REPORT

Millport Coastal Flood Protection Scheme: Environmental Statement

Chapter 17 Ground Conditions and Contamination

Client: North Ayrshire Council

Reference: PB4749-RHD-ZZ-XX-RP-Z-0017

Status: Final/P01.01

Date: 31 January 2020

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Document title:	Millport Coastal Flood Protection Scheme: Environmental Statement
Document short title:	
Reference:	PB4749-RHD-ZZ-XX-RP-Z-0017
Status:	P01.01/Final
Date:	31 January 2020
Project name:	Millport Coastal Flood Protection Scheme
Project number:	PB4749
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Date / initials:	06/12/2019
Approved by:	Frank Fortune
Date / initials:	20/12/2019

Classification
Project related

Royal HaskoningDHV

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Acronyms

Acronym	Acronym Description
BGS	British Geological Survey
CAR	Controlled Activities Regulations
CDM	Construction Design Management Regulations
CIA	Cumulative Impact Assessment
CSM	Conceptual Site Model
EIA	Environmental Impact Assessment
ES	Environmental Statement
LDP	Local Development Plan
LNR	Local Nature Reserve
LoD	Limit of Detection
GAC	Generic Assessment Criteria
GPP	Guidance for Pollution Prevention
GQRA	Generic Quantitative Risk Assessment
NPF	National Planning Framework
PANS	Planning Advice Notes
PAHs	Polycyclic Aromatic Hydrocarbons
PCOCs	Potential Contaminants of Concern
PPC	Pollution Prevention and Control
PPG	Pollution Prevention Guidelines

SEPA	Scottish Environment Protection Agency
SAC	Special Areas of Conservation
SPA	Special Protection Areas
SPP	Scottish Planning Policy
SSSI	Site of Special Scientific Interest
TPH	Total Petroleum Hydrocarbons
WFD	Water Framework Directive

Glossary

Glossary Term	Glossary Text
Environmental Impact Assessment (EIA)	A statutory process by which certain planned projects must be assessed before a formal decision to proceed can be made. It involves the collection and consideration of environmental information, which fulfils the assessment requirements of the EIA Directive and EIA Regulations, including the publication of an Environmental Statement.
Environmental Statement (ES)	A document reporting the findings of the EIA and produced in accordance with the EIA Directive as transposed into UK law by the EIA Regulations.
Made Ground	Land where natural and undisturbed soils have largely been replaced by man-made or artificial materials
Millport Coastal Flood Protection Scheme	The scheme consists of offshore rock armour structures which will be built in the vicinity of the rock islets within Millport Bay. Onshore works will include flood walls, improvement works to existing coast protection structures, and works to raise the level of existing grass areas. Works on the foreshore include shore-connected rock armour breakwaters and rock armour revetments.

17 Ground Conditions and Contamination

17.1 Introduction

1. This chapter of the Environmental Statement (ES) considers the potential impacts of the proposed Millport Coastal Flood Protection Scheme (the proposed scheme) on receptors as a result of interactions between the proposed scheme and ground conditions, including potential contamination.

2. This chapter provides a summary description of key aspects of the existing environment followed by an assessment of the magnitude and significance of the effects upon the baseline conditions resulting from the construction and operation of the Proposed Scheme as well as those effects resulting from cumulative interactions with other existing or planned projects.

3. This chapter has been prepared by Royal HaskoningDHV in accordance with the relevant legislation and policies, adhering to the methodology for Environmental Impact Assessment (EIA) and Cumulative Impact Assessment (CIA) as discussed in Section 17.4.

4. Due to the close association between ground conditions, groundwater, surface water and ecology topics, this chapter should be read in conjunction with **Chapter 7 Marine Water and Sediment Quality, Chapter 16 Terrestrial Ecology and Chapter 18 Water Resources and Flood Risk.** .

17.2 Policy, Legislation and Guidance

5. There are a number of pieces of legislation applicable to ground conditions and contamination. The following key pieces of International and UK legislation which are relevant to this chapter. Further details are provided in **Chapter 2 Policy and Legislation** on the following legislation.

6. The policies and plans outlined throughout this section have also been reviewed for their relevance to ground conditions and contamination when undertaking the EIA for the proposed scheme.

17.2.1 International Legislation

7. Table 17-1 below provides a brief summary of the key international legislation and policy relevant to the scheme.

Table 17-1 Summary of key international legislation and policy relevant to this proposed scheme

Legislation	Relevance
Water Framework Directive (2000/60/EC)	Council Directive 2000/60/EC establishing a framework for community action in the field of water policy. requires that all European Union (EU) Member States must prevent deterioration and protect and enhance the status of aquatic ecosystems. This means that EU Member States must ensure that new schemes do not adversely impact upon the status of aquatic ecosystems, and that historical modifications that are already impacting it need to be addressed.
Groundwater Directive (2006/118/EC)	The Groundwater Directive (2006/118/EC) establishes a regime which sets groundwater quality standards and introduces measures to prevent or limit inputs of pollutants into groundwater.

17.2.2 National Legislation and Policy

17.2.2.1 National Legislation

8. Table 17-2 below provides a brief summary of the key national legislation and policy relevant to the scheme.

Table 17-2 Summary of key national legislation and policy relevant to this proposed scheme

Legislation	Relevance
Environmental Protection Act 1990 (Part IIA) (Amendment) (Scotland) Regulations 2001	The management and remediation of contaminated land that, in its current state, is causing or has the potential to cause significant harm or significant pollution of the water environment, is regulated by legislation contained within the Environmental Protection Act (1990) known as Part IIA.
The Contaminated Land (Scotland) Regulations 2005	Amendments to Contaminated Land (Scotland) Regulations 2000 and Environmental Protection act 1990 to align the contaminated land regime and the relevant provisions of the Water Environment and Water Services (Scotland) Act 2003.
The Pollution Prevention and Control (Scotland) Regulations 2000	The Pollution Prevention and Control (Scotland) Regulations 2000 (PPC), transpose into Scottish law the requirements of the European Union's Integrated Pollution Prevention and Control Directive (96/61/EC).
The Environmental Liability (Scotland) Amendment Regulations 2015	These regulations require operators to take preventative measures where there is an imminent threat of environmental damage, and to remediate any environmental damage caused by their activities.
Water Environment and Water Services (Scotland) Act 2003 (WEWS Act)	This arose from the Water Framework Directive 2000/60/EC becoming law in Scotland. It commits Scotland to achieve good qualitative and quantitative status of all water bodies by 2015 with the final deadline for meeting objectives being 2027
Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended)	The Controlled Activities Regulations 2011 (CARs) (and it's amendments in 2013 and 2017) apply regulatory controls over activities which may affect Scotland's water environment. The regulations cover rivers, lochs, transitional waters (estuaries), coastal waters, groundwater and groundwater dependent wetlands.

17.2.2.2 National Planning Policy and Guidance

National Planning Framework:

9. Scotland's third National Planning Framework (NPF) (Scottish Government, 2014a) includes no specific reference to contaminated land, and contains general guidance on Planning "making Scotland a natural, resilient place – helping to protect and enhance our natural and cultural assets, and facilitating their sustainable use.".

Scottish Planning Policy

10. Scotland's Planning Policy (SPP) (Scottish Government, 2014b) contains the following Policy Principles with regards to Valuing the Natural Environment and these have been taken into consideration when undertaking the EIA for the proposed scheme:

11. The planning system should:

- *Facilitate positive change while maintaining and enhancing distinctive landscape character;*
- *Conserve and enhance protected sites and species, taking account of the need to maintain healthy ecosystems and work with the natural processes which provide important services to communities;*

- *Promote protection and improvement of the water environment, including rivers, lochs, estuaries, wetlands, coastal waters and groundwater, in a sustainable and co-ordinated way;*
- *Seek benefits for biodiversity from new development where possible, including the restoration of degraded habitats and the avoidance of further fragmentation or isolation of habitats; and*
- *Support opportunities for enjoying and learning about the natural environment.*

Planning Advice Notes (PANS)

12. **Planning Advice Note (PAN) 1/2013: Environmental Impact Assessment** explains the role of individual planning authorities and that of the Consultation Bodies in EIA, as well as providing guidance on the ways in which EIA can be integrated into the overall development management process.

