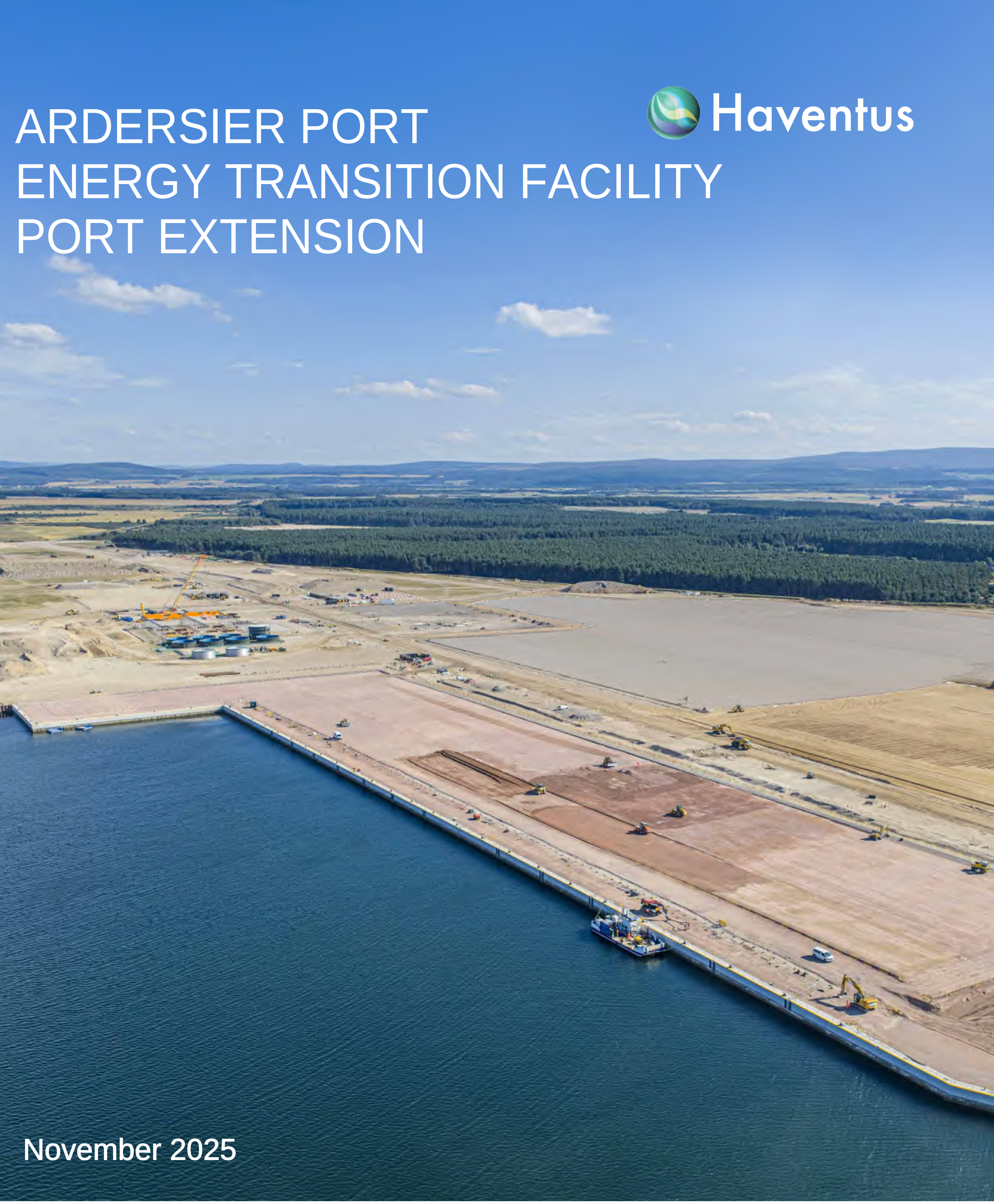
ARDERSIER PORT
ENERGY TRANSITION FACILITY
PORT EXTENSION

Haventus



November 2025

Appendix 9.1: Legislation, Policy and Guidance

Appendix 9.1: Legislation, Policy and Guidance

The purpose of this appendix is to support Chapter 9 (Hydrology and Hydrogeology) of the Environmental Impact Assessment Report (EIAR).

The proposed development description is provided in Chapter 3 (Project Description). The Indicative Masterplan is provided in Chapter 3. An Environmental Constraints Plan is provided in Figure 1.4 of Chapter 1 (Introduction).

