bentonite release which can deterioration of water quality of estuarine habitats.

Further, any unintended release of bentonite into the river channel may result in an initial localised area of high viscosity material onto the riverbed. This will slowly disperse in flowing water to produce a small plume of suspended solids. In this instance, bentonite would remain in suspension in the Avoca Estuary which is likely be flushed in and out of the Arklow Bay due to tidal influence.

It should be noted that the components within the bentonite drilling fluid are inert, naturally occurring and non-toxic to marine benthic fauna. Bentonite is benign, a naturally occurring clay that will disperse normally over a short period of time if an unintended release should occur. As the flow of any plume produced into the fast-flowing tidal currents will be expected to be small, diffuse and short term, this will not provide any impact on benthos, fish or suspension feeding species (including shellfish) located within the estuary. The Avoca Estuary is tidal in nature and any bentonite release during low flow conditions in the Avoca River is expected to be flushed into the Irish Sea during daily high tide periods and therefore is unlikely to cause any significant impacts. **Chapter 11** describes in detail the likely significant effects on aquatic biodiversity.

The generation of silt-laden run-off during construction may result in short term significant negative effects associated with the following:

- There is the potential for silt-laden surface runoff during the enabling works, site clearance and groundworks that would be required to be undertaken throughout the works areas. This potential for silt-laden surface runoff is likely to continue throughout construction until the ground has been completely consolidated and reinstatement of the working area has been completed.
- The proposed development will require construction of temporary sheet pile walls in the river channel to accommodate the open cut construction of the river based section of the interceptor sewer (Refer to **Section 5.6.3.3 of Chapter 5** for further detail). This may disturb the sediment in the river bed and thus could increase in suspended solids concentrations in the Avoca River.

Coastal Waters

Impacts on coastal waters during the construction of the proposed development relate primarily to the excavation and potential dispersion of sediments. This is dealt with under **Section 15.4.2.2**.

15.4.2.2 Coastal Processes

Revetment Upgrade

Given the nature and scale of works, the only likely effect that the revetment upgrade works could have on the existing coastal dynamics during construction is the dispersion of material at this location (Refer to **Appendix 15.5** for further detail).

The excavation of material from the seabed is limited at the toe of the proposed revetment and the volume of material is expected to be small. Excavation of the seabed is limited to the toe along the section of the revetment to be upgraded, therefore the volume of material is expected to be relatively small as detailed in **Section 5.8 of Chapter 5**. Further, excavated sediment may either be reused as part of the material required at the toe of the revetment or disposed of at a suitably licensed facility (in respect of which a waste permit or a waste licence is granted).

The transport of any potential suspended material that may arise from this excavation will be mostly confined within the surf zone (approximately limited by the bathymetric contour -6.5m CD). Moreover, this coastal area is relatively sheltered by the entrance of the Arklow Harbour as described in **Section 15.3.3.** Therefore, any potential dispersion of the material is expected to be naturally deposited within the study area and mostly limited by both the harbour entrance at the south and the natural headland at the north.

On this basis, the likely effect of dispersing material on coastal processes is considered not significant during construction of the revetment upgrade.

Long Sea Outfall

This section considers the likely significant effects on coastal processes as a result of the two open cut construction methodologies for the long sea outfall (i.e., construction by means of the float and flood or bottom pull method which requires a trench to be excavated – Refer to **Chapter 5** for further details). The likely significant effect due to dispersion of the excavated seabed material (which is proposed to be side casted along the edge of the trench during construction), dispersion of any sediment mobilised during the dredging process and the exposure of the outfall and/or scour protection during operation of the proposed development have been assessed.

The likely significant effects associated with the horizontal directional drilling method would not involve any change in the seabed geometry during construction or operation, therefore this option is not considered to result in any significant effects on coastal processes.

The seabed material along the alignment of the long sea outfall is expected to be non-cohesive and with a low content of fines (Refer to **Section 14.3 of Chapter 14** for further details), therefore significant suspension of fines is not anticipated.

