Stranraer Marina Expansion

Flood Risk Assessment

June 2025

FAIRHURST

CONTROL SHEET

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1. Introduction

Fairhurst was appointed by Dumfries and Galloway Council (DGC) to carry out a Flood Risk Assessment (FRA) for the proposed expansion and redevelopment of Stranraer Marina, in the Dumfries and Galloway local authority area (see **Figure 1-1**). The proposed development comprises both land (terrestrial) and marine elements located at the existing Stranraer Marina and harbour at the southern end of Loch Ryan – a predominantly shallow, sheltered sea loch, which opens into the Firth of Clyde and the Atlantic Ocean to the north.

This report forms an assessment of flood risk for the development as a whole in accordance with National Planning Framework 4 (NPF4). This considers both terrestrial and marine elements of the development. Flood risk has primarily been assessed in relation to coastal flood risk from Loch Ryan; however, other potential sources of flood risk have also been considered.

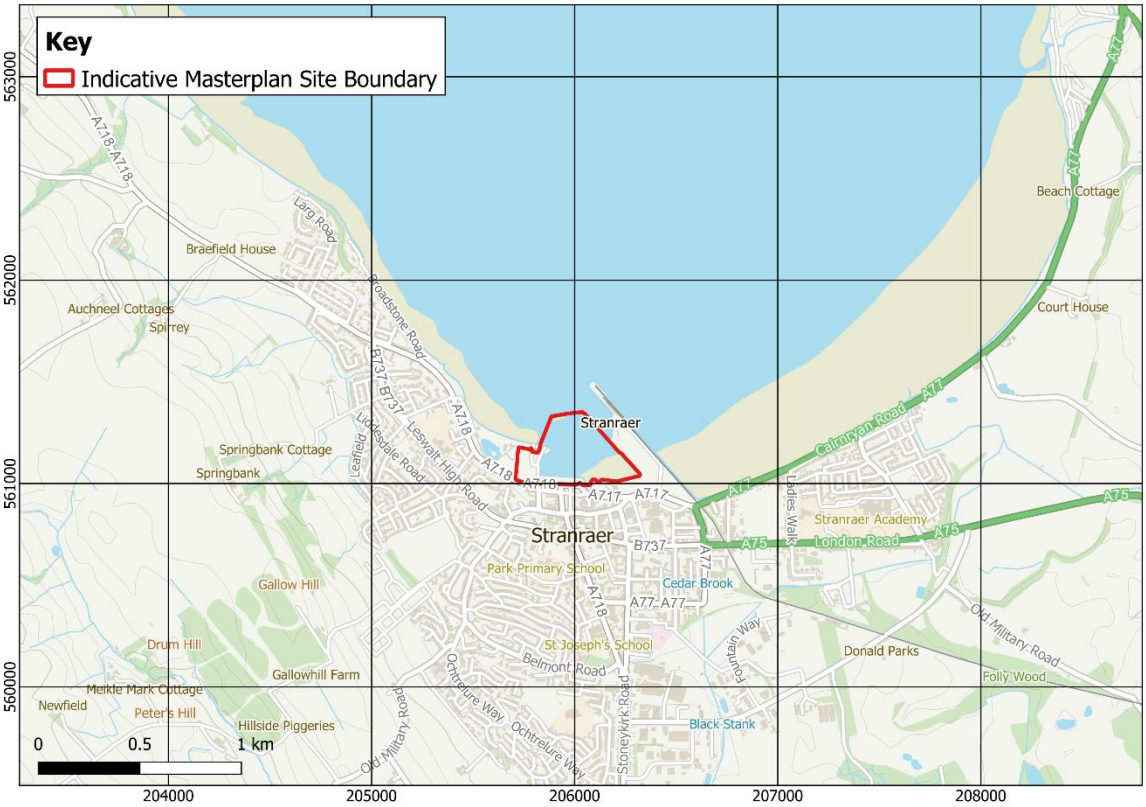

Figure 1-1: Site Location Plan

2. Planning Policy

2.1 National Planning Framework 4

In consideration of planning applications, planning authorities require to be satisfied that due account has been taken of NPF4, and the Scottish Government's online Planning Advice on Flood Risk. It is necessary to show that adequate protection against flooding exists or can be provided for the proposed development and that the development does not increase flood risk to others.

Policy 22 of NPF4, 'Flood Risk and Water Management', sets out the requirements for development proposals at risk of flooding or in a flood risk area. The policy states:

a) *"Development proposals at risk of flooding or in a flood risk area will only be supported if they are for:*

   i. *essential infrastructure where the location is required for operational reasons;*

   ii. *water compatible uses;*

   iii. *redevelopment of an existing building or site for an equal or less vulnerable use; or*

   iv. *redevelopment of previously used sites in built up areas where the LDP has identified a need to bring these into positive use and where proposals demonstrate that long-term safety and resilience can be secured in accordance with relevant SEPA advice.*

   The protection offered by an existing formal flood protection scheme or one under construction can be taken into account when determining flood risk.

   In such cases, it will be demonstrated by the applicant that:

   - *all risks of flooding are understood and addressed;*
   - *there is no reduction in floodplain capacity, increased risk for others, or a need for future flood protection schemes;*
   - *the development remains safe and operational during floods;*
   - *flood resistant and resilient materials and construction methods are used; and*
   - *future adaptations can be made to accommodate the effects of climate change.*

   Additionally, for development proposals meeting criteria part iv), where flood risk is managed at the site rather than avoided these will also require:

   - *the first occupied/utilised floor, and the underside of the development if relevant, to be above the flood risk level and have an additional allowance for freeboard; and*
   - *that the proposal does not create an island of development and that safe access/ egress can be achieved.*

b) *Small scale extensions and alterations to existing buildings will only be supported where they will not significantly increase flood risk.*

c) *Development proposals will:*

   i. *not increase the risk of surface water flooding to others, or itself be at risk.*

   ii. *manage all rain and surface water through sustainable urban drainage systems (SUDS), which should form part of and integrate with proposed and existing blue-green infrastructure. All proposals should presume no surface water connection to the combined sewer;*

   iii. *seek to minimise the area of impermeable surface.*

d) Development proposals will be supported if they can be connected to the public water mains. If connection is not feasible, the applicant will need to demonstrate that water for drinking water purposes will be sourced from a sustainable water source that is resilient to periods of water scarcity.

e) Development proposals which create, expand or enhance opportunities for natural flood risk management, including blue and green infrastructure, will be supported."

2.2 Local Planning Policy

Dumfries and Galloway Council (DGC) adopted its current Local Development Plan 2 (LDP2) in October 2019. The Plan represents the Council's vision for development within the area over the next 20 years, providing the planning framework and guiding the future use and development of land in towns, villages and the rural area. LDP2 was published prior to the release of NPF4, and therefore makes reference to the policies set out in Scottish Planning Policy (SPP), which has now been superseded.

Primary Policy IN7: 'Flooding and Development', which outlines the Council's approach to flood risk, states:

> *"The avoidance principle is the most sustainable form of flood management, in accordance with the policy principle for managing flood risk of SPP and the Flood Risk Management (Scotland) Act 2009. Where proposed development could lead to an unacceptable on-site or off-site flood risk[1], as defined by the Risk Framework in SPP, then it will not be permitted. Where a proposed development could lead to an unacceptable flood risk, it may be that a Flood Risk Assessment (FRA) is able to clarify to the satisfaction of the Council and SEPA that the level of risk both on and off site would be acceptable. For any site a Drainage Impact Assessment (DIA) may be required to ensure that surface water flows are properly taken into account in the development design. Consideration should be given to pluvial flows[2] especially those which exceed the capacity of the proposed drainage systems. Design of development must avoid flood risk from exceedance flows[3]. (See also Policy IN8 for Surface Water Drainage and SuDS.)*
>
> *In order to satisfy the Council in respect of FRAs and DIAs, parties will be expected to provide independent verification of their professional competence, unless it is clear that this is not required.*
>
> *Supplementary guidance provides further detail on the levels and requirements for Flood Risk Assessments.*

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[1] Note: The meaning of 'flood risk' is from SPP. It is 'the combination of the probability of a flood and of the potential adverse consequences, associated with a flood, for human health, the environment, cultural heritage and economic activity'.

[2] Pluvial flooding is a result of rainfall runoff flowing or ponding over the ground before it enters a natural drainage system (e.g. watercourse) or an artificial one (e.g. sewer) because for example the system is already full to capacity or the drainage inlets have limited capacity.

[3] Those which exceed the capacity of any formal drainage system."

Supplementary Guidance (SG) is also available, providing practical detail for applying LDP2 Policy IN7: 'Flooding and Development', which expands on Policy IN7.

The Stranraer Waterfront has been designated for mixed use development as part of LDP2, with a regeneration masterplan adopted as Planning Guidance in November 2019 ('Stranraer Waterfront Urban Design Strategy and Masterplan'). This seeks to create a mixed use development that will reconnect Stranraer town with the waterfront, and will support the overall ambition for the town: "to reposition Stranraer and Loch Ryan as a distinctive and successful marine leisure destination". The regeneration proposals set out the vision to develop an attractive seaside town and a high quality service hub for residents, businesses and visitors.

2.3 Dumfries & Galloway Shoreline Management Plan

The Dumfries & Galloway Shoreline Management Plan (D&G SMP) is a plan for managing flood and erosion risk along the D&G coast, looking at the short, medium and long term. Policy Unit 32 within the Plan ('McCullochs Point to Innermessan (Stranraer)') includes approximately 7 km of shoreline around the head of Loch Ryan and encompasses the proposed development site at Stranraer Marina. The recommended shoreline management policy in this area comprises 'Hold the Line' (e.g. maintaining the existing shoreline position and preventing further retreat by implementing defences or interventions) possibly in combination with 'Managed Realignment' (e.g. landward movement of roads in the future).

3. Development Site

3.1 Existing Conditions

The proposed masterplan development site covers the existing Stranraer Marina, car parking areas and public open space, as illustrated in **Figure 3-1** and **Photograph 3-1**. The existing marina currently consists of a dogleg quay and finger pontoon, the latter of which is used by smaller fishing vessels, along with excursion and recreational craft. The West and East Piers, and associated support structures, project into Loch Ryan, and an existing breakwater is located north of the West Pier.

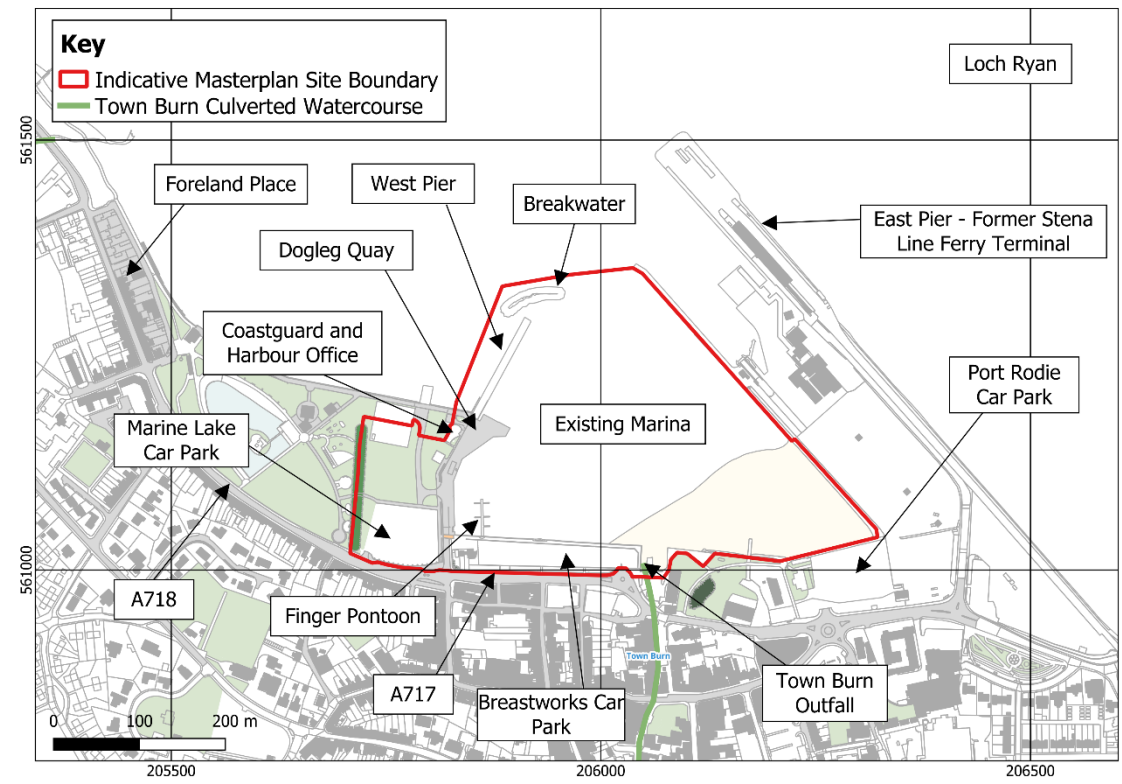

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Figure 3-1: Existing Conditions

Existing site access is from the Market Street / Harbour Street (A717) roundabout and from Agnew Crescent (A718) immediately to the south of the development boundary. The site is bounded to the south by the A717 / A718 and the existing Port Rodie Car Park; to the west by Agnew Park; to the north by Loch Ryan; and to the east by the East Pier, a former Stena Line ferry terminal. The culverted Town Burn watercourse discharges northwards directly into the harbour, with the culvert outfall, as identified in **Figure 3-1**, located adjacent to an existing concrete slipway.

