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GRAIGUENAMANAGH TINNAHINCH

FLOOD RELIEF SCHEME

Environmental Constraints Study

Kilkenny County Council
Comhairle Chontae Chill Chainnigh

In association with

CARLOW COUNTY COUNCIL

OPW Oifig na nOibreacha Poibli/ Office of Public Works

Tionscadal Éireann Project Ireland 2040

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Disclaimer: Please note that this report is based on specific information, instructions and information from our Client and should not be relied upon by third parties.					

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Terms and Abbreviations

°C	degrees Celsius
%	Percentage
I	One
II	Two
III	Three
IV	Four
V	Five
AADT	Annual Average Daily Traffic
AAS	Areas of Archaeological Sensitivity
ACA	Architectural Conservation Area
ADT	Annual Daily Traffic
AEP	Annual Exceedance Probability
AFA	Area for Further Assessment
AlluviMIN	EPA geoportal code for mineral alluvium
AminDW	EPA geoportal code for deep well drained mineral (derived from mainly acidic parent materials)
AminPD	EPA geoportal code for deep poorly drained mineral (derived from mainly acidic parent materials)
AminPDPT	EPA geoportal code for poorly drained mineral soils with peaty topsoil (derived from mainly acidic parent materials)
AminSP	EPA geoportal code for shallow poorly drained mineral soil (derived from mainly acidic parent materials)
AminSW	EPA geoportal code for shallow well drained mineral (derived from mainly acidic parent materials)
AQIH	Air Quality Index for Health
BL	ByrneLooby
BminSP	EPA geoportal code for shallow poorly drained mineral soil (derived from mainly basic parent materials)
BminSW	EPA geoportal code for shallow well drained mineral (derived from mainly basic parent materials)
BOD	Biological Oxygen Demand
c.	Approximately
CCC	Carlow County Council
CDP	Council Development Plan
CEMP	Construction Environmental Management Plan
CFRAMS	Catchment Flood Risk Assessment and Management Study
Co.	County

COVID-19	Coronavirus disease 2019
DCCAE	Department of the Environment, Climate and Communications
DCHG	Department of Culture, Heritage and the Gaeltacht
DLRCC	Dun Laoghaire-Rathdown County Council
EC	Executive Council
EIA	Environmental impact assessment
EIAR	Environmental impact assessment report
Eir	Eircom Limited
EirGrid	EirGrid Group
EIS	Environmental Impact Statement
EMD	Exploration and Mining Division (of the Department of Communications, Climate Action and Environment)
EPA	Environmental Protection Agency
EQSD	Directive on Environmental Quality Standards
ESB	Electricity Supply Board
EU	European Union
FAQ	Frequently asked questions
fl.	Floruit, abbreviated fl. (or occasionally flor.), Latin for "he/she flourished", denotes a date or period during which a person was known to have been alive or active.
FRMP	Flood Risk and Management Plan
FRS	Flood Relief Scheme
FSU	Flood Studies Update
GIS	Geographic Information Systems
GLAP	Graiguenamanagh Local Area Plan
GSI	Geological Survey Ireland
GTFRS	Graiguenamanagh-Tinnahinch Flood Relief Scheme
GWB	Groundwater Bodies
HCV	Heavy Commercial Vehicles
HEP	Hydroelectric plant
HLC	Historic Landscape Characterisation
IFI	Inland Fisheries Ireland
IPC	Integrated Pollution Control
IPCC	Irish Peatland Conservation Council
KCC	Kilkenny County Council
km	Kilometres

km^2	Kilometres squared
kV	Kilovolt
KCC	Kilkenny County Council
LAP	Local Area Plan
LCA	Landscape Character Assessment
Made	EPA geoportal code for made ground
m	meter(s)
mg/l	Milligrams per litre
mm/yr	Millimeters per year
NBDC	National Biodiversity Data Centre
NHA/ pNHA	Natural Heritage Areas / Proposed Natural Heritage Areas
NIAH	National Inventory of Architectural Heritage
NMI	National Museum of Ireland
NMS	National Monuments Service
NPWS	National Parks and Wildlife Service
NRA	National Road Schemes
NSS	National Spatial Strategy
NTA	National Transport Authority
OPW	Office of Public Works
pe	Population Equivalent.
PA	Project Archaeologist
PAHs	Poly Aromatic Hydrocarbons
Pers. Comm.	Personal Communication
Pre-WFD	Pre-Water Framework Directive
Q1	Quarter one
QI	Qualifying Interests
Q-value	Biological River Quality Classification System
RMP	Record of Monuments and Places
RPS	Record of Protected Structures
SAC	Special Areas of Conservation
SCI	Sites of Community Importance OR Species of Conservation Interest
SEA	Strategic Environmental Assessment OR Social and Environmental Assessment
SI	Site Investigation OR Statutory Instrument
SL	Speed Limit

SMR	Sites and Monuments Record
SPA	Special Protection Area
sp.	Species (singular)
spp.	Species (plural)
Sv%	Speed Violation Percentage
TII	Transport Infrastructure Ireland
UNESCO	United Nations Educational, Scientific and Cultural Organization
V85	85% of the vehicles are driving at or below the speed limit
Va	Average Speed
WFD	Water Framework Directive
WHS	World Heritage Site
WwTP	Wastewater Treatment Plant
ZAP	Zone of Archaeological Potential

1 Introduction

1.1 Overview

The OPW, working in partnership with Kilkenny County Council (KCC), Country Carlow Council (CCC) and other Local Authorities, commissioned and have completed the South Eastern Catchment Flood Risk Assessment and Management (CFRAM) Study. The relevant CFRAM Study reports are available, for information purposes, from the publications section of www.FloodInfo.ie (CFRAM) (Office of Public Works, 2020).

The South Eastern CFRAM study area included Graiguenamanagh-Tinnahinch as an Area for Further Assessment (AFA) and concluded that a flood relief scheme would be viable and effective for the community. The viable scheme (currently under review) is comprised mainly of construction of hard defences and associated works through the urban area of Graiguenamanagh along the banks of both the River Duiske and River Barrow. The scheme area is shown in Figure 1-1.

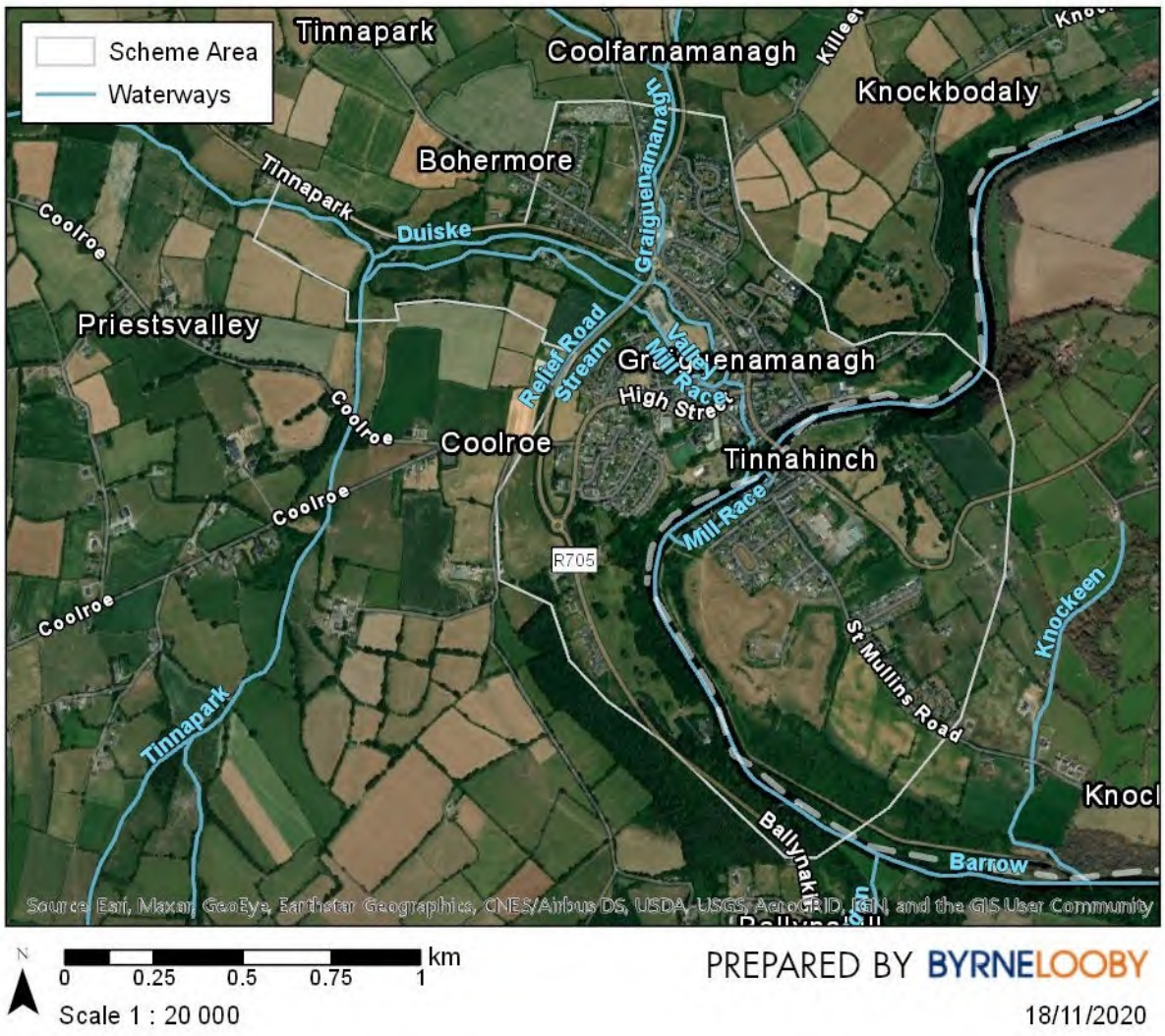


Figure 1-1 Scheme area

Flood risk in Ireland has historically been addressed through the use of structural or engineered solutions (arterial drainage schemes and/or flood relief schemes). In line with internationally changing perspectives, the government adopted a new policy in 2004 that shifted the emphasis in addressing flood risk towards:

- Catchment-based context for managing risk.
- More pro-active flood hazard and risk assessment and management, with a view to avoiding or minimising future increases in risk, such as that which might arise from development in floodplains.
- Increased use of non-structural and flood impact mitigation measures.

Notwithstanding this shift, engineered solutions to manage existing risks are likely to continue to form a key component of the overall national flood risk management programme and strategy. A further influence on the management of flood risk in Ireland is the 'Directive on the Assessment and Management of Flood Risks 2007/60/EC' (also known as the 'Floods Directive'). The aim of this Directive is to reduce the adverse consequences of flooding on human health, the environment, cultural heritage and economic activity.

Typical proposed flood relief works could involve raising the flood defence levels of the river by constructing new flood defence walls incorporating flood gates and/or strengthening and raising existing ones, constructing new flood defence embankments and/or strengthening and raising existing ones, raising and repairing existing bridge parapets, work on weirs, work on channels and culverts, constructing storage ponds and/or strengthening and enlarging existing ones, installing new flap valves and repairing or replacing existing ones, installing new screens on culvert inlets and/or replacing existing ones, installing pressure manhole covers, and may include ancillary works such as pumping stations and/or storage tanks.

1.2 Environmental Study Area

The Barrow River Basin is predominantly rural and agricultural in nature and covers an area of 3,025 km^2 and includes much of County Carlow, portions of south Kildare, east Laois, southeast Offaly, east Kilkenny and small areas within west Wexford and Wicklow. The main river in this area is the River Barrow and its tributaries.

Graiguenamanagh and Tinnahinch are located on the River Barrow with the Duiske River, a tributary of the River Barrow, running through the town of Graiguenamanagh.

The environmental constraints study area has been developed in consideration of the preferred option in the CFRAM study. The preferred measures, their location(s), and overall project footprint may be liable to change as more information becomes available through project level assessment.

The environmental constraints study area includes consideration of proposed flood storage areas located in an area to the west/north-west of Graiguenamanagh. However, it is noted that the

inclusion of flood storage areas as a measure and the locations of such areas are not preferred measures or finalised components of the scheme at the time of writing.

The environmental constraints study area includes the lengths of river channel / watercourse that have hydraulic influence on the area intended to benefit from, and be protected by, any feasible scheme as well as the catchment areas draining to the downstream ends of those river channels. The study area boundary for each environmental discipline will vary according to the location of receptors and individual topic best practice, appropriate statutory and/or specialist guidance, and applicable legislation and regulations.

The environmental constraints study area for each discipline topic is defined in each section, accompanied by a figure showing the extents of the study area for that topic.

The constraints study will consider the effects of the construction and operation of the scheme in the catchment area as a whole, where appropriate. Site surveys have been and will be undertaken to collect recent and site-specific baseline data to inform the scheme design, the scoping report and environmental impact assessment (EIA) for this scheme and data, where appropriate and available at the time of writing and, have been included in consideration of potential constraints.

1.3 Project Background and Need for the Scheme

Flood hazard is the potential threat posed by flooding to people, property, the environment, and our cultural heritage. Flooding only presents a risk however when people, property, businesses, farms, infrastructure, the environment, or our cultural heritage can be potentially impacted or damaged by floods.

Flood risk is the combination of the probability of flood events of different magnitudes and the degree of the potential impact or damage arising from a flood.

The objective of this project is the identification, design and submission (for planning consent) of a Flood Relief Scheme (FRS), that is technically, socially, environmentally and economically acceptable, to alleviate the risk of flooding to the community of Graiguenamanagh and Tinnahinch in accordance with to the standards of the EU Directive on the Assessment and Management of Flood Risk (Floods Directive 2007/60/EC) transposed into Irish Law as SI 122 of 2010.

1.4 History of flooding

Flooding in Graiguenamanagh-Tinnahinch has historically been from either the River Barrow or River Duiske. The River Barrow drains a large catchment and typically rises slowly during historical flood events. During these events, the two effected areas are the quay front of Graiguenamanagh and the quay front of Tinnahinch. The River Duiske is a small flashy river that flows through the town of Graiguenamanagh before joining the River Barrow. During past flood events, out of bank flow from the River Duiske has travelled through the town affecting residential and commercial properties along Main Street and Turf Market area, as reported during 2015/2016 flood events.

The GTFRS Hydrology Report states that a total of 17 reports of flood events have occurred within the scheme area and a timeline of these events is displayed in Figure 1-2.

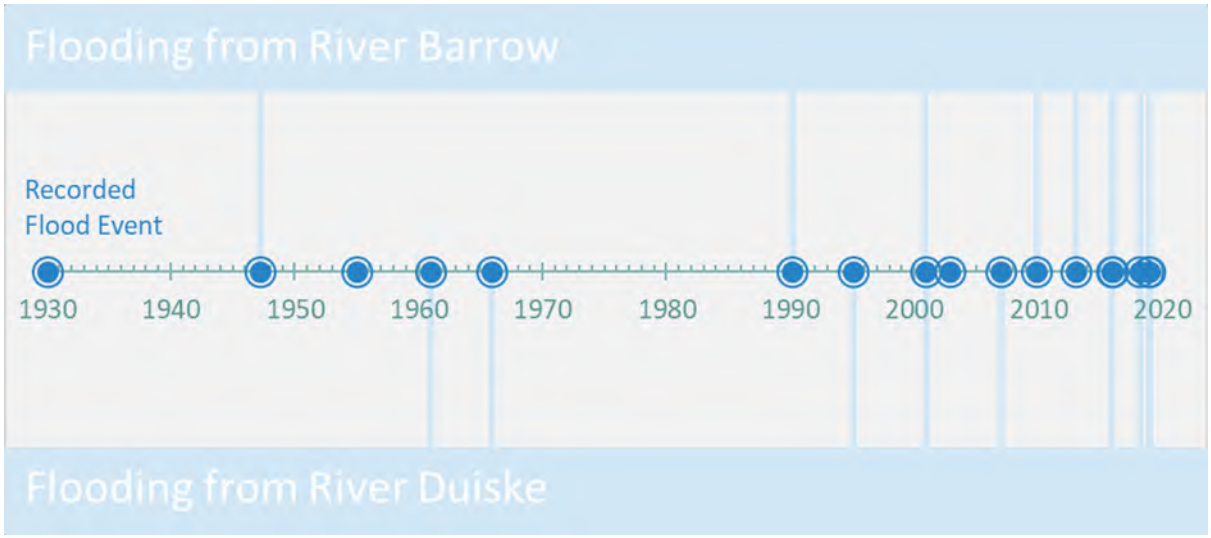


Figure 1-2 Flood Event Timeline and Reported Flooding Source

1.5 Potential Flood Risk Management Measures

A viable scheme option for Graiguenamanagh-Tinnahinch was identified in the CFRAM level of assessment and the preferred measures outlined in the CFRAM comprise:

- Building hard defences, with at risk properties protected by a series of embankments and walls, sheet piled where necessary and set back where possible from, the river channel.
- Hard defences that would protect properties from the 1% AEP fluvial event and with an estimated average height of 1.56 m and total length of 1.31 km.

A project-level options assessment will consider the scheme option outlined in the CFRAM and any other viable options arising out of project-level assessment. Development of the latter is ongoing and will be based on more detailed information than was available for the CFRAM, including detailed hydrological assessment, hydraulic modelling studies and environmental studies. Consequently the type and location of measures outlined in the CFRAM and shown in Figure 1-3 are liable to change as further information becomes available through project level assessment.

Figure 1-3 and Figure 1-4 show the location of hard defences in the preferred option in the CFRAM and the potential flood storage areas along the River Duiske.