The assessment for the hydrology and hydrogeology has been undertaken with reference to the following relevant legislation, planning policy and guidance presented below.

Legislation

Relevant legislation and guidance documents have been reviewed and taken into account as part of this assessment. Of particular relevance are:

- Water Framework Directive (WFD) 2000/60/EC of the European Parliament;
- The Conservation (Natural Habitats, &c.) Regulations 1994 (N.0 2716)
- Water Environment and Water Services (Scotland) Act 2003;
- Water Environment (Controlled Activities) (Scotland) Regulations 2011, as amended (CAR);
- Water Environment (Miscellaneous) (Scotland) Regulations 2017;
- Flood Risk Management (Scotland) Act 2009;
- The Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations.

Planning Policy

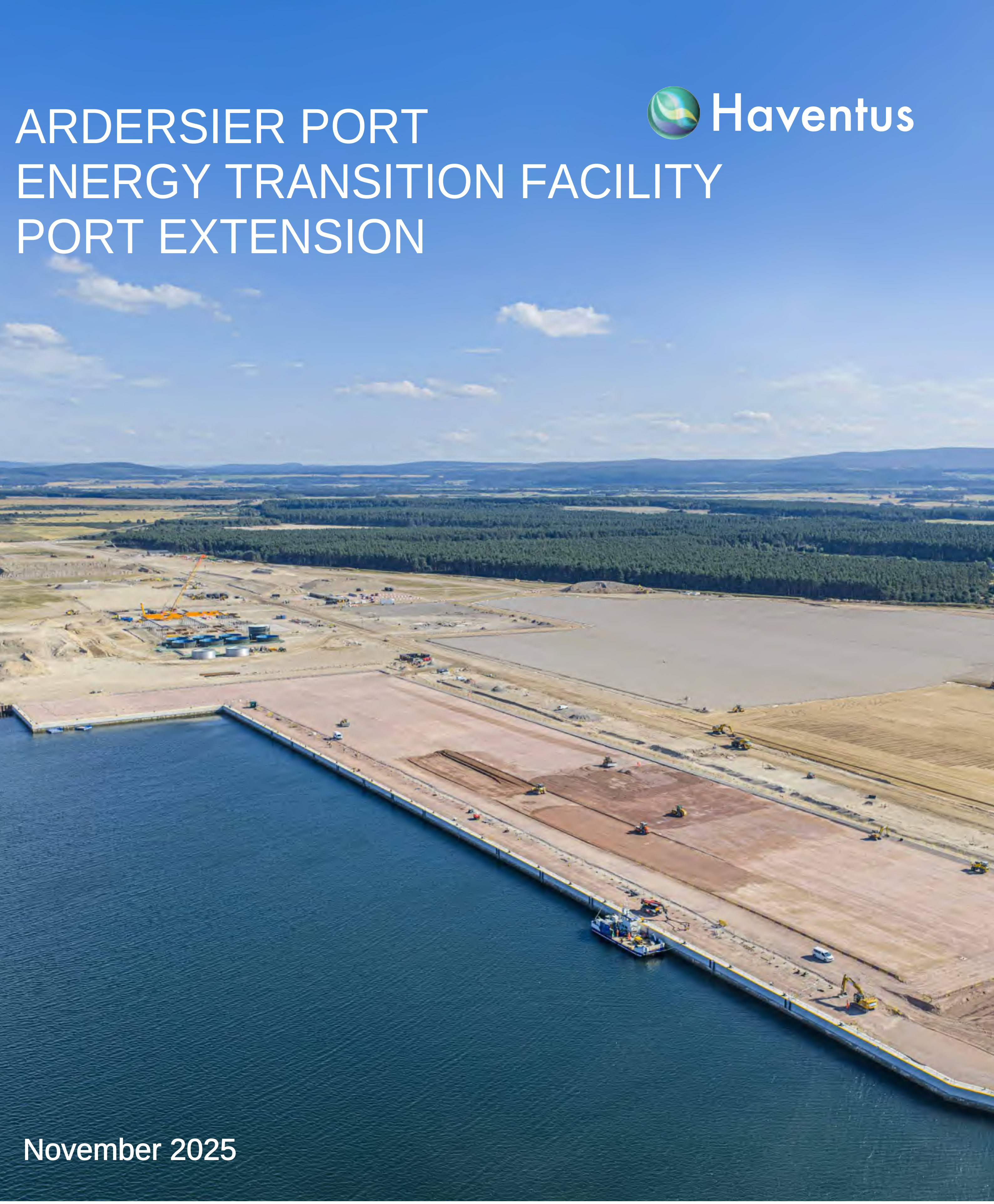
- UK Marine Policy Statement (DEFRA, 2011);
- National Planning Framework (NPF4) (The Scottish Government, 2023);
- Scotland's National Marine Plan (The Scottish Government, 2015); and
- The Highland Council Highland Wide Local Development Plan (THC, 2012);