The existing shoreline at Stranraer is heavily developed, with significant areas of reclaimed land along the seafront between Foreland Place, to the west, and the East Pier. A topographical survey was carried out by Balfour Beatty in August 2024 for the site area, as shown on Drawing CRSSS082-24060-IS-001 Sheets 1-4 in **Appendix A**, which indicates that ground is relatively flat within the site area. Levels range typically between 3.0 and 3.5 mAOD, falling locally below 3.0 mAOD in the Marine Lake Car Park (in a local depression immediately west of the Coastguard and Harbour Office), and at the slipway entrance adjacent to the Town Burn.

Existing sea walls are present along the entirety of the shoreline within the study area, extending from the West Pier to the East Pier. The top of walls are typically flush with (or close to) shore-side ground levels, with the exception of a local raised wall immediately west of the West Pier (**Photograph 3-2**) and within the Port Rodie Car Park area – where a locally lower promenade runs behind the sea wall (see **Photograph 3-3** and **Photograph 3-4**). The Port Rodie Car Park area is then raised to levels comparable to the top of the sea wall, via a second retaining wall. A non-continuous raised wall is also present set back from the promenade within the Breastworks car park area (**Photograph 3-5**).

Photograph 3-1: Existing infrastructure in the harbour

Photograph 3-2: West Pier

Photograph 3-3: Port Rodie car park sea wall

Photograph 3-4: Port Rodie car park sea wall / promenade

Photograph 3-5: Breastworks car park

3.2 Proposed Development

The proposed development consists of a number of elements, including both marine and terrestrial development. Marine elements will include a revised marina layout, with associated dredging and breakwater provision, and additional berths. Terrestrial elements will include car parking and harbour buildings – including the Solway Coast and Marine Pilot Project (SCAMPP) and Coastguard building, and a new electrical substation. An area of land reclamation is proposed between the existing slipway and the East Pier in front of the existing Port Rodie car park area, which will provide additional car parking and public open space. A new quay wall is also proposed along the Breastworks car park, as well as redevelopment of the public slipway at the Town Burn outfall. Drawing 161378-FRH-00-00-DG-Z-000001 S1 P02.1 in **Appendix A** shows the latest proposed layout for the masterplan development site.

3.3 Sources of Flood Risk Information

3.3.1 SEPA Potentially Vulnerable Areas

The site is located within the Stranraer Potentially Vulnerable Area (PVA) 02/14/23, Target Area 142, as identified within the Solway Local Plan District (LPD 14) Flood Risk Management Plan (FRMP) 2022-2028. PVAs are areas where significant flood risk exists now or is likely to occur in the future. The Stranraer Target Area Local FRMP datasheet reports that the main source of flooding in Stranraer is coastal flooding, however there are also risks from river and surface water flooding.

Further detail on potential flood risk is not provided in the current PVA reporting, however the previous iteration of the FRMP for the Solway LPD (PVA 14/15, 2016-2022) highlighted that coastal flooding has impacts within the harbour area and former ferry terminal, as well as on local transport, residential properties, community facilities and utilities. Fluvial flood risk was also identified associated with the Town Burn, and interactions between fluvial and coastal flooding were identified as having the potential to increase the identified risk, including at Stranraer Harbour at the Town Burn outfall.

3.3.2 SEPA Flood Maps

SEPA's flood maps provide guidance on the possible extent, depth and velocity for different likelihoods ('High, Medium and Low') of fluvial, coastal and pluvial flooding, alongside various associated information. These maps are a strategic planning tool, the resolution of which does not take account of individual hydraulic structures or drainage infrastructure. These provide indicative flood risk information, rather than site-specific detail.

The SEPA flood maps indicate that the entire proposed development site and its immediate surroundings are at risk of coastal flooding in the 1 in 200 year plus climate change (+ CC) event: the flood maps show complete inundation of the site in this scenario.

The SEPA flood maps indicate that an area immediately south of the site boundary – along the A717 – is at risk of fluvial flooding associated with the Town Burn in the 1 in 200 year + CC event. The indicative fluvial flood extents impact the Market Street / Harbour Street (A717) roundabout access to the site and encroach marginally into the site in the vicinity of the Town Burn outfall and slipway. However, this watercourse is culverted along much of its length and so these maps are unlikely to be representative of flood risk associated with this watercourse. No other fluvial flood risk is identified within the site area.

The SEPA flood maps also indicate that local low lying areas of the site are potentially at risk from pluvial flooding in a 1 in 200 year + CC storm event.

Whilst the flood maps can be a useful tool for initially considering whether a site may be at risk of flooding, the following caveat is attached to their use:

> *"The Flood Maps are indicative and of a strategic nature. Whilst all reasonable effort has been made to ensure that the Flood Maps are accurate for their intended purpose, no warranty is given by SEPA in this regard… It is inappropriate for these Flood Maps to be used to assess flood risk to an individual property."*

More detailed analysis is required to fully understand the flood risk to any development site and is provided in **Section 5** of this report.

3.3.3 SEPA Reservoirs Map

In order to implement the Reservoirs (Scotland) Act 2011, SEPA produced reservoir inundation maps (RIMs). These maps illustrate the areas likely to be flooded by an uncontrolled release of water from a reservoir with storage volume of 25,000 m^3 or more. The SEPA RIMs indicate that the site is not at risk of reservoir flooding.

3.3.4 Existing Flood Alleviation Works

Existing studies and works have been carried out for the purpose of alleviating flood risk in Stranraer. In response to a request for information on these works, DGC provided the following reports:

- **Mouchel, 2009. Stranraer Flood Study Options Report**
    - A study to investigate potential options for flood alleviation in Stranraer. The study assessed fluvial flood risk associated with the main watercourses in Stranraer, including the Town Burn watercourse that outfalls to the harbour. As part of this assessment a number of flood alleviation works were recommended.
- **Kaya, 2023. Notes on Modelling of Town Burn and Black Stank**
    - Letter addressed to DGC Flood Risk Management Team (FRMT) detailing model construction methods for the Black Stank and Town Burn.

No further information has been provided by DGC to date and it has not been confirmed which, if any, of the 2009 Flood Study recommendations have been progressed or the exact purpose of the additional 2023 model note. However, review of the DGC planning portal identified the following:

- **23/0259/FUL: Proposed Stranraer Flood Protection Scheme Land To South Of Former Railway Embankment And Burnside Court Stranraer.**
    - This application relates to the formation of an earth embankment and associated pipework across the upper reaches of the Town Burn and is supported by an undated *Initial Flood Risk Assessment*. This document suggests that the purpose of these works is to limit flows towards the lower reaches of the Town Burn, by storing more water within the large floodplain shared by both the Town Burn and Black Stank in the Black Parks area (between the railway and Commerce Road). Initial model results are provided to indicate that the concept is feasible, however, no detailed assessment is provided. The application was approved in April 2023.

- Associated general arrangement drawings are provided, and observations by Fairhurst during a site visit in October 2024 indicate that this embankment has been constructed and that a new pipe and sluice gate have been installed which will allow for the storage of Town Burn flows upstream of the railway. However, no information has been provided on procedures / triggers in regards the operation of the sluice gate, or on the return period event to which alleviation works have been designed.

3.3.5 Previous Flood Risk Assessments

A number of historic FRAs have been carried out in relation to the Stranraer Waterfront, including:

- **Stranraer Waterfront Development FRA (Terrenus CDH Ltd., 2011)**
  - This FRA was commissioned by DGC with the aim of developing an understanding of potential coastal flood mechanisms; assessing potential constraints to the proposed waterfront masterplan; and providing recommendations relating to possible mitigation measures.
  - The findings of this FRA have been reviewed to inform the current assessment. However, it must be recognised that masterplan proposals, planning policy and assessment methods have evolved significantly since its production in 2011, and that additional data sources are now available. Regardless, the following recommendations remain of relevance to current proposals:
    - *"The complete land raising or flood bunding of the Masterplan area could result in a loss of some 100,000 m^3 of sea water storage. Given the nature and location of the Stranraer shore front...it is considered that a storage loss as a result of land raising will have no effect on the general coastal environment… The cost and aesthetic implications of land raising or bunding are however considerable."*
    - *"Enhanced protection within the Marina area by the use of water resistant construction techniques and raised electrical utilities should be considered."*
    - *"Appropriate management of staff and visitor movement during exceptional tides and storms is…recommended. Alternatively raised pedestrian walkways could be considered…"*
  - It is also noted that this study identified a 1 in 200 year return period extreme stillwater design maximum of 4.37 mAOD (excluding wave effects) and 1 in 200 year return period wave maximum of 4.67 mAOD within the harbour, based on methods applied at the time. Finished floor level (FFL) recommendations started at 4.00 mAOD for low sensitivity receptors, assuming enhanced protection (e.g. water-resistant construction techniques) was also implemented.
- **Proposed Water Sports Centre, West Pier FRA (TransTech Ltd., 2020) - Planning Application 23/0970/FUL ('SWSA Planning Application')**
  - This FRA was carried out with reference to the requirements of (the now superseded) SPP in support of the planning application for the development of a water sports centre on the West Pier in Stranraer Marina, which was acknowledged as part of the wider

Stranraer Waterfront Masterplan. The findings of this FRA have been reviewed to inform the current assessment.

- This study identified 1 in 200 year and 1 in 200 year + CC return period extreme sea levels (ESLs) of 3.86 mAOD and 4.74 mAOD respectively (excluding wave effects), and a 1 in 200 year + CC level of 5.31 mAOD (including an allowance for waves). A FFL of 4.0 mAOD was proposed, providing 0.14 m freeboard above the 1 in 200 year return period ESL. The FRA recommended water-resistant construction techniques and raised electrical utilities in consideration of potential 5.31 mAOD flood levels when climate change and waves are taken into account. The FRA also recognised that the existing Coastguard and Harbour Master building (which was constructed after the 2011 FRA detailed above) has a comparable FFL of 4.0 mAOD.
- This FRA also states:
  - *"To permit new non-residential development along Stranraer's seafront, it is necessary to relax SEPA's typical requirement of the FFL lying at least 0.6 m above the 1:200 year flood level and for the finished ground level of the site to lie below the 1:200 year flood level. Given that the proposed development is a sports facility, it is generally acceptable to propose flood resilience measures as appropriate mitigation when the proposed FFL exceeds the 1:200 year flood level, as is the case for this site…In terms of safe egress and access during a flood event, a flood plan for staff and visitor movement and evacuation will be written by the Water Sports Centre's management team prior to occupation and put on prominent display to staff and visitors. If there is any risk of flooding to the development or its access, the Water Sports Centre will be closed down and all employees and visitors sent home."*
- It is recognised that this FRA was carried out prior to the adoption of NPF4 in February 2023, however, the planning application was made in 2023 and SEPA responded to this planning application in June 2023 to confirm that the development is acceptable under NPF4 given that it is for a water compatible use. DGC's FRMT also provided no objection on review of provided information.

3.3.6 Stakeholder Consultation

Fairhurst submitted a formal request to relevant stakeholders and regulatory bodies, dated 13th October 2020, for an Environmental Impact Assessment (EIA) Screening Opinion for the proposed marina expansion works, and a subsequent EIA Scoping Request was distributed by RPS, dated March 2021. Responses in relation to flood risk / coastal development were received from SEPA and Marine Scotland (the regulatory bodies for terrestrial and marine development, respectively) as part of the screening and scoping process. Additional consultation has since been undertaken with both SEPA and DGC to inform this FRA. Responses are detailed in full in the Stranraer Marina Expansion Scheme Environmental Impact Assessment Report (EIAR)[1] (EIAR Volume 1, Chapter 10: Flood Risk), with key flood risk information summarised below.

[1] Fairhurst, 2025. Stranraer Marina Expansion Scheme: Environmental Impact Assessment Report, Volume 1 – Main Technical Assessments. Document Reference: D/I/D/161379/501

SEPA

SEPA provided the following advice / information as part of their initial consultation responses:

- The site will require appropriate FFLs, safe access / egress and evacuation plans where necessary – in line with NPF4 and LDP2 requirements.
- The site is located within the Flood Warning Target Area (FWTA) for Loch Ryan, with the following operational information provided:
    - Coastal flood warnings for Stranraer use flood forecasts based on stillwater level and wave overtopping forecasts.
    - Flood warnings are typically issued three to six hours in advance of forecasted flooding, however can be issued up to 12 hours in advance depending on confidence in forecast modelling.
- SEPA's Observed Flood Event database currently holds 37 records of flooding within 500 m of the site, ranging from January 1852 to February 2019 – see **Section 3.4**.

Further consultation (dated 21st January 2025) was carried out to address specific queries surrounding acceptable mitigation requirements and land use vulnerability classifications for the proposed buildings. SEPA's response, dated 10th February 2025, provided the following guidance and should be considered alongside the DGC response (dated 3rd February 2025 and outlined below in the *'Dumfries & Galloway Council'* Consultation Section):

- Based on current proposals, SEPA "would be satisfied that these were water compatible uses", however:
    - DGC FRMT, in their capacity as the Planning Authority, will ultimately determine the land use vulnerability of the proposed development, as well as providing advice on freeboard and finished floor level
    - SEPA would likely direct DGC to their Flood Risk Standing Advice if formally consulted, rather than provide a bespoke detailed response
- SEPA "welcome the commitment to implement an appropriate flood plan to ensure appropriate evacuation and closure of buildings prior to extreme coastal events"

Dumfries & Galloway Council

The DGC FRMT response to the request for information relating to flooding at the proposed development site, dated 13th November 2024, provided the following information:

- Historic flood records – see **Section 3.4.**
- Historic modelling studies associated with the Town Burn and associated flood defences including Mouchel's *Stranraer Flood Study Options Report* (dated 2009) – see **Section 3.3.4.**
- The DGC response also stated:

> *"As general advice, the FRMT would have no issues with uses classed as Water Compatible Uses as long as flood risks are understood and addressed, in accordance with NPF4, also to demonstrate no aspects of the proposals would increase the flood risk elsewhere. The other bullet points*

from NPF4 Policy 22 part 'a' should also be considered where development is for water compatible uses."