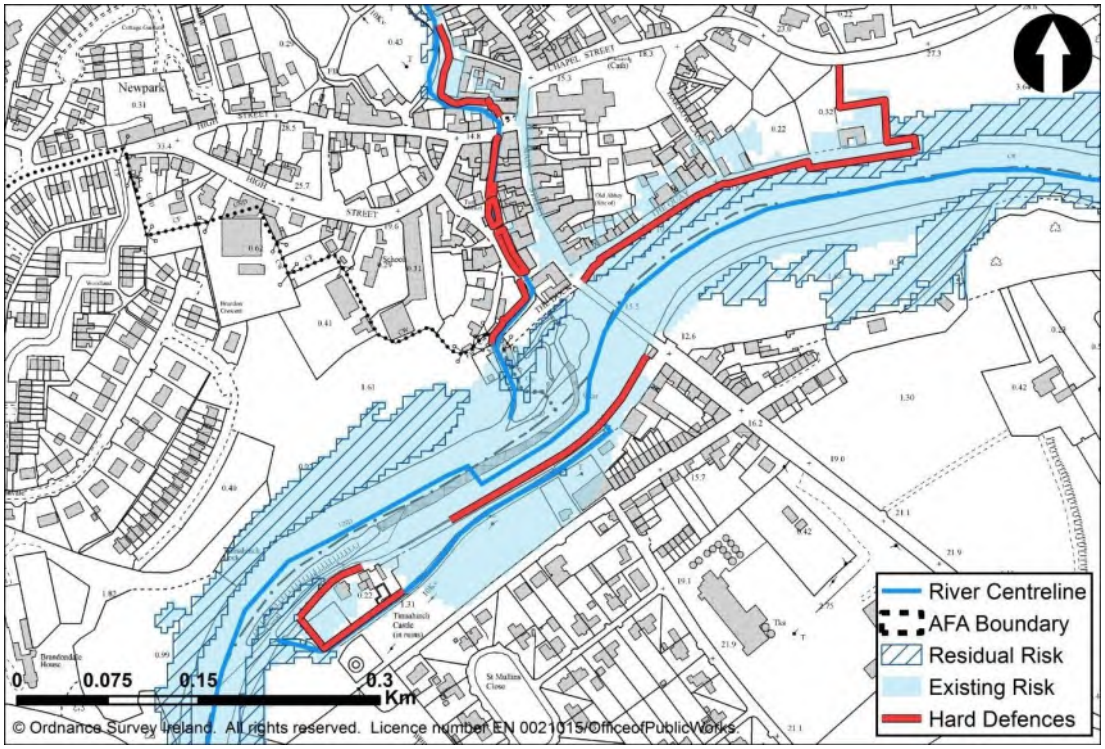


Figure 1-3 CFRAM Proposed flood defence measures

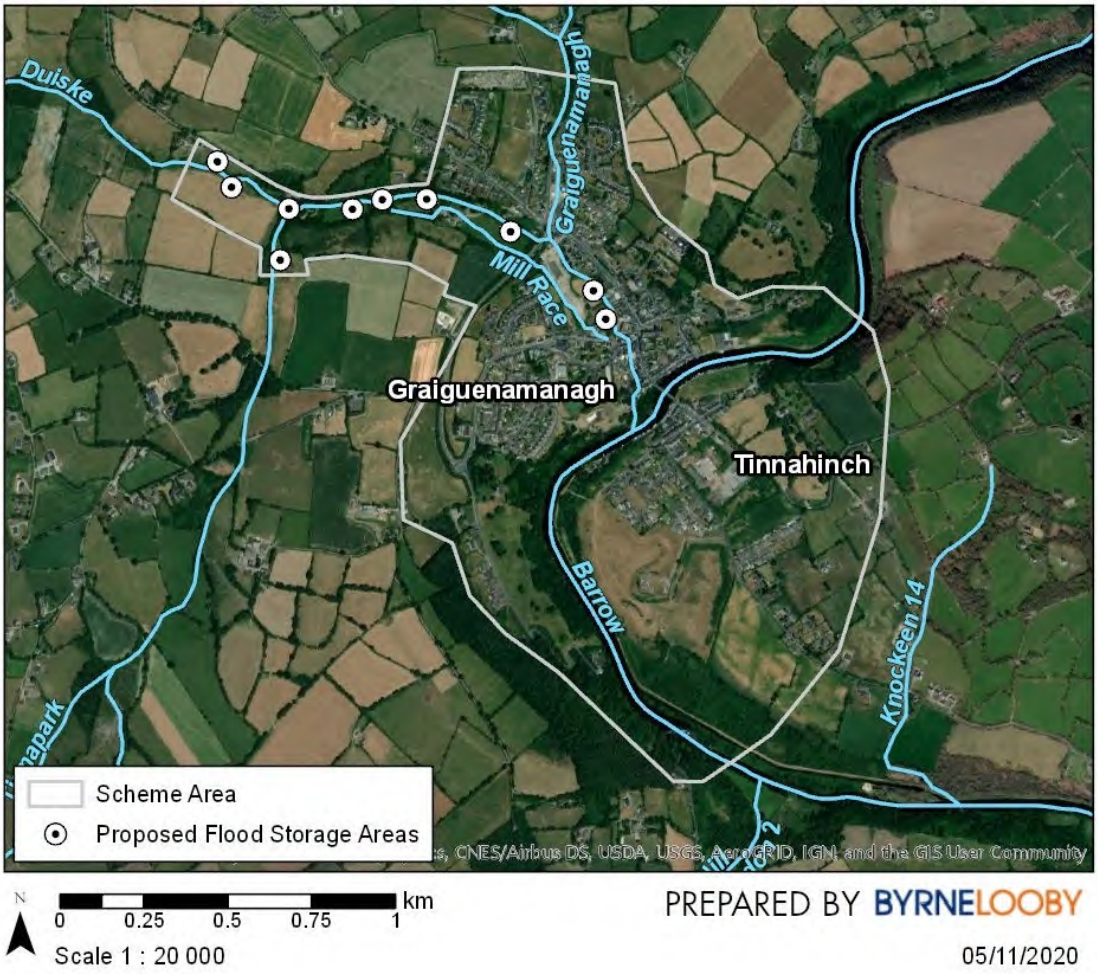


Figure 1-4 Potential locations of proposed flood storage areas

2 Environmental Constraints

2.1 Stages of Work

Various stages of work are carried out in the completion of a flood relief scheme. There are five stages of work as outlined in Table 2-1 and the progression to each subsequent stage depends on the outcome of the previous stage.

Table 2-1 Flood Relief Scheme Stages

Stage	Environmental Assessment	Examples of the specific studies completed as the scheme progresses
I	Scheme Development	Data Gathering and review Ecology Surveys Archaeological Investigation Hydrology Study & Hydraulic Modelling Geotechnical Surveys Flow Velocity Surveys Topographic Surveys Site Investigations and site walkovers Conduct Flood Risk Assessments Prepare a number of Flood Risk Management Options Carry out a Cost Benefit Analysis Selection of a Preferred Option Flood Risk Management Plan Interference Notices Public Consultation
	Initial Consultation with Stakeholders	
	Constraint Study	
	Screening for Appropriate Assessment	
	Appropriate Assessment	
	Detailed Design	
	Scoping for EIA	
	Environmental Impact Assessment	
	Public Consultation	
	Preparation of Environmental Assessment of Options Report	
	Public Consultation on Preferred Scheme	
	EIAR for Preferred Option	
II	Preparation of Part X Planning Application	
	Submission of a Part X Planning Application to An Bord Pleanála	
III	Detailed Design Confirmation	
	Tender	
IV	Construction Supervision	
V	Handover to Client	

ByrneLooby have been appointed to bring the scheme from preliminary design (Stage I), assessing various options available, through public consultation, detailed design and environmental procedures (Environmental Impact Assessment and Appropriate Assessment) to planning application to An Bord Pleanála (Stage II).

Subject to successfully satisfying An Bord Pleanála requirements, the scheme will then be tendered (Stage III), constructed (Stage IV) and delivered (completed) to the client (Stage V).

2.2 Scope of Constraints Study

The Environmental Constraints Study is the first step in the preparation of an environmental impact assessment report for the Graiguenamanagh-Tinnahinch Flood Relief Scheme. The purpose of the constraints study is to identify the key environmental aspects which may be impacted upon by possible flood relief measures and/or which may impose constraints on the viability and/or design of these measures.

The scope of the Constraints Study has followed the guidelines prepared by the Department of Housing, Planning and Local Government: Guidelines for Planning Authorities and An Bord Pleanála on carrying out Environmental Impact Assessment (August 2018).

Guidance contained with the Environmental Protection Agency's Guidelines 'Advice Notes on the Current Practice in the Preparation of Environmental Impact Statements' (2015) has also been considered.

This environmental constraints study has been reported under the following sub-discipline/topic area headings:

- Resources and Materials
- Population and Human Health
- Hydrology
- Soils, Geology and Hydrogeology
- Biodiversity
- Cultural Heritage and Archaeology
- Landscape and Visual
- Air Quality
- Noise

For this study we have combined the human health, land use, traffic and population in the population and human health section. Similarly, other sections of the constraints study e.g. noise, air quality, etc. are also applicable to human beings. Air quality includes climate and noise includes vibration due to the nature and location of the scheme.

2.3 Methodology

ByrneLooby and its specialists have undertaken a series of desk studies and preliminary site visits as part of the constraints study. Further details on constraints are presented in the following sections of this report. Information has been gathered with due regard to the likely environmental impacts of the proposed scheme, and the statutory requirements for Environmental Impact

Assessment and Appropriate Assessment as set out in the EU Directives and associated Irish legislation.

The constraints study has had regard in general to the following guidance and information sources as mentioned below. Specific guidance and information sources are referenced in individual specialist sub- sections.

2.3.1 Guidance and background information

The following guidance and information sources were referred to in the preparation of this constrains study report:

- Department of Housing, Planning and Local Government, August 2018. Guidelines for Planning Authorities and An Bord Pleanála on carrying out Environmental Impact Assessment;
- Guidelines on the information to be contained in Environmental Impact Statements, 2002 (Environmental Protection Agency) and Draft Revised Guidelines, 2017;
- Advice Notes on Current Practice in the Preparation of Environmental Impact Statements (Environmental Protection Agency, 2003) and Draft Revised Notes, 2015.Department of Environment, Heritage and Local Government (2010) Appropriate Assessment of Plans and Projects in Ireland - Guidance for Planning Authorities;
- European Communities (2000) Managing Natura 2000 Sites: The Provision of Article 6 of the Habitats Directive 92/43/EEC;
- EC Environment Directorate-General (2000) Assessment of plans and projects significantly affecting Natura 2000 sites: Methodological guidance on the provisions of Article 6(3) and (4) of the Habitats Directive 92/43/EEC;
- Directive 2014/52/EU of the European Parliament and of the Council of 16 April 2014 amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment;
- Department of Environment, Heritage and Local Government (2010) Circular NPW1/10 & PSSP 2/10 Appropriate Assessment of Plans and Projects in Ireland - Guidance for Planning Authorities;
- Flood Risk Management Plan River Basin (14) Barrow (2018);
- Strategic Environmental Assessment Statement For River Basin (14) Barrow Flood Risk Management Plan (2018);
- South Eastern CFRAM Study Final Report Unit of Management 14 (2017);
- South Eastern CFRAM Study UoM14 Flood Risk Management Plan Natura Impact Statement (2017);

- South Eastern CFRAM Study Strategic Environmental Assessment-Scoping Report (2017);
- South Eastern CFRAM Study Appropriate Assessment - Screening Report (2016);
- Strategic Environmental Assessment UoM14 – Barrow (2016);
- Carlow County Development Plan 2015 -2021;
- Kilkenny County Development Plan 2014-2020[1];
- Graiguenamanagh / Tinnahinch Tourism and recreational project concept study executive summary (SLR, 2019).

Key guidance or references specific to specialist areas considered in this report are included in the discipline specific methodology sections, where appropriate.

2.4 Project Team

This environmental constraints report was drafted by the Byrne Looby: Fiona Symes (oversight, generalist inputs), Rhian Llewellyn (geology, soils, hydrogeology and hydrology and generalist inputs) and Paige Leresche (generalist inputs), David Moran (scheme information and hydrology). Specialist technical inputs were provided by the following subject matter experts: Siobhán Deery and Lisa Courtney (cultural heritage and archaeology specialists, Courtney Deery), Brendan O'Connor (Ecologist, Aquafact), Steven Tooher (Ecologist, Cuthbert Environmental) Linda Maher and Dan Egdan (landscape and visual amenity specialists, The Big Space ('TBS')), Benny Cryan (Acoustics and vibration specialist, Amplitude Acoustics).

2.5 Consultation

Consultation has been carried out with the public and various stakeholders, the purpose of which was to engage with them, to gather local knowledge on flooding and environmental constraints and opportunities for addressing flood risk in the area.

Comprehensive communication and engagement plans have been developed and adopted by the team such as a project website, direct emails, local media, and public consultation among other approaches listed in Table 2-2. Consultation includes the establishment of a maintained project website and regular project newsletters.

At the time of writing consultation is ongoing and the views of statutory bodies, non-statutory bodies and interested stakeholders will be considered in the preparation of the EIA. Where stakeholders have provided inputs that have implications on the project constraints these have been considered.

[1] The KCC & CCC Graiguenamanagh-Tinnahinch Draft Joint Local Area Plan was published on Friday 20th November and is currently out for consultation which ends on Monday 25th January 2021. This document will be reviewed and considered as appropriate as the scheme progresses. The Draft Plan can be viewed via the following link: http://consult.kilkenny.ie.

Table 2-2: Consultation Plan

Communication Activity	Purpose / Correspondence
Project website	https://www.floodinfo.ie/frs/en/graiguenamanagh-tinnahinchfrs/home/ The website provides regular updates and information to stakeholders about the scheme. The website provides scheme information, scheme news and updates, a photo gallery, and resources section comprised of FAQ, glossary and contact subsections. Publicly available key project documents are provided for direct download from the project website, as they become available. The website is available in Gaeilge and English language.
Direct Email	A dedicated project email address is the primary source of contact for all interested Parties (unless otherwise requested by a party): GTFRS@byrnelooby.com. On the 7th July, project information letters were sent to 50 relevant authorities and stakeholders. The responses to these letters have been logged and further information is provided in the Consultation Report (ref W3451-W-PCD02).
Local authority / community publications such as parish newsletters	Items in local authority / community group newsletters are likely to reach a wide range of citizens. A newsletter is published quarterly by ByrneLooby to the project website. c.1,000 newsletters were circulated in the local area in the vicinity of the scheme (hand delivered to all properties).
Social Media	Both Kilkenny County Council and Carlow County Council advertise any project information on their social media outlets.
Public Consultation Days / workshop	Consultation exhibitions / events offer a more extensive and open form of engagement on a personal basis. They provide opportunities for members of the public to express views on the consultation subject area, ask questions, and receive feedback on the issues they raise. Public consultation day no. 1 (18th June – 9th July) was held online due to COVID-19 restrictions. A questionnaire was issued via online survey for any interested parties to complete. Thirteen responses were received. Due to the COVID-19 Pandemic, alternative consultation methods, such as the above, will continued to be considered.

The most common issues that arose during the first Public Consultation held 18th June – 9th July 2020 were:

- Concerns that hard defence walls may "destroy the character of the town and its heritage" and individual defences for properties prone to flooding may be a better option.
- Local people affected by flooding feel they have been ignored in the past and want to be kept informed and have their own input in the flood relief scheme.

- Locals stated there are insufficient storm drains in the area, leading to the River Duiske and the River Barrow just bursting their banks. The River Duiske that runs through the town has storm drains directly discharging from many houses along the Duiske.
- Residents of the area requested the possibility of some temporary measures being put in place during the intervening years till the flood relief scheme is complete.

(source: Public Consultation 01 Summary Report, Report no. W3451-W-PCD02)

Five statutory bodies have responded to a stakeholder letter (sent during June 2020), reference no W3451/PCD/0001) asking for their views on the proposed scheme by letter. At the time of writing responses had been provided as follows:

- The Health and Safety Authority (letter dated 3rd July 2020): Based on the information supplied, the Authority has no specific observation to make at this time.
- Department of Culture, Heritage and the Gaeltacht (letter dated 26th August 2020): They recommend that the services of a suitably qualified and experienced underwater archaeologist be engaged to act as Project Archaeologist (PA) for the proposed scheme. The PA should be integral to advising on tender documents for the engagement of Consultant Archaeologists either directly by the Council/OPW or the main works contractor and any sub-contractors that may need to be engaged.
- Irish water (IW) (letter dated 7th September 2020): They advise that they have assets within the study area. Key comments are:
    - They requested for continued engagement through the feasibility, design and construction stages in order to ensure public water services and sources are protected and access is maintained;
    - Any proposed works within close proximity to Irish Water assets, whether above ground or below ground should be assessed to ensure no impact to IW assets. Any impacts caused by potential increase or decrease to the level of overburden on assets as well as the impact of any increase in river levels on stormwater overflows, WWTP outfalls, etc needs to be taken into consideration;
    - That any proposals by the applicant to divert existing water services (watermains, service connections, rising mains, foul and surface water sewers, culverts, etc.) shall be submitted to Irish Water prior to works commencing;
    - As this is a flood defence scheme with the potential for flood walls/embankments to be part of the scheme we wish to advise that such measures may impact on IW assets such as overflows from pumping stations and sewers, drinking water source intakes, etc. We request that Irish Water is consulted further on the proposed design of flood defences to ensure there is no detriment to the performance of Irish Water assets as a result of the scheme and that interface issues are managed appropriately. All necessary measures to protect and

maintain access to Irish Water infrastructure and water sources shall be undertaken and incorporated into the design;

- Any potential impact on the contributing catchment of water sources either in terms of water abstraction for the development (and resultant potential impact on the capacity of the source) or the potential of the development to influence/ present a risk to the quality of the water abstracted by IW for public supply should be considered; and
- Any temporary connection throughout the construction phase is subject to a connection agreement with Irish Water.