13. **PAN 33 (2017): Development of Contaminated Land** provides advice on the implications of the contaminated land regime on the planning system. The note states that "*In considering the re-use of land, the possibility that it may be contaminated cannot be ignored. Chemicals are extensively used in industrial, domestic and agricultural applications. They may be introduced to land during their manufacture, use or disposal, and may also be deposited from the atmosphere, accidental spills, migration, leaks and illegal disposal. There are also natural sources of contamination, whereby concentrations of certain substances in the soil are elevated, and may pose a threat to people or the environment e.g. methane may build up from the breakdown of organic material.*"

14. The role of the planning system

15. Contamination may threaten public safety, the natural and built environment, and act as a barrier to economic activity. … a key role of the planning system with regard to contaminated land, is to ensure that land is made suitable for any new use, as planning permission is given for that new use. Therefore, whether confirmed or suspected, contamination is a material planning consideration. It should be considered as one of the factors in the preparation of development plans, as well as in the determination of planning applications.

Groundwater Protection Policy for Scotland

16. The Groundwater Protection Policy for Scotland (SEPA, 2009) aims to provide a sustainable future for Scotland's groundwater resource by protecting groundwater quality by minimising the risks posed by point and diffuse sources of pollution.

Environmental Protection Act 1990: Part IIA Contaminated Land Statutory Guidance: Edition 2

17. This guidance document covers the change in the contaminated land regime following the implementation of the Contaminated Land (Scotland) Regulations 2005.

18. The guidance explains that "The purpose of the changes introduced by the 2005 Regulations is, primarily:

- *To prevent disproportionate regulation being applied to contaminated land causing only trivial amounts of pollution to the water environment; and*
- *To align the contaminated land regime and the relevant provisions of the Water Environment and Water Services Act 2003 (the 2003 Act)."*

17.2.3 Local Planning Policy

19. The proposed scheme falls within the North Ayrshire Council local authority boundaries.

20. North Ayrshire Council have adopted a new Local Development Plan for North Ayrshire on 28th November 2019 (North Ayrshire Council, 2019), the LDP covers a 20 year period. For the purpose of the Local Plan, Millport and the footprint of the proposed scheme is categorised to be within 'Developed Coast'.

21. The Ayrshire Joint Structure Plan 'Growing A Sustainable Ayrshire' (North Ayrshire Council, East Ayrshire Council and South Ayrshire Council, 2007) establishes a framework that brings together the aspirations of communities with those of business and industry, and the area's many supporting agencies and organisations, to provide a strategic land use context to the year 2025.

22. Table 17-3 provides details of the local planning policy documents and the relevant policies in respect to ground conditions and contamination. These policy document have been considered when undertaking the EIA for the proposed scheme.

Table 17-3 Relevant local planning policies

Document	Policy / Guidance	Policy / Guidance purpose	ES Reference
Adopted Local Development Plan (LDP2) (North Ayrshire Council, 2019)	Policy 16: Protection of our Designated Sites	We will support development which would not have an unacceptable adverse effect on our valuable natural environment as defined by the following legislative and planning designations; a) Nature Conservation Sites of International Importance; b) Nature Conservation Sites of National Importance; c) Nature Conservation Sites of Local Importance; d) Marine Protected Areas; e) Biodiversity Action Plan Habitats and Species; and f) Protected Species.	Kames Bay Site of Special Scientific Interest is considered in Section 17.5.7, however it is considered further in Chapter
	Policy 22: Water Environment Quality	We will support development that helps achieve the objectives of the Water Framework Directive and the River Basin Management Plan for Scotland. Generally, development which would lead to the deterioration of the water environment will be resisted unless it would deliver significant social, environmental or economic benefits.	Consideration of impacts on groundwater is within Section 17.6.4.2.

Document	Policy / Guidance	Policy / Guidance purpose	ES Reference
Ayrshire Joint Structure Plan (2014)	ENV 9 Water Framework Directive	The three Ayrshire councils shall work with other agencies to introduce the Water Framework Directive into Planning Policy.	The Water Framework Directive Status of the water supply is considered in the Impact Assessment Methodology in Section 17.4.2.

17.2.4 Best Practice and Guidance

23. The Scottish Environment Protection Agency (SEPA) Guidance for Pollution Prevention (GPPs) provide environmental regulatory guidance to Scotland and provide guidance for construction projects. These GPPs are currently replacing the Pollution Prevention Guidelines (PPGs). The guidance documents which are relevant to the proposed scheme and ground conditions and contamination include:

- GPP5: Works and maintenance in or near water (Northern Ireland Environment Agency (NIEA), Department for Agriculture the Environment and Rural Affairs (DAERA, SEPA and Natural Resources Wales (NRW), 2018);
- Pollution Prevention Guidance (PPG) 6: Working at construction or demolition sites (Environment Agency (EA), NIEA and SEPA, 2012);
- GPP21: Pollution incident response planning (NIEA, SEPA and NRW, 2017); and,
- GPP22: Dealing with spills (NIEA, DAERA, SEPA and NRW, 2018a).

24. PPG6 has not yet been superseded by an updated GPP document and in the absence of other regulatory guidance this is still considered adequate to help manage environmental responsibilities and protect the environment.

25. The following UK guidance has been considered relevant to ground conditions and contamination:

- British Standard BS10175 Investigation of Potentially Contaminated Sites – Code of Practice;
- British Standard BS5930 Code of Practice for Site Investigations;
- CIRIA publication C532: Control of water pollution from construction sites, Guidance for consultants and contractors (CIRIA, 2001);
- CIRIA publication C741: Environmental good practice on site guide (4th Edition) (CIRIA, 2015); and
- CIRIA publication C665: Assessing risks posed by hazardous ground gases to buildings (CIRIA, 2007).

17.3 Consultation

26. To inform the ES, North Ayrshire Council has undertaken a thorough pre-application consultation process, which has included the following key stages:

- Scoping Reports submitted to Marine Scotland and North Ayrshire Council (Royal HaskoningDHV 2017); and
- Scoping Opinion received from Marine Scotland and North Ayrshire Council (2017).

27. Full details of the proposed scheme consultation process to date is presented within **Chapter 3 EIA Methodology and Consultation.**

28. A summary of the consultation carried out at key stages throughout the proposed scheme, of particular relevance to ground conditions and contamination, is presented in Table 17-4.

Table 17-4 Consultation responses

Consultee	Date/ Document	Comment	Response / Where addressed in the ES
Scottish Environment Protection Agency (SEPA)	19-05-2017 Scoping Report	No soil or groundwater sampling was undertaken as part of the ground investigations undertaken in 2014 although a petrol odour was reported. We note that land sided ground investigations (including sampling) will be undertaken and welcome the proposal to consult SEPA and the LA in relation to sample locations and the analysis suite to be used.	A ground investigation was undertaken in 2017 and shown in the Ground Investigation Report (Royal HaskoningDHV, 2017).
		No mention is made of groundwater being a receptor (tables 4.7 and 4.8) and the risk to groundwater, more specifically in the sand and gravel raised beach deposits skirting the south of the island should be included.	Potential impacts on the groundwater, specifically the Raised Beach Deposits are covered in Section 17.6.4.3.
		No mention of the scale of the ground investigations is provided and we recommend that care should be taken to ensure the investigations are fit for purpose.	A ground investigation was undertaken in 2017 and shown in the Ground Investigation Report (Royal HaskoningDHV, 2017).

17.4 Methodology

29. This section describes the methodology used to obtain baseline data, characterise the ground conditions of the area and undertake the EIA.

17.4.1 Baseline Data and Study Area

17.4.1.1 Summary of Study Area

30. The study area is defined by the distance over which impacts on ground conditions and contamination from the Project may occur and by the location of any receptors that might be affected by those potential impacts.

31. The onshore infrastructure for the proposed scheme is detailed in **Chapter 5 Project Description**, and represented in Figure 1-1, in summary it will include:

- Onshore and foreshore works – improvements to coastal defence structures;
- Improvements to existing sea walls;
- New flood wall; and
- Raised ground levels.

17.4.1.2 Data Sources – Desk Study

32. Baseline data was obtained from the Millport Flood Protection Scheme, North Ayrshire: Geotechnical and Land Contamination Desk Study, Royal HaskoningDHV 2016. This study provides a review of the available published information about the geology, ground conditions and historical land use at the Millport Flood Protection Scheme site and highlights the potential risks associated with the proposed works through a Conceptual Site Model. The report proposed a ground investigation in order to confirm the risk of land contamination.