CIRIA states[38] that tide-induced seabed velocities alone are rarely sufficient to initiate motion of non-cohesive sediments at coastal sites, and hence significant movement of sand and gravel tends to be associated with periods of high wave activity only. In this regard, the most significant movement may happen in or close to the surf zone.

Construction of the long sea outfall is envisaged to be undertaken in summer to facilitate the necessary calm wave conditions required to operate the plant and equipment required for excavation of the trench (a maximum wave height of 0.5m is a typical operational limit for such operations). Under these wave conditions, the surf zone is estimated to be nearshore.

Given the proximity of the alignment of the long sea outfall with the river's breakwaters, this area is sheltered from the south wave action as described in **Section 15.3.3**. Where the seaward end of the outfall is constructed outside the nearshore surf area and Arklow Harbour entrance, the suspended sediment transport is expected to be very limited, however some local sediment movement on the seabed may occur during construction.

The marine environment is also dynamic and there is a continuous process of sedimentation/deposition which naturally occurs. Against this background, the impact of the sedimentation due to the engineering works will not be significant.

The volumes of excavated material are considered relatively low are and expected to be partially re-used as described in **Chapter 5** and **Chapter 16**, if deemed suitable by the contractor.

Outside the Area of Interest (Refer to **Appendix 15.5**), there is a very limited potential for dredged material to be dispersed within a larger area outside the Area of Interest and the presence of the Arklow Harbour piers provides shelter to the adjacent area to the south in the area where most of sediment transport is expected (nearshore area).

In summary therefore, it is considered that overall coastal patterns will not be affected. No erosion or accretion of adjoining areas is expected to result from the outfall construction.

Thus, the likely significant effect of local sediment movement is considered to be not significant in relation to coastal processes during construction of the long sea outfall by open cut methods.

SWO at the WwTP

The proposed SWO discharges at the shoreline (below Mean Low Water Springs) beneath the toe of the revetment. Given this, the construction of the SWO, similar to that of the revetment, will not result in a significant effect in relation to coastal processes.

[38] CIRIA (1996) 159 Report: Sea outfalls – Construction, inspection and repair. An engineering guide

15.4.2.3 Flood Risk

Interceptor Sewers

The TELEMAC2D hydraulic model of the Avoca River was run to examine the implications of the construction of a temporary causeway 10m wide for approximately 270m within the channel to facilitate the construction of the interceptor sewer and quay wall. The simulation assumed that the upstream in-channel works have been completed, including the deepening and underpinning of the second (southernmost) bridge arch, the construction of the interceptor sewer manhole encroachment upstream of the bridge and all the in-stream works completed at the Arklow Bridge (i.e. interceptor sewer through first arch completed and arch reopened). The river modelling undertaken (refer to **Appendix 15.2 and Appendix 15.3** for further detail) predicts that the construction of the temporary causeway would cause increases in local flood levels downstream of the Arklow Bridge of approximately 1.9cm and 5.5cm with these increases found not to affect the floodplain inundation and flood risk. Further, with the construction sequence described, it was noted that there was an overall minor reduction in the flood extents which would be a short-term slight positive effect.

A temporary causeway, approximately 10m wide (but inclusive of the 6m wide permanent encroachment) will also be constructed within the river channel to facilitate construction of the interceptor sewer. The temporary causeway will be contained on the river side by either gabions or sheet piles, with these raised above the height of the causeway, to be effective. The proposed elevation of the temporary causeway is c. 0.8 m OD which accounts for highwater mean spring tide of 0.5 m OD plus 0.3 m freeboard. There is the potential, without appropriate mitigation, for this temporary causeway to exacerbate flooding risk.

WwTP site

Flood risk associated with the construction of the Arklow WwTP itself is regarded as relatively low. This is due to the fact that the site itself is located outside of the 1 in 1000-year flood zone. Access and egress routes to the WwTP site during the construction period are also regarded as being at relatively low risk from flooding. Please refer to **Appendix 15.6** for further information.