In response to a request (dated 21st January 2025) for further clarification that all proposed buildings associated with the development are considered water compatible in line with NPF4 definitions and that flood resilience rather than freeboard would be acceptable in regards building mitigation, Fairhurst received the following response, dated 3rd February 2025:

"The FRMT agrees that the proposals fall under "Water Compatible Uses" and could be supported as per NPF4 Policy 22; as for mitigation measures we would also agree that similar measures as those required as part of the SWSA building application would be appropriate, i.e. Flood Resilient construction methods and appropriate Flood and emergency evacuation plans."

3.4 Historic Flood Records

SEPA's consultation response did not provide detail on specific flood events held on record, noting only that the 37 recorded flood events were within 500 m of Stranraer Marina and occurred between January 1852 and February 2019. Other identified events (detailed in **Table 3-1**) may be accounted for within the SEPA records, however this cannot be confirmed based on the level of detail provided. The SEPA recorded events were categorised as follows:

- 16 records of surface water flooding due to heavy rainfall (pluvial flooding)
- 14 records of flooding due to the sea
- Five records of unknown flooding
- One record of groundwater flooding
- One record is associated with a burst water pipe

Pertinent events extracted from historic flood records provided by DGC FRMT, summarised in **Table 3-1**, include events with impacts ranging from property / street level, to town level, and resulting from coastal, pluvial and other drainage sources. Further historic flooding information presented in **Table 3-1** was obtained through reference to the previous studies / reports discussed in **Section 3.3**. Available historic records have identified only coastal flood events impacting the site area, with no records of flooding from other sources cited explicitly within the site area itself.

Table 3-1: Historic Flood Records

Date	Location	Source of Flood	Details	Source of Information
03/01/2014	Stranraer Harbour	Coastal	Fairhurst have reviewed record photographs of this event against current topographic survey, which infers that water levels reached around 3 mAOD during this event.	DGC / PVA / SEPA
13/02/2011	West Pier	Coastal	Flooding on the first 200 yards of the West Pier. Walkway closed and flooding up to electricity junction box. Current topographic	DGC

Date	Location	Source of Flood	Details	Source of Information
			survey indicates that the junction box is at a level of 3.5 mAOD.	
28/06/2007	Market Street	Other drainage	Severe flooding of road	DGC
28/06/2007	Fisher Street	Other drainage	Severe flooding of road	DGC
25/08/2024	Rear Post Office (Charlotte Street)	Other drainage	Private drainage flooding into warehouse	DGC
23/08/2024	Rear Post Office/Tesco (Charlotte Street)	Other drainage	Private drainage flooding property	DGC
28/06/2018	Charlotte Street (near Tesco)	Other Drainage	Drain flooded outside and flooding warehouse	DGC
28/06/2007	Charlotte Street	Other drainage	Flooding behind Tesco	DGC
25/01/2002	Port Rodie (near Police Station)	Surface Runoff	Localised, minor road flooding	DGC
1938/39	King Street / Agnew Crescent	Coastal (anecdotal)	Estimated peak water levels around 3.9 mAOD, areas inundated, though modest wave heights.	2011 Terrenus FRA
January 1928	North Strand Street	Coastal (anecdotal)	Peak tide coincided with northerly storm, estimated peak water levels around 3.6 mAOD	2011 Terrenus FRA
1923	Market Street	Coastal (assumed)	Flooding noted in Stranraer Burgh Council Minutes	2009 Mouchel
1905	Stranraer Town / Not stated	Coastal	Wigtownshire Free Press article headline: “Stranraer disastrous gale & floods” (tidal)	2009 Mouchel
1894	Stranraer Town / Not stated	Coastal	Highest tidal levels in Stranraer, led to significant coastal flooding	PVA
1852	Not stated	Coastal	Coastal flooding caused destruction to roads and properties	PVA

4. Potential Sources of Flood Risk

There are several potential sources of flooding that require consideration:

- **Coastal flooding:** Extreme sea levels and coastal waves have the potential to cause rapid inundation of a development, posing a threat to the welfare of occupants and potentially preventing emergency access to properties and essential infrastructure.
- **Fluvial flows:** Extreme fluvial flood events have the potential to cause rapid inundation of a development, posing a threat to the welfare of occupants and potentially preventing emergency access to properties and essential infrastructure.
- **Infrastructure failure:** The failure of conveyance infrastructure such as culverts or bridges, or the failure of any man-made water storage or conveyance infrastructure that could increase the risk of flooding at the site.
- **Overland flow:** Overland flow occurs when the infiltration capacity of the ground is exceeded in a storm event. This could result in water travelling as sheet flow overland or excess water being conveyed from one location to another via local road networks.
- **Sewer flooding:** If the capacity of sewers is exceeded in an extreme event, or a blockage occurs, surcharging of the network can result in surface flooding. The local drainage network should be considered with a view to assessing flood risk to the site.
- **Groundwater:** High groundwater levels could exacerbate flooding occurring at low points on any given site, potentially contributing to flood risk from other sources.

5. Flood Risk Analysis

Potential sources of flood risk identified for consideration in **Section 4** are discussed below.

5.1 Coastal Flooding

Existing coastal flood risk has been assessed in **Section 5.1.1**, as the location of the site on the shore of Loch Ryan means that it is potentially at risk from tidal inundation and coastal waves. The marine elements of the proposal also have the potential to impact on wave conditions and flood risk. As such, potential changes in coastal flood risk for the proposed scenario (with the development in place) have been assessed in **Section 5.1.2**.

5.1.1 Existing Scenario Coastal Flood Risk

Extreme Sea Levels (ESLs)

The Environment Agency (EA), in collaboration with SEPA and Natural Resources Wales (NRW), has produced a dataset of ESLs around the coastline of the UK[2], based on joint probability analysis of the likelihood of co-occurrence of tidal high water and extreme storm surges. ESLs derived for Loch Ryan in the vicinity of Stranraer are detailed in **Table 5-1**. SEPA guidance on applying climate change allowances in the assessment of flood risk provides predictions of anticipated sea level rise around Scotland, based on UK Climate Projections 2018 (UKCP18). Stranraer is situated at the head of Loch Ryan in the Solway River Basin Region where a sea level rise allowance of 0.88 m is recommended up to the year 2100. This uplift has been applied to identified ESLs, also detailed in **Table 5-1**.

Table 5-1: Loch Ryan ESLs – Stranraer Harbour and Marina (mAOD)

Return Period (Years)	Current Climate*	2100 Climate (+0.88 m)
2	3.03	3.91
5	3.21	4.09
10	3.32	4.20
20	3.44	4.32
25	3.47	4.35
50	3.61	4.49
100	3.73	4.61
200	3.86	4.74
1000	4.12	5.00

* Coastal Flood Boundary (Estuary) dataset node 1678_7 © Environment Agency copyright and/or database right 2019. All rights reserved. Copyright Associated British Ports 2010-2014

Review of ESLs against topographic data for the site (see **Section 3.1** and **Appendix A**) indicates that tidal inundation will begin in as little as a 1 in 2 year return period event under current climate conditions – with low lying ground at the slipway entrance adjacent to the Town Burn to the west of the existing Harbour Office, and within the existing boatyard and Marine Lake Car Park, impacted in this

[2] Environment Agency, 2018. Coastal Design Sea Levels - Coastal Flood Boundary Extreme Sea Levels

event. Complete inundation of the entire existing development site is expected during a 1 in 200 year return period ESL event under current conditions, with expected water depths around 0.3 – 0.7 m. Review of ESLs in comparison with estimated peak flood levels within identified historic records (**Table 3-1** in **Section 3.4**), suggests that water levels in excess of a 1 in 200 year event occurred in 1938 / 1939. However, it should be recognised that reported water levels may have been exacerbated by waves during this event (see discussion on wave contributions below).

Under future climate conditions, ESLs in a 1 in 2 year + CC event will exceed present day 1 in 200 year ESLs, and during the 1 in 200 year + CC event water depths are expected to be typically in excess of 1.2 m across terrestrial areas of the site – with depths up to around 2.5 m in discrete areas of lower lying ground. The indicative mapped coastal flood extent for the 1 in 200 year + CC return period event, based on available LiDAR and topographic survey data, is provided in **Figure 5-1**.

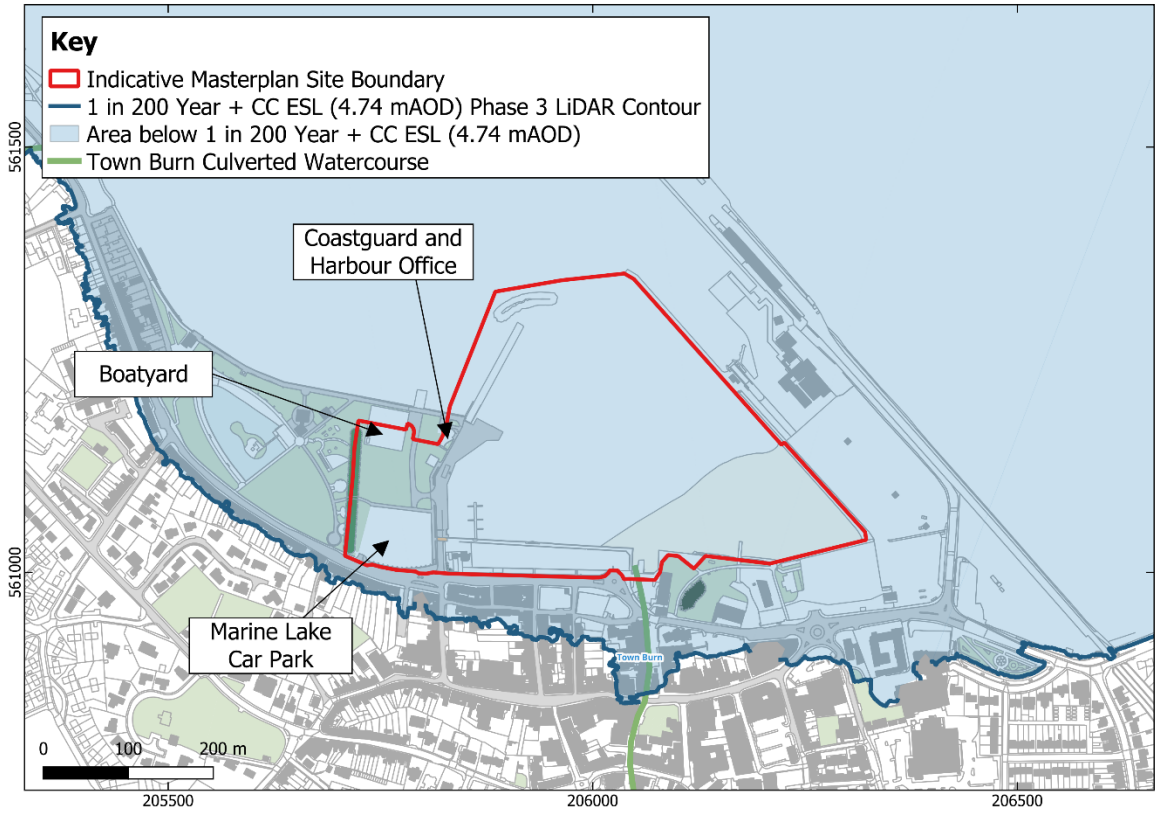

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Figure 5-1: 1 in 200 year + CC Extreme Sea Level (4.74 mAOD)

Predicted Wave Heights

The site is susceptible to wave action along the shoreline and within the Marina itself as a result of wind-generated waves from Loch Ryan. Waves are generated where wind travels uninterrupted over open water; with the strength and height of the wave controlled by the available distance of travel (wind fetch) and by wind speed. The overall wave crest level is dependent on the stillwater level on which it forms. RPS have carried out a wave study and coastal flood modelling to estimate potential combinations of ESLs and significant wave heights[3] that could coincide to result in a 1 in 200 year / 1

[3] Significant wave height represents the average height of the highest one-third of waves. This is typically used to provide an indication of overall wave conditions, although it is noted that individual waves can be larger than this.

in 200 year + CC joint probability return period event around the Stranraer coast (at locations illustrated on **Figure 5-2**), and to identify potential impacts of the proposed development on significant wave heights. The model report provided by RPS[4] is presented in **Appendix B**. Two Excel workbooks accompany this report containing: the combinations of water levels, significant wave heights, mean energy wave periods, and mean wave direction, which have a 1 in 200 year or 1 in 200 year + CC joint probability return period. The contents of these workbooks have been reviewed to inform this FRA, with pertinent information summarised below.