17.4.1.3 Data Sources – Site Specific Surveys and Reports

33. The Millport Coastal Flood Protection Scheme 2017 ground investigation was carried out by BAM Ritchies between 18th January and 2nd February 2017 (Royal HaskoningDHV 2017). The purpose of this investigation was to provide geotechnical parameters and contamination assessment to enable design and construction of the proposed developments to be undertaken. This included:

- 4 no. cable percussion boreholes (BH-TP-01 to 04) drilled to depths of up to 2.7m below ground level.
- 8 no. hand dug inspection pits (TP01A, 02A, 7, 13, 13A, 14 to 16) to depths of up to 1.7m below ground level.
- 26 no. machine excavated trial pits (TP5, 6, 8, 9, 17 to 29, TPA, B, C, F, G, H, J, K, L, and TPA, B, C, F, G, H, J, K and L) to depths of up to 2.4m below ground level.
- In situ standard penetration testing (SPTs).
- Hand vane testing.
- Geotechnical and geo-environmental sampling.
- Plate bearing tests.
- Ground water level monitoring and ground water sampling; and
- Geophysical Surveys including (multibeam bathymetric survey, sub bottom profile survey, magnetometer survey, side scan sonar survey and ground penetrating radar survey of the existing pier).

34. The locations of the boreholes and trial pits are shown within Appendix B of the Ground Investigation Report, (Royal HaskoningDHV, 2017).

35. Geotechnical laboratory testing was carried out by BAM Ritchies and Geo-environmental testing was carried out by Exova (UK) Ltd. The geo-environmental testing included:

- Suite E (Arsenic, Boron, Cadmium, Chromium (total and VI), Copper, Lead, Mercury, Nickel, Zinc, pH, water soluble Sulphate, Organic Matter, TPH, Speciated PAH (USEPA 16), Cyanide (free and total), Asbestos Screen and Phenol Screen); and
- Suite F (Arsenic, Boron, Cadmium, Chromium (total and VI), Copper, Lead, Mercury, Nickel, Zinc, pH, TPH, Spectated PAH (USEPA 16), Cyanide (total), Phenol Screen, Calcium, Organic Carbon and Carbonate Alkalinity).

36. Following laboratory testing, as an Appendix to the 2017 Ground Investigation Report (Appendix E), Royal HaskoningDHV provided an assessment of the laboratory results in the form of a Generic Quantitative Risk Assessment.

17.4.1.4 Assessment of Ground Conditions

37. The assessment of ground conditions has followed a phased risk-based approach including consideration of potential sources, pathways and receptors to identify potential pollutant linkages that may result in unacceptable risks to receptors from ground contamination. For a risk to exist, all three elements (defined below) must be present.

- Source: A potentially polluting activity or existing ground contamination;
- Pathway: A route or means by which a receptor could be exposed to or affected by contamination; and
- Receptor: Something that could be adversely affected by contamination.

38. A Geotechnical and Land Contamination Desk Study (Royal HaskoningDHV, 2016) was undertaken alongside the Scoping Report, which provided an initial step in the assessment of potentially contaminated land. This assessment was carried out to determine plausible pollutant linkages that require further consideration this is outlined in the Conceptual Site Model (CSM).

39. The Conceptual Site Model and the data from the Ground Investigation Report (Royal HaskoningDHV, 2017) has formed the baseline for this assessment. The baseline comprises a description of the current ground conditions and potential receptors. The impact assessment compared the baseline to a CSM describing feasible pollutant linkages associated with the construction and operational phases of the proposed scheme.

17.4.2 Impact Assessment Methodology

40. General methods for EIA are discussed in **Chapter 3 EIA Methodology and Consultation.** The following sections describe the methodology used to assess the potential impacts of the proposed scheme on receptors in more detail.

41. The approach to determining the significance of an impact follows a systematic process for all impacts. This involves identifying, qualifying and, where possible, quantifying the sensitivity, value and magnitude of all receptors which have been scoped into this assessment. Using this information, a significance of each potential impact has been determined. Each of these steps is set out in the remainder of this section.

42. For impacts relating to ground conditions and contamination, receptors identified include:

- Human Health; and
- The Water Environment.

17.4.2.1 Sensitivity, Value, Magnitude

43. The sensitivity and value of discrete receptors and the magnitude of effect are assessed using expert judgement and described with a standard semantic scale. These expert judgements of receptor sensitivity, value and magnitude of effect are guided by the conceptual understanding of baseline conditions.

Receptor Sensitivity

44. The sensitivity of a receptor (Table 17-5) is dependent upon its:

- Tolerance: the extent to which the receptor is adversely affected by an effect;
- Adaptability: the ability of the receptor to avoid adverse impacts that would otherwise arise from an effect; and
- Recoverability: a measure of a receptor's ability to return to a state at, or close to, that which existed before the effect caused a change.

Table 17-5 Definitions of Sensitivity Levels for Receptors

Sensitivity Criteria	Definition Examples
High Has very limited or no capacity to accommodate physical or chemical changes; or, Is an international or nationally important resource.	**Human Health** Construction Workers General Public
	The Water Environment Very high productivity bedrock aquifer (>20 l/s). Very high Dominantly intergranular flow and/or Intergranular / fracture flow. Licenced groundwater / surface water abstractions. Surface Waters with Water Framework Directive 'High' status objective. Groundwater within Water Framework Directive 'Good' status objective Surface water or groundwater supporting internationally designated or nationally important conservation site (e.g. Special Areas of Conservation, Special Protection Area, Ramsar site / Site of Special Scientific Interest) or fishery.
Medium Has limited capacity to accommodate physical or chemical changes or influences. Is a regionally import resource.	**The Water Environment** High productivity bedrock aquifer (10-20 l/s). High intergranular flow and/or Intergranular / fracture flow High productivity superficial aquifers (>10 l/s). Licenced groundwater / surface water abstractions.

Sensitivity Criteria	Definition Examples
	Surface waters with Water Framework Directive Status / Potential objective 'Good'. Groundwater within Water Framework Directive 'Good' status objective Water Regulation Zone Surface Water Drinking Water Protected Area Groundwater Drinking Water Protected Area Surface water or groundwater supporting regionally important wildlife sites (Local Nature Reserve, Site of Nature Conservation Interest) or commercial aquaculture.
Low Has moderate capacity to accommodate physical or chemical changes. Is a locally important resource.	**The Water Environment** Moderate productivity bedrock aquifer (1-10 l/s). Moderate intergranular/ fracture flow and/or moderate fracture flow / low productivity bedrock aquifer (0.1-1 l/s)– low intergranular/ fracture flow and/or low fracture flow Moderate productivity superficial aquifers (1-10 l/s) / Low productivity superficial aquifer (0.1-1 l/s) Unlicensed water supplies. Surface waters with Water Framework Directive Status / Potential objective 'Moderate' / 'Poor' Groundwater within Water Framework Directive 'Good' status objective Surface water or groundwater supporting locally important wildlife or amenity site.
Negligible Is generally tolerant of physical or chemical changes. Is of no significant resource value.	**The Water Environment** Very low productivity bedrock aquifer (<0.1-1 l/s) – very low fracture flow. Superficial 'non aquifers' Surface waters with Water Framework Directive Status / Potential objective 'Bad'. Groundwater within Water Framework Directive 'Poor' status objective.

Value

45. The sensitivity assessment takes into account how 'acceptable' changes to the availability or quality of a particular resource would be. This is dependent on the value of that resource which is assessed based on its strategic or geographic importance, which is

Table 17-6 Definitions of the Different Value Levels for Receptors

Value	Definition
High	Is an international or nationally important resource.
Medium	Is a regionally important resource
Low	Is a locally important resource
Negligible	Is of no significant value

Magnitude

46. Potential effects may be adverse, beneficial or neutral. The magnitude of an effect is assessed qualitatively, according to the criteria set out in Table 17-7. The following definitions apply to time periods used in the magnitude assessment:

- Long-term: >5 years;
- Medium-term: 1 to 5 years; and
- Short-term: <1 year.

47. For human health, magnitude reflects the likely increase or decrease in exposure risk for a receptor. For the water environment, magnitude represents the likely effect that an activity would have on resource usability or value, at the receptor. Magnitude is therefore affected by the distance and connectivity between an impact source and the receptor.