15.4.2.4 Cumulative

It is possible that the construction of the proposed Arklow Flood Relief Scheme may take place in parallel with the construction of the proposed development. The contemporaneous construction of both developments would exacerbate effects on the hydrological regime and flooding.

However, where practicable, coordination would be undertaken by the contractors appointed to each development to ensure that underpinning of the arches and lowering of the arch included as part of the proposed development is undertaken in advance of the construction of the proposed interceptor sewer to mitigate any significant flood risk during construction of the interceptor sewers in the Avoca River.

The construction of interceptor sewers along South Quay and River Walk, and nearby construction of the proposed Arklow Flood Relief Scheme may generate the potential for direct and indirect short term significant negative effects on the hydrology of the Avoca River during construction for those reasons outlined above.

It should be noted that other infrastructure developments in Arklow, as identified in **Sections 2.6.6 and 2.6.7 of Chapter 2** will not exacerbate likely significant effects associated with the proposed development.

15.4.3 Assessment of Effects during Operation

15.4.3.1 Hydrology and Water Quality

The drainage network within Arklow town discharges wastewater directly into the Avoca River. There is a mixture of separate, partially separate and combined sewers. The latter are generally the older sewers within the town, dating back to the 1930's and 1940's and carrying a mixture of foul sewage and surface water. The proposed development includes the construction of interceptor sewers, in order to collect existing discharges to the Avoca River and Estuary and convey wastewater to the proposed WwTP which will have a significant positive effect during operation of the proposed development.

Further, the provision of the new wastewater infrastructure that caters for a 50-year design horizon and likely population growth in Arklow town is considered as a significant positive effect as it would ensure compliance with the UWWT Directive during operation of the proposed development.

The existing sewer network in Arklow town regularly surcharges and spills to the Avoca River via a number of existing outfalls and overflows located along the northern and southern banks of the river channel. The existing SWO at the Alps site is currently spilling in excess of 30 times per year to the Avoca River. Overflows of storm flows would be maintained, however the provision of the stormwater storage tank will limit the frequency of spills to 7 times per bathing season. This would significantly improve the Avoca River water quality and is thus considered a significant positive effect during operation of the proposed development.

In addition, there will be two SWOs provided as part of the proposed development at shaft TSS3 and at the Inlet Works building at the WwTP that would discharge storm flows to the Avoca River and Irish Sea (respectively) during storm events.

Modelling was undertaken for the 10-year Time Series Rainfall events to determine the frequency of discharge from the SWOs.

The modelling has predicted that the SWOs will spill on average once per bathing season which is well below the permitted 7 spills per bathing season for recreational/contact waters. It should be noted that the discharges from all the above SWOs will require the appropriate licensing under the WWDA for the proposed development that would be obtained from the EPA as described in detail in **Section 4.5 of Chapter 4**.

During operation, the majority of the storm flows will be conveyed to the WwTP with the SWOs limited to no more than 7 spills per bathing season in accordance with Waste Water Discharge (Authorisation) Regulations which requires that Storm Water Overflows are assessed and designed in accordance with "Procedures and Criteria in relation to Storm Water Overflow" by the DoEHLG, 1995.

In summary, the proposed development will remove the need to discharge untreated wastewater into the Avoca River in as far as reasonably possible to ensure compliance with the Waste Water Discharge (Authorisation) Regulations. The proposed development will therefore result in a long term significant positive effect on surface water quality.

There will be no significant effects on drainage during operation. All excess storm flows will be discharged via SWOs (as appropriate) and combined flows (foul) will be conveyed to the WwTP via the proposed interceptor sewer network.

Surface Water Quality

The existing sewer network in Arklow town regularly surcharges and spills to the Avoca River via 19 of existing outfalls/CSOs located along the northern and southern banks of the river channel. The proposed development will remove all existing untreated outfalls (excluding the Alps SWO at the head of the interceptor sewer network). This SWO will be upgraded to discharge excess storm flows during operation. In addition, there will be two SWOs provided as part of the proposed development (on South Quay at shaft TSS3 and at the Inlet Works building) to provide relief for excess flows in the sewered catchment during extreme storm events and extended power outages. These SWOs will discharge to the Avoca River and Irish Sea (respectively). During operation, the majority of the storm flows will be conveyed to the WwTP with spills through the SWOs limited to no more than 7 spills per bathing season in accordance with the relevant standards. This will result in a short-term negative effect.