Guidance

Consideration has been taken of the following best practice guidelines/guidance:

- NetRegs Guidance for Pollution Prevention (GPP) Documents. Available at: https://www.netregs.org.uk/environmental-topics/guidance-for-pollution-prevention-gpp-documents/
    - GPP1 1: Understanding your environmental responsibilities – good environmental practices
    - GPP 2: Above ground oil storage;
    - GPP 3: Use and design of oil separators in surface water drainage systems;
    - GPP 5: Works and maintenance in or near water;
    - GPP 6: Working at construction and demolition sites;
    - GPP 8: Safe storage and disposal of used oils;
    - GPP 13: Vehicle washing and cleaning;
    - GPP 21: Pollution incident response planning;
    - GPP 22: Dealing with spills;
    - GPP 26 Safe storage - drums and intermediate bulk containers;

- SEPA, 2006. Guidelines for Water Pollution Prevention from Civil Engineering Contracts. Available at: https://www.sepa.org.uk/media/152220/wat_sg_31.pdf ;
- SEPA, 2009. Engineering in the Water Environment Good Practice Guide – Temporary Construction Methods. Available at: https://www.sepa.org.uk/media/150997/wat_sg_29.pdf
- SEPA, 2014. Land Use Planning System SEPA Guidance Note 31. Available at: https://www.sepa.org.uk/media/143868/lupsgu31_planning_guidance_on_groundwater_abstractions.pdf
- SEPA, 2024. Flood Risk and Land Use Vulnerability Guidance.
- SEPA. 2024 Guidance on assessing the impacts of developments on groundwater dependant terrestrial ecosystems;
- SEPA, 2024. Guidance on assessing the impacts of developments on groundwater abstractions;
- SEPA, 2025. Climate change allowances for flood risk assessment in land use planning (V6). Available at: https://www.sepa.org.uk/media/jjwpxuso/climate-change-allowances-guidance_v6.pdf



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Appendix 9.2: Assessment Methodology

Appendix 9.2: Assessment Methodology

1.1 Introduction

The purpose of this appendix is to support Chapter 9 (Hydrology and Hydrogeology) of the Environmental Impact Assessment Report (EIAR). This appendix presents the assessment methodology applied within Chapter 9.

The methodology follows standard Environmental Impact Assessment (EIA) procedures, in accordance with the Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2017, and involves the following:

- Consultation with key stakeholders;
- Desk based study establishing the existing baseline conditions;
- Identification of sensitive receptors and environmental constraints;
- Identification of potential environmental impacts including cumulative impacts;
- Assessment of impact magnitude;
- Identification and assessment of mitigation, enhancement, and monitoring measures; and
- Statement of significance of residual effects.

1.2 Study Area

The study areas for the different components were as follows:

- Surface water hydrology, flood risk and drainage, hydrogeology and water quality: the assessment focused on surface water hydrology within the application site, including external areas to the south of the site which are within the hydrological catchment area of land drains within the site and the saltmarsh area to the east of the site that receives discharge from some of the site's internal land drains. Characteristics of the wider catchment areas have been considered up to a 1km buffer where relevant, including the receiving coastal water bodies, and impacts within a 2km buffer have been considered for designated sites;
- Groundwater Dependant Terrestrial Ecosystems (GWDTEs): Within the Site and up to 250m from the proposed location of excavations over 1m depth and within 100m of excavations under 1m depth;
- Abstractions: This assessment focused on abstraction such as Private Water Supplies (PWS) and Scottish Environment Protection Agency (SEPA) abstractions registered under controlled Activities Regulation (CAR) within the application site and wider 2km buffer; and
- Geology, soils and peat: Assessment focused on the area within the application site.
- Intra-project effects: The assessment focused on effects within the application site for the various construction phases (marine and terrestrial);
- Cumulative impacts: The assessment focused on developments within a 15 km of the application site. For hydrology and hydrogeology the zone of influence (ZOI) for assessment focuses on the wider catchment area of the site, lagoon, saltmarsh and the receiving coastal waterbody (Hilton of Cadboll to Whiteness Head coastal water body) as shown within Figure 1: Zone of Influence and Figure 2: Zone of Influence at the Site. The ZOI covers an area of 15,302 ha.