Table 17-7 Definitions of magnitude levels

Criteria	Examples – Proposed development are "likely" to result in:
High Permanent or large-scale change affecting usability, risk or, value over a wide area, or certain to affect regulatory compliance	**Human Health** Permanent or major change to existing risk of exposure (Adverse / Beneficial). Unacceptable risks to one or more receptors over the long-term or permanently (Adverse). Prosecution e.g. under health and safety legislation (Adverse). Remediation and complete source removal (Beneficial). Construction workers at risk due to lack of appropriate personal protective equipment (Adverse).
	The Water Environment Permanent, long-term or wide scale effects on water quality or availability (Adverse / Beneficial). Permanent loss or long-term derogation of a water supply source resulting in prosecution (Adverse). Change in WFD water body status / potential or its ability to achieve WFD status objectives in the future (Adverse / Beneficial). Permanent habitat creation or complete loss (Adverse / Beneficial). Measurable habitat change that is sustainable / recoverable over the long-term (Adverse / Beneficial).
Moderate Permanent or long-term reversible change affecting usability, value, or risk, over the medium-term or local area; possibly affecting regulatory compliance	**Human Health** Medium-term or moderate change to existing risk of exposure (Adverse / Beneficial). Unacceptable risks to one or more receptors over the medium-term (Adverse). Serious concerns or opposition from statutory consultees (Adverse).
	The Water Environment

Criteria	Examples – Proposed development are "likely" to result in:
	Medium-term or local scale effects on water quality or availability (Adverse / Beneficial). Medium-term derogation of a water supply source, possibly resulting in prosecution (Adverse). Observable habitat change that is sustainable / recoverable over the medium-term (Adverse / Beneficial). Temporary change in status / potential of a WFD waterbody or its ability to meet objectives (Adverse / Beneficial).
Low Temporary change affecting usability, risk or value over the short-term or within the site boundary; measurable permanent change with minimal effect usability, risk or value; no effect on regulatory compliance	**Human Health** Short-term temporary or minor change to existing risk of exposure (Adverse / Beneficial). Unacceptable risks to one or more receptors over the short-term (Adverse).
	The Water Environment Short-term or very localised effects on water quality or availability. (Adverse / Beneficial). Short-term derogation of a water supply source (Adverse). Measurable permanent effects on a water supply source that do not impact on its operation (Adverse). Observable habitat change that is sustainable / recoverable over the short-term (Adverse / Beneficial). No change in status / potential of a WFD waterbody or its ability to meet objectives (Neutral).
Negligible Minor permanent or temporary change, indiscernible over the medium- to long-term short-term, with no effect on usability, risk or value	**Human Health** Negligible change to existing risk of exposure. Activity is unlikely to result in unacceptable risks to receptors (Neutral).
	The Water Environment Very minor or intermittent impact on local water quality or availability (Adverse / Beneficial). Usability of a water supply source will be unaffected (Neutral). Very slight local changes that have no observable impact on dependent receptors (Neutral). No change in status / potential of a WFD waterbody or its ability to meet objectives (Neutral).

17.4.2.2 Impact Significance

48. Following the identification of receptor importance and magnitude of the effect, it is possible to determine the significance of the impact.

49. The impact significance assessment combines receptor sensitivity with effect magnitude, as shown in Table 17-8. Assessment of impact significance is qualitative and reliant on professional experience, interpretation and judgement. The matrix should therefore be viewed as a framework to aid understanding of how a judgement has been reached, rather than as a prescriptive, formulaic tool.

50. The assessment of potential impacts has been undertaken assuming implementation of embedded mitigation and commitments for the proposed scheme. Residual impacts include any additional mitigation measures required. An assessment of residual impacts is then made, after assuming implementation of additional mitigation measures where required, i.e. the significance of the effects that are predicted to remain after the implementation of all committed mitigation measures.

Table 17-8 Impact significance matrix

		Negative Magnitude				Beneficial Magnitude			
		High	Medium	Low	Negligible	Negligible	Low	Medium	High
Sensitivity	High	Major	Major	Moderate	Minor	Minor	Moderate	Major	Major
	Medium	Major	Moderate	Minor	Minor	Minor	Minor	Moderate	Major
	Low	Moderate	Minor	Minor	Negligible	Negligible	Minor	Minor	Moderate
	Negligible	Minor	Minor	Negligible	Negligible	Negligible	Negligible	Minor	Minor

51. As with the definitions of magnitude and sensitivity, the matrix used for a topic is clearly defined by the assessor within the context of that assessment. The impact significance categories are divided as shown in Table 17-9.

Table 17-9 Impact significance definitions

Impact Significance	Definition
Major	Very large or large change in receptor condition, both adverse or beneficial, which are likely to be important considerations at a regional or district level because they contribute to achieving national, regional or local objectives, or, could result in exceedance of statutory objectives and / or breaches of legislation.
Moderate	Intermediate change in receptor condition, which are likely to be important considerations at a local level.
Minor	Small change in receptor condition, which may be raised as local issues but are unlikely to be important in the decision making process.
Negligible	No discernible change in receptor condition.
No Change	No change, therefore no impact on receptor condition.

52. Note that for the purposes of the EIA, major and moderate impacts are deemed to be significant. In addition, whilst minor impacts are not significant in their own right, it is important to distinguish these from other non-significant impacts as they may contribute to significant impacts cumulatively or through interactions.

53. Embedded mitigation has been referred to and included in the initial assessment of impact. If the impact does not require mitigation (or none is possible) the residual impact remains the same. However, if mitigation is required, an assessment of the post-mitigation residual impact is provided.

17.4.2.3 Cumulative Impact Assessment

54. For an introduction to the methodology used for the Cumulative Impact Assessment (CIA), please refer to **Chapter 3 EIA Methodology and Consultation**.

55. The CIA involves consideration of whether impacts on a receptor can occur on a cumulative basis between the Project and other activities, projects and plans for which sufficient information regarding location and scale exist.

56. The potential for cumulative effects has been considered for the construction, operation and decommissioning of the proposed scheme cumulatively with other projects.

57. It is assumed that any consented development would be subject to mitigation and management measures which would reduce impacts to non-significant unless there were exceptional circumstances, it is accepted that such projects or schemes may contribute to a wider cumulative impact.

58. In cases where this proposed scheme has negligible or no impact on a receptor (through for example avoidance of impact through routeing or construction methodology) it is considered that there is no pathway for a cumulative impact.

59. The CIA is presented in Section 17.7.

17.4.3 Assumptions and Limitations

60. This assessment is based on a range of publicly available information and data. The direct assessments and judgements given in this report are limited by the finite data on which they are based. However, there is a level of uncertainty associated with extrapolation of site-specific data or non-site data to other locations within the study area.

17.5 Existing Environment

61. This section describes the existing environment in relation to ground conditions and contamination. The Geotechnical and Land Contamination Desk Study, (HaskoningDHV, 2016) (completed as part of the Scoping Report) and Ground Investigation Report (Royal HaskoningDHV, 2017), provide the source of the baseline environmental information that was utilised to assess the environmental impacts associated with the proposed scheme.

17.5.1 Overview

62. The island of Great Cumbrae is located in the Firth of Clyde about 1.5km from the mainland. The majority of the coast of the island is characterised by an emergent rock platform, with isolated pocket bays containing beaches. The rock foreshore is currently stable with low rates of change. Millport Bay is the part of the island coast that contains larger lengths of mobile beach sediment. The bay can be divided into three parts:

- Kames Bay located in the northeast corner of Millport which contains a 150m-wide sandy beach;
- A sandy beach (about 50m wide) on rock platform at Newtown Bay; and
- The rest of the Millport shore, which has a sand and gravel veneer overlying rock platform.

63. Millport Bay faces south, with Kames Bay (at the eastern end) aligned to the south-southwest. Within the bay, there are large rock outcrops, known as the Eileans, the Leug and the Spoig, which provide shelter to the central section of Millport Bay against waves from the south. The shelter provided by these outcrops has led to the deposition of sand in their lee along the Newtown Bay shoreline (i.e. forming a small salient).