In summary, the proposed development will remove the need to discharge untreated wastewater into the Avoca River in as far as reasonably possible to ensure compliance. The proposed development will therefore result in a long term significant positive effect on surface water quality.

Coastal Water Quality

With regard to the long sea outfall, three potential offshore discharge locations were originally considered, with only the furthest location (900 m outfall) meeting all compliance requirements. The water depth at the proposed outfall discharge point is approximately 10m.

Model simulations of the proposed 900m outfall were conducted for a range of conditions. These included both spring and neap tides for calm and windy conditions and for a full spring–neap cycle. Assessment of the overall existing situation in terms of 95%ile compliance with the bathing water regulations is presented in Figure 4.18 of **Appendix 15.2**. The region of consistently elevated concentrations follows the axis of the plume and remains well offshore.

The bacterial concentrations at all of the identified bathing areas (listed in Table 4.7 of **Appendix 15.2**) are below the model resolution of 5cfu/100ml and well within the target 'Excellent' e.coli category limit of 250 cfu/100ml and the IE limit of 100 cfu/100ml.

The DIN and BOD plumes from the outfall follow the same trajectories as indicated for e.coli. The associated concentrations are very low as once the plume has surfaced from the diffuser and only a small amount of additional dilution is required to reduce levels to near background. The DIN mixing zone envelope is calculated to extend 200m to the north of the proposed outfall on the flood tide and about 100m to the south on the ebb. It will have an overall width of about 40m. This envelope represents the potential zone of influence of the plume for all stages of the tide.

The beaches to the north and south of the harbour mouth are popular bathing areas. The nearest designated bathing waters are at Clogga Beach, 3km to the south of the harbour and Brittas Bay 9km to the north. The design objective is to ensure that all the local beaches will meet the bacterial standards for e.coli and intestinal enterococci (IE) as set out in the Bathing Water Directive (2006/7/EC), which is transposed into Irish law through the Bathing Water Quality Regulations 2008 (SI 79 of 2008). The maximum outfall discharge concentrations for these parameters have been chosen to be conservatively high (e.coli = 1x106 cfu/100ml and IE = 2x105 cfu/100ml). The model data shows that even with these high values any bacterial contamination of bathing areas arising from the proposed outfall will be well below the limits specified in the regulations.

The proposed SWO at the WwTP is to be located at the shoreline to the north of the main outfall route. This will only discharge during exceptional rainfall events. Model simulation of a short term discharge (1 hour) with flows corresponding to the 1-year event show that the e.coli levels on Clogga beach and the bathing area to the north and south of the harbour will be impacted for a period of up to about 24 hours after the event.

The proposed 900m outfall and SWOs will replace the 19 existing SWOs/outfalls and all of which discharge into the harbour. There will thus be a significant improvement in water quality both in the harbour and on the bathing areas, resulting in a long term positive significant effect.

15.4.3.2 Coastal Processes

Revetment Upgrade

No significant effects on existing coastal processes are likely within the study area during operation given that the coastline has already been fixed by the existing rock armour revetment as outlined in **Section 15.3.3**.

Further, the alignment of the upgraded revetment will follow the existing revetment alignment. The revetment upgrade will ensure coastal protection within the site for a 500-year return period storm event as it has been designed to protect against wave overtopping and satisfy functional and safety requirements.

The design ensures that the upgraded revetment can withstand the expected incident waves. The upgraded revetment is a porous flexible structure where wave energy can be partly absorbed and dissipated. For this reason, local wave reflections are expected to be minimum and similar to those currently experienced. The upgraded revetment, being parallel to the coastline and located in the shadow of the Arklow harbour entrance, does not impose a barrier, or an obstruction to the predominant longshore sediment transport patterns. In this regard, no change in sediment transport is expected with the upgraded revetment from that which exists currently.