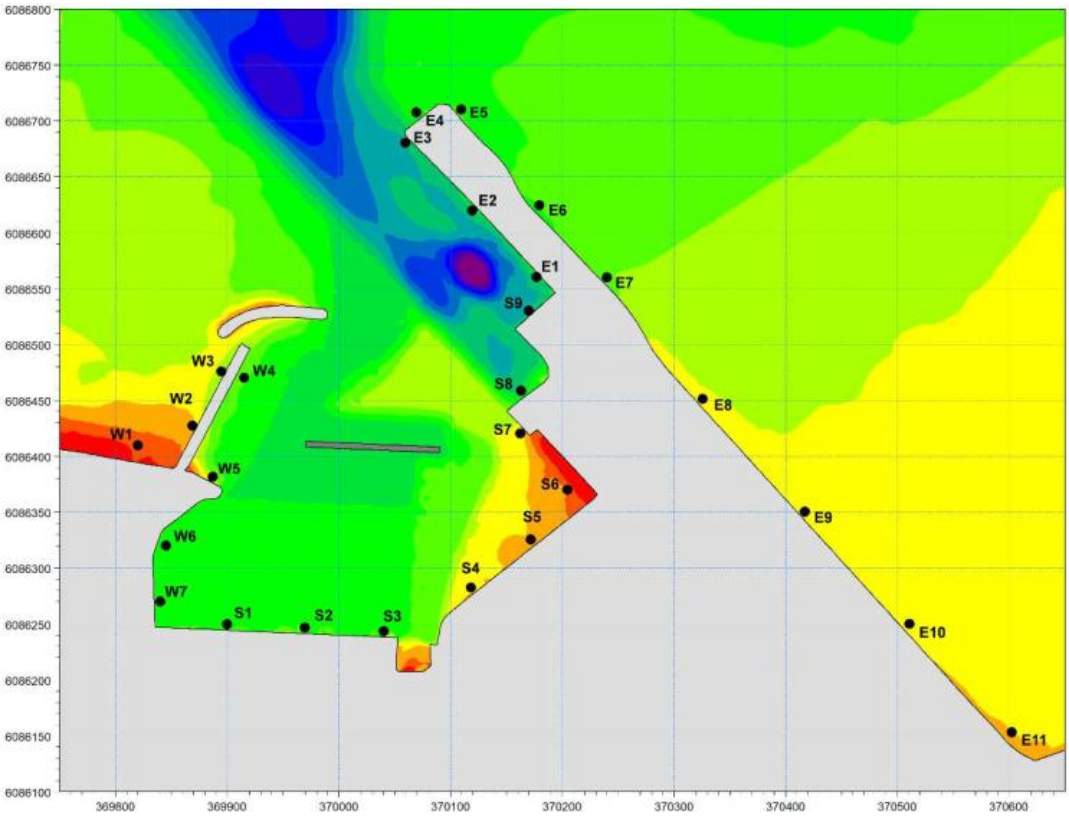

Figure 5-2: Location of wave and water level data points around Stranraer harbour

For the purpose of considering potential flood implications associated with coastal waves, a maximum flood level has been defined based on the maximum crest level resulting from predicted 1 in 200 year + CC joint probability ESL / significant wave height combinations within the RPS study area. This was found to occur as a result of north-westerly waves acting on the exposed shoreline immediately west of the West Pier (location W1 on **Figure 5-2**), creating significant wave heights of 1.03 m in combination with the 1 in 200 year + CC ESL in existing conditions. The maximum wave crest level has been identified based on half the significant wave height (which relates to the total height between wave trough and crest) acting on top of ESL. This results in a maximum associated flood level of 5.27 mAOD (see **Table 5-2**)[5]. In this scenario, the site is considered to have no protection from waves as the stillwater level and wave trough (4.23 mAOD) lie well above (typically >0.7 m) ground levels.

[4] RPS, 2025. Stranraer Marina Expansion – RPS Wave Modelling for Proposed Layout: Wave and Water Levels for Design and Overtopping. *[RPS confirmed via email 05th August 2025 that model updates subsequent to completion of this study do not impact on maximum possible flood levels as identified from this study, or on conclusions reported herein regarding potential impacts of the proposed development on maximum wave heights.]*

[5] It is recognised that this is lower than the 5.31 mAOD level identified in the FRA associated with the SWSA Planning Application (see **Section 3.3.5**); however, that study considered 1D methods of wave estimation only. The 2D coastal modelling carried out as part of the RPS study is considered to provide a more refined estimate of wave heights within the vicinity of the development.

Although waves will break as they travel over the quay, depth conditions mean that large volumes of water will be overflowing and so the wave crest top is considered an appropriate design flood level.

Table 5-2: Critical Wave Climate for 1 in 200 year + CC Joint Probability Event

ESL (mAOD)	Significant Wave Height, Hs (m)	Hs / 2 (m)	Wave Crest (mAOD)	Wave Trough (mAOD)
4.75*	1.03	0.52	5.27	4.23

* The RPS study rounds up the recommended 0.88 m climate change uplift to 0.9 m, resulting in a more conservative estimate of ESL. This has been taken forward to inform the Design Flood Level.

5.1.2 Proposed Scenario Coastal Flood Risk

The RPS wave study and coastal flood modelling considers both existing and proposed scenarios, with proposed scenario modelling accounting for proposed marine elements, including the area of reclaimed land. The results of the RPS coastal modelling show that the design and placement of marine elements is largely expected to reduce significant wave heights within Loch Ryan in the vicinity of the harbour and marina, with reductions identified at locations W4 to W7 and S1 to S3 in critical modelled events (see **Figure 5-2**). This is due to increased interaction between the propagating waves and the foreshore / marine structures, which results in increased off-shore wave breaking / dissipation and hence reduced significant wave heights. This offers a betterment in regards coastal flood risk within this local area.

RPS have confirmed that there is no change in significant wave heights at all other locations along the modelled extent of the adjacent coast in critical events. The maximum predicted 1 in 200 year + CC joint probability ESL / significant wave height combination remains the same at the exposed shoreline immediately west of the West Pier (location W1 on **Figure 5-2**), and so the maximum identified flood level of 5.27 mAOD (when accounting for waves) remains the same in the proposed scenario. As a result, it is concluded that proposals will not increase flood risk elsewhere as a result of wave action.

5.1.3 Implications for Proposed Development

Although the entire site area is at risk in a 1 in 200 year + CC coastal flood event, DGC have confirmed that the proposed development is considered to be water compatible. Additionally, the proposed electrical substation is considered essential infrastructure, with the location required for operational reasons. Such development is considered acceptable in flood risk areas in accordance with NPF4 (see **Section 2**), as long as:

- flood resistant and resilient materials and construction methods are used;
- the development remains safe and operational during floods; and
- there is no reduction in floodplain capacity, increased risk for others, or a need for future flood protection schemes.

Associated implications for the proposed development in line with each of these requirements are detailed below.

Flood resistant and resilient materials and construction methods

A level of 5.27 mAOD has been taken as the design flood level for the proposed development, which accounts for a 1 in 200 year + CC ESL with an allowance for waves (as defined above). **Flood resilience should be considered for elements up to a 600 mm freeboard above this level (i.e.**

5.87 mAOD). Freeboard is required to account for modelling uncertainty and in recognition of the potential for higher waves to occur.

Marine elements and the majority of terrestrial elements (e.g. boatyards, car parking) of the proposed development will be inherently water resilient. The design flood level, wave effects and freeboard should be accounted for in the design of any elements where their functionality would be affected by inundation. Consultation with DGC and SEPA (responses dated 3rd February 2025 and 10th February 2025, respectively – see **Section 3.3.6**) has also confirmed that harbour buildings are considered water compatible in line with NPF4 definitions as long as proposals demonstrate that long-term safety and resilience can be secured in accordance with relevant SEPA standing advice.

The existing harbour reception building and the proposed SWSA building (granted planning permission under application 23/0970/FUL) within the wider marina area have FFLs of 4.0 mAOD, which exceed present day 1 in 200 year ESLs. Where possible FFLs of new buildings should be designed with a 600 mm freeboard above the design flood level of 5.27 mAOD. However, where FFLs comparable to existing are required (e.g. for accessibility reasons), it is recommended that appropriate flood resilience be embedded within these buildings up to a 600 mm freeboard above the design flood level in line with the guidance in Living with Flooding published in 2019 by the Scottish Government's Property Flood Resilience Delivery Group[6] and Improving the Flood Performance of New Buildings - Flood Resilient Construction[7].

Potential strategies in relation to building resilience will ultimately be the developer's decision, i.e., the level of risk they deem the building can be exposed to; however, recommended strategies include:

- **Water Entry Strategy** – This may be appropriate for e.g. workshop areas or storage areas and would involve measures such as:
    - Use of materials with low permeability;
    - Design to drain water away after flooding;
    - Access to all spaces to permit drying and cleaning; or
    - Any equipment / materials stored in areas at risk of flooding should be able to withstand some flooding, and be secured during storage.
- **Water Exclusion Strategy** – Potentially required for e.g. SCAMPP and Coastguard Buildings and would involve measures such as:
    - Self-closing airbricks where the placement of airbricks is below design flood level;
    - Waterproofing brickwork;
    - Flood resistant ground floor doors;
    - Lightweight doors with rising butt hinges on the ground floor;
    - Raised electrical utilities;

[6] Scottish Government Property Flood Resilience Delivery Group, 2019. *Living with Flooding: An Action Plan for Delivering Property Flood Resilience in Scotland*. Available at: https://www.gov.scot/publications/living-flooding-action-plan-delivering-property-flood-resilience-scotland/

[7] Bowker, P., Escarameia, M. and Tagg, A. (2007). *Improving the Flood Performance of New Buildings - Flood Resilient Construction,* Department for Communities and Local Government Buildings Regulations (Sanitation) Research Framework and joint Defra / EA Flood Risk Management R&D programme. EA Science Report SC040066/SR. Available at: https://assets.publishing.service.gov.uk/media/602d673ee90e0709e8d085d8/Improving_the_Flood_Resilience_of_Buildings_Through_Improved_Materials__Methods_and_Details_Technical_Report.pdf

- Separate electrical circuit for ground and upper floors;
- Closed-cell type insulation in ground floor cavity walls;
- On the ground floor, tiled floors with waterproof adhesive and waterproof grout;
- Non return valve in sewer pipe; or
- Easily accessed storage for flood barriers and/or blocks.

Additional flood resilience should be embedded within individual elements of the development as required. For example, the substation will require suitable flood resilience to protect electrical plant and equipment in line with the operator's requirements, and the fuel berth, effluent discharge units, and wash bay should be designed with appropriate bunding and non-return valves.

Remaining safe and operational during floods

A flood plan should also be developed for staff and other users in advance of the occupation of the site. This should include details for named duty holders with 24hr / appropriate contact details and contingency arrangements / appropriate plans to ensure safe and effective management of the use of the facility during flood events, including evacuation of the buildings as required. The plan should confirm trigger conditions for action and this could include for notification under SEPA's flood warning scheme for the Loch Ryan area (**Section 3.3.6**) and / or other monitoring thresholds as appropriate. The plan should be a live document, with review requirements at suitable frequencies embedded in the operational procedures of the site.

Avoiding impacts on flood risk elsewhere

In regards to potential impacts on flood risk elsewhere, as indicated in the strategic 2011 Stranraer Waterfront Development FRA (see **Section 3.3.5**), the issue of potential floodplain capacity loss at this scale is not relevant when considering coastal flood extents, as the volume of tidal inundation is so vast during an extreme event that any localised loss of capacity would not materially increase depths elsewhere. Storage loss as a result of proposed land reclamation and any discrete land raising within the development area are not considered to impact on coastal flood storage.

As detailed in **Section 5.1.2**, the design and placement of marine elements is largely expected to reduce significant wave heights within Loch Ryan in the vicinity of the harbour and marina, reducing flood risk. No increase in significant wave heights has been identified along the modelled extent of the adjacent coast and so no increase in coastal flood risk has been identified to receptors elsewhere.

Any reprofiling of existing ground levels, proposed profiling of the reclaimed land area and new drainage should consider coastal flood risk and be designed appropriately to mitigate the potential for tidal waters being routed inland and / or backing-up drainage systems and emerging at surface, either within the site or elsewhere (see **Section 5.5**).

5.2 Fluvial Flows

The culverted Town Burn watercourse discharges northwards directly into the harbour, with the culvert outfall located adjacent to an existing concrete slipway (**Figure 5-3**). As discussed in **Section 3.3.1**, the SEPA flood maps show fluvial flood risk along the route of this watercourse, extending into the site in the 1 in 200 year and 1 in 200 year + CC event. However, the SEPA maps consider LiDAR data only and do not consider site-specific detail or structures. Additionally, although previous hydraulic modelling has been carried out of the watercourses in Stranraer (see **Section 3.3.4**) this is focused on the upper reaches of the Town Burn and provides limited pertinent information in relation to existing

flood risk within the proposed development area in a 1 in 200 year + CC event. As coastal flood risk is predominant by far at the proposed development site, a qualitative assessment of fluvial flood risk has been carried out.

The Town Burn is extensively culverted along its length, as illustrated on **Figure 5-3a**. This includes an approximately 0.5 km culverted reach commencing upstream of Hanover Street and extending to the harbour, as well as numerous culverted reaches upstream of this location. If the capacity of the culverted reaches were to be exceeded in the 1 in 200 year + CC flood event, flows have the potential to be routed from culvert inlets overland through the dense network of streets within Stranraer. As the general fall of the land is down towards the Marina, there is a potential for these flows to be routed towards the site along the route of flooding indicated by SEPA flood maps (**Figure 5-3b**). However, given the density of buildings and other obstructions to flow in the intervening space, the majority of this flow would be expected to pond in low lying ground within the vicinity of the culvert inlets – the nearest of which is over 300 m from the site – and / or behind buildings and obstructions on route to the coast. Regardless, any flows routed towards the site would enter at the pre-existing low point within the vicinity of the Town Burn culvert outlet and drain immediately to Loch Ryan in a fluvially critical event.