17.5.2 Geology

64. The British Geological Survey Geology of Britain viewer indicates that superficial deposits of sand and gravel exist in the western portion of the site at Newtown Bay, and the eastern part of the site at Kames Bay. The superficial deposits overlie sedimentary rock strata of Carboniferous age with igneous intrusions of Carboniferous and Palaeogene age. On the eastern end of Kames Bay there is a headland formed by outcropping rock strata of Devonian age. The geological map (solid edition) shows that the site is underlain by four significant faults running in a north south orientation. Two of the faults are located at the western end of the site at each side of Foul Port and the other two are located at each side of Kames Bay at the eastern end of the site.

65. Other significant rock outcrops at the site include Bessy's Port, Long Point and the island group known as "The Eileans". Rock outcrops in the bay show rock dipping at angles of about 30-50° to the east. The anticipated stratigraphy at the site in order of superposition is summarised in Table 17-10 below:

Table 17-10 Summary of published geology

Stratum	Age	Name	Description
Superficial deposits	Pleistocene and Holocene (Quaternary)	Glacial Till	Moraines of till with outwash sand and gravel deposits. Superficial deposits formed up to 2 million years ago.
		Raised Marine Deposits	Sand and gravel. Superficial deposits formed up to 2 million years ago in the Quaternary Period.
		Marine Beach Deposits	Sand and gravel. Superficial deposits formed up to 3 million years ago in the Quaternary Period.
Bedrock Geology	Palaeogene	Mull Dyke-swarm (North Britain Paleogene Dyke Suite)	Microgabbro. Igneous bedrock formed approximately 23 to 66 million years ago in the Palaeogene Period.
	Carboniferous	Dinantian Dykes (Midland Valley Carboniferous to Early Permian Alkaline Basic Dyke Suite)	Microgabbro. Igneous bedrock formed approximately 326 to 359 million years ago in the Carboniferous period, intruding previous Carboniferous and Devonian age deposits.
		Millport Cornstones Member (Inverclyde Group)	Sandstone, silty mudstone and cornstone (nodular limestone). Sedimentary bedrock formed approximately 343 to 352 million years ago in the Carboniferous period.
		Ballagan Formation (Inverclyde Group)	Mudstone, limestone and calcareous mudstone. Sedimentary bedrock formed approximately 343 to 359 million years ago in the Carboniferous period.
		West Bay Cornstone (Inverclyde Group)	Sandstone and nodular limestone (cornstone). Sedimentary bedrock formed approximately 352 to 359 million years ago in the Carboniferous period.
		Foulport Mudstone Member (Inverclyde Group)	Sandstone And Nodular Limestone (cornstone). Sedimentary Bedrock formed approximately 352 to 385 million years ago in the Carboniferous and Devonian Periods.
	Devonian	Kelly Burn Sandstone Formation (Stratheden Group)	Interbedded sandstone and conglomerate. Sedimentary bedrock formed approximately 359 to 385 million years ago in the Devonian period.

66. The Millport Coastal Flood Protection Scheme 2017 ground investigation was carried out by BAM Ritchies between 18th January and 2nd February 2017. This included four cable percussion boreholes, drilled to depths of up to 2.7m below ground level, eight hand dug inspection pits to depths of up to 1.7m below ground level and 26 machine excavated trial pits to depths of up to 2.4m below ground level.

67. The Ground Investigation Report also considers a ground investigation undertaken in June 2014 by Raeburn Drilling and Geotechnical Ltd for URS as part of a Ground Investigation / Options Report for Millport Pier. The ground investigation included eight boreholes which were sunk through the pier to depths of between 4.05m to 15.05m below ground level, four of which were cored in rock.

68. The locations of these boreholes are within Appendix B of the Ground Investigation Report (Royal HaskoningDHV, 2017). Ten main stratigraphic units for design were identified at the site as defined, in order of superposition, in Table 17-11.

Table 17-11 Stratigraphic Units Encountered

Unit name	General Description	Thickness (m)	Occurrence
Made Ground	Surfacing variously comprises of topsoil, concrete and Tarmacadam. Underlying made ground consists of slightly silty to silty, slightly sandy to sandy GRAVEL with low to high cobble content, to gravelly to very gravelly, slightly sandy to very sandy SILT occasionally with high cobble content.	0.1-7.7m	Onshore on land with exception of beach. Not found offshore
Marine Beach Deposits	Multi graded gravelly to very gravelly silty SAND, SAND & GRAVEL to slightly sandy slightly silty GRAVEL, with low to medium cobble content.	Min thickness 0.7m Base of unit not encountered across site	TPA – TPL only on beach.
Raised Beach Deposits	Even graded gravelly to very gravelly silty SAND, medium graded SAND & GRAVEL with low cobble content to multi graded sandy to very sandy very silty GRAVEL, with low to medium cobble content. Material described as Peat, was encountered locally. Recovered as a multi graded gravelly silty SAND.	Min thickness 1m Base of unit not encountered across site Peat deposit 0.2m	BHTP03, BHTP04, TP13, TP15, TP17, TP18, TP19, TP20, TP21, TP24, TP27, TP28, TP29 Not found offshore
Devensian Till/Weathered Millport Cornstones Member	Multi graded SAND & GRAVEL slightly silty to silty with low cobble content to gravelly, very sandy low plasticity CLAY.	0.0 to 3.0m	BH01, BH01A, BH02, BH03
Dinantian Dykes	Strong massive dark grey BASALT with 1.5 - 3.0mm phenocrysts and occasional white veins. Two vein sets: 1 generally subvertical: 2 dipping at 50- 60. Partial weathering along fracture surfaces with yellow discolouration penetrating 4mm and clay smearing. Two fracture sets: 1 widely spaced dipping at ~10? undulating and rough with 4mm of penetrating yellow discolouration: 2 widely spaced dipping at ~50-60 undulating and rough along quartz veins, clay smeared	Base of unit not encountered	BH01, BH01A, BH03, BH05, & BH07 only
Weathered Millport Cornstones Member	Recovered as cobbles of sandstone to very silty SAND & GRAVEL with low cobble content, to very sandy gravelly low to medium plasticity CLAY.	Base of unit not encountered	BH07, Tp22, Tp23, TP24, TPH, TPJ, TPK
Millport Cornstones Member	Red SANDSTONE, occasionally recovered as reddish brown sandy fine to coarse angular gravel of SANDSTONE. Crumbles into sand.	Base of unit not encountered	TP22, TP23, TP24, TPK TPJ, TPH, BH01 BH01A, BH02, BH03 BH07
Ballagan Formation	Recovered as light grey sandy fine to coarse angular gravel of SANDSTONE.	Base of unit not encountered	BHTP03 only
West Bay Cornstones Formation	Recovered as light grey sandy fine to coarse angular gravel of SANDSTONE.	Base of unit not encountered	BHTP02 only
Foul Port Mudstone Member	Recovered as light grey sandy fine to coarse angular gravel of SANDSTONE.	Base of unit not encountered	BHTP01 only

69. The geological sensitivity is considered to be **negligible** as the land use is currently residential and there is unlikely to be any exploitation of resources (such as quarrying) within the vicinity of the proposed scheme.

17.5.3 Hydrology

70. There are minor watercourses on site, such as Mill Burn in the west of the town and an unnamed burn that discharges in to Kames Bay, and as discussed below in Section 17.5.7, Kames Bay is designated as a Site of Special Scientific Interest (SSSI) due to the sandflats. The burns are culverted within the area of town. The surrounding areas are classified as being as an area of high and medium susceptibility to surface water flooding.

71. There are no surface water, Water Framework Directive (WFD) Classifications on Great Cumbrae, however offshore, the Largs Channel (Fairlie Roads) coastal water body (Reference ID: 200026) is classed as 'Good' (SEPA, 2018).

72. There are no surface Drinking Water Protected Areas on Great Cumbrae (Scottish Government, 2018).

73. The sensitivity of Mill Burn is considered **negligible**, as there are no surface water WFD classifications or surface Drinking Water Protected Areas. However, as the culvert to the west of the town discharges into the Kames Bay SSSI and therefore is considered to be of **high** sensitivity.

74. Impacts to surface water receptors were not scoped into the Conceptual Site Model (Royal HaskoningDHV, 2016), and it is not anticipated that the culvert will be impacted by the proposed scheme, therefore this receptor has not been considered further within this assessment.

75. The sensitivity of the sea (Firth of Clyde) due to the surface water WFD classification and presence of the Kames Bay SSSI, is considered to be **high**.