Therefore, the likely effect of the existence of the upgraded revetment is considered to be not significant in relation to coastal processes, during operation of the proposed development.

Long Sea Outfall

Scour protection will be installed (where construction of the outfall is by open cut methods) to ensure the structural integrity of the outfall during operation. The scour protection will consist of a layer of concrete mattresses embedded in the existing seabed. This scour protection will be designed to be stable and prevent any scour of the seabed against nearshore wave action and currents. The scour protection will be designed to match the seabed level to avoid the creation of a sediment transport barrier. The scour protection will also stabilise and prevent the movement of seabed material in the local area of the outfall.

In the event that seabed levels in the area close to the scour protection reduce, the concrete mattresses would accommodate to the new geometry. It is important to note that the outfall and associated scour protection will be designed against this outcome, but it is assessed as a reasonable worst case scenario given projected climate change and historic trends. This potential lowering of the seabed will not impose a barrier to sediment transport based on the following:

- Longshore sediment transport occurs within the break area.
- The break area of the outfall is mostly sheltered by the entrance of Arklow Harbour.
- Bed load represents a small fraction of longshore transport compared to suspended load transport and therefore any local new feature of the seabed would not change any existing longshore sediment transport patterns.

On this basis, no change in the existing coastal processes (involving erosion or accretion of the adjoining coastal areas) is expected due to the presence of this outfall. Therefore, no significant effects are likely during operation of the proposed development.

Thus, the likely long term effect of the outfall is considered to be not significant with respect to coastal processes within the Area of Interest during operation of the proposed development.

SWO at the WwTP

With regard to the SWO at the WwTP, given that it ceases at the shoreline, the operation of the SWO will not result in a significant effect in relation to coastal processes during operation.

15.4.3.3 Flood risk

Interceptor sewers

The proposed development includes the realignment of the Avoca River (encroaching approximately 6m into the existing river channel) downstream of the Arklow Bridge over a distance of approximately 270m.

The TELEMAC2D hydraulic model of the Avoca was run with the proposed interceptor sewer quay wall encroachment for the design flood event design flood of 835 m^3/s and a corresponding tide with a highwater level of 0.84m OD Malin. The computed river flood levels between the existing and the proposed encroachment case show that the effect of the proposed 6m narrowing over approximately 270m length of the Avoca estuarine channel immediately downstream of Arklow Bridge and the local encroachment immediately upstream of the Bridge produces a c. 3.3cm rise in flood level immediately downstream of the Arklow Bridge. The combined impact upstream of the encroachment including the upstream manhole encroachment produces a small rise of c. 1.9cm (Refer **Appendix 15.3** for further details).

It should be noted that a rise of 3.3cm in flood level from the interceptor sewer encroachment applies to a localised section immediately downstream of Arklow Bridge. Further the hydraulic impact assessment states that for much of the encroachment reach the flow velocity increases which in turn slightly reduces peak flood level in the narrowed river section.

As described in detail in **Section 5.6.3 of Chapter 5**, the Arklow Bridge works would involve underpinning of two arches and the lowering of the second arch by 1m depth which will fully mitigate the effects upstream of the Arklow Bridge at the design flood event and at various return period flood flows. However, such a measure will not mitigate the downstream channel increase of c. 3.3cm at the 100-year design flood event. This downstream increase in flood level will only occur towards the upstream end of the sewer encroachment, close to the downstream face of Arklow Bridge.

This increase is not critical, as locally the existing quay walls are sufficiently elevated to prevent overtopping. Increases in flood levels upstream are more critical as such increases will increase the magnitude and frequency of overtopping onto the southern and northern sides of the river channel producing a larger floodplain flow that bypasses Arklow Bridge and flows eastward through the urban developed areas.