- Office of Public Works (letter dated 7th September 2020): Based on the information supplied, the Authority has no specific observation to make at this time.
- Department of Agriculture, Food and the Marine (letter dated 7th September 2020): Comments received outline the licencing process for afforestation and tree felling. A high-level outline of the environmental process was also provided.

Where communications have been received that advise the inclusion of specific third parties in consultation these requests have been actioned.

3 Resources and Materials

3.1 Introduction

This section describes the constraints relating to material assets within the scheme study area and identifies possible issues which have the potential to constrain the flood relief scheme design.

For the purposes of this report, the study is defined as the area shown in Figure 3-1 which includes the towns of Graiguenamanagh (County Kilkenny) and Tinnahinch (County Carlow) and some of the surrounding rural area. Features outside of this boundary (up to an outer extent of 2 km) are discussed where relevant. Wastewater Treatment Plants and associated discharge points within the River Barrow Catchment are considered up to 10 km from the Graiguenamanagh Bridge due to their interaction with hydrology in the catchment (see section 5.2).

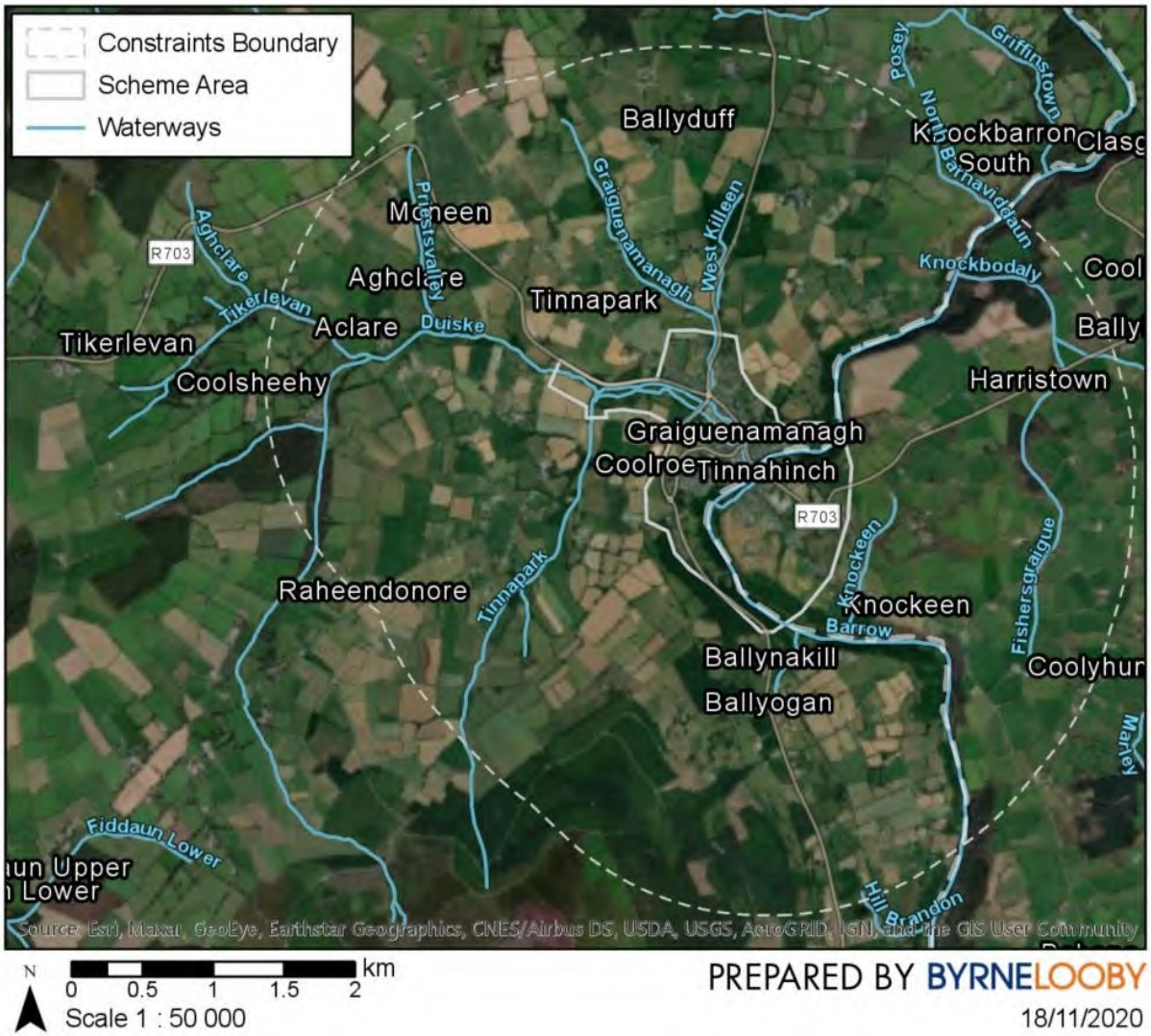


Figure 3-1 Constraints study area for resources and materials

3.2 Methodology

The material assets within the study area were assessed by consultation with the following documents:

- Draft Graiguenamanagh Tinnahinch Joint Local Area Plan 2020-2026.
- Kilkenny County Council County Development Plan 2014 – 2020.
- Carlow County Development Plan 2015 – 2021.
- EPA data base on waste licenced facilities within the study area.
- EPA Focus on Urban Waste Water Discharges in Ireland (2012).

The methodology included:

- Identification of possible material assets within the scheme study area.
- Identification of locations where there may be existing sensitive receptors.
- Identification of material assets constraints.

3.3 Baseline / Receiving Environment

Material assets within the study area include:

- Wastewater infrastructure.
- Waste management facilities.
- Utilities.
- Land ownership.
- Roads and Transportation network (including pedestrians and cyclists).

3.3.1 Wastewater

3.3.1.1 Wastewater Treatment Plants

The towns of Graiguenamanagh and Tinnahinch are served by Graiguenamanagh Sewerage Scheme and Wastewater Treatment Plant (including storm water overflow) with a capacity PE of 3000. The treatment process includes preliminary treatment (screens), secondary treatment (aeration) nutrient removal (biological Nitrogen & Phosphorus removal) and discharges treated effluent into the Barrow and occasionally transfers liquid sludge to Kilkenny Main Drainage.

Tinnahinch is served by the existing sewage treatment facility Graiguenamanagh. The sewage treatment has capacity for further development, both residential and industrial, and can readily be upgraded to cater for extended development beyond the planned period. Kilkenny County

Council and Carlow County Council (2020a) report that loading of the Graiguenamanagh WWTP is c. 3,000 PE. The 2018 figures from Irish Water indicate that the wastewater treatment plant in Graiguenamanagh has capacity for up to 350 housing units (Kilkenny County Council and Carlow County Council, 2020a)

EPA licenced waste water treatment facilities within 10 km of Graiguenamanagh-Tinnahinch and the sub-catchment are described in Table 3-1and their locations shown in Figure 3-2.

Table 3-1 Sewage treatment locations with waste water discharge authorisation in the vicinity of the scheme

Facility name (registration number)*	County	Facility type	Treatment type as reported to EPA	Location of emission
Goresbridge Wastewater Treatment Plant (D0529-01)	Kilkenny	Sewage Treatment >500pe	Tertiary nitrogen and phosphorus removal	Outfall to the River Barrow at Barrowmount, Goresbridge, Co. Kilkenny (emission ID TPEFF1500D0529SW00)
Borris Wastewater Works (D0248-01)	Carlow	Sewage Treatment >500pe	Tertiary nitrogen and phosphorus removal	Primary emission into Mountain River, tributary of the River Barrow upstream of study area, at Borris Wastewater Works (Emission ID: TPEFF0100D0248SW001)
Skeaghvosteen Wastewater Treatment Plant (A0057-01)	Kilkenny	Sewage Treatment <500pe	Secondary treatment	7.5 km north of Graiguenamanagh. Plant discharges to ground.
Graiguenamanagh Sewerage Scheme and Wastewater Treatment Plant (D-0155-01)	Kilkenny	Sewage Treatment >500pe	Tertiary nitrogen and phosphorus removal	Emission into River Barrow at Graiguenamanagh Tinnahinch treatment plant (emission ID TPEFF1500D0155SW001)
St Mullins Wastewater Treatment Plant (A0085-01)	Carlow	Sewage Treatment <500pe	Secondary Treatment	Emission into River Barrow downstream of study area, at St Mullins Wastewater Treatment Plant (emission ID TPEFF0100A0085SW001)
Glynn Wastewater Treatment Plant (A0225-01))	Carlow	Sewage Treatment <500pe	Primary	Emission potentially into unnamed waterbody within the subcatchment feeding into the River Barrow at St. Mullins, downstream of the study area, at Glynn Wastewater Treatment Plant (emission ID: TPEFF0100A0225SW001)

* The lead water services authority for all facilities listed in this table is Irish Water.
Note: a sewage treatment facility (<500pe) and three discharge locations at Inistoige are not included as these do not occur within the subcatchment. A sewage treatment facility (<500pe) and one discharge location at Dungarvan are not included as they are located on the boundary of the study area and are unlikely to interact with the subcatchment in the scheme area (cathchments.ie).

Data source: EPA online data for Licensing and Permitting (accessed October 2020)

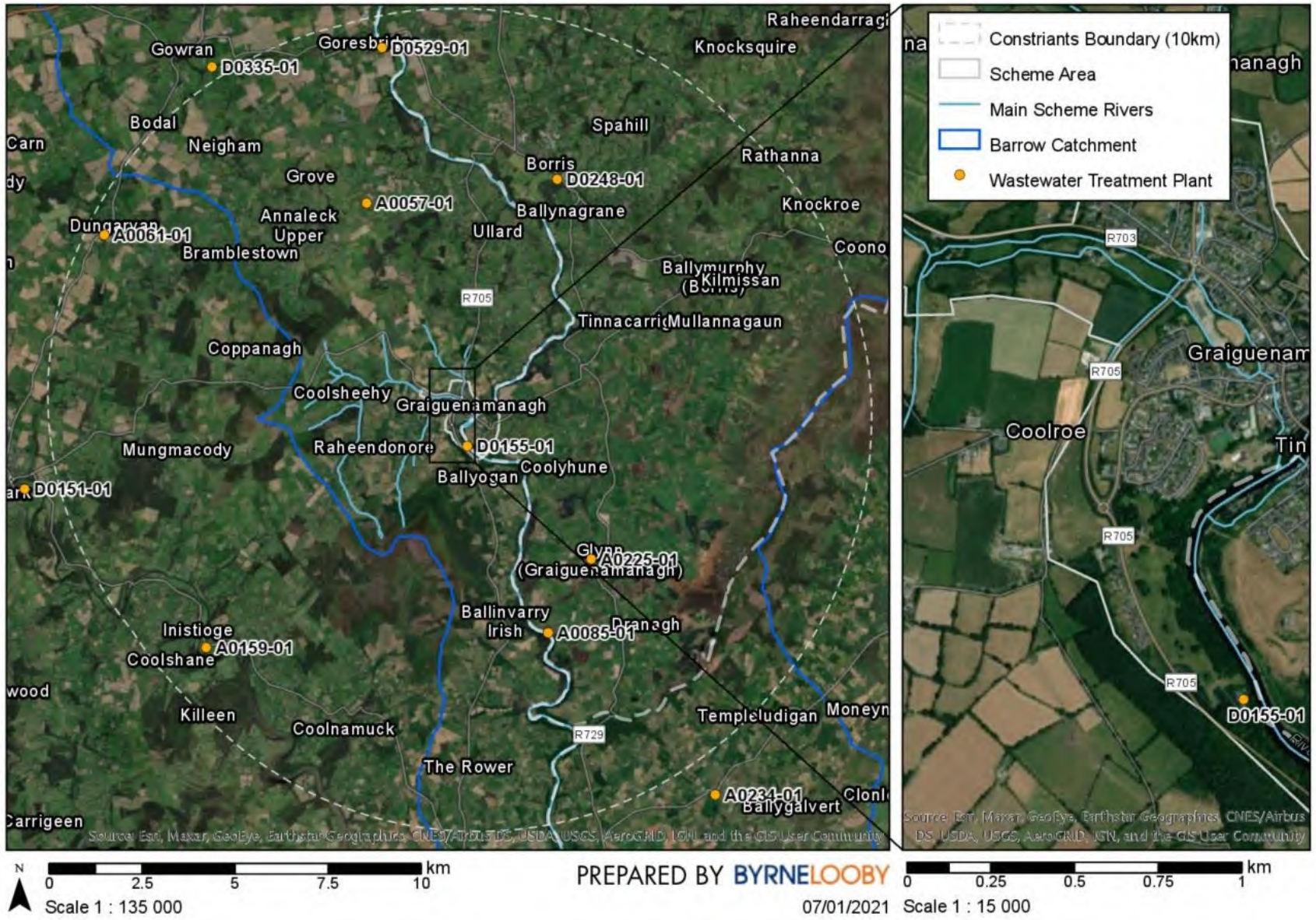


Figure 3-2 Waste water treatment facilities within 10 km of Graiguenamanagh Bridge and the River Barrow Catchment
(Data Source: EPA online data for Licensing and Permitting)

EPA data indicates that downriver of the scheme boundary, at Ballyogan (c. 4.3 km south of Graiguenamanagh-Tinnahinch), the River Barrow becomes the Barrow Estuary and is classed as an Urban Waste Water Treatment Directive Sensitive Area between this location and New Ross.

3.3.1.2 Foul and storm water sewers

The foul network is operated and maintained by Irish Water. Data provided by Irish Water has been used to identify existing foul networks.

Murphy Surveys undertook Lot 5 utilities surveys as part of the GTFRS in 2020. Ground penetrating radar was used to identify the locations of underground utilities, including foul and storm networks in the scheme area. A map of the surveyed network is provided in Figure 3-3. Both foul networks for Tinnahinch and Graiguenamanagh go to the local wastewater treatment plant. Two pumping stations are present in the scheme area at the quay in Graiguenamanagh (ca. 26 m north east of the bridge) and the quay at Tinnahinch (ca. 25 m south west of the bridge) respectively.

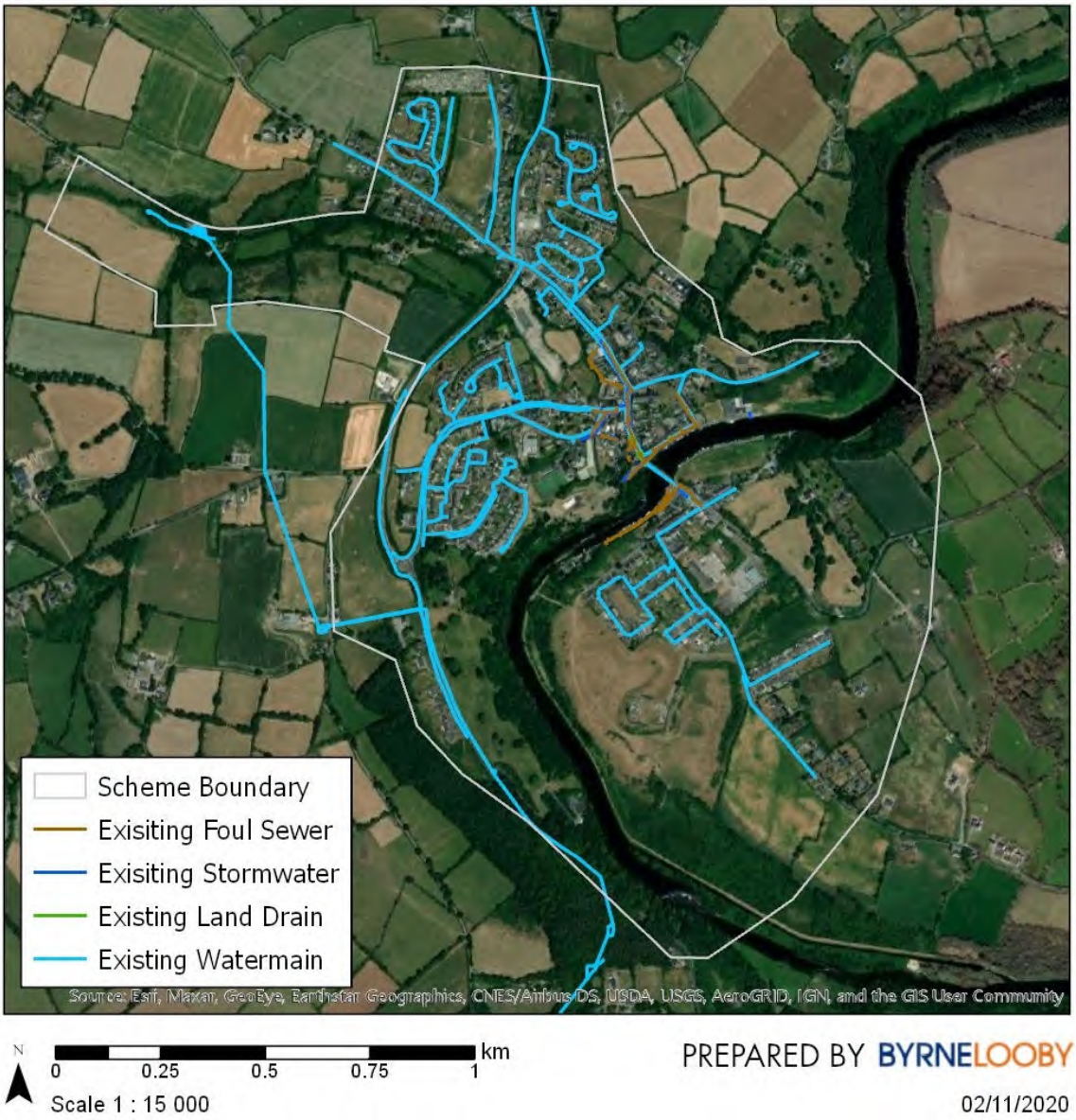


Figure 3-3 Surveyed Foul and Sewer Lines

3.3.2 Waste Management

The EPA data map viewer for waste indicates that there are no licensed waste management facilities or dump sites present within at least 10 km of the study area.