17.5.4 Hydrogeology

76. According to the desk based assessment (Royal HaskoningDHV, 2016) the groundwater flow in the vicinity of Millport is likely to be dominated by flow from the centre of the island radially towards the coast. Locally the flow is likely to be modified slightly by the presence of dykes and faults. Groundwater levels are likely to be tidally influenced. Close to the route of the watercourse which emerges from its culvert onto Kames Bay, flow is likely to be into that watercourse. There are records of seepage of brackish water onto Kames Bay. and the presence of relatively fresh water is supported by the number of wells recorded historically within 100 m of the shore within Millport.

77. Historically there were around 10 wells between 50m and 100m inland of the high water mark, only three of the wells were remaining in 1896, however has been assumed that the remaining wells are no longer used for abstraction, due to the use of mains water at Millport (Royal HaskoningDHV, 2016).

78. Currently, there are no surface water abstractions, within 1km of the site, however there are two discharge licence consents located at the eastern extent of the site. There are no pollution incidents identified within 200m of the site.

79. Table 17-12 below provides a summary of relevant groundwater designation information from the Scottish Environmental Protection Agency.

Table 17-12 Groundwater aquifer designation

Aspect	Classification	Details
Superficial Deposits	Low to moderately productive aquifer with intergranular flow*	Raised marine deposits with intergranular flow yielding between 1 to 10 l/s.
Bedrock (Inverclyde Group)	Moderately productive aquifer in which flow is virtually all through fractures and other discontinuities	Multi-layered aquifer with fracture flow yielding up to 10 l/s.
Bedrock (Stratheden Group)	Moderately productive aquifer with significant intergranular flow	Sandstone, partly pebbly with subordinate siltstone and mudstone produce moderate amounts of groundwater.

*Although the Superficial Deposits were "Not Defined" in the 2016 desk based assessment, 'A User Guide: Aquifer Productivity (Scotland) GIS datasets, Version 2' (BGS, 2011) explains that the superficial deposits productivity map only includes four productivity classes: high; moderate to high; moderate; and a category to signify that a deposit is 'not a significant aquifer', however, further explanation within the report defines Raised Beach and Marine Deposits as "low to moderate productivity aquifers" The guide also has a note which states "*Any mixed deposit of marine or tidal origin, if not specified as clay and silt, may have the potential to form a moderately productive aquifer capable of supplying sustainable borehole yields of at least 1 l/s, if it contains sufficient sand and/or gravel, is thick enough and is of large enough lateral extent.*" As shown in Table 17-11, the Marine Beach Deposits and Raised Beach Deposits contain sand and gravel. However, the trial pits reveal that the Marine Beach Deposits only occur on the beach, and therefore saline intrusion is likely. Therefore, Raised Beach Deposits are more likely to be a **low - moderately productive aquifer** with flow yielding around 1-10l/s.

80. The groundwater Water Framework Directive Classification on Great Cumbrae (Reference ID: 150440) is 'Good' (SEPA, 2018). The groundwater below Millport (excluding Kames Bay and other beach areas) is classed as a 'Water Regulation Zone', which represents the extent of the area supplied by Scotland's water authority, as represented on the Scottish Government's data viewer (Scottish Government, 2018). The majority of Great Cumbrae is also a groundwater Drinking Water Protected Area (Scottish Government, 2018), which area areas defined by the Scottish Environment Protection Agency in line with the requirements of The Water Environment (Drinking Water Protected Areas) (Scotland) Order 2013.

81. Due to the classification of the area as a Water Regulation Zone and a Groundwater Drinking Water Protected Area, the sensitivity of both the superficial and bedrock aquifers are considered to be **medium**.

17.5.5 Land Quality

82. The desk based assessment (Royal HaskoningDHV, 2016) identified three potentially contaminative historic land uses in the vicinity of Millport:

- The 'Mill' adjacent to the watercourse approximately 100 m to the north of high water at the Kames Bay;
- Garage on Marine Parade, north of Kames Bay; and
- Backfilling of the quarry to the east of Kames Bay.

83. However, these land uses are distant from the proposed works.

84. In addition, **Appendix 15.1 Archaeological Desk Based Assessment** makes reference to the Millport Gasworks which was active in the 19th and 20th century (Canmore National Record of the Historic Environment, 2019), and is now disused, which is approximately 650m north of the site. Although there is the potential for contamination from the gasworks, the distance from the disused

gasworks to site is considered sufficient for a potential pathway to the site to be unlikely. Therefore this source is not considered further within this assessment.

85. Potential contaminative sources within the footprint of the development were suggested to include fuel storage associated with the harbour facilities and asbestos from demolition material incorporated into made ground. There is also the potential for contamination of the marine sediment within the footprint of the breakwater.

86. A Generic Quantitative Risk Assessment (GQRA) for Human Heath and Controlled Waters was undertaken as an appendix to the Ground Investigation Report, 2017 (Appendix E). This included an assessment of laboratory results associated with soil and water samples, which is summarised below.

Human Health

87. During the ground investigation forty-six soil samples were recovered for laboratory analysis of a range of determinands. The samples were generally recovered from the upper metre of the soil profile. The results of the laboratory analysis were screened against Generic Assessment Criteria (GAC) for a commercial end use.

88. The data assessment was summarised as follows:

- The majority of the determinands were not recorded at concentrations exceeding the laboratory limit of detection;
- Determinands were not recorded at concentrations exceeding the GAC for a commercial end use; and
- Amosite asbestos as loose fibres was identified in one sample recovered from TP02A at 0.5mbgl, however quantification analysis was not undertaken. Note: although Made Ground was encountered at this exploratory hole, there was no evidence of asbestos containing materials.

Controlled Waters

89. During the ground investigation forty-six soil samples were recovered and scheduled for leachability analysis to establish the mobility of potential contaminants of concern. The assessment of risks to controlled waters comprised a Generic Quantitative Risk Assessment (GQRA) in which dissolved phase contaminant concentrations were screened against appropriate Generic Assessment Criteria (GACs). Substances present at concentrations greater than a GAC were listed as Potential Contaminants of Concern (PCOCs) pending further assessment (where deemed necessary).

90. Overall, potentially leachable determinands were identified in the soils at concentrations exceeding the assessment criteria, although the average concentrations for a number of the determinands were below the assessment criteria. Copper, zinc, a number of PAHs, DRO and MRO exceeded the assessment criteria including the average concentration, although the average PAH and DRO concentrations only marginally exceeded the assessment criteria. The ground investigation works did not observe gross contamination, but did encounter tarmac, ash and cinders which may be the source of the elevated determinands.

17.5.6 Human Health

91. The baseline human health receptors likely to interact with the proposed scheme for the construction stage are construction workers and the general public. The general public is considered to be represented by residents and business owners adjacent to the proposed works and pedestrians

adjacent to the construction works. For the operational phase of the proposed scheme, maintenance workers and the general public are considered under the same parameters as during construction.

92. The sensitivity of human health receptors is considered to be **high**.

17.5.7 Sensitive Land Use

93. Kames Bay Site of Special Scientific Interest (SSSI), is the only statutory designated site within the footprint of the proposed scheme, and is designated for biological coastline habitat (including marine mammals), specifically for sandflats (as described further in **Chapter 16 Terrestrial Ecology**). There are no further designated sites within 250m of the site boundary. This ecological receptor is not considered further within the assessment. There is the potential for marine mammals to be impacted (by direct contact, ingestion and inhalation) from site derived contamination. However, the dilution and attenuation of contaminants to potential receptors is such that the pathway is not considered to be plausible. Therefore, ecological receptors are not considered further within this assessment.

17.6 Impact Assessment

17.6.1 Overview of Potential Impacts

94. Following the methodology presented in Section 17.4 above, the impacts associated with the human health and the water environment have been assessed and are presented in this section. Where measures over and above the embedded mitigation described in Section 17.6.3 are required to avoid, reduce, remedy/compensate or enhance the adverse impacts of the proposed scheme, this information has been provided.

17.6.2 Worst Case Scenario

95. Table 17-13 identifies those realistic worst-case parameters the proposed scheme that are relevant to ground conditions and contamination. Please refer to **Chapter 5 Project Description** for more detail regarding specific activities, and their durations, which fall within the construction phase.