In summary, with the underpinning and lowering of the second bridge arch by c. 1m, a minor reduction in the overall flood extent was predicted for the approximately 6m wide permanent encroachment in the Avoca River which would be a long-term slight positive effect.

Therefore, underpinning of Arklow Bridge should be undertaken prior to the construction of the interceptor sewer in order to increase the capacity of the bridge and to reduce any increased flood risk associated with the construction of the interceptor sewer in the river channel and associated encroachment.

The hydraulic assessment of the existing system incorporating the proposed interceptor sewer and SWOs shows that the total flooding within the Arklow sewerage (wastewater collection network) catchment is only marginally reduced without implementation of all other upgrades proposed in Phase 3 of the GDSDS Study[18]. Further, all the flows from the Arklow catchment will be conveyed to the proposed WwTP at Ferrybank (albeit that emergency relief for excess flows in the sewered catchment is provided by the SWOs). Hence, the discharge of untreated wastewater into Avoca River will, for the most part, be eliminated, following the construction of the proposed development.

The result of the hydraulic assessment of the future sewer system which incorporates all upgrades proposed in Phase 3 of the GDSDS[18], the proposed interceptor sewer, proposed SWOs and WwTP indicates very minor flooding within the catchment for a 1 in 30-year critical duration storm event with MHWS including allowance of climate change.

The results of spill frequency analysis of the future system indicate that proposed SWOs spill on average less than once during bathing season which is well below the permitted 7 spills/bathing season. Therefore, the proposed development would remove the need to discharge untreated wastewater into the Avoca River excluding discharges via SWOs which are compliant with Waste Water Discharge (Authorisation) Regulations, SI No. 684 of 2007 which requires that Storm Water Overflows are assessed and designed in accordance with "Procedures and Criteria in relation to Storm Water Overflow" by the DoEHLG, 1995.

<u>WwTP site</u>

Given the absence of a significant risk of flooding of the site of the proposed WwTP, the impact on flood risk during operation will be very low. Access and egress routes are unlikely to be compromised during flood events and the proposed development will have no impact on floodplain storage and conveyance as it is located outside of the 1 in 1000-year flood plain.

15.5 Mitigation Measures and Monitoring

15.5.1 Mitigation

15.5.1.1 Mitigation During Construction

Hydrology and Water Quality

The standard best practice measures in the Outline CEMP (Refer to **Appendix 5.1**) for the proposed development will mitigate significant negative effects on surface water quality during construction.

Further, temporary works will be designed to minimise effects on the hydrology and flow regime in the study area during construction. The Outline CEMP includes a range of site specific measures which will include the following:

- During construction, surface water runoff would be collected by the temporary drainage system installed by the contractor and then treated or desilted on-site before discharge into the Avoca River;
- Earthworks operations shall be carried out such that the surfaces are designed with adequate slope to promote safe runoff and prevent flooding;
- Good housekeeping such as site clean ups, use of disposal bins, etc will be adopted in construction areas;
- In order to prevent accidental release of hazardous materials such as fuels, cleaning agents etc into surface water during construction, all hazardous materials will be stored within appropriately bunded containment areas designed to retain spillages;
- Temporary bunds will be used for storage of oil/diesel; and
- The temporary causeway and the surface water runoff from this area would be entirely contained to prevent any pollution entering the Avoca River. This would be contained through the implementation of best practice measures outlined in the Outline CEMP (Refer to **Appendix 5.1**).
- As outlined in **Chapter 5**, it is necessary to construct launch and reception chambers to facilitate tunnelling works. As these shafts will extend beneath the ground water level, it will be necessary to “plug” these shafts to prevent water ingress.

Mitigation during construction will include implementing best practice during excavation and tunnelling works to avoid the release of bentonite and prevent sediment running into the drainage network and/or hydrological environment during construction of the proposed development.

Coastal processes

The following mitigation measures have been proposed with respect to effects on coastal processes from construction of the proposed development:

- Construction of the long sea outfall will generally be restricted to the period May – September, with the period between November-February generally avoided. In this manner, the months with likely worst wave and wind conditions, which lead to higher levels of sediment suspension and transport, are avoided.