The EPA data map viewer for industry indicates that closest licenced 'Industrial Emissions Licensing facility' is operated by Runtalrad Ltd in Thomastown who produce radiators and are located c. 14 km west of the study area.

Domestic, commercial and industrial waste are collected by private operators and disposed of mainly at the council's centre landfill site at Powerstown and in County Kilkenny.

Recycling and domestic waste services are provided by commercial operators within the study area. There is a bring bank located in Graiguenamanagh.

3.3.3 Utilities

3.3.3.1 Water utilities

The Graiguenamanagh public water supply scheme (scheme code: 1500PUB1008) serves a population of 1,630 people in Graiguenamanagh and Tinnahinch with a volume of approximately 490 m^3 per day. The supply was developed in the 1950s and much of the infrastructure dates back to that time. The water supply for Tinnahinch is supplied from Graiguenamanagh by Kilkenny County Council.

The supply is sourced from two sources located within County Kilkenny; the River Duiske and the Ballyogan springs sources from Brandon Hill. Raw water from the River Duiske is fed into slow sand filters prior to being fed into a package treatment plant comprised of pressure filters and UV disinfection. The water is them pumped to the Coolroe Water Treatment Plant (WTP). Raw water from the spring sources is fed to the Coolroe WTP where it is treated by pressure filters and UV disinfection. Chlorination and pH correction is undertaken at the Coolroe water treatment plant prior to storage in the reservoir (source: EPA data, EPA Drinking Water Audit Report, 2015 and 2018).

The Ballyogan springs are described in section 6.3.8. The River Duiske is described in section 5.3.2.2.

3.3.3.2 Electricity networks

The Electricity Supply Board (ESB) Networks maintains the distribution electricity infrastructure. Figure 3-4 (overleaf) shows the layout of the network, with one piece of High Voltage 110kV overhead lines. The rest of the infrastructure is network with a mix of overhead and underground lines. The Medium Voltage lines are either 20kV or 20kV while the Low Voltage lines are 230V for single phase and 400V for three phase.

The nearest transition lines are located 5 km to the east of Graiguenamanagh. These are 220kV overhead lines maintained by EirGrid.

3.3.3.3 Gas infrastructure

There is no gas distribution or transmission infrastructure reported within the scheme boundary of wider vicinity.

3.3.3.4 Digital infrastructure

With regards to the Department of the Environment, Climate and Communications' National Broadband Plan Map, the study area includes areas classed as:

- target areas for the State intervention of the National Broadband Plan;
- areas where commercial operators are delivering or have indicated plans to deliver high speed broadband services.

(source: National Broadband Plan Map developed using GeoDirectory Q1 2020 data on Gov.ie website).

Internet and landline services are provided by several commercial operators with available internet speeds averaging from 75 Mb to 1000 Mb through 'part fibre' technology (source: switcher.ie accessed October 2020).

Eircom Limited ('Eir') own and maintain the telecoms network for the Area Mobile phone coverage for 2G, 3G, and 4G is provided by commercial operators in the study area with coverage classed as ranging from good to very good by the Commission for Communication Regulation (coveragemap.comreg.ie accessed October 2020).

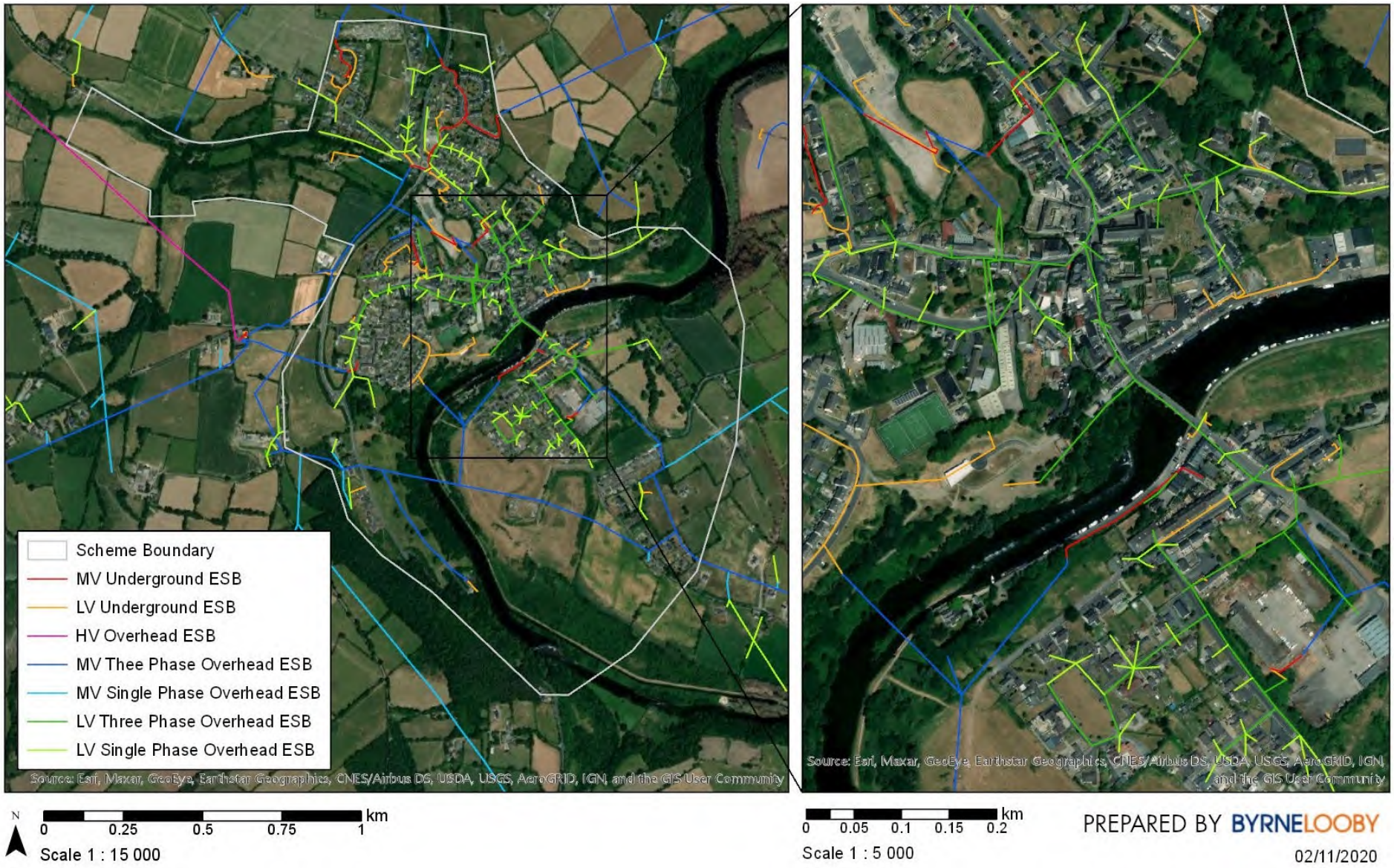


Figure 3-4 Electricity infrastructure in the scheme boundary and vicinity

3.3.4 Land Ownership and Zoning

Graiguenamanagh is classified as a District Town within the Kilkenny County Settlement Hierarchy, while Tinnahinch is designated a Village within the Carlow County Settlement Hierarchy. Land ownership and land use in the scheme study area are varied, including private, public, residential, commercial, and recreational. This regime may be altered by the proposed scheme.

Access to privately owned lands may be required for construction and maintenance works, and land may also need to be acquired as a result of the scheme. Depending on the nature of the land use in the particular areas, there may be a land use change engendered by the proposed scheme.

Both Graiguenamanagh and Tinnahinch are surrounded by agricultural land use with the town being largely residential with supporting community and educational services. Figure 3-5 shows the 2020- 2026 land use zoning for Graiguenamanagh and Tinnahinch. For detailed land use maps see section 9.3.4.

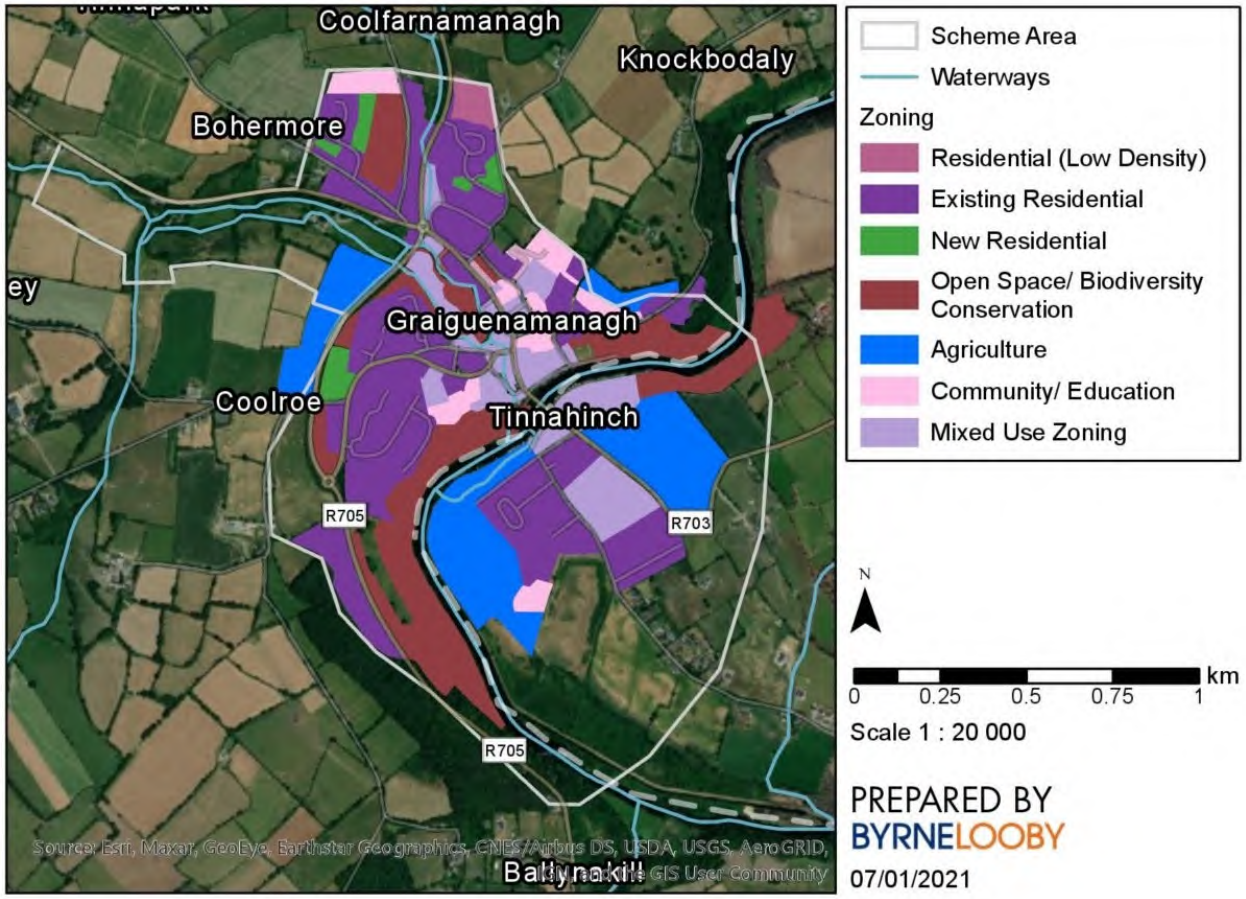


Figure 3-5 Combined Land Use Zoning Map Graiguenamanagh and Tinnahinch
(Data source: Kilkenny County Council Online)

3.3.5 Roads and Transportation Network

The study area is served by the road network with regional ('R') roads the greatest capacity roads present in the vicinity of the proposed scheme. The R703 is the main road that runs east to west between Tinnahinch and Graiguenamanagh and crosses the Barrow river via a bridge. The R705 runs north to south and intersects the R703 and some of the proposed Scheme works in Graiguenamanagh. All roads in the scheme study area are maintained by the respective County Councils, however any modifications to National Primary and Secondary roads would require consultation with Transport Infrastructure Ireland (TII).

As of September 2020, there are no major roads projects on TII's Major Roads Project Active List proposed within the vicinity of the study area (TII, 2020).

There are no railways or tramways directly serving the study area. Graiguenamanagh/ Tinnahinch is served by the '881' bus which connects the town to Kilkenny (and Kilkenny train station) via Borris, Goresbridge and Gowran. A private coach company operates a route linking the town to Kilkenny via Gowran.

Graiguenamanagh Bridge provides road and pedestrian access between Graiguenamanagh and Tinnahinch and it is the only bridge crossing the River Barrow until:

- the R705 crosses the River Barrow into Factory Cross, co. Carlow, at c. 7.1 km north of Graiguenamanagh Bridge.
- the R700 crosses the River Barrow into Macmurrough Island, co. Wexford, at c. 21.7 km south of Graiguenamanagh Bridge.

3.3.6 Pedestrian and Cycling Network

Various walking/cycling pathways are located along much of the length of the river and its immediate surrounds. Public amenity areas green areas in vicinity of the scheme are connected by public walkways, foot bridges and bridges.

The town is located along the route of two significant 'Waymarked Ways'; the Barrow Way and the South Leinster Way. Figures showing the routes are provided in section 9.3.4.

The South Leinster Way extends 102 km from Kildavin in County Carlow to Carrick in Suir in County Tipperary via Graiguenamanagh-Tinnahinch.

The Barrow Way is a 113 km national waymarked trail from Robertstown, County Kildare, to St. Mullin's (County Carlow). The trail follows the towpath, originally a patch alongside the River Barrow where horses pulled barges and goods for transport. Graiguenamanagh-Tinnahinch are located between stage 5 and 6 of the trail, which passes through the study area adjacent to the river in Co. Carlow (source: Carlow tourism website). The promotion and development of this trail as an attraction forms part of the County Carlow Tourism Strategy and Action Plan 2020 – 2015, particularly through the 'Room to Breathe' and 'Do It the Barrow Way' initiatives. The plan seeks to capitalise on the natural environment of County Carlow, and to create opportunities for visitors to purchase more saleable experiences based on that environment.

Shorter walking routes are available in Graiguenamanagh including the Silaire Wood Loop Walk (2 km loop located the north of the town along the western bank of the River Barrow) and the Heritage Trail of Graiguenamanagh (1 km) (SLR, 2019).

Waterways Ireland has responsibility for the management, maintenance, development, and restoration of the River Barrow, principally for recreational purposes. Waterways Ireland's Barrow Blueway project to develop a hard-surface tow path for increasing footfall and cyclists is effectively on hold at the time of writing following refusal of permission of the submitted scheme from An Bord Pleanála in in spring 2019 (source: myplan.ie/national-planning-application-map-viewer).

At the time of writing, no further information is available with regard to pedestrian and non-vehicular users of the study area (for example cyclists and equestrians). This data has been requested and will be considered as the scheme progresses.

3.4 Key Constraints

Impacts on services and utilities such as watermains, gas mains, underground powerlines etc. will all need to be considered during the design process. The possible interruption of these services and utilities should be minimised, where possible. Furthermore, impacts on road and rail infrastructure and land ownership will need to be considered.

Additional general and site-specific constraints will need to be considered as the scheme progresses, including:

- During planning, development, and construction, the utilities infrastructure must be fully considered to ensure that disruptions to the utilities infrastructure are avoided.
- During the construction stage, measures may have to be taken in order to ensure the construction does not interfere in any of the underground or overground utilities services.
- It will be necessary to contact ESB if there is a need for lines to be turned off for a period of time (e.g. for works or relocation of infrastructure) and to determine if the affected residences could be serviced from elsewhere.
- It will be necessary to contact Irish Water if there is a need for water utilities to be turned off for a period of time (e.g. for works or relocation of infrastructure) and to determine if the affected residences could be serviced from elsewhere.
- During planning, development, and construction, any proposals by the applicant to divert existing water services (watermains, service connections, rising mains, foul and surface water sewers, culverts, etc.) will need to be submitted to Irish Water prior to works commencing.
- During the construction stage, measures should be taken in order to ensure the construction does not interfere with underground services. Where works occur in

proximity to electrical lines, some areas may have to be cut-off for the remainder of the work. This could cause an impact to local residents and business.

- Underground electrical lines in the study area may be at risk of flooding in extreme weather conditions causing power outages in areas of Graiguenamanagh-Tinnahinch. The location of the underground cable routes in the planning and construction stages of the scheme should be taken into consideration.
- Consideration of the designs effect on sewerage capacity in the event of hydrological changes or flooding.
- Impacts on road infrastructure and land ownership will need to be considered.
- Impacts on public rights of way, footpaths and cycle routes will need to be considered. The proposed scheme design should ensure continuity of the public walkways within its footprint and future plans for same.
- Graiguenamanagh Bridge provides a significant crossing of the River Barrow and public right of way and access should be maintained throughout the project construction and operation phases.