Likewise, should backflow occur through the lower Town Burn culvert as a result of elevated tidal levels there is potential for water to emerge at surface via pre-existing manholes, connecting drainage gullies and / or at the culvert inlet. Were this to occur, comparable flooding would be expected as in the case of the capacity of this culvert being overwhelmed.

Proposals include a new quay wall along the Breastworks car park and slipway improvement works. Development proposals for the slipway improvement incorporate local land reclamation and new slipway extending into the harbour. This will incorporate an extension of the existing Town Burn culvert below locally reclaimed land. The proposed culvert structure and slipway extension, and any potential interaction with the new quay wall along the Breastworks car park, should be appropriately assessed and designed to avoid any reduction in capacity in comparison to existing conditions, in order to avoid any increase in flood risk from the Town Burn as a result of the proposed development. Ground levels should also be profiled to maintain existing overland flow routes, in order to avoid an increase in flood risk from the Town Burn in culvert capacity exceedance events.

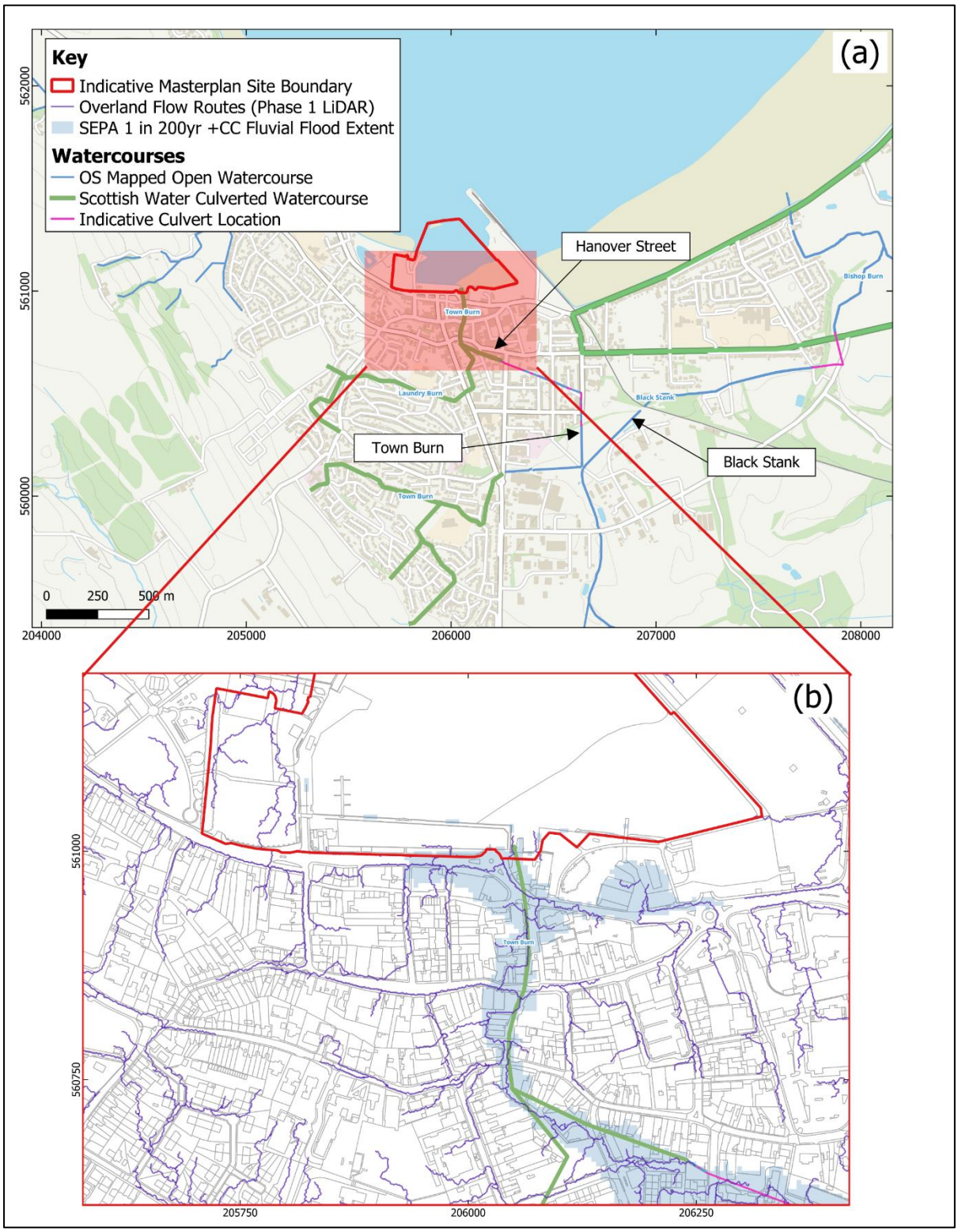

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Figure 5-3: (a) Stranraer Watercourse Routes; (b) SEPA Fluvial Flood Extents (1 in 200 Year + CC) and Phase 1 LiDAR Overland Flow Routes

5.3 Infrastructure Failure

In the event that culverts along the Town Burn were to become blocked, there is the potential for flood levels upstream of these structures to increase, resulting in an increase in fluvial flood risk. Should this occur, comparable flooding would be expected as in the case of the capacity of these culverts being overwhelmed – as detailed in **Section 5.2** above.

The SEPA RIM does not show the site to be at risk in the event of an uncontrolled release of water from any reservoir covered by the Reservoirs (Scotland) Act 2011, and no other sources of infrastructure failure have been identified as potentially contributing to flood risk at the site.

5.4 Overland Flow

Potential overland flow routes through the development site have been assessed using QGIS watershed analysis tools and Phase 1 and Phase 3 LiDAR data. Indicative flow routes are shown in blue in **Figure 5-4**.

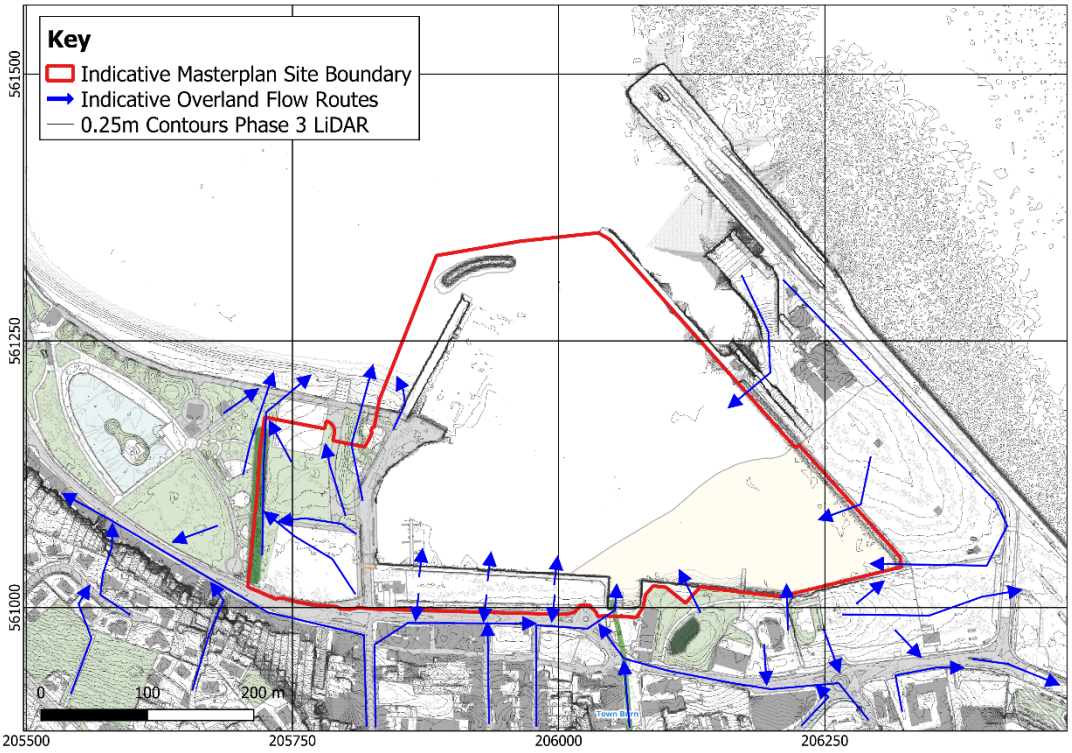

Figure 5-4: Overland Flow Routes

The results indicate that overland flow from the south towards the Marina is intercepted by the A717 / A718 and is typically transmitted away from the site along these roads and / or directed to Loch Ryan via the low point at the Town Burn outfall / existing slipway on the southern boundary of the site. Overland flows generated within the site itself are expected to drain towards Loch Ryan to the North or to lower ground associated with the A717 / A718 to the south, following the flow routes shown on **Figure 5-4**. This has the potential to result in localised surface water flood risk along the A717 / A718 and in pockets of low-lying ground along the waterfront, including the Port Rodie promenade, as indicated by SEPA Surface Water Flood Maps for the 1 in 200 year + CC event.

In order to mitigate residual risk from this source of flooding, any reprofiling of existing ground levels / proposed profiling of the reclaimed land area should be appropriate to route overland flows around and away from receptors. Dedicated drainage systems should also be incorporated, designed to appropriate standards, and building FFLs should be set above surrounding ground.

5.5 Sewer Flooding

Sewer flooding can occur when prolonged or heavy rainfall exceeds the capacity of the sewer network; if tidal waters ingress the sewer network via outfalls on the seawall; if high tidal waters block the release of surface water flows via outfalls on the seawall; or if the sewer network becomes blocked. Review of the Scottish Water (SW) Asset Database indicates that there is existing drainage infrastructure within the site area. The SW Asset Plans show several existing combined rising mains (500 mm PE and 315 mm PE); a 375 mm concrete gravity combined sewer; and a 225 mm VC gravity surface water sewer within the site boundary. An existing drainage network serving the surrounding areas of Stranraer town is also located immediately adjacent to the site. Should existing sewers become blocked or the pipe capacity be exceeded, surcharging water would flow overland following the flow routes described in **Section 5.4** and be routed away from the site via the A717 / A718 from the wider town drainage network or, in the case of surcharging flows generated from pipes within the site, towards Loch Ryan. Residual risk from this source of flooding can be mitigated by the same measures required to mitigate risk from overland flow.

Dedicated drainage systems should also be developed for the site as part of proposals. These are expected to utilise existing infrastructure or discharge into coastal waters via existing or new surface water outfalls. The drainage strategy should be developed in consultation with DGC, to identify any discharge constraints in regards new coastal outfalls, and Scottish Water, with alterations / additional discharges to the existing sewer network subject to their acceptance to avoid exacerbating sewer flood risk. Existing sewer pipes should also be extended beyond the reclaimed ground to new coastal outfalls where required, with extensions sized appropriately to avoid adverse impacts on flooding. The drainage strategy should consider the potential for tidal waters entering new drainage systems. This may require the use of non-return valves, subject to appropriate consideration of combined events. Storage may be required within the drainage system to mitigate the risk of high tidal waters blocking the release of surface water flows. Residual risk associated with drainage systems can be addressed by the same measures required to mitigate risk from overland flow.

5.6 Groundwater Flooding

Groundwater is generally a contributing factor to flooding rather than the primary source. SEPA flood maps indicate areas where groundwater could influence the duration and extent of flooding from other sources. The proposed site is situated outwith groundwater influenced flood extents on these maps.

The proposed site is made up of reclaimed land and comprises predominantly made ground and paved surfaces, which is expected to limit the potential for emergence of groundwater at the surface. Groundwater monitoring was carried out as part of ground investigation works, detailed in the 2024 Fairhurst Geo-Environmental and Geotechnical Interpretative Report (Document No.: 161378-FRH-XX-00-RP-G-000001). This investigation recorded groundwater levels ranging from 0.30 to 2.80 metres below ground level (mbgl) during Phase 1 and 1.25 to 3.0 mbgl during Phase 2. It was also noted that groundwater flow is likely to be generally to the north towards Loch Ryan.

Monitoring was also undertaken to determine the possible tidal effects onto the groundwater. It was considered that groundwater at the site is under tidal influence, with the highest difference in daily groundwater tidal range observed as 1.0 m between high and low tide. This illustrates that hydraulic connectivity between groundwater below the site and Loch Ryan. This is also expected to limit the potential for groundwater emerging above ground on the site.

Groundwater flooding is, therefore, considered unlikely. In the event groundwater levels exceed the ground levels at the site, the excess water would follow the same flow patterns towards Loch Ryan as for overland flow and residual risk can be mitigated by the same measures required to mitigate risk from overland flow.

6. Conclusion and Recommendations

Fairhurst was appointed by Dumfries and Galloway Council (DGC) to carry out a Flood Risk Assessment (FRA) for the proposed expansion and redevelopment of Stranraer Marina. Flood risk at the site has been assessed primarily in relation to coastal flood risk from Loch Ryan; as well as fluvial flood risk from adjacent watercourses, infrastructure failure, overland flows, sewer and groundwater flooding.

Coastal modelling outputs indicate that the design and placement of marine elements is largely expected to reduce significant wave heights within Loch Ryan in the vicinity of the harbour and marina – between the West and East Piers – in critical modelled events. This offers a betterment in regards coastal flood risk within this local area. No change has been identified in significant wave heights along the remainder of the modelled extent of the adjacent coast in critical events. As a result, it is concluded that proposals will not increase risk from wave action to receptors elsewhere.