Flood risk

<u>Site of the proposed WwTP</u>

During the construction period, there is a risk of coastal erosion and a risk of wave overtopping. Similarly, to the construction of the long sea outfall, works between November and February should be avoided. It is also recommended that the contractor considers tidal and wind forecasts and monitors these closely to minimise the risk of coastal erosion and wave overtopping.

Given the absence of a significant risk of flooding at the site of the proposed WwTP, no further mitigation measures to address flood risk during construction are required.

Interceptor sewers

In order to mitigate and minimise the potential flood risk caused by the construction of the temporary causeway and the interceptor sewers in the Avoca river channel, the following sequence of works is proposed prior to construction of the temporary causeway:

- Proposed underpinning of the first 2 arches and lowering of the 2nd Arch by c. 1m at the bridge is completed.
- Proposed in-stream works at and upstream of the bridge is fully completed (i.e. the upstream interceptor sewer manhole and the laying of the interceptor sewer beneath the bed of Bridge Arch 1).
- The temporary works should proceed from downstream to upstream (i.e. from east to west direction).
- Following completion of construction of the interceptor sewer in the Avoca River (i.e. when the causeway is no longer required), the causeway would be removed in a similar sequential manner.
- Timely removal of sections of the causeway should be a priority once works have been completed

15.5.1.2 Mitigation During Operation

Hydrology and Water Quality

The proposed development will improve water quality in the Avoca River by eliminating, in as far as reasonably possible, the discharge of untreated wastewater into the river channel. Excess storm flows would continue to be discharged as emergency overflows in the event of WwTP pumping station failure, however this is likely to occur significantly less than the permitted 7 spills per bathing season.

All storm flows to the Avoca River (discharged as emergency overflows) will be screened via static screens in the SWOs to ensure the maximum particle size in the water column does not exceed 6mm in diameter to ensure compliance with Irish Water standards.

Coastal processes

No mitigation measures have been proposed with respect to effects on coastal processes from operation of the proposed development.

Flood risk

Given the absence of a significant risk of flooding of the site of the proposed WwTP, no mitigation measures to address flood risk during operation are required.

As the proposed development directs almost all wastewater flows to the WwTP shows that the proposed development will result in an overall slight beneficial impact upstream of the bridge in terms of flooding, no mitigation measures are required to address flood risk during operation.

15.5.2 Monitoring

15.5.2.1 Monitoring During Construction

Hydrology and water quality

Visual monitoring will be undertaken as part of the regular site audits during the construction of the proposed development to ensure existing surface water drainage discharge into the Avoca River/coastal waters is not impacted by the proposed development.

This is necessary to ensure that surface water flooding is not caused by any damages to existing surface water sewers/outfalls discharging into the Avoca River during construction of the interceptor sewers.

Flood risk

The contractor is required to monitor tide and wind forecasts to minimise the risk of coastal erosion and wave overtopping. The contractor is required to monitor weather forecasts to inform operation of temporary causeway.

15.5.2.2 Monitoring During Operation

Hydrology and water quality

Monitoring of all SWOs by storm water level indicator instruments will be undertaken by the operator to provide records of any overflows, ensuring that bathing season spill events are recorded.

Coastal processes

The scour protection shall be monitored to ensure its performance and avoid any potential risk derived from the potential future exposure of the pipe. Scour protection will be monitored by Irish Water as part of the overall long outfall maintenance. Outfall monitoring would include visual inspection either by divers or robotics and would be performed every 5 years and after significant storm events as part of the overall operational management regime. The inspection crew would check the pipeline for scour protection damage, slide, anchor, or other damage. Scour protection shall be reinstated and/ or repaired if any damage is observed.

Flood risk

No monitoring during operation is required for flood risk during the operation of the proposed development.