4 Population and Human Health

4.1 Introduction

This section sets out the principal constraints in relation to the socioeconomic setting of the study area. These include population, recreation/tourism, and public health matters characterising the study area that may impact on the selection of the flood relief measures for the proposed scheme, and which relate to the main settlement areas near which any flood relief measures are likely to be undertaken.

For the purposes of this report, the study is defined as the area shown in Figure 4-1 which includes the towns of Graiguenamanagh (County Kilkenny) and Tinnahinch (County Carlow) and some of the surrounding rural area. Potential constraints outside of this boundary (up to an outer extent of 1km) are discussed where relevant.

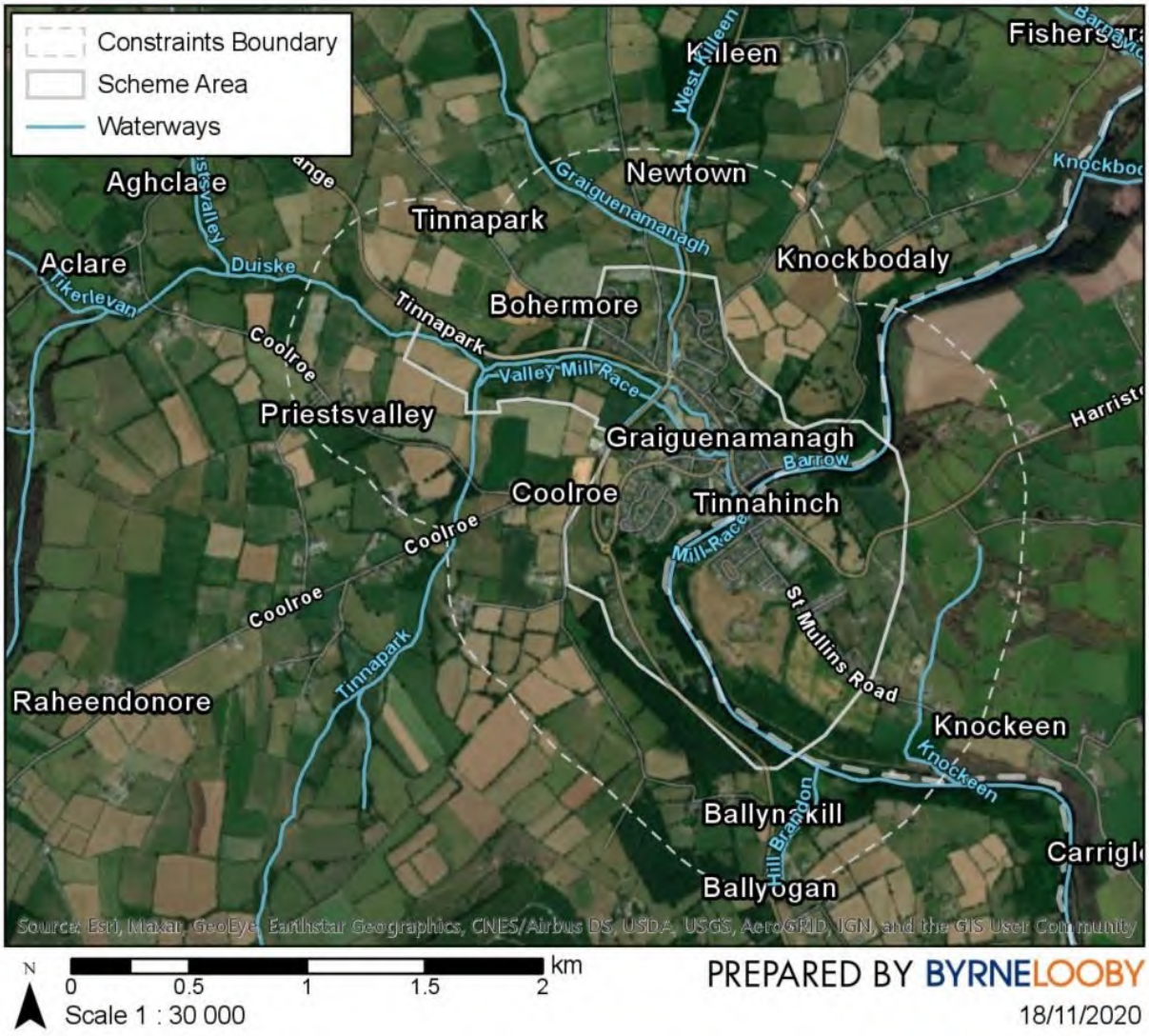


Figure 4-1 Constraints study area for socioeconomics

4.2 Methodology

A desktop study was undertaken to identify the key population and human health constraints within the study area. The following sources of information were used in the preparation of this section:

- Draft Graiguenamanagh Tinnahinch Joint Local Area Plan 2020-2026.
- Graiguenamanagh / Tinnahinch Tourism and recreational project concept study executive summary (SLR, 2019).
- Censuses of Ireland 2016.
- County Carlow's Outdoor Recreation Vision for 2040, and our Plan for 2023.
- County Carlow - Tourism Strategy and Action Plan 2020 – 2025.
- Traffic data provided by KKC (*pers. comm.* 2020)
- Barrow Valley Activities Hub website (barrowvalleyactivitieshub.ie).
- Google Maps (google.com/maps).
- Trail maps hosted at Sports Ireland Outdoors (sportireland.ie).
- Ordnance Survey Ireland (OSi), National Mapping Agency data accessed through the Geohive map veiwer (http://map.geohive.ie).

Sensitive receptors and potential constraints have been identified. Other environmental interactions with population and human health, e.g. noise, vibration, air quality, climate, and material assets are addressed in the relevant sections of this report.

4.3 Baseline / Receiving Environment

4.3.1 Population, land use, and human health

Graiguenamanagh–Tinnahinch is situated on the River Barrow in the steep sided valley between Brandon Hill in County Kilkenny and Mount Leinster in County Carlow. It is a rich cultural town located 16 km from Thomastown, 33km from Kilkenny City, 40 km from Carlow, 19km from New Ross and 41km from Waterford City (Kilkenny County Council and Carlow County Council, 2020b)

The 2016 Census of Population recorded a population of 1,475 persons living within the defined settlement boundary of Graiguenamanagh-Tinnahinch. Graiguenamanagh is classified as a District Town within the Kilkenny County Settlement Hierarchy, while Tinnahinch is designated a Village within the Carlow County Settlement Hierarchy (Kilkenny County Council and Carlow County Council, 2020b)

While not currently above the numerical population threshold used to designate a district town, the towns possess many of the characteristics of a district town as identified in the Regional Planning Guidelines RPG's, 2010- 2022 such as being close to the population level of1,500 and having primary and second level schools.

The Graiguenamanagh bank of the Barrow River (north-western bank) is mainly designated as open space with natural river banks aside from the area directly north of the bridge "The Quay" which is a 200m stetch of road directly along the water's edge. Along this road there mixed commercial, residential and recreational activities such as a guest house and a scout hall. There is an architectural conservation area and several protected buildings near The Quay.

The open riverbanks are also utilised as public recreation areas. Duiske College is situated south of the bridge with the sports field only 100 m from the water's edge.

Along the Tinnahinch banks (south-eastern bank) the is a foot path / narrow road that runs along the river north and south of the bridge. At the south end of this path is Tinnahinch Castle as well as a set of lock gates. There are many small private and recreational boats moored along the wall of the path

Further inland either side of the river is mainly residential with a few supporting commercial and community services (such as restaurants, stores, post offices etc.) and further beyond the towns is agricultural land.

Local services within Graiguenamanagh include Graiguenamanagh Health Centre, and Graiguenamanagh Garda Station. Land use and zonation is described in section 3.3.4.

4.3.2 Tourism and recreation

Graiguenamanagh-Tinnahinch is a popular section of the River Barrow for walking and water sports. Existing outdoor recreation sites include rowing, kayaking, walking trails and open water swim (source: County Carlow's Outdoor Recreation Vision for 2040, and our Plan for 2023).

Recreational game and coarse fishing take place on the River Barrow. Guesthouses and self-catering cottages provide accommodation to tourists in the area. Catering is provided by bars, restaurants and cafes in the area.

The Carlow County Development Plan 2015 – 2021 identifies the opportunity for the outdoors in the county. Specific outdoor recreation developments include the interconnecting network of river routes along watercourses along the River Barrow, River Slaney and River Burren. Two significant walking trails cross the study area, and these amenities are described in section 3.3.5.

The Barrow Valley Activities Hub (also known as 'Barrow Valley Community Development') was established adjacent to the River Barrow in Graiguenamanagh in 2011. Its aim is to 'create an innovative outdoor venue that integrates education, economic and social resources of the Graiguenamanagh and Barrow Valley region by using the local attractive natural environment'' (source: Barrow Activities Hub website, 2020). It provides a range of indoor and outdoor

facilities to amenities users from the local communities and beyond, including an all-weather playing pitch. SLR (2019) report that parking and vehicular access it limited for the facility and it has not reached its envisaged revenue potential.

SLR (2019) reports that in August each year, Graiguenamanagh hosts an annual month of festivals comprising the regatta weekend (1st weekend), walking festival (2nd weekend), music festival (3rd weekend), and Town of Books (4th weekend).

4.3.3 Traffic

Table 4-1 presents data of 7-day traffic counts undertaken in Graiguenamanagh town between 2017 and 2020. Annual Daily Traffic (ADT) ranges from 884 to 3356 and Annual Average Daily Traffic (AADT) between 835 and 3576, with the highest traffic counts recorded on Road No. 705 and the lowest on Road No. 703. The highest vehicle speeds are also recorded on both of these roads, with a moderate to high percentage of speed violations recorded (especially on Road No. 705). Generally, the percentage of Heavy Commercial Vehicles (HCV) travelling through the town is low, ranging from 10 – 1%, with Road No. 705 illustrating the highest percentage.

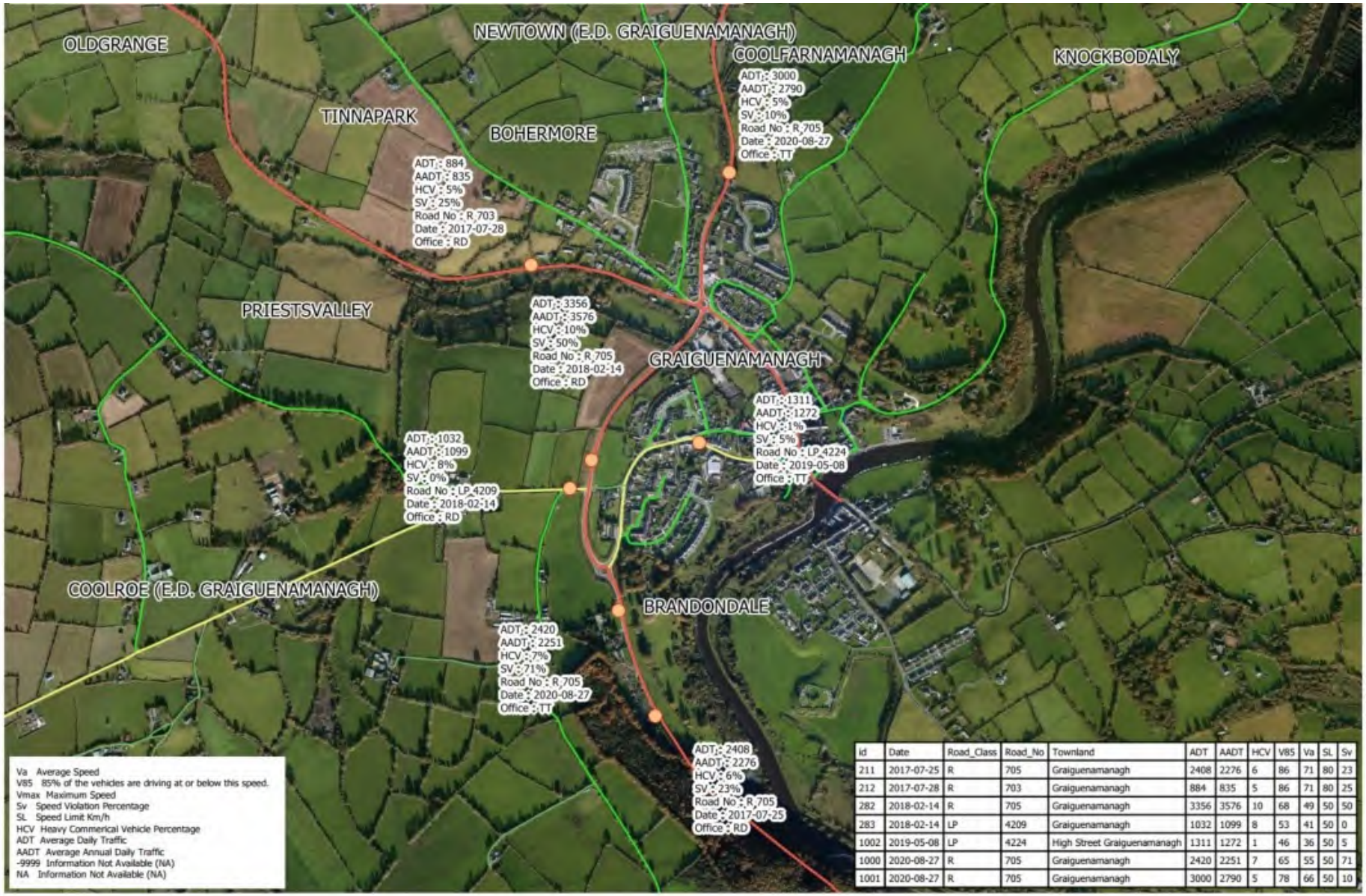
Table 4-1: Graiguenamanagh Traffic Counts

Date	Road Class	Road No.	Town	ADT	AADT	HCV %	V85 (km)	Va (km)	SL (km)	Sv %
25-07-17	R	705	Graiguenamanagh	2408	2276	6	86	71	80	23
28-07-17	R	703	Graiguenamanagh	884	835	5	86	71	80	25
14-02-18	R	705	Graiguenamanagh	3356	3576	10	68	49	50	50
14-02-18	LP	4209	Graiguenamanagh	1032	1099	8	53	41	50	0
27-08-20	R	705	Graiguenamanagh	2420	2251	7	65	55	50	71
27-08-20	R	705	Graiguenamanagh	3000	2790	5	78	66	50	10
08-05-19	LP	4224	High Street Graiguenamanagh	1311	1272	1	46	36	50	5

Abbreviations:
ADT: Annual Daily Traffic
AADT: Annual Average Daily Traffic
HCV: Heavy Commercial Vehicles
V85: 85% if the vehicles are driving at or below this speed
Va: Average Speed
SL: Speed Limit
Sv%: Speed Violation Percentage.
Source: pers comm. KCC, November 2020.

The above data has been represented on a map, in Figure 4-2, illustrating the location of the counts and data compiled for each location.

Traffic data for Tinnahinch has been requested and was not available at the time of writing.



id	Date	Road_Class	Road_No	Townland	ADT	AADT	HCV	V85	Va	SL	Sv
211	2017-07-25	R	705	Graiguenamanagh	2408	2276	6	86	71	80	23
212	2017-07-28	R	703	Graiguenamanagh	884	835	5	86	71	80	25
282	2018-02-14	R	705	Graiguenamanagh	3356	3576	10	68	49	50	50
283	2018-02-14	LP	4209	Graiguenamanagh	1032	1099	8	53	41	50	0
1002	2019-05-08	LP	4224	High Street Graiguenamanagh	1311	1272	1	46	36	50	5
1000	2020-08-27	R	705	Graiguenamanagh	2420	2251	7	65	55	50	71
1001	2020-08-27	R	705	Graiguenamanagh	3000	2790	5	78	66	50	10

Figure 4-2 Graiguenamanagh Traffic Counts, Nov 2020

4.4 Key Constraints

- Constraints on population and human health will depend on the final nature and extent of the scheme, as well as the duration and nature of the construction phase.
- Public and tourist amenities and facilities should also be considered key constraints. Impacts on public amenity areas adjacent to and requiring access to the rivers such as riverside walks, parks. playgrounds and tourist features should be considered, with replacement mitigation proposed if necessary. Impacts on tourist facilities, recreation and amenity facilities in the area should be considered constraints, especially those requiring access to the watercourses in the area.
- Development of the proposed scheme must take into consideration ways for areas of commercial or tourist potential maintain their aesthetic and public attractiveness both during construction and operation of the scheme.
- Development of the proposed scheme must take into consideration ways to complement and enhance public amenities including green spaces in the proposed scheme footprint. Measures to protect extant recreational areas and green public spaces should be developed within the proposed scheme. The proposed scheme design should ensure continuity of the public walkways within its footprint.
- The scheme design should take into account the value (both cultural and economic) of any buildings (residential, retail, etc.) close to the rivers' edges or potential flood storage areas or likely to be adversely affected by the scheme within the scheme study area.
- Regional roads in the project are likely to be congested at peak travel times. Some roads in the scheme area are narrow and may not be suitable for site access. Graiguenamanagh Bridge provides road and pedestrian access between Graiguenamanagh and Tinnahinch as is the only bridge crossing the River Barrow in the vicinity of the scheme and access to the bridge should be maintained throughout scheme construction and development. There is a potential for construction to make traffic more congested in the study area and vicinity in the short term. A traffic management plan will be required with the CEMP.
- Any design proposals should ensure that any bridges over watercourses are maintained where feasible so that temporary or permanent disruption of local transport links and access to homes and businesses in the study area are minimised. It is also noted that facilities such as schools, medical facilities, and shops are located predominantly in Graiguenamanagh, fewer and less diverse facilities are available in Tinnahinch.
- The River Barrow and River Duiske has access and movement limited by urban development in some areas. During construction of the scheme, traffic restrictions could pose problems for deliveries and site access and traffic management measures will be considered as part of the environmental impact assessment process.