Table 17-13 Worst case parameters values

Impact	Parameter
Construction Phase	
Impacts to human health Impacts to the water environment	Potential on-site source of contamination from: Excavation of beach materials (Millburn Street and Crichton Street junction); Excavation of masonry revetment and beach excavation at Cross House and Crichton Street, Excavation of footpath along Marine Parade and West Bay Road (asbestos contamination has been observed in this area in the Ground Investigation) and existing road along Millburn Street, Excavation for foundation of flood walls 1.5m deep and 3m wide; and Excavation of the promenade Steel rods drilled and grouted into rock at the foreshore. Removal of existing grass and topsoil along Glasgow Street, adjacent to Kelburn Street and around Kames Bay. Potential for break out of some bedrock for the foundation of the flood wall.
Operation Phase	
No potential impacts. Only maintenance works as required to check the integrity of the flood walls, sea walls and breakwater, and conduct any remedial works required	
Decommissioning Phase	
As a flood prevention scheme, the Proposed Scheme is anticipated to be maintained rather than removed, and therefore decommissioning activities are currently unknown. This will be assessed at the time of any decommissioning activities required.	

17.6.3 Embedded Mitigation

17.6.3.1 Scheme design

96. Embedding mitigation into the proposed scheme design is a type of primary mitigation and is an inherent aspect of the EIA process. A full account of embedded mitigation measures is contained in **Chapter 5 Project Description.** Where embedded mitigation measures have been developed into the design of the proposed scheme with specific regard to land and water quality and human health, these are described in Table 17-14. Additional mitigation measures are also included to follow best practice and policy requirements. These mitigation measures are described in Table 17-15.

Table 17-14 Embedded mitigation measures within scheme design

Parameter	Mitigation measures embedded into the scheme design
Footprint	Localised reduction of the width of the Proposed Working Area where practical
Drainage	Drainage through and/or past the crest walls will be included in the design, by adding new drainage gullies, scupper holes through the crest walls, and/or adjusting falls and levels of hard surfaces to maintain drainage flow paths.
Consultation	Ongoing consultation with local community and other relevant stakeholders

Table 17-15 Embedded mitigation through Best Practice and Policy

Parameter	Mitigation measures through Best Practice and Policy
Construction Design Management Regulations (CDM-2015)	All works/operations to be carried out by appropriately trained personnel. Appropriate personal protective equipment (PPE) and working practices to be adopted by construction workers, including subcontractors, and health and safety measures would be implemented to mitigate any short term risk during construction. Development of CDM site specific risk assessment.
CL:AIRE Industry Code of Practice for waste management	Adoption of a CL:AIRE Industry Code of Practice to manage excavated soils on site, thereby maximise sustainability and providing an audit trail to demonstrate the appropriate use of materials. A Material Management Plan (MMP) will be drafted in advance of any construction works. Validation of materials imported to site in line with pre-agreed assessment criteria to ensure that they are suitable for proposed end use. A Site and Excavated Waste Management Plan (SWMP) for the Project will be developed.
Planning Advice Note 33 (2017): Development of Contaminated Land	Best practice guidance including the Planning Advice Note 33: Development of Contaminated Land.
General best practice, to be specified in Construction Environmental Management Plan	Store oils and fuel within designated areas above ground in impervious storage bunds with a minimum of 110 % capacity to contain any leaks or spillages. Carry out regular inspections of oil and fuel storage areas. Restrict refuelling activities to designated areas were impermeable surfaces and drip trays are utilised. Have spill kit available for use on site always. All staff to have site inductions were appropriate use of chemical and fuels on site are discussed. A pollution prevention plan and incident response plan will be incorporated into the environmental management plan. This is to be agreed with SEPA and follow industry best practice.

Parameter	Mitigation measures through Best Practice and Policy
	Storage of hazardous materials will be done with due care and if adequate store locations cannot be identified within the site compound, these materials will be stored off-site in a secure location. A protocol for dealing with potentially contaminated materials will be utilised during the construction works.

17.6.4 Potential Impacts during Construction

97. This section discusses the potential impacts which may occur to receptors during activities associated with the construction of the proposed scheme. Impacts to marine water and sediment quality are considered in **Chapter 7 Marine Water and Sediment Quality.** Impacts to terrestrial ecology are considered in **Chapter 16 Terrestrial Ecology.** Impacts to water resources and flood risk are considered in **Chapter 18 Water Resources and Flood Risk.**

98. Four potential impacts on receptors resulting from the construction stage have been identified. These are:

- Impacts on human health during excavation activities;
- Impacts on bedrock groundwater during construction activities (excavation, bedrock break out and steel rod drilling);
- Impacts on superficial deposits groundwater during excavation; and
- Impact on the Firth of Clyde during construction activities due to groundwater migration.

17.6.4.1 Construction Impact 1: Impact to Human Health, including Construction Workers and the General Public during Excavations.

99. The impacts to human health from the construction stage have been considered in the context of existing identified contaminated sources and how excavations are likely to interact with these.

100. The Ground Investigation Report, (Royal HaskoningDHV, 2017) identified through the Generic Quantitative Risk Assessment identified amosite asbestos as loose fibres in one sample recovered from TP02A at 0.5mbgl, however quantification analysis was not undertaken. It was noted that although Made Ground was encountered at this exploratory hole, there was no evidence of asbestos containing materials. Overall, the majority of the determinands were not recorded at concentrations exceeding the laboratory limit of detection and were not recorded at concentrations exceeding the GAC for a commercial end use.

101. The excavation of materials and stockpiling has the potential to mobilise existing ground contamination (where present) which could result in impact on human health through dermal contact, inhalation and ingestion. There is the potential for asbestos risk, although the presence may be localised as it was only found in one sample. Embedded mitigation measures included in Table 17-15 and Table 17-15 including appropriate Personal Protective Equipment (PPE), should mitigate the short term risk during construction.

102. In the event of exposing soils and stockpiling construction waste (including excavated materials), dust could be generated during dry and windy conditions. Under these conditions, construction workers and the general public, such as users of neighbouring sites and surrounding residents, could temporarily be exposed to contamination via the inhalation of potentially contaminated dust. However, the volume of stockpiled materials on site is anticipated to be low.

103. The sensitivity of human health as a receptor (construction workers and the general public), is considered to be **high**.

104. The impacts are predicted to be of local spatial extent (localised to the work areas), of short-term duration, of intermittent occurrence and high reversibility (only occurring during the works). Following incorporation of embedded mitigation measures as detailed in Table 17-15 the magnitude of effect was assessed as **negligible**.

105. Given the magnitude of the impact and sensitivity of the receptors, impacts were therefore predicted to be of **minor adverse** significance for construction workers and general public prior to further mitigation.

Mitigation

106. No mitigation is required to reduce the impact significance.

Residual Impact

107. The residual impact is minor adverse which is not significant.

17.6.4.2 Construction Impact 2: Impact to Groundwater Quality in the Moderately Productive Bedrock Aquifers during Construction Activities (Excavation, Bedrock Break Out and Steel Rod Drilling)

108. Direct impacts to the moderately productive aquifers within the bedrock may occur due to the intrusive nature of construction, including excavation and steel rod drilling, and due to break out of the bedrock. The significance of the disturbance will be dependent on the depth of the aquifer unit in relation to the proposed depth of the excavation, however significance will be high for where the bedrock is directly impacted.

109. During construction, surface layers will be excavated, allowing increased infiltration of rainwater and surface run-off to the subsurface. This could potentially mobilise any residual contamination already present in overlying strata which could potentially migrate into the underlying aquifers. Steel rod drilling could result in the creation of preferential pathways. Where the bedrock is directly broken out this could create a direct pathway for migration of contaminants. The Ground Investigation Report found that several contaminants including copper, zinc, a number of PAHs, DRO and MRO exceeded the assessment criteria including the average concentration for leachability analysis. For petroleum hydrocarbons, this was a conservative assessment as the Limit of Detection (LoD) was used as a screening value (Royal HaskoningDHV, 2017).

110. It is also anticipated that potentially polluting substances and activities could be introduced during the construction works.