15.6 Residual Effects

15.6.1 Residual Effects during Construction

15.6.1.1 Hydrology and Water Quality

Hydrology

With the implementation of mitigation measures described in **Section 15.5.5.1** and **15.5.5.2**, including in particular, the phasing of works such that the bridge underpinning and upstream works are complete before commencing construction of the temporary causeway downstream of the bridge, there will be no significant residual effect on hydrology during construction.

Drainage

There will be no significant residual effect on drainage during construction.

Water Quality

With the implementation of the mitigation and monitoring measures described in **Sections 15.5.1.1 and 15.5.2.1**, the residual effects on water quality will be short term slight negative effects during construction of the proposed development.

15.6.1.2 Coastal Processes

It is considered that, with the implementation of the proposed mitigation and monitoring measures, that there will be no significant residual effects from the proposed development on coastal processes (including sediment dispersion and local scour/siltation effects).

15.6.1.3 Flood Risk

Interceptor sewers

With the implementation of the mitigation measures, a short term slight negative effect would occur due to the installation of the sheet pile wall in the Avoca River and the alteration to the flow regime during construction. The predicted increase in flood level downstream of Arklow Bridge will only occur towards the upstream end of the sewer encroachment, close to the downstream face of Arklow Bridge, which is not critical, as locally the existing quay walls are sufficiently elevated to prevent overtopping.

With the implementation of mitigation measures described in **Section 15.5.5.1** and **15.5.5.2**, including in particular, the phasing of works such that the bridge underpinning and upstream works are complete before commencing construction of the temporary causeway downstream of the bridge, there will be no significant residual effect on flood risk during construction.

WwTP

No significant residual effect is expected on flood risk to the site of the proposed WwTP during construction.

15.6.2 Residual Effects during Operation

15.6.2.1 Hydrology and Water Quality

Hydrology and Drainage

The hydraulic modelling of the existing system shows that 7,566m³ of untreated wastewater is predicted to spill via the existing outfalls into the Avoca River during Dry Weather Flow (DWF). During operation, all flows from the Arklow catchment will be conveyed to the WwTP, save during extreme rainfall events where overflows through the SWOs may occur (albeit modelling has confirmed that these spills will be very limited). Hence, for the most part, there will be no discharge of wastewater into the Avoca River once operational and this will improve the existing water quality in the Avoca River/Estuary.

During operation as the majority of the storm flows will be conveyed to the WwTP, the spills via the SWO's will be on average less than 1 spill/bathing season which is well below the permitted 7 spills/bathing season. There will be an overall reduction in the frequency of sewer surcharge associated with the proposed development which is considered a significant positive effect during operation of the proposed development.

Therefore, there will be not be any significant residual negative effect on water quality due to SWO discharges and indeed, there will be a significant positive residual impact due to the removal of existing outfalls and appropriate treatment of all wastewater.

Surface Water Quality

During operation, the proposed development would eliminate, in so far as possible, the need to discharge wastewater directly into the Avoca River and thus will have a significant positive residual effect on surface water quality from the operation of the proposed development.

Coastal Water Quality

The proposed 900m outfall and SWO at the WwTP replace approximately 19 existing outfalls and overflows all of which discharge into the harbour. There will thus be a significant positive impact on water quality both in the harbour and on the bathing areas, as a result of the proposed development.

15.6.2.2 Coastal Processes

No significant residual effect is expected on coastal processes during operation.

15.6.2.3 Flood Risk

Two arches of the Arklow Bridge will be underpinned and the second arch lowered by 1m which will mitigate against any rise in flood levels upstream of the Arklow Bridge due to the existence of the interceptor sewer and the manhole in the river channel. Therefore, there will be an overall reduction in the existing flood extent following construction of the proposed development which will be a short-term slight positive effect.

It should be noted that the sheet pile wall constructed as part of the proposed development would also serve as advance works for the flood walls to be built as part of the proposed Arklow Flood Relief Scheme. It is recognised that once constructed, the proposed Arklow Flood Relief Scheme would further reduce any residual flood risk during the operation of the proposed development and thus bring about further positive, cumulative effects on flood risk.

15.7 References

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