- Construction works will have to be mindful of maintaining access for both pedestrians and cyclists. A traffic management plan will be required during construction works.
- The traffic associated with construction works will need to be mindful of the tourist and retail trades.
- Sensitive receptors e.g. homes, schools, medical facilities, and outdoor learning/training organisations should be considered key constraints in the design of the flood relief scheme. The scheme design should take into account the value (both cultural and economic) of any buildings (residential, retail, etc.) close to the rivers' edges or likely to be adversely affected by the scheme within the scheme study area. Medical facilities in the scheme study area are sensitive receptors and must be given due consideration. Flooding events can cause devastation to homes, businesses and local facilities, with social and human health impacts. Their specific protection through adequate flood defences should be considered in the design of the scheme.

Other impacts to population that are also concerned with human health, including material assets such as water supply, wastewater treatment, and utilities should also be given due consideration.

Constraints and considerations regarding the architectural conservation area are addressed in section 8.

5 Hydrology

5.1 Introduction

This section of the report outlines the environmental constraints associated with the hydrology of the study area. The principal surface water bodies within the study area are the River Barrow and the River Duiske. Two Mill Races are also present in the scheme area and associated with these waterbodies.

For the purposes of this report, the study is defined as an area approximately 3 km in radius from the scheme area (see Figure 5-1). Features outside of this boundary (up to an outer extent of 10 km) are discussed where relevant to give greater context within the wider vicinity of the project area, where relevant (as they are considered unlikely to interact with the scheme). This 10 km extent for such features will be reviewed at scoping for EIA and EIA stages and when further details for the design and construction of the scheme become available to ensure adequate consideration of interactions, were relevant.

This constraint study area is located within the wider River Barrow catchment area (shown in Figure 5-2 overleaf), which is also considered in this section as appropriate.

Table 5-1 National water quality monitoring stations and hydrometric gauges within 3km of the scheme area

Map Label	EPA Registration Number	Type	River	Status
01	RS14D040100	National Water Quality Monitoring Station	Duiske	Operational
02	RS14D040150	National Water Quality Monitoring Station	Duiske	Operational
03	RS14D040170	National Water Quality Monitoring Station	Duiske	Pre-WFD
04	RS14D040180	National Water Quality Monitoring Station	Duiske	Pre-WFD
05	RS14D040200	National Water Quality Monitoring Station	Duiske	Operational
06	RS14B013500	National Water Quality Monitoring Station	Barrow	Surveillance and Operational
07	RS14B013490	National Water Quality Monitoring Station	Barrow	Investigative
08	RS14B013480	National Water Quality Monitoring Station	Barrow	Investigative
09	RS14B013450	National Water Quality Monitoring Station	Barrow	Investigative
10	RS14B013504	National Water Quality Monitoring Station	Barrow	Investigative
11	RS14B013510	National Water Quality Monitoring Station	Barrow	Investigative
12	RS14B013514	National Water Quality Monitoring Station	Barrow	Investigative
13	RS14B013520	National Water Quality Monitoring Station	Barrow	Pre-WFD
14	RS14B013400	National Water Quality Monitoring Station	Barrow	Pre-WFD
14023	14023	Hydrometric Gauge	Barrow	Inactive
14029	14029	Hydrometric Gauge	Barrow	Active (Recorder)
14049	14049	Hydrometric Gauge	Duiske	Inactive
14051	14051	Hydrometric Gauge	Barrow	Inactive

Map Label	EPA Registration Number	Type	River	Status
14122	14122	Hydrometric Gauge	Duiske	Active (Recorder)
14123	14123	Hydrometric Gauge	Duiske	Active (Recorder)

(Data source: EPA GeoPortal, 2020).

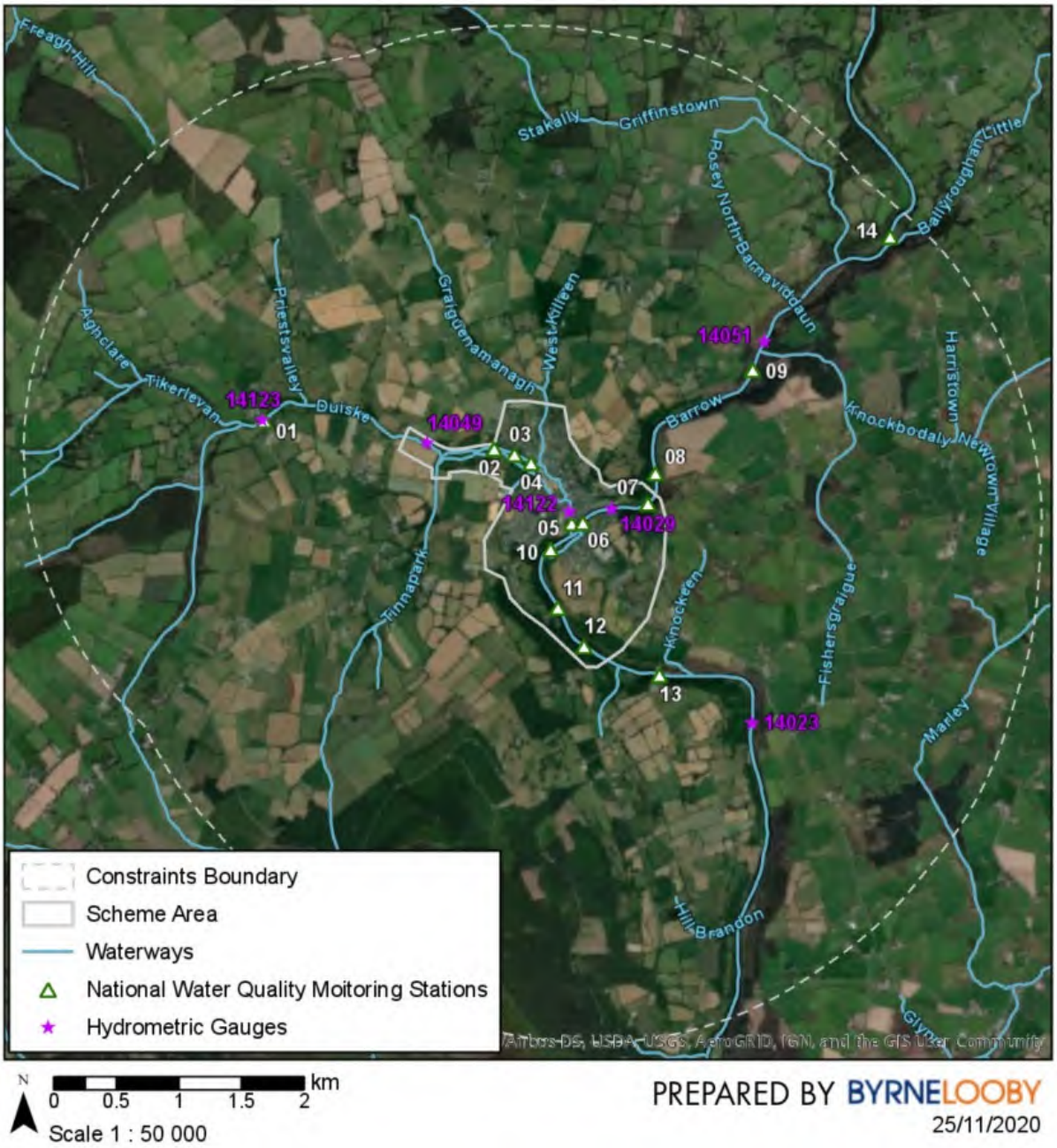


Figure 5-1 Hydrology constraints study area with locations of national water quality monitoring stations and hydrometric gauges
(Data source: EPA GeoPortal, 2020).

Recent and publicly available surface water quality data is available for the study areas from the catchments.ie website. Physicochemical surface water data is available from monitoring station codes in the scheme area and vicinity: RS14B013500, RS14B013500, RS14M010200, RS14B013510, RS14B013514 and RS14D040150 (Environmental Protection Agengcy,

2020) (Environmental Protection Agency, 2020). This data will be considered with of the environmental impact assessment.

A desktop study was undertaken to describe the overall hydrological regime and water quality within the study area and to define hydrological constraints. The sources of publicly available information consulted in order to identify possible hydrological constraints within the study area include:

- EPA geoportal website including map viewer and water quality database.
- Geological data available through the GSI data portal and map viewer series.
- Data available through the EPA data portal and map viewer series.
- Water Framework Directive website www.wfd.ie
- The catchments.ie website.
- The OPW's floodinfo.ie portal website.

A number of other datasets are also relevant to hydrology due to their interactions, e.g. ecological sites and hydrogeological features. These have been dealt with in other relevant sections of this report.

The Catchments.ie website publishes water quality data for the sections of rivers within the study area under the sub catchment classification 'BARROW_230' (code: IE_SE_14B013514), DUISKE_010 (code: IE_SE_14D040100), and 'DUISKE_020' (code: IE_SE_14D040200).

The characterisation of the baseline in this section is based on desktop study.

5.2 Baseline / Receiving Environment

5.2.1 The Barrow Catchment

All rivers in the study area are located within the River Barrow catchment. The River Barrow's total length is c.192 km and its total catchment area is c 3,015 km^2. The source of the river is at Glenbarrow in the Slieve Bloom Mountains, County Laois, to the north of the study area.

The total population of the Barrow catchment is approximately 188,117 with a population density of 62 people per km^2. The catchment is underlain in its flat northern area by limestones of varying purity which continue down the western side of the catchment. On the eastern side of the catchment, granites dominate, culminating in the summits of the Blackstairs Mountains (source: catchments.ie website).

The River Barrow is one of the constituents of a groups of three rivers called 'the three sisters' along with the River Nore (which has a tributary with the River Barrow north of New Ross near the Barrow Bridge) and the River Suir (which has a tributary with the River Barrow at Cheekpoint, near the Port or Waterford). Both tributaries occur downriver and south of the study area.

Figure 5-2 River Barrow Catchment
(Data source: EPA GeoPortal)

5.2.2 Water bodies in the Study Area

EPA data indicates that tidal and/or river tidal effects do not occur in the study area. Lakes, transitional waters and coastal waters are not present in the study area. Figure 5 1 outlines the hydrological regime within the study area.

A review of OPW arterial drainage schemes indicate there are no arterial drainage schemes or benefitting lands within the model catchment (source: floodinfo.ie interactive drainage map).

The Carlow County Development Plan 2015 -2021 (section 10.4 and policy 7 therein) outlines the policy of CCC to protect existing and potential water sources[2] for the county through the following measures:

- Actively participate in the implementation of the Water Framework Directive.
- Implement the South Eastern River Basin District Management Plan and the Program of Measures.
- Increase public awareness of water quality issues.
- Ensure the sustainable and economic provision of an adequate supply of good quality water for industrial, domestic and other beneficial uses, including the propagation of healthy fish stocks.
- Ensure the protection of sources of potable water and monitoring the quality of water resources.
- Prevent industrial water pollution requiring that wastewater treatment facilities are adequate.
- Protect existing and potential water resources for County Carlow, in accordance with the EU Water Framework Directive (2000/60/EC), the South- East River Basin Management Plan 2009-2015 and any updated version, the Pollution Reduction Programmes for designated shellfish waters, the provisions of Groundwater Protection Scheme for the County and any other protection plans for water supply sources.
- Ensure that developments permitted comply with the requirements of the EU Water Framework Directive, the relevant River Basin Management Plans and the Habitats Directive.
- Promote compliance with the requirements of the European Communities (Surface Waters) Regulations 2009 and the European Communities (Groundwater) Regulations 2010 and any other relevant legislation.
- Continue to improve water quality by implementing the measures outlined in the Nitrates Directive (91/676/EEC) and the national Nitrates Action Programme.
- Ensure that development permitted would not have an unacceptable impact on water quality and quantity, including surface water, ground water, designated source protection areas, river corridors and associated wetlands, estuarine waters, coastal and transitional waters.
- Implement the EPA Code of Practice for Wastewater Treatment Systems serving Single Houses (2009) in order to protect water quality.

[2] surface water and groundwater

- Prevent pollution of water by means of development management and enforcement measures.
- Ensure that developments that may adversely affect water quality will not proceed unless mitigatory measures are employed, such as settlements ponds, interceptors, etc.
- Support the protection of groundwater resources and dependent wildlife/habitats in accordance with the Groundwater Directive 2006/118/EC and the European Communities Environmental Objectives (groundwater) Regulations, 2010 (S.I. No. 9 of 2010) or any updated legislation.

The Kilkenny County Council County Development Plan 2014 – 2020 (the most recent plan developed at the time of writing) includes a strategic aim to provide a framework for the protection of the environment, including water quality and the avoidance of flood risk. The Council has responsibilities for the protection of all waters including rivers, lakes, estuarine waters and groundwater. The work includes implementation of pollution control measures, licensing of effluent discharges, implementing and monitoring compliance with environmental legislation, and drawing up pollution contingency measures. The Council participate in the implementation of the Water Framework Directive. The plan state that the Council will continue to take appropriate measures in relation to all development in order to prevent ground and surface water pollution and will implement the South Eastern River Basin Management Plan.

5.2.2.1 Built structures

A description of the built structures associated with the River Barrow and River Duiske in the scheme area are provided in Table 5-2.

Table 5-2 List of bridges and in-river built structures within the scheme area

Location	Structure Type	Name	Description	Location (ITM coordinate system)
River Barrow	Bridge	Graiguenamanagh Bridge	Masonry Arch Road Bridge	670932.669, 643644.820
River Barrow	Weir	Graiguenamanagh Weir	'L' shaped weir c.1 m in height	670891.036, 643562.545
River Barrow	Millrace	Tinnahinch Mill Race	Mill Race (see section 5.2.2.4)	670907.268, 643537.020
River Barrow	Lock Gates	Tinnahinch Lock Gates	A section of two lock gates	670692.412, 643428.229
River Duiske	Millrace	Valley Mills Mill Race	Mill Race (see section 5.2.2.4)	669798.787, 644155.321
River Duiske	Bridge	R705 Road Bridge	Precast concrete road bridge access to Aldi	670572.345, 644097.332
River Duiske	Bridge	Aldi Bridge	Precast concrete road bridge	670610.756, 644085.809
River Duiske	Bridge	Well Lane Bridge	Steel Pedestrian foot bridge	670755.481, 643915.807

Location	Structure Type	Name	Description	Location (ITM coordinate system)
River Duiske	Bridge	Clapper Bridge	Stone foot bridge	670782.740, 643831.797
River Duiske	Bridge	High Street Bridge	Masonry Arch Road Bridge	670836.269, 643795.120
River Duiske	Bridge	Residential access bridges	A series of flat concrete and steel accessways to residential properties	670828.339, 643733.662
River Duiske	Bridge	Turf Market Bridge	Masonry Arch Road Bridge	670828.339, 643733.662
River Duiske	Bridge	Dock Bridge	Masonry Arch Road Bridge	670832.923, 643612.480
Killeen	Culvert	Killeen Culvert	300m culvert out falling to the River Duiske	670592.789, 644120.627
Relief Road	Culvert	Relief Road Culvert	20m culvert out falling to the River Duiske	670533.314, 644099.810

5.2.2.2 River Barrow

The overall direction river flow is broadly south and within the study area the River Barrow meanders south east though Graiguenamanagh-Tinnahinch and to the south west once south of the town. A bridge crosses the River Barrow at Graiguenamanagh-Tinnahinch. A tributary with the River Duiske occurs downriver of the bridge on the bank in Kilkenny (see section 5.2.2.3).

The river is overlapping/partly within the protected areas of the River Barrow and River Nore SAC discussed in section 7.3. Q values are discussed in discussed in ecology section 7.

The WFD surface water monitoring programme 2013-2018 reported that in the study area (IE_SE_14B013514) Chemical Surface Water Status was classified as 'Good'. EPA data reports that that ammonium, phosphorous conditions (including orthophosphate) were classed as 'High'.

The WFD surface water monitoring programme 2013-2018 reported that in the study area (IE_SE_14B013514) Ecological Status or Potential was classified as 'Poor'.

The most recent published WFD 'River Waterbody Approved Risk' classification assigned to the River Barrow in the scheme area ('BARROW_230') reports the waterbody as 'At risk' due to its less than 'Good' ecological status. Significant pressures identified in the sub catchment are urban-run off with run-off (with pressures including agglomeration PE of 1001 to 2000) and hydromorphology, particularly where this is influenced by dams, barriers, locks and weirs The WFD cycle 2 report notes that a wastewater treatment plant is impacting the water quality of 'BARROW_230' while in-channel barriers may be impacting fish status. (source: WFD cycle 2 Catchment Barrow Subcatchment Barrow_SC_130 Code 14_7 report).

5.2.2.3 River Duiske

The River Duiske is 12.23km in length and flows in a broadly south east direction through the town of Graiguenamanagh where it joins the River Barrow at the Old Dock downriver of the bridge. The river is overlapping/partly within the protected areas of the River Barrow and River Nore SAC, discussed in section 7. Water abstraction from the River Duiske is discussed in section 3.3.3.1.