Coastal modelling identifies a maximum flood level of 5.27 mAOD in existing conditions, which accounts for a 1 in 200 year + CC ESL with an allowance for waves. This was identified on the exposed coast immediately west of West Pier, and this critical level was found to remain the same in the proposed scenario as it is beyond the influence of proposed marine structures. This level has, therefore, been taken as the 1 in 200 year + CC design flood level.

The entire site area is at risk in this 1 in 200 year + CC event, however, DGC have confirmed that the proposed development is considered to be water compatible and as such development is considered acceptable in accordance with NPF4 as long as:

- flood resistant and resilient materials and construction methods are used;
- the development remains safe and operational during floods; and
- there is no reduction in floodplain capacity, increased risk for others, or a need for future flood protection schemes.

A level of 5.27 mAOD has been taken as the design flood level for the proposed development. Marine elements and the majority of terrestrial elements of the proposed development will be inherently water resilient, however, additional flood resilience should be embedded into elements up to a 600 mm freeboard above the design flood level (i.e. 5.87 mAOD) where required. Where possible, FFLs of the proposed harbour buildings should be set with a 600 mm freeboard above the design flood level. Where lower FFLs are required (e.g. for accessibility reasons), appropriate flood resilient construction and other mitigation measures should be employed to embed water resilience up to a 600 mm freeboard above the design flood level. A flood plan should also be implemented, which outlines the evacuation arrangements for the site in response to SEPA coastal flood warnings for the Loch Ryan FWTA, or other warning thresholds as appropriate. With this mitigation in place, the risk from coastal flooding can be managed in accordance with NPF4 requirements.

Flood risk from other sources including fluvial flooding, surface water flooding, sewer flooding and groundwater flooding has also been considered. Residual flood risk from these sources should be mitigated by the appropriate assessment and design of the Town Burn outfall culvert extension; incorporation of dedicated drainage systems designed to appropriate standards; the appropriate profiling of ground levels to route overland flows around and away from receptors; and setting building FFLs above surrounding ground as a minimum.

Appendix A

Drawings

Rev -

Status -

Drawing Number CRSSS082-24060-IS-001-1

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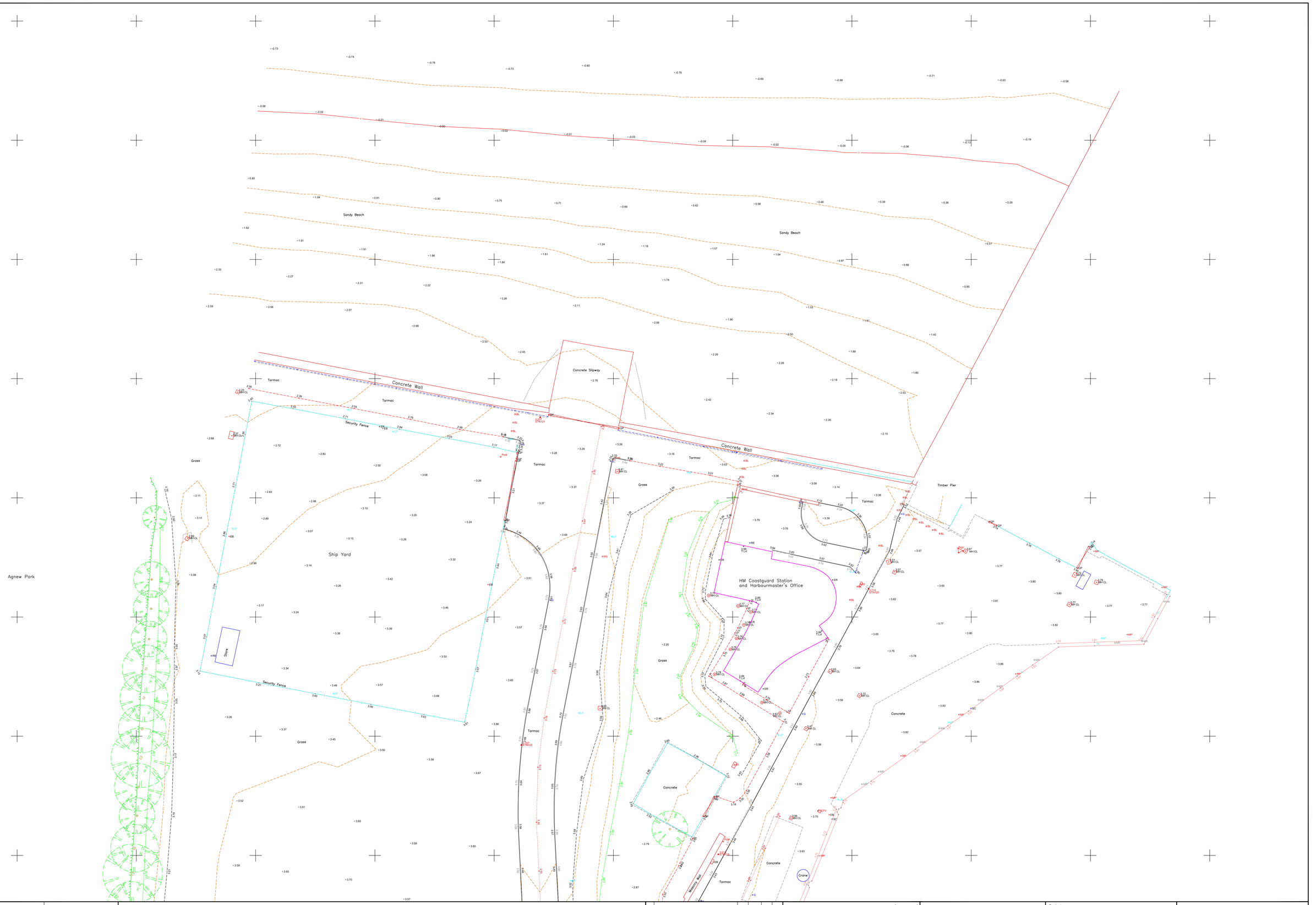

SHEET LAYOUT

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Grid: Local grid orientated to OS Grid (OSTN15)
Datum: Ordnance Survey Datum (OSGM15)
Site Centred Local Scale Factor 1.00000 about Station 100

Balfour Beatty

Project
STRANRAER MARINA

Title
Topographic Survey
Sheet 1 of 4

Balfour Beatty
Maxim 7
Maxim Office Park
Parklands Avenue
Eurocentral ML1 4WD
Tel: 01698 647500
www.balfourbeatty.com

Original Scale	Surveyed	Design/Drawn	Checked
1:200	IS	IS	
	Date 28/8/24	Date 3/9/24	Date

Status -

Drawing Number CRSSS082-24060-IS-001-1

Rev -

Reference	Subject	Maker

Rev	Description	By	Date	Chk'd	Auth

Status: - | Drawing Number: CRSSS082-24060-IS-001-2 | Rev: -

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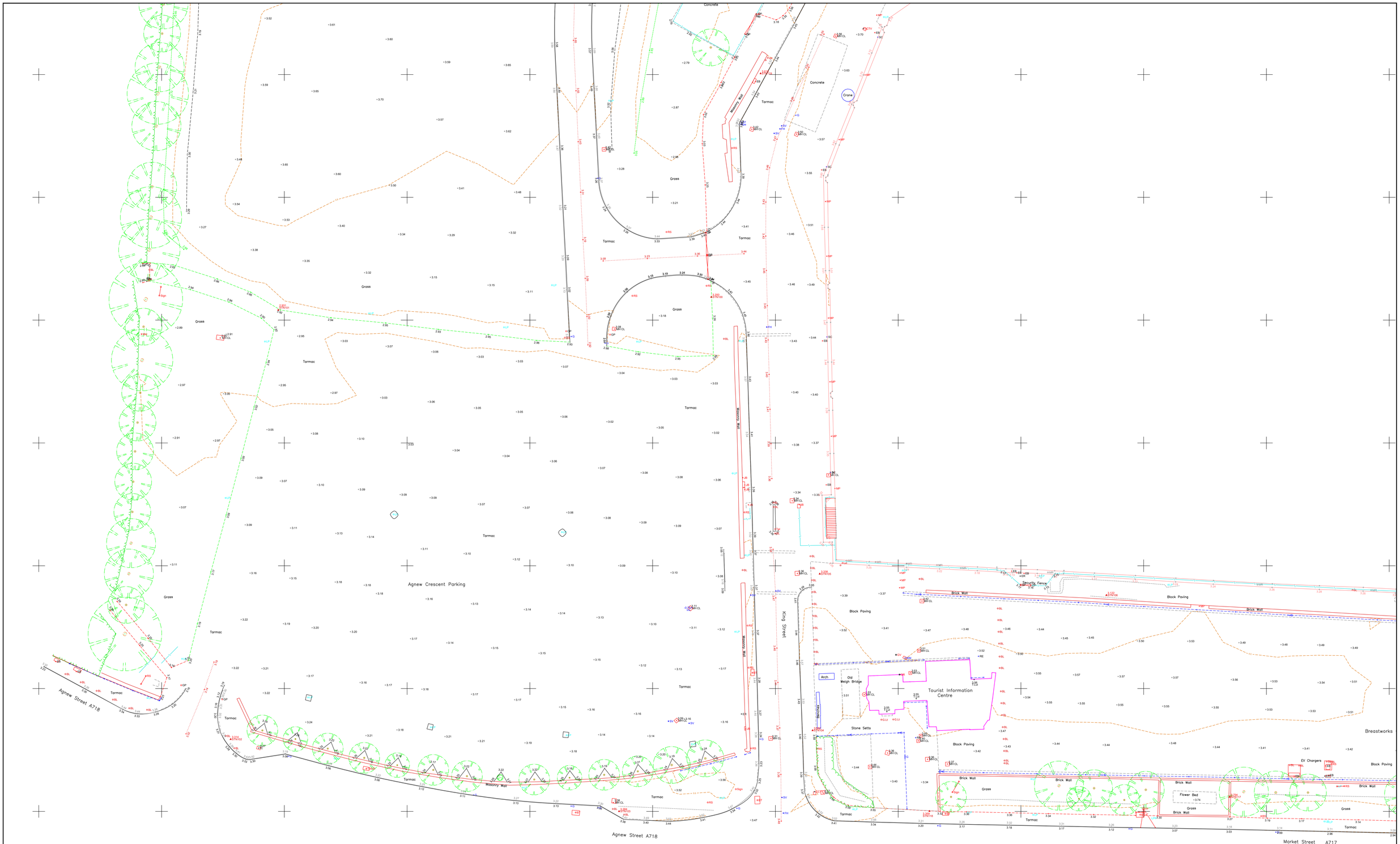

SHEET LAYOUT

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Datum: Ordnance Survey Datum (OSGM15)
Site Centred Local Scale Factor 1.00000 about Station 100

Reference	Subject	Maker

Rev	Description	By	Date	Chk'd	Auth

Balfour Beatty

Project: STRANRAER MARINA

Title: Topographic Survey Sheet 2 of 4

Balfour Beatty
Maxim 7
Maxim Office Park
Parklands Avenue
Eurocentral ML1 4WD
Tel: 01698 647500
www.balfourbeatty.com

Original Scale	Surveyed	Design/Drawn	Checked
1:200	IS	IS	
	Date 28/8/24	Date 3/9/24	Date

Status	Drawing Number	Rev
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Status	Drawing Number	Rev
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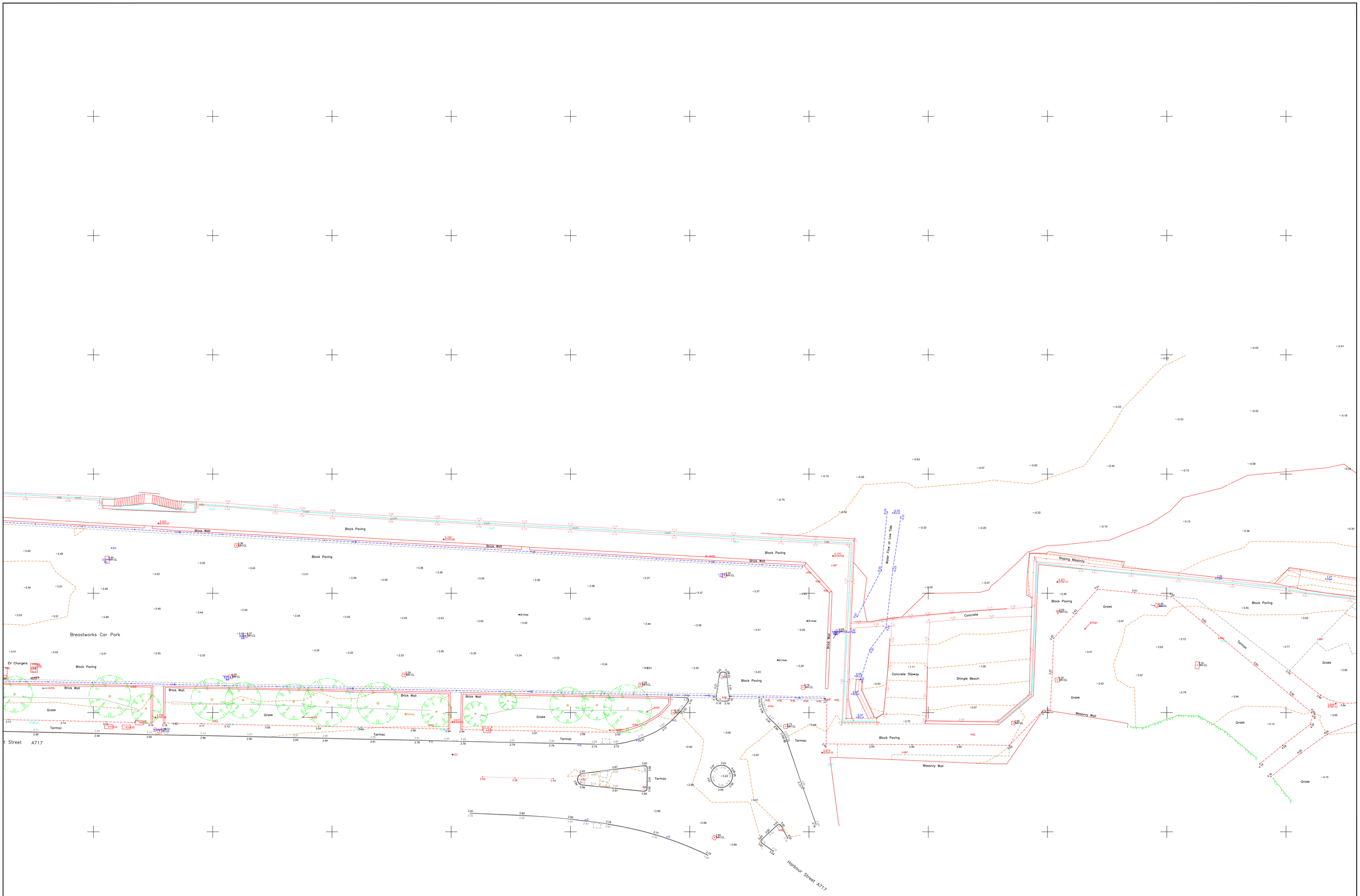