Figure 1: Zone of Influence

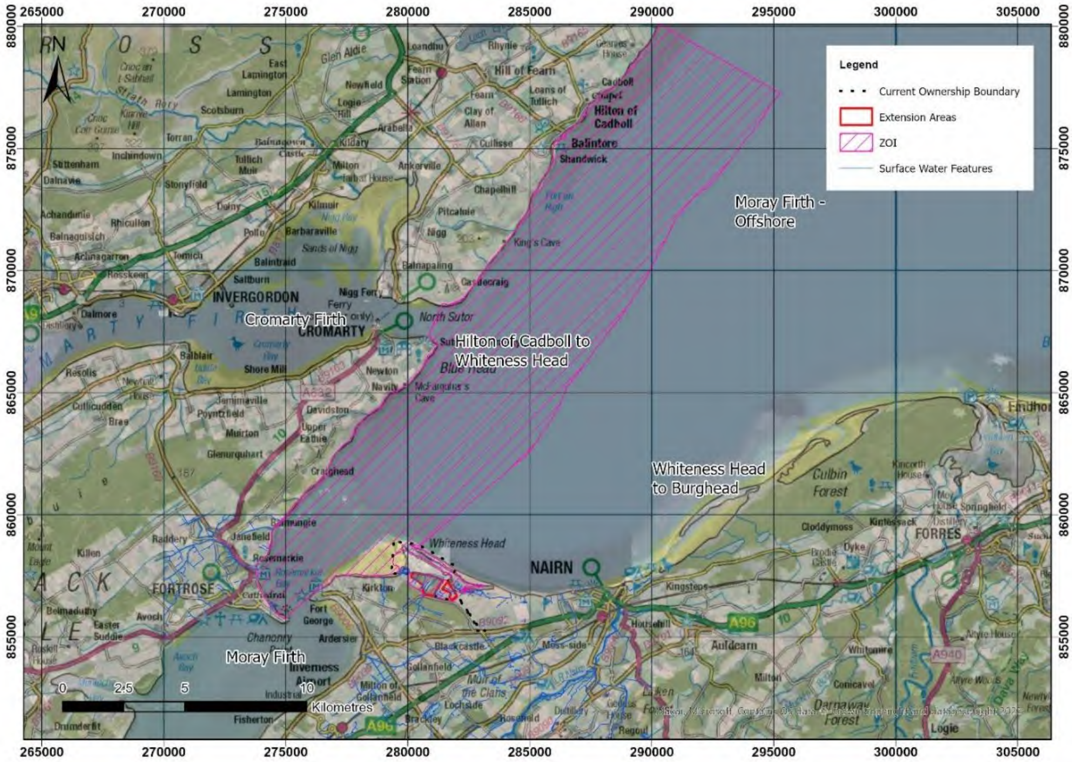
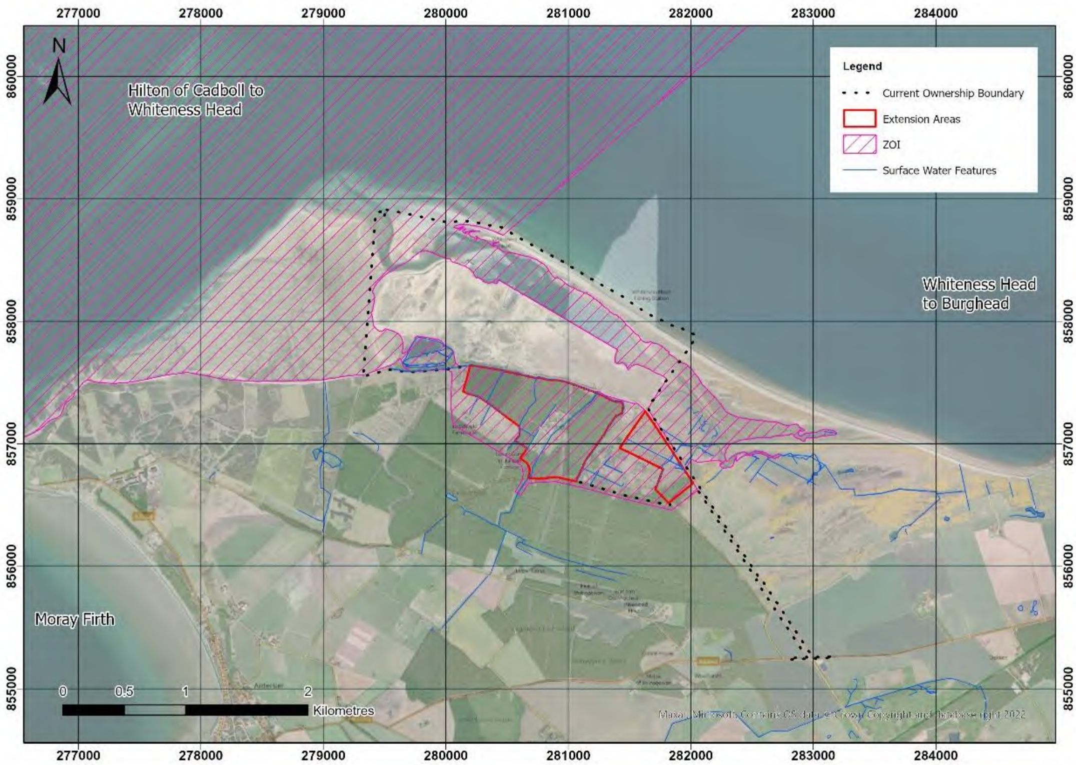