WFD surface water monitoring programme 2013-2018 reported that the Ecological Status or Potential in the study area (IE_SE_14D040200) was classed as Moderate. Supporting Chemistry Conditions were classified as 'Pass' with ammonium, phosphorous conditions (including orthophosphate) classed as 'High'.

The most recent WFD 'River Waterbody Approved Risk' classification assigned to the waterbody is 'At risk' due to its less than 'Good' ecological status. Significant pressures identified in the sub catchment are urban run-off with run-off from diffuse sources and agriculture (source: WFD cycle 2 Catchment Barrow Subcatchment Barrow_SC_130 Code 14_7 report). However, in the rivers upper sections (code: IE_SE_14D040100), broadly this comprises sections of the river to the west of where it is crossed by the L8243 road, the River Duiske is classified as 'Not at risk' in the most recent WFD 'River Waterbody Approved Risk' classification.

5.2.2.4 Mill Races

There are two millraces present in the scheme area; the Tinnahinch Millrace (Tinnahinch) and the Valley Mills Millrace (Graiguenamanagh) (see Table 5-2).

The Tinnahinch mill race is situated on the left bank of the River Barrow and flows parallel to the river for c.350 from Graiguenamanagh Wier and adjacent to Tinnahinch Castle before re-joining the River Barrow downstream of the lock gates. There are no active mills or associated infrastructure present on the mill race.

The Valley Mills Millrace is on the River Duiske and is c.1 km in length and flows parallel with the Duiske from its upper catchment to the Graiguenamanagh town. The Valley Mills currently operate a small hydroelectric plant (HEP) on the millrace to the west of Graiguenamanagh town. Downflow of the HEP, the waterbody pass through Cushendale Mills, adjacent to Mill Road, Graiguenamanagh, before re-joining the Duiske c. 50 m to the east of the mill. The is no turbine or wheel structures at Cushendale Mills but there is a mill drop. Several overflow weirs are used along the mill race to maintain water levels and excess water flows to the River Duiske.

5.3 Key Constraints

- Some of the principal surface water bodies in the study area are classed under the Water Framework Directive as 'At risk'.
- Under WFD requirements, the development of the scheme should incorporate measures not to worsen its status. All possible risks of point source pollution or runoff during

construction and operation should be assessed and prevented. Works during the construction of the scheme could pose a threat to the water quality of water bodies within and downstream of the study area though various mechanism, chiefly:

(1) Increasing suspended solids in the water bodies through release or run-off of significant amounts of suspended solids during enabling works and construction; and

(2) Unplanned events such as leaks/spills/runoff/accidental release or escape of fuels, oils and lubricants, bulk liquid cement, contaminated leachate, etc.

- Measures to protect surface water from leaks/spills, contamination, increased turbidity or input of suspended solid, etc, should be considered.
- Contamination potentially present on site from historical land use must also be considered. The CEMP for the scheme will include measures to avoid mobilising and/or creating pathways for any contaminants present on site to the surface where surface runoff can introduce contaminants to surface water during enabling and construction works.
- Measures to protect active national water monitoring stations and hydrometric gauges and avoid impacting their data collection processes should be considered during design and construction phases.
- The scheme design and schedule will need to take into consideration the development of any WWTPs, water abstraction facilities or third party 'WFD' projects in the vicinity of the scheme area, including potential impacts to utilities and infrastructure.

6 Soils, Geology and Groundwater

6.1 Introduction

This section of the report outlines the environmental constraints associated with the soils, geology and groundwater/hydrogeology of the study area.

The topic specific constraint boundaries are provided in the relevant figures in the following section and are:

- 1 km of the scheme area boundary for geology, karst features, geoheritage, geohazards, economic geology, and soil.
- 3 km of the scheme area boundary for groundwater.

Features outside of these boundaries may be discussed in the following subsections to give greater context within the wider vicinity of the project area, where relevant. However, such features are not considered within the constraint boundary as they are unlikely to interact with the scheme.

6.2 Methodology

A desktop study was undertaken to describe the environmental constraints associated with the soils, geology and hydrogeology of the study area. The sources of publicly available information consulted in order to identify possible constraints within the study area include:

- Geological Survey Ireland (GSI) data and map viewer, including hydrogeology, geology, soils, geoheritage, karst database and GeoUrban. GSI is a division of the Department of Communications, Climate Action and Environment. Specific attribution statement: "This report contains Irish Public Sector Data (Geological Survey) licensed under a Creative Commons Attribution 4.0 International (CC BY 4.0) licence".
- County Kilkenny Groundwater Protection Scheme Volume II: Source Protection Zones, DCCAE (Draft. May 2002).
- Teagasc Irish Soil Information System.
- Exploration and Mining Division (EMD) data and map viewer. EMD is a division of the Department of Communications, Climate Action and Environment.
- EPA Map data and map viewer.
- Groundwater data hosted on Catchments.ie

The characterisation of the baseline in this section is based on desktop study.

6.3 Baseline / Receiving Environment

6.3.1 Geology

The River Barrow rises in the Old Red Sandstone of the Slieve Bloom Mountains before passing through a band of Carboniferous shales and sandstones. The upper reaches of the Barrow run through limestone. The middle reaches and many of the eastern tributaries, sourced in the Blackstairs Mountains, run through Leinster Granite. The southern end runs over intrusive rocks poor in silica. Waterford Harbour is a deep valley that was excavated by historical glacial floodwaters. The coast shelves quite rapidly along much of the shore. (source: River Barrow and River Nore SAC site synopsis; GSI map viewer data).

Bedrock geology in the study area and wider vicinity is comprised of Lower Palaeozoic strata and intrusives. The formations and lithological descriptions are presented in Table 6-1and Figure 6-1.

Table 6-1 Bedrock geology in the study area

Formation	Lithology	Global series (local stage)
Maulin Formation	Penetratively cleaved dark blue grey slates and phyllites which are commonly striped with pale siltstone laminae. Bands of garnetiferous quartzite that are 20 m thick occur in the granite aureole. there are also thick lenses of orthoquartzite.	Ordovician, (questionably Lower Arenig)
Brownsford Member (Maulin Formation)	Grey psammites and semi-pelitic schists interbedded with dark blue-grey pelitic schists and phyllites.	Ordovician, (Tremadoc)
Type 2 Equigranular Granite (Tullow Pluton)	Pale, fine to coarse grained granite.	'Caledonian'
Blackstairs Grananamgah Granite Gneiss	Highly foliated gneissic granodiorite	'Caledonian'
Type 1 Granite (Blackstairs Granite)	Fine-grained granodiorite to granite.	'Caledonian'
Type 2 Equigranular Granite (Blackstairs Granite)	Pale, fine to coarse-grained granite.	'Caledonian'
Type 2 Microcline Porphyritic Granite (Blackstairs Granite)	Granite with microcline phenocrysts.	'Caledonian'
Source: GSI mapping viewer data for100k Bedrock Geology (2020)		

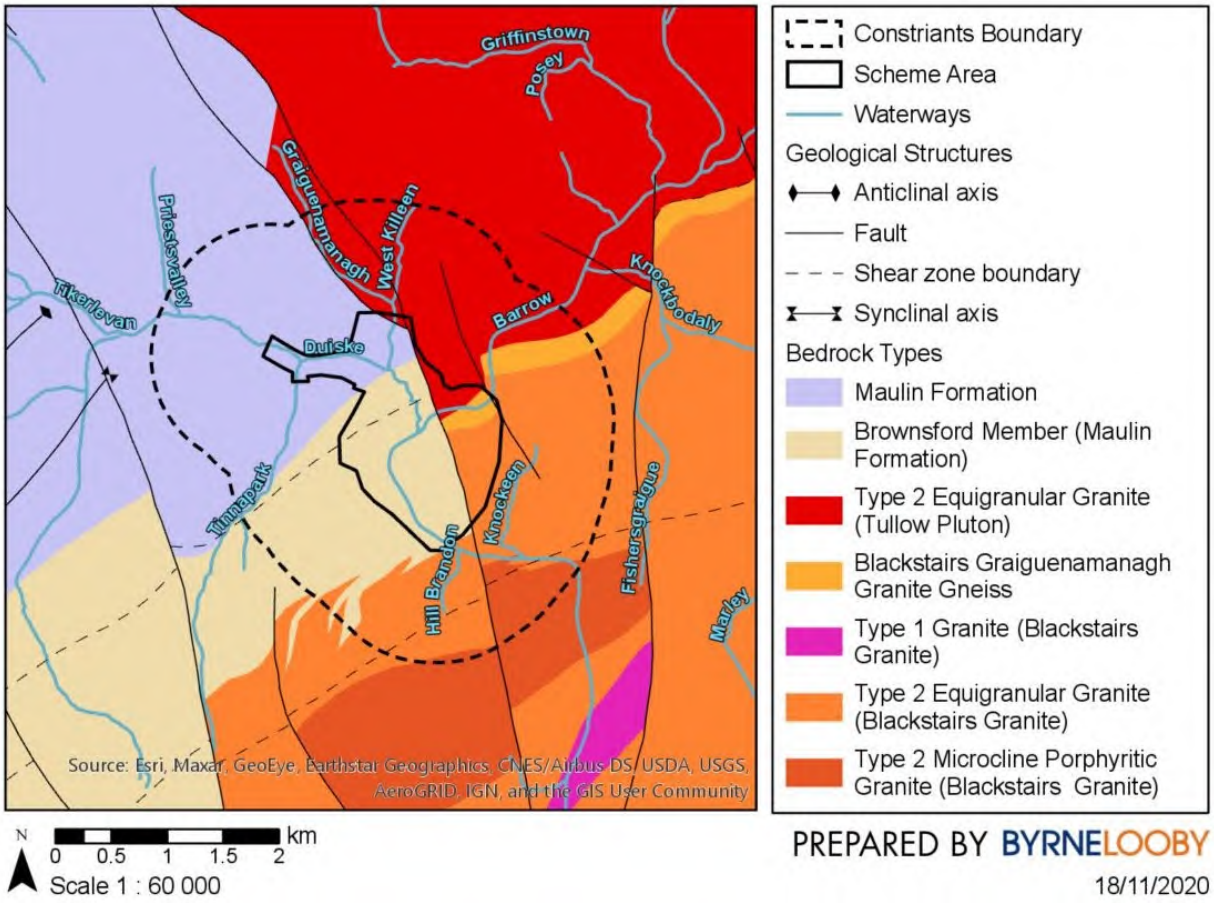


Figure 6-1 Bedrock geology
(Data source: GSI mapping viewer data for100k Bedrock Geology (2020))

GSI data indicates that Quaternary geology in the study area is comprised of gravels derived from limestones broadly located in Tinnahinch and areas in the south east of the study area. Alluvium is reported underlying and immediately adjacent to the River Barrow and River Duiske. Quaternary geology in Graiguenamanagh is indicated to be composed of areas comprised of till derived from Lower Palaeozoic sandstones and shales or granites and areas of outcrop.

6.3.2 Karst features

Karst can form on any rock that is soluble in water and, within Ireland, most karst is found in Carboniferous limestones. Karsts features can cause structural instability to overlying and adjacent land and increase vulnerability to groundwater by creating a pathway for contaminants present on land or surface waters to enter the subsurface.

GSI bedrock mapping data (2020) indicates that Carboniferous limestone is not present within the study area. Kart feature data compiles by the groundwater unit at the Department of the Environment, Climate and Communications (DCCAE) indicates that there are no karst features reported from the scheme area or vicinity. The closest recorded karstic feature is a spring in the Heigham Townland (Easting ITM 664776, Northing ITM 650065) that is located in a limestone lithology c. 8.5 km northwest of Graiguenamanagh. The closet recorded karstic feature further up the catchment is an 'enclosed depression' recorded near Goresbridge (Easting ITM 669165,

Northing ITM 653424) c. 9.5 km north of Graiguenamanagh. There are no karst features reported in proximity of the lower catchment (source: DCCAE 2020)

6.3.3 Soils

Teagasc (Environmental Protection Agency , 2020)data indicates that soils in the study area are generally mineral soils, largely derived from mainly acidic parent materials. Soils range from shallow to deep and poorly to well drained, with the majority of soils present in the study reported to be well draining.

Teagasc (Environmental Protection Agency , 2020) data indicates soils that made soils underlie Graiguenamanagh town. Made soils are not reported as present within Tinnahinch but the presence of residential and commercial properties that have been constructed within the area suggests that made ground is probably present as intrusive works would likely have taken place during construction of many more recent properties.

Historical site investigation data for soils, including reports outlining the presence of any soil contamination that may be present in the scheme area, were not available at the time of writing. However, it is noted that a licenced waste facility, Graiguenamanagh WwPT, is present in the study area and could be a potential source of contamination. EPA data indicates that there are no waste boundaries or dumpsite boundaries within the scheme area. However, the location and nature of any contaminated soils, if present in the scheme, may not be recorded, particularly where caused by historical events.

Soils in the scheme area and vicinity are shown in Figure 6-2.

The distribution and type of subsoils in the scheme area and vicinity is shown in Figure 6-3.

DCCAE provide high level soil permeability data that is not available through the constraints boundary area of scheme area. This data indicates that subsoil permeability ranges from low to high in the study area, with:

- Tinnahinch, the section of the River Barrow c. 200 m either side of the bridge, and the southwest of the scheme area reported as having high subsoil permeability;
- Graiguenamanagh and the west of the scheme areas reported as having medium subsoil permeability;
- the most northern extent of Graiguenamanagh town reported as having low permeability.

(source: DCCAE's online groundwater data viewer)

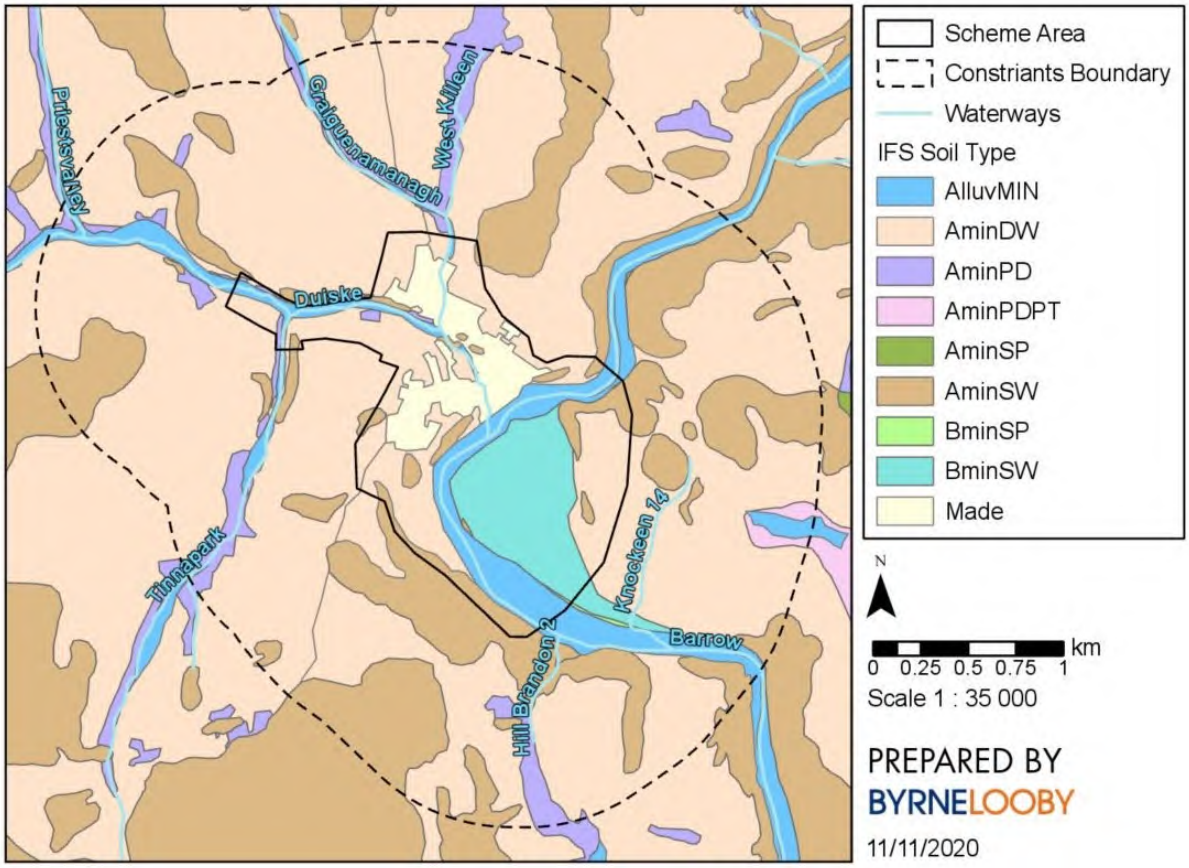


Figure 6-2 Soils in the scheme area and vicinity.
(Source: EPA GeoPortal).
Abbreviations for soil categories: AlluviMIN = mineral alluvium; AminDW = deep well drained mineral (derived from mainly acidic parent materials); AminPD = deep poorly drained mineral (derived from mainly acidic parent materials); AminPDPT = poorly drained mineral soils with peaty topsoil (derived from mainly acidic parent materials); AminSP = Shallow poorly drained mineral soil (derived from mainly acidic parent materials); AminSW = shallow well drained mineral (derived from mainly acidic parent materials); BminSP = shallow poorly drained mineral soil (derived from mainly basic parent materials); BminSW = Shallow well drained mineral (derived from mainly basic parent materials); Made = made ground

6.3.4 Geoheritage

GSI data indicates that there are no audited or unaudited sites of geological heritage in the study area. The closest sites are an audited site at Inistioge, c. 6 to the southwest of the study area, where there are glacial meltwater channels with localised exposures of schist in deeply incised channels along a 11 km section of the River Nore. Blackstairs Mountain, 9 km to the east of the study area, is also and audited site (GSI map viewer, 2020).