Reference	Subject	Maker

SHEET LAYOUT

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Rev	Description	By	Date	Chk'd	Auth

Grid: Local grid orientated to OS Grid (OSTN15)
Datum: Ordnance Survey Datum (OSGM15)
Site Centred Local Scale Factor 1.00000 about Station 100

Balfour Beatty

Project
STRANRAER MARINA

Title
Topographic Survey
Sheet 3 of 4

Balfour Beatty
Maxim 7
Maxim Office Park
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Eurocentral ML1 4WD
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Original Scale	Surveyed	Design/Drawn	Checked
1:200	IS	IS	
	Date 28/8/24	Date 3/9/24	Date

Status	Drawing Number	Rev
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DO NOT SCALE

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Reference	Subject	Maker

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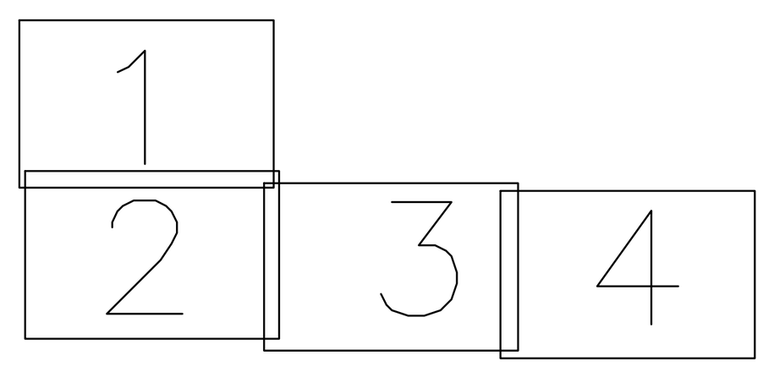

Rev	Description	By	Date	Chk'd	Auth

Grid: Local grid orientated to OS Grid (OSTN15)
Datum: Ordnance Survey Datum (OSGM15)
Site Centred Local Scale Factor 1.00000 about Station 100

Balfour Beatty

Project
STRANRAER MARINA

Title
Topographic Survey
Sheet 4 of 4

Balfour Beatty
Maxim 7
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Original Scale	Surveyed	Design/Drawn	Checked
1:200	IS	IS	
	Date 28/8/24	Date 3/9/24	Date

Status	Drawing Number	Rev
-	CRSSS082-24060-IS-001-4	-

N

5.0

2.0

0.0

DREDGED NAVIGATION CHANNEL TBC IN RELATION TO CROWN ESTATES OWNED ROSS PIER

22-00

01-02

01-00

01-03

01-06

14-00

07-00

19-00

02-00

03-00

04-00

16-00

06-00

01-04

17-00

05-00

06-07

01-01

20-00

21-00

18-00

13-00

08-00

15-00

01-09

01-05

08-08

09-00

09-10

Beach

West Pier

Slipway

East Pier

Agnew Crescent

Market Street

King Street

Existing car park

Existing car park

The Unexpected Garden

Harbour Street

NOTES

1. DIMENSIONS ARE NOT TO BE SCALED FROM THIS DRAWING.
2. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.

PROPOSED BUILDINGS

SITE BOUNDARY

DO NOT SCALE FROM THIS DRAWING

SAFETY HEALTH AND ENVIRONMENTAL INFORMATION

In addition to the hazard/risks normally associated with the types of work detailed on this drawing, note the following risks and information.

CONSTRUCTION

MAINTENANCE AND INSPECTION

DEMOLITION

For information relating to use, cleaning and maintenance refer to the Health and Safety file.

It is assumed that all works will be carried out by a competent contractor working, where appropriate, to an approved method statement.

MASTERPLAN KEY

01-00	MARINA
01-01	NEW BERTHS (UP TO 185)
01-02	EXISTING BERTHS (45)
01-03	COMMERCIAL BERTHS
01-04	PILLAR CRANE
01-05	MARINA ACCESS BRIDGE
01-06	EXISTING MARINA ACCESS BRIDGE
01-09	FLOATING FACILITIES
02-00	HARBOUR RECEPTION BUILDING
03-00	STRANRAER WATER SPORTS ASSOCIATION (SWSA)
04-00	EXISTING BOATYARD
05-00	MARINA BOATYARD
06-00	WORKSHOPS
06-07	WASHBAY
07-00	FISHERMEN'S COMPOUND
08-00	MARINE LAKE CAR PARK
08-08	MOTORHOME STANCES
09-00	BREASTWORKS CAR PARK
09-10	SUBSTATION PLANT COMPOUND
13-00	CAR PARK ON RECLAIMED LAND
14-00	FUEL BERTH
15-00	BREASTWORKS QUAY WALL
16-00	SOLWAY COAST AND MARINE PILOT PROJECT (SCAMPP)
17-00	COASTGUARD BUILDING
18-00	SLIPWAY DEVELOPMENT
19-00	KNUCKLE QUAY WALL
20-00	REVETMENT INCLUDING STEPS
21-00	RECLAIMED LAND
22-00	BREAKWATER EXTENSION

Rev	Date	Description	Drawn	Chkd	Appd
P02.1	23/07/25	General Update	CFPG	SRB	JC
P01.1	30/05/25	Reclaimed Land Boundary Edit	CFPG	SRB	JC

Drawing Status

Extent of Works Plan

Dumfries & Galloway Council

Balfour Beatty | FAIRHURST

SCAPE SCOTLAND CIVIL ENGINEERING

Project Title

Stranraer Marina Expansion

Drawing Title

Extent of Works Plan

Drawn	Date	Designed	Date
CFPG	30/05/25	FRH	30/05/25
Checked	Date	Approved	Date
SRB	30/05/25	-	-

Size	Scale	Fairhurst Ref
A1	1:1000	

Drawing Number	Status	Revision
161378-FRH-00-00-DG-Z-000001	S1	P02.1

Appendix B

RPS Coastal Modelling Outputs

Stranraer Marina Expansion

RPS Wave Modelling for Proposed Layout

Wave and Water Levels for Design and Overtopping

1. Introduction

The brief for the wave study included the requirement to establish the 1 in 200 year joint probability water level/wave climate conditions around the harbour area so that design and overtopping calculations for flood risk analysis could be undertaken by others. The data was required for current sea level conditions and with sea level rise by 2100. The critical 1 in 200yr joint probability event results were to be provided in a format suitable for undertaking EurOtop overtopping assessments.

2. Methodology

Water level data analysis

The water level data for Loch Ryan and its surrounding area was taken from EA/Defra/SEPA Coastal Flood Boundary Extreme Sea Levels data base using Estuary point 1678-7 in Loch Ryan. This data was then converted to Chart Datum for use in the models. The sea level rise due to climate change was taken from UKCP18 data at the entrance to Loch Ryan. The UKCP18 data was based on the 95-percentile value of RCP8.5 scenario as recommended by SEPA. This gives a sea level rise of 0.90m by 2100.

Wind data analysis

The wind data for the analysis was based on data from the BS EN 1991-1-4:2005+A1:2010 wind code. This data set gives extreme overland wind speeds. For over water fetches. where the wind bed friction is considerably lower than for overland, the wind speeds were increased to full the overwater speeds (+31%) for fetches in excess of 10 kilometres with proportionally lower increases for fetches below 10 kilometres.

Joint probability analysis

The joint probability analysis was undertaken using the data and techniques given in the Defra/Environment Agency's Report FD2308/TR1 "Joint Probability: Dependence Mapping and Best Practice". The critical storm directions for waves along the frontage at Stranraer are between 300° to 045°. As the wave climate at Stranraer is primarily a function of wind wave generation alone (i.e. no influence from Atlantic storm swell) the joint probability analysis was undertaken for winds and water levels. The correlation coefficient between winds (giving wave heights) and water levels for the 300° to 045° directions was based on the "all wave" directional data in Figure 4.1 of FD2308/TR1 for the area around Loch Ryan with a value 0.58.

An example of the output from the joint probability analysis of winds and water levels for the 345° direction is shown in Figure 2.1.

Value of first variable: Present-day sea level off Loch Ryan(mCD)	Joint exceedence return period (years) 1	2	5	10	20	50	100	200
	Value of second variable:			Windspeed (m/s) over Offshore 345 deg fetch				
3.50	17.87	18.91	20.98	22.28	23.58	25.40	26.70	28.27
3.62	17.87	18.91	20.98	22.28	23.58	25.40	26.70	28.27
3.79	17.15	18.86	20.98	22.28	23.58	25.40	26.70	28.27
3.91	15.72	17.79	20.23	22.22	23.58	25.40	26.70	28.27
4.03	14.35	16.31	18.75	20.90	22.78	25.34	26.70	28.27
4.19	12.60	14.50	17.15	18.86	21.06	23.52	25.49	27.48
4.32	11.27	13.17	15.72	17.80	19.51	22.22	24.11	26.05
4.44	#N/A	11.84	14.36	16.31	18.27	20.91	22.78	24.71
4.60	#N/A	#N/A	12.60	14.51	16.47	18.86	21.07	22.93
4.72	#N/A	#N/A	#N/A	13.18	15.10	17.80	19.52	21.63
4.85	#N/A	#N/A	#N/A	#N/A	13.75	16.32	18.27	20.19
5.01	#N/A	#N/A	#N/A	#N/A	#N/A	14.51	16.48	18.39
5.13	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	15.10	17.12
5.25	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	15.69

Figure 2.1 Joint probability table of winds and water level for 345° storm direction

Harbour Layout

The harbour layout used in the modelling was based on the scheme shown on Fairhurst drawing number 161678-FRH-00-00-DG-W-000100.

Wave modelling

The Mike21 SW model was used to simulate the growth and transformation of each of the 1 in 200 year return period joint probability storm events across the Firth of Clyde into Loch Ryan. The simulations were undertaken for each of the combinations of winds and water levels for each 15° direction from 300° to 045°. The wave climate along the boundary of the Loch Ryan model was extracted from the results of these simulations.

The second stage of the wave transformation modelling was undertaken using the Mike 21 SW wave model of Loch Ryan as shown in Figure 2.2 (left). Simulations were undertaken for each of the combinations of winds and water levels for each 15° direction from 300° to 045°. Simulations were first undertaken for the current sea level conditions and then repeated with the effects of sea level rise to 2100 included in the model and input data.

A third stage of modelling was undertaken for points within the harbour basin itself using the model bathymetry shown in Figure 2.2 (right). Normally the Boussinesq wave model (BW) is used for harbour disturbance studies, however, this model does not include wind wave generation within the model domain. Thus, for cases where the wave climate is composed of short steep wind driven waves, the BW model can underestimate the storm wave heights within the harbour basin. As the storm waves approaching Stranraer have a relatively short wave length, with periods of between 3.3 to 4.5 seconds, the modelling of the wave disturbance within the proposed harbour basin was undertaken using a special version of the Mike 21 SW model which included diffraction, wave reflections and line structures

which can account for wave transmission and reflections to represent the effect of the floating breakwater. The simulations were undertaken for each of the combinations of winds and water levels for each 15^{o} direction from 300^{o} to 045^{o} for both the harbour with and without the floating breakwater in place.