111. The moderately productive aquifers which form part of the bedrock are part of a Groundwater Drinking Water Protected Area and therefore are considered to be of **medium** sensitivity. Any potentially polluting incidents that occur during the construction phase are predicated to be of local spatial extent within each aquifer unit, of short-term duration (related to the working areas only), of intermittent occurrence and high reversibility. With implementation of embedded mitigation measures covered in Table 17-14 and Table 17-15, the magnitude of effect is therefore considered to be **low**. The potential impact to the bedrock moderately productive aquifers is deemed to be **minor adverse**.

Mitigation

112. In addition to embedded mitigation, stockpiles should be sealed during construction to reduce infiltration and therefore reduce the possibility of mobilising leachable contaminants.

Residual Impact

113. Following additional mitigation, the magnitude of effect is considered to be **negligible**, but the potential impact will remain **minor adverse** which is not significant.

17.6.4.3 Construction Impact 3: Impact to Groundwater Quality in the Raised Beach Deposits Superficial Aquifer during Construction Activities (Excavation)

114. Direct impacts to the low - moderately productive aquifers within the Raised Beach Deposits may occur due to the intrusive nature of construction. As the layer of made ground varies in thickness between 0.25 and 2.5m according to the Ground Investigation Report (Royal HaskoningDHV, 2017), it is likely that Raised Marine Deposits will be excavated as excavations are likely to be between 1 – 2 m deep.

115. Excavation of layers allows increased infiltration of rainwater and surface run-off to the subsurface. This could potentially mobilise any residual contamination already present in overlying strata which could potentially migrate into the superficial aquifers.

116. The low - moderately productive aquifers which form part of the superficial deposits form part of the Water Regulation Zone and Groundwater Drinking Water Protected Area for Great Cumbrae Island and therefore are considered to be of **medium** sensitivity. Any potentially polluting incidents that occur during the construction phase are predicated to be of local spatial extent within each aquifer unit, of short-term duration (related to the working areas only), of intermittent occurrence and high reversibility. With implementation of embedded mitigation measures covered in Table 17-14 and Table 17-15, the magnitude of effect is therefore considered to be **low**. The potential impact to the superficial deposits is deemed to be **minor adverse**.

Mitigation

117. In addition to embedded mitigation, stockpiles should be sealed during construction to reduce infiltration and therefore reduce the possibility of mobilising leachable contaminants.

Residual Impact

118. Following additional mitigation, the magnitude of effect is considered to be **negligible**, and the potential impact remains **minor adverse**, which is not significant.

17.6.4.4 Construction Impact 4: Impact on the Firth of Clyde during Construction Activities due to Groundwater Migration

119. As discussed in the desk based assessment (Royal HaskoningDHV, 2016), as the Firth of Clyde is in close proximity to the groundwater there is a potential pathway for dissolved phase and free phase lateral groundwater migration through . However, as the potential impact to the groundwater is considered to not be significant, and due to the dilution and attenuation of potential site derived contaminants from the pathway from site to the receptor is such that the likelihood of a pathway is not considered to be plausible on the Firth of Clyde.

17.6.5 Potential Impacts during Operation

120. There are unlikely to be any impacts during operation as maintenance works are proposed to be low involving checking the integrity of the flood walls, sea walls and breakwater, and conduct any remedial works required.

17.6.6 Potential Impacts during Decommissioning

121. The structures forming the coastal flood prevention scheme would be designed to have a life of at least 50 years. As the purpose of the proposed scheme is for flood protection, it is unlikely that it would be decommissioned entirely; it is more likely that the scheme would be repaired, or sections replaced or improved if needed in the future. No decision has been made regarding the final decommissioning policy for the offshore infrastructure of the proposed scheme as it is recognised that industry best practice, rules and legislation change over time.

122. The detail and scope of the decommissioning works will be determined by the relevant legislation and guidance at the time of decommissioning and agreed with the regulator. As discussed in **Chapter 5 Project Description**, a decommissioning plan will be submitted for approval by the regulatory authorities prior to construction. As such, impacts no greater than those identified for the construction phase are expected for the decommissioning phase.

17.7 Cumulative Impact Assessment

123. The only project which could cause cumulative impacts with the proposed scheme is the Mill Burn Flood Scheme which currently includes two options for diverting and upgrading the existing Mill Burn culvert. However, this scheme is due to be completed at the latest before Summer 2021, with the Millport Flood Protection Scheme due to begin construction in Autumn 2021, so unless there is a change to the Mill Burn programme, these schemes will not overlap.

17.8 Inter-relationships

124. Table 17-16 lists out the inter relationships between other chapters within the ES.

Table 17-16 Inter-topic relationships

Topic	Related Chapter	Where addressed in this chapter	Rationale
Effect on human health from excavations	Chapter 23 Tourism and Recreation	Section 17.6.4.1	Concern over excavations may impact tourism and recreation at Millport.
Effect on groundwater (superficial deposits or bedrock) from construction activities.	Chapter 18 Water Resources and Flood Risk	Section 17.6.4.2 and 17.6.4.3	Effects on groundwater may impact on water resource quality.

Topic	Related Chapter	Where addressed in this chapter	Rationale
Effect on the Firth of Clyde during construction activities due to groundwater migration	Chapter 7 Marine Water and Sediment Quality	Section 17.6.4.4	Effects on the Firth of Clyde would impact on marine water quality.

17.9 Interactions

125. The impacts identified and assessed in this chapter have the potential to interact with each other, which could give rise to synergistic impacts as a result of that interaction. The worst case impacts assessed within this chapter take these interactions into account and for the impact assessments are considered conservative and robust. For clarity, the areas of interaction between impacts are presented in Table 17-17 along with an indication as to whether the interaction may give rise to synergistic impacts.

Table 17-17 Potential interactions between impacts

Potential interaction between impacts				
Construction	1 Impact to Human Health, including Construction Workers and the General Public during Excavations.	2 Impact to Groundwater Quality in the Moderately Productive Bedrock Aquifers during Construction Activities	3 Impact to Groundwater Quality in the Raised Beach Deposits Superficial Aquifer during Construction Activities (Excavation)	4 Impact on the Firth of Clyde during construction activities due to groundwater migration
1 Impact to Human Health, including Construction Workers and the General Public during Excavations.		No	No	Yes
2 Impact to Groundwater Quality in the Moderately Productive Bedrock Aquifers during Construction Activities	No		Yes	Yes
3 Impact to Groundwater Quality in the Raised Beach Deposits Superficial Aquifer during Construction Activities (Excavation)	No	Yes		Yes

Potential interaction between impacts				
4 Impact on the Firth of Clyde during construction activities due to groundwater migration	Yes	Yes	Yes	
Operation	Not applicable.			

17.10 Summary

126. The main potential impacts of the proposed scheme on human health and the water environment receptors have been identified.

127. Four potential impacts during construction have been identified.

128. A summary of the potential impacts and proposed mitigation is presented in Table 17-18.

Table 17-18 Potential Impacts Identified for Ground Conditions and Contamination

Potential Impact	Receptor	Value	Magnitude	Significance	Examples of Potential Mitigation Measures	Residual Impact
Construction						
Impact 1: Impact to Human Health, including Construction Workers and the General Public during Excavations.	Construction Workers and the General Public	High	Negligible	Minor Adverse (Not Significant)	None	Minor Adverse (Not Significant)
Impact 2: Impact to Groundwater Quality in the Moderately Productive Bedrock Aquifers during Construction Activities	Moderately Productive Bedrock Aquifers	Medium	Low	Minor Adverse (Not Significant)	Stockpiles should be sealed during construction to reduce infiltration.	Minor Adverse (Not Significant)
Impact 3: Impact to Groundwater Quality in the Raised Beach Deposits Superficial Aquifer during Construction Activities (Excavation)	Raised Beach Deposits Superficial Aquifer	Medium	Low	Minor Adverse (Not Significant)	Stockpiles should be sealed during construction to reduce infiltration.	Minor Adverse (Not Significant)

Potential Impact	Receptor	Value	Magnitude	Significance	Examples of Potential Mitigation Measures	Residual Impact
Impact 4: Impact on the Firth of Clyde during construction activities due to groundwater migration	Firth of Clyde	No plausible pathway.				
Operation						
There are no potential impacts on human health or the water environment during the operation of the proposed scheme with embedded mitigation measures.						
Decommissioning						
As a flood prevention scheme, the Proposed Scheme is anticipated to be maintained rather than removed, and therefore decommissioning activities are currently unknown. This will be assessed at the time of any decommissioning activities required.						

17.11 References

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