6.3.5 Geohazards

GSI data indicates that there are no landslides reported from the area. The closest recorded event was the partial blockage of the Thomastown/Inistioge Road (R700) at Brownsbarn Bridge following a landslide on the 18th January 2013 (GSI map viewer, 2020).

6.3.6 Economic geology

GSI data indicates that there are no active quarries or areas of active mineral exploitation within the study area. It is noted from GSI data that within the vicinity:

- Knockeen Quarry (disused) - pyrrhotite/pyrite/chalcopyrite is present. Mineralisation extends beyond the quarry but is considered to be subeconomic.
- Potentially economically viable aggregate sources (sand and gravel) may occur within the study area however with imprecise location data.
- That there has been a report of a small amount of float of spodumene pegmatite boulders with lithium content at an unknown location in CoolyHune Townland (likely outside of the study area)

(source: GSI map viewer data 2020)

Other GIS datasets indicated that closest extractive industries registered site is Ballyellen limeworks (registration no QS0679) which is operated by Glendstone Ltd and located c. 14 km north of Graiguenamanagh at Ballyellen Cross, Carlow, adjacent to the River Barrow. From ariel photography it appears the quarry is now disused (Geological Survey Ireland, 2020)

There is a disused lime kiln reported in mapping from the 1830s located near the site of 'Brandon Hill Camping' in Coolroe, Graiguenamanagh (OSi, 2020).

There is a disused historic gravel pit reported in mapping from the 1830s located within the site of 'Glanbia Agribusiness Graiguenamanagh', adjacent to the R703 at Tinnahinch (OSi, 2020).

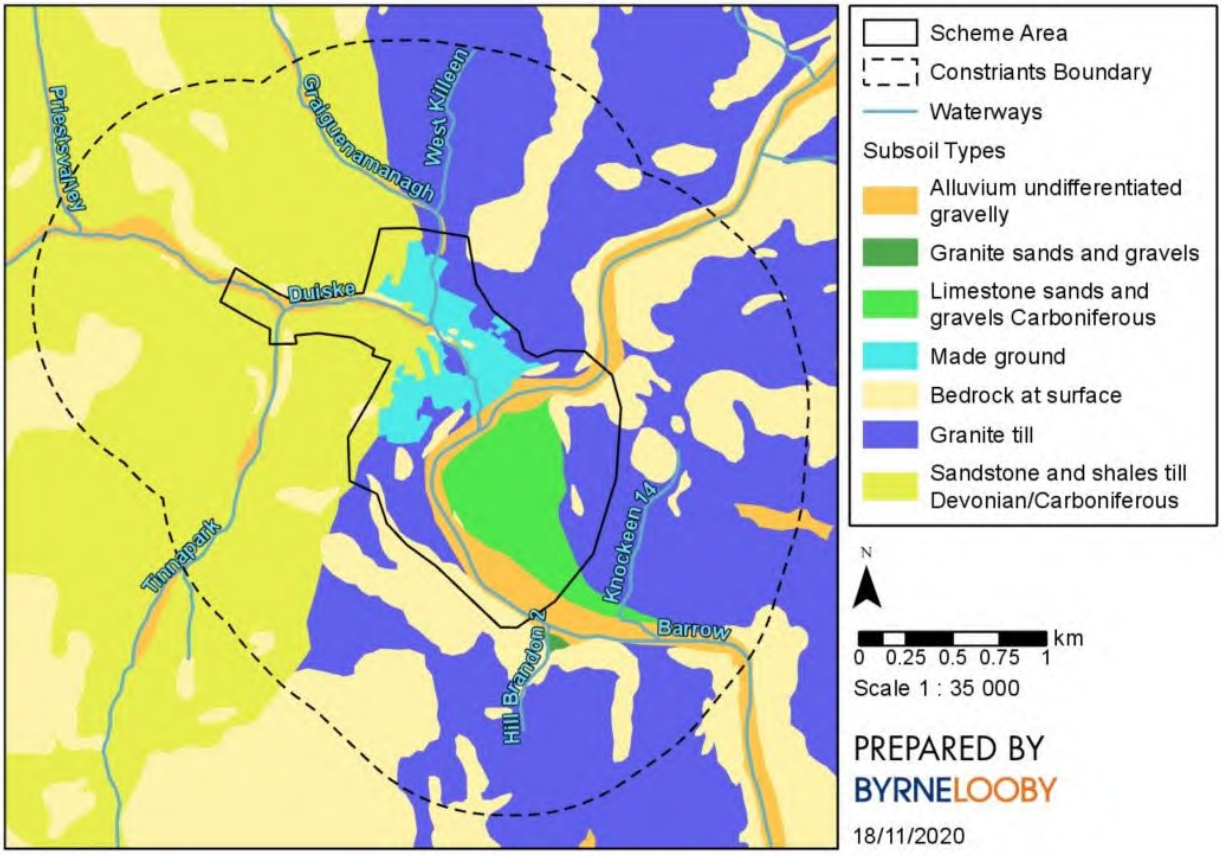


Figure 6-3 Subsoils in the scheme area and vicinity.
(Source: EPA GeoPortal).

6.3.7 Groundwater

The Ballyogan springs lie on the flanks of Brandon Hill within the catchment of the River Barrow (western side). These springs form part of the Graiguenamanagh Water Supply Scheme (see section 3.3.3.1). The source comprises four springs, forming a line 230 m long in Ballyogan townland. The springs all lie close to the 170 m contour on the flanks of Brandon Hill, some 1.4 km north east of its peak. These springs and the areas immediately surrounding them are designated a GSI Public Supply Source Protection Area and are owned by KCC (see Figure 6-4). No information is available on the sanitary protection measures at the springs.

Hydrostratigraphic rock unit groups in the constraints area broadly fall into two categories: igneous intrusive rock (in which the Ballyogan springs are located) and Ordovician metasediments. The granites in in the area are all classified as a poor aquifer which is generally unproductive except for local zones where bedrock is moderately productive. Fracture flow is expected to be dominant with flows are expected to be concentrated in fractured and weathered zones (DCCAE groundwater mapping data 2020).

OS data indicates that there are two historic wells (springs) located within scheme area in Tinnahinch, Lady's Well and Keeting's Well, and these are discussed in section 8.3.1.3. OS data indicates that eight historic wells, including Michaels Well (see section 8.3.1.4), are located within the scheme area at Tinnahinch with no further details available at the time of

writing (OSi, 2020). The archaeological and cultural heritage significance of such structures is discussed in section 8, where relevant.

The hydrological setting in the study area consist of made ground and largely well-draining soils and subsoils of low to high permeability.

GSI data indicates that a single borehole well, 'Carlow Co. Council Pump No.183', with a poor yield class is recorded from Tinnahinch and may be located within the study area (location accuracy to 1 km). There is not data to indicate if abstraction is taking place at present.

The Carlow County Development Plan 2015 -2021 (section 10.4 and policy 7 therein) outlines the policy of CCC to protect existing and potential water sources for the county through the measures discussed in section 5.2.2.

Groundwater recharge as varies across the study area with typical average recharge 129 – 200 mm/yr where subsoils is bedrock outcrop and subcrop, till derived chiefly from Lower Palaeozoic rocks, and made ground. Subsoil permeability is classed at medium to high with areas within the study with no data available as they have not been mapped

At the time of writing, no further data was available with regard to local Ground Waterbodies such as name(s) and location(s), description, characterisation, hydraulic connectivity, confined/unconfined aquifer GWB elevations, recharge rates and recharge mechanism(s). This data has been requested and will be considered during the scheme development as it progresses.

The Ground Waterbody WFD Status 2013-2018 for the study area (IE_SE_G_152) is general classified as good, see Table Table 6-2 Ground Waterbody WFD Status 2013-2018 for the study area.

Table 6-2 Ground Waterbody WFD Status 2013-2018 for the study area

Chemical	Overall Groundwater Status	Quantitative Groundwater Status
Good	Good	Good

The GSI groundwater vulnerability map indicates groundwater in the study area is classified from low vulnerability to extreme vulnerability. Discrete areas classified as extremely vulnerable or 'rock at or near surface of karst' are located within the study area and surrounding environs (karst feature have not been reported from the area. See section 6.3.2 for discussion). These include areas on the R703 road, the Quay and the areas between Tobar Bridge and the River Barrow in Graiguenamanagh and extending across the Barrow into Tinnahinch (shown inFigure 6-4), that are at/or near the locations for proposed hard defence measures.

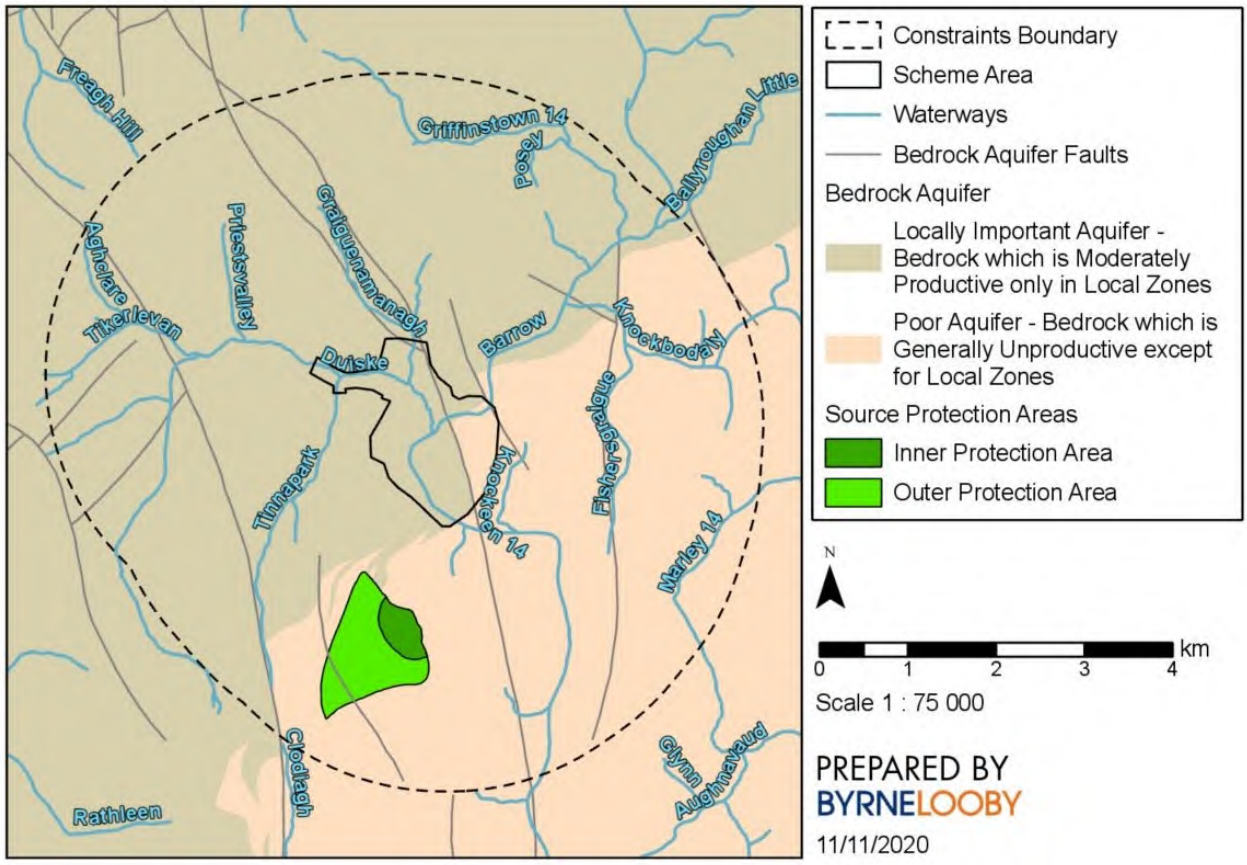


Figure 6-4 Geological Survey Ireland Public supply protection areas

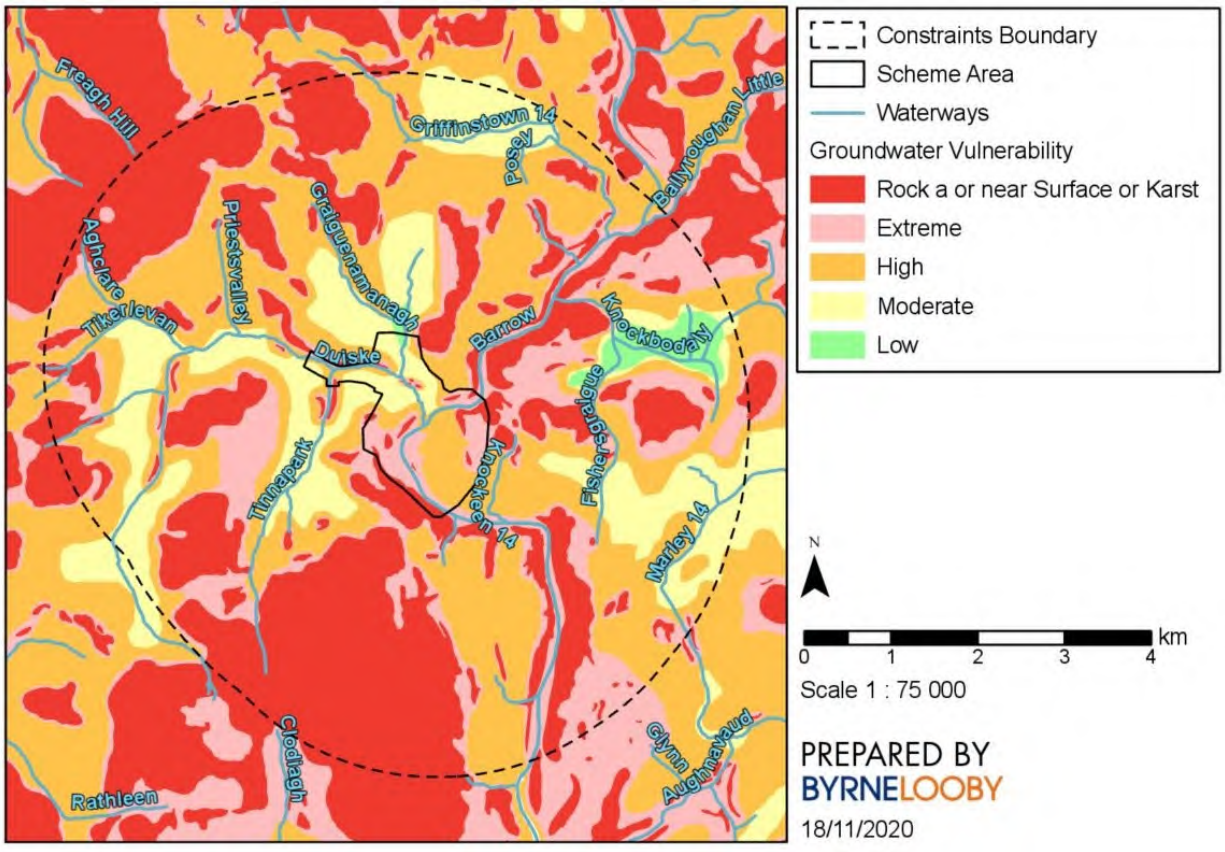


Figure 6-5 Groundwater vulnerability in the study area

6.4 Key Constraints

Key constraints associated with the soils, geology and hydrogeology of the study area include:

- Made ground and/or contaminated ground: Depending on the scheme design and type of works, for areas where made ground is uncompacted and/or highly variable it may require to excavate and place this material and replace with suitable founding material. This material may also be a possible a source of contamination. As this material will be excavated during construction, it may require contamination testing be undertaken during the detailed site investigation.

- Contaminated land: The scheme area is located in an area with industrial heritage and commercial properties. If intrusive works are required during construction at locations where known or unknown contaminated land may be present (e.g. from recorded historical land-use), an investigation may be required into determine if land contamination is present and, if present, to determine its nature and extent.

- Soils and groundwater: Poor draining soils occurring within the scheme footprint are potentially soft and compressible and will likely require a detailed site investigation (SI) in order to design a suitable flood defence scheme. Appropriate environmental controls and management measures will be implemented for any advance SI works, this may include a requirement for AA screening, or an application/notification to NPWS for approval. A CEMP will be developed for construction activities. The CEMP will identify appropriate equipment and construction techniques that should be used in circumstances where there is a potential impact to the environment. Engineering design should minimise the impacts of the flood relief scheme on the sections of river within the study areas and the wide catchment.

- Groundwater vulnerability to contamination: Depending on the design of the scheme, works may occur adjacent or within areas where groundwater is classified by the GSI as 'extremely vulnerable' to contamination. Appropriate environmental controls and management measures will be implemented for any advance SI works. A CEMP will be developed for construction activities. A CEMP will be developed for all site investigation works, construction activities and traffic management.

- Karst features: GSI data indicated that there are no recorded karst features in the study area. However, despite the lack of carbonate lithologies in bedrock in the study area it is prudent to consider that karst features such as caves, swallow holes, weathered rock and dolines may be present and can lead to ground surface and ground instability and are a constraint to be considered in the engineering design of the scheme.

- Geoheritage: It is good practice to inform the Geological Survey Ireland (GSI) (contact: Beatriz.Mozon@gsi.ie) where:

    - construction works temporarily or permanently uncover significant outcrop;

    - were reports detailing any site investigations can be made available to the GSI;

- a digital photographic record of any significant new excavation can be produced and provided to the GSI.