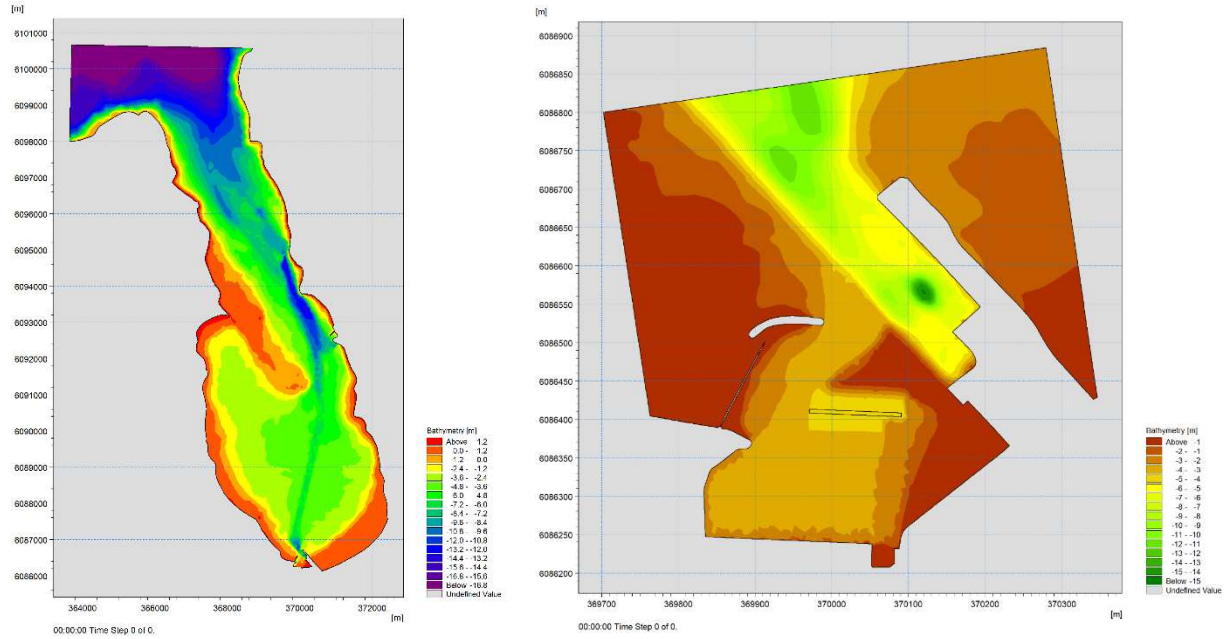

Figure 2.2 Wave model bathymetries used in simulation of waves around the harbour

The wave climate along the exterior boundaries of the harbour was taken directly from the results of the Spectral Wave model simulations for Loch Ryan as a whole. For frontages within the harbour area the wave heights were modelled using the special Mike21 SW model with and without the floating breakwater in place. As expected, it was found that the wave climate along the frontages within the harbour basin were more energetic without the floating breakwater in place. Thus, the wave climate results along the frontage are given for the scheme without the breakwater installed in case, for any reason, the floating structure has been removed at the time of a future storm.

3. Results of the Modelling and Analysis

The wave climate was simulated for 1 in 200 year return period joint probability events at a series of locations around the harbour. The location of the various points selected for the analysis is shown in Figure 3.1

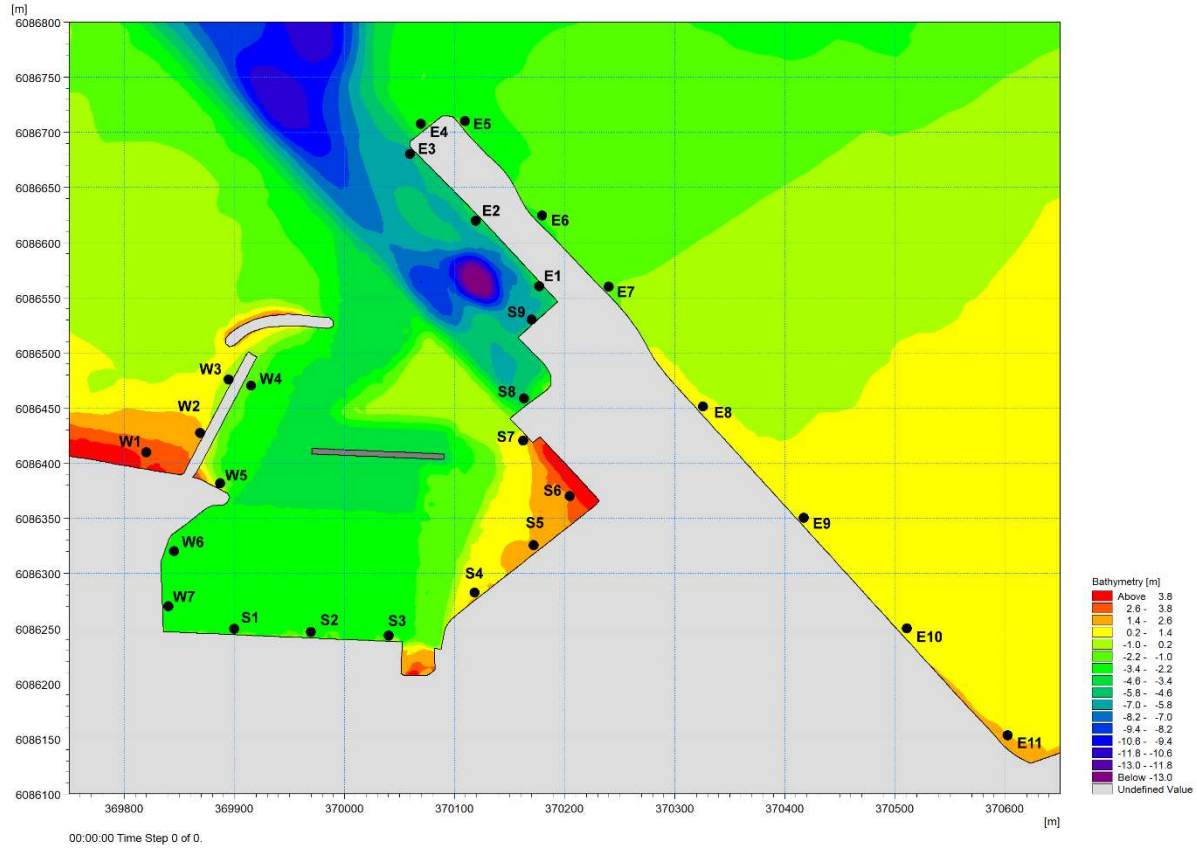

Figure 3.1 Location of FRA wave and water level data points around Stranraer harbour

The data for input into the FRA analysis is given in three Excel workbooks which accompany this document.

Stranraer Marina Expansion - FRA_E1_E11_pts_200_JPstm_wave_water-levels_C.xlsx

Stranraer Marina Expansion - FRA_S1-S9_W1-W7_pts_200_JPstm_wave_water-levels_C.xlsx.

Stranraer Marina Expansion - FRA_Existing_S1-S3_W4-W7_pts_200_JPstm_wave_water-levels_C.xlsx

The tables in these Excel workbooks show the combinations of water levels, significant wave heights Hm0, mean energy wave periods Tm_{10}, and mean wave direction which all have a 1 in 200 year joint probability return period. Due to the wave reflections within the harbour, the wave directions inside the basin have generally been taken as being approximately normal to the harbour structures. Similarly, the data gives the incoming wave climate approaching each structure as this is the data that is normally used for design and overtopping. The data takes account of cases where the wave reflections from an adjoining structure influences the incoming wave climate at a neighbouring structure.

The tables in the Excel workbooks give the wave climate for water levels varying from 4.031m to 5.252m CD for present day sea levels and from 4.931m to 6.152m CD with sea level rise to 2100. As noted

above for the proposed scheme, the wave climate results around the basin are given for the scheme without the breakwater installed in case, for any reason, the floating structure has been removed at the time of a future storm.

The Excel workbook for the existing harbour gives the data for the points where the results will be different than for the harbour with the proposed scheme. At the remaining points it was found that the results were the same as for the harbour with the proposed scheme. Thus, for these points the wave climate/levels are the same for the existing harbour and the harbour with the proposed scheme in place.

Design Wave Climate

The design wave climate for the floating breakwater and the extension to the rubble mound breakwater was extracted for the most energetic incoming wave climate which occurred with a water level of 4.031m CD to today's water levels and at 4.931m CD with sea level rise by 2100. The locations of the design wave points are shown by the purple dots in Figure 3.2 below.

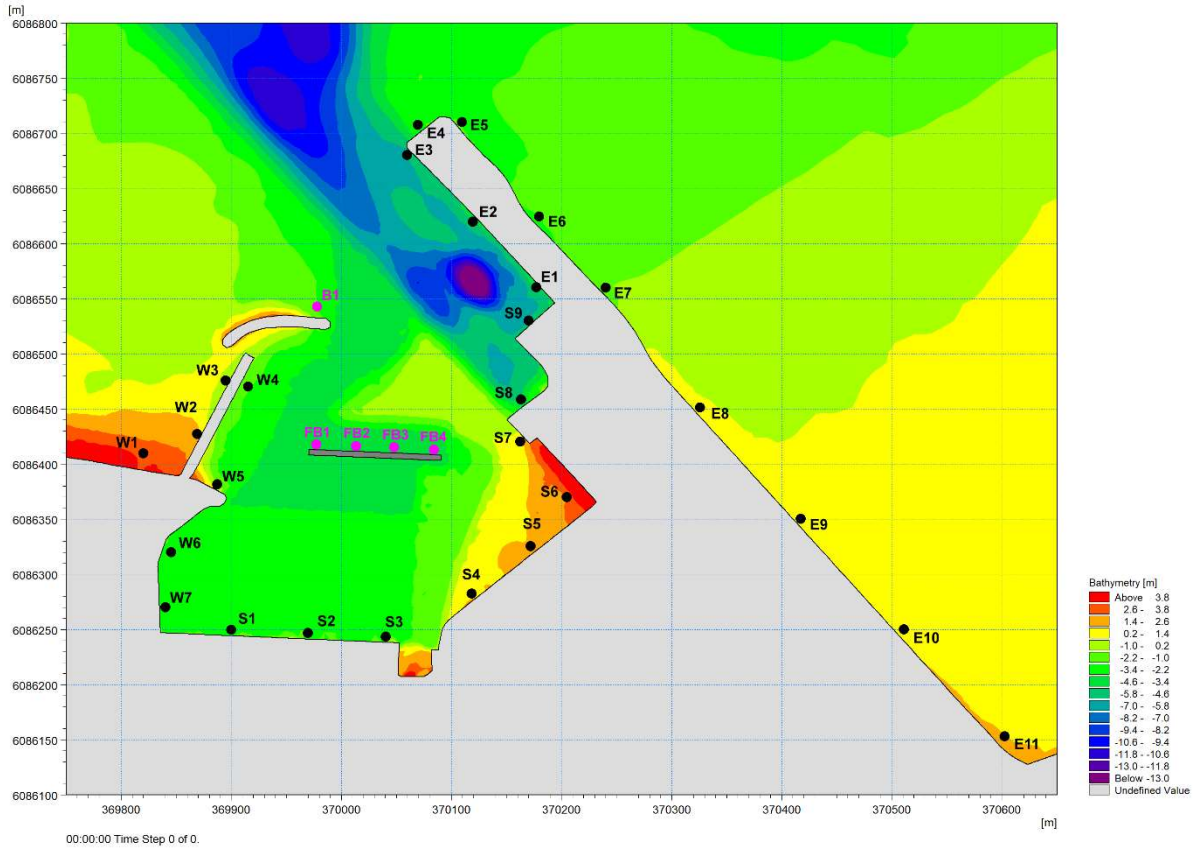

Figure 3.2 Location of the breakwater design wave points (purple) in the marina basin

The 1 in 200 year return period wave climate approaching the rubble mound breakwater extension had significant wave heights of up to 1.565m with spectral peak wave periods of 4.39s for today's water levels and up to 1.731m Hm0 with spectral peak wave periods of 4.49s with sea level rise to 2100.

The wave climate along the floating breakwater was most energetic at the eastern end of the structure (FB4) with the wave climate varying from 0.813m Hm0 at FB1 to 1.187m Hm0 at FB4 at 4.031m CD water levels. The mean energy wave period was about 4 seconds. With sea level rise to 2100 the

incoming wave heights along the floating breakwater varied from 0.871m Hm0 (FB1) to 1.299m Hm0 (FB4). The largest waves approached the eastern end of the breakwater during storms from 315° while storms from 0° produced the largest waves at the western end of the structure. Details of the wave climate are given in the Excel spreadsheet;

Stranraer Marina Expansion - 200_JPstm_FB1-FB4_B1_design_wave_climate_C.xlxs which also accompanies this document.

Adrian Bell C Eng FIAE FIEI MICE MIStructE
Senior Director - Coastal Engineering and Environment
RPS Consulting UK & Ireland

Appendix C

Self Certification

APPENDIX 3: Self Certification

FRA Guidance Assessment Compliance Certificate	
I certify that all reasonable skill, care and attention to be expected of a qualified and experienced professional in this field have been exercised in carrying out the attached Assessment. I also confirm that I maintain the required Professional Indemnity Insurance[8]. The report has been prepared in support of the below named development in accordance with the reporting requirements issued by Dumfries & Galloway Council.	
Assessment type: FRA	
Additional Information	
Assessment Ref No:	161378-FRM-00-00-RP-W-00001 P02 S
Assessment Date:	5/8/25
Name of Proposed Development:	STRANRAER MARINA EXPANSION SCHEME
Address:	STRANRAER, DG9 7EF
Name of Prospective Developer:	DUMFRIES & GALLOWAY COUNCIL
Name and Address of Organisation preparing this Assessment	FAIRHURST GROUP LLP
Name of Approver	[Redacted]
Signed:	
Date:	5/8/25
Position Held:	TECHNICAL DIRECTOR
Qualification of person responsible for signing off this Assessment[9]	BEng (Hons) CEng MICE

[8] Please attach appropriate evidence of Professional indemnity Insurance

[9] A Chartered member of a relevant professional institution

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