Figure 2: Zone of Influence at the Site



1.3 Data Sources

The following published data sources have been used:

- Ordnance Survey (OS) 1:25,000 digital mapping to provide topographical data and information about water features and land forms;
- British Geological Survey (BGS) 1:50,000 digital map data (BGS, 2016) has been used to establish the baseline environment for assessment of the underlying solid and superficial geology;
- Aquifer Productivity and Vulnerability maps have been used to establish the baseline environment for the underlying superficial and bedrock hydrogeology (Dochartaigh, et al. 2011);
- The River Basin Management Plan (RBMP) Interactive Map has been used to establish the baseline water quality status for surface water and coastal water bodies (SEPA, 2015);
- The James Hutton Institute (JHI) soil maps (James Hutton Institute, 2018) have been used to establish the baseline environment for assessment of the underlying soils;
- SEPA Flood Maps (Scotland) (SEPA, 2025) have been used to assess baseline flood fluvial, surface and coastal flood risk;
- SEPA (2017). Land Use Planning System Guidance Note 31 has been used to establish habitat potential for groundwater dependency;
- Climates change allowance have been established from SEPA (2025) online web map for the northeast Scotland region;
- LiDAR for Scotland Phase 1 DTM data (2011-12), obtained from the Scottish Remote Sensing Portal, has been used to extend coverage of ground elevation information, for areas not covered by privately commissioned LiDAR and topographic survey.

Additionally, the following technical reports have been reviewed as part of this assessment which are provided in relevant appendices of this EIAR:

- Appendix 12.14 Botanaeco (2025). Haventus Extension Area. Habitats, vegetation and GWDTE.

Baseline information on PWS and abstractions was also sought directly through consultation with The Highland Council and SEPA, respectively.

A hydrological site walkover was undertaken by EnviroCentre on 1-2 May 2025, to confirm routes, flow directions, connectivity and general characteristics of existing land drainage channels within and draining towards the site, and to inform specification of topographic survey of these drainage channels for subsequent representation in flood modelling. Further details are presented in the Flood Risk Assessment report (Appendix 9.3).

1.4 Methodology

The assessment follows standard EIA procedures which include:

- Desk based review of the design of the proposed development in relation to the local water environment, soils and geology;
- Consultation with key stakeholders to obtain relevant information and to ensure their concerns are addressed within the study;
- Establishing the existing baseline conditions:
    - Review topography, soils, geology and ground conditions at the application site and wider study area;

  - Review of hydrology, catchment characteristics, and water quality conditions;
  - Review of ecological habitats;
  - Review of detailed flood risk assessment provided within Appendix 9.3
  - Review of drainage design statement provided within Appendix 9.4;
  - Reporting of baseline conditions to provide a basis for assessment of the potential impact.
- Impact assessment:
  - Identification of sensitive receptors and environmental constraints;
  - Identification of potential impacts;
  - Assessment of impact magnitude;
  - Identification and assessment of mitigation measures to reduce or avoid any potential impacts of the proposed development; and
  - Statement of residual effects.

Potential impacts arising from the proposed development have been predicted and evaluated. The observed baseline data was used along with professional opinion to qualitatively assess the potential impacts and the significance to receptors.

1.5 Assessment Criteria

The assessment criteria set out in Table 1 and **Error! Reference source not found.** have been used to develop a matrix to assess the significance of effects from the proposed development on the local water environment (Table 3).

The assessment considers whether the impact is positive or negative. The assessment of residual effects takes into consideration the probability of the effect occurring within the following probabilities:

- Certain;
- Likely;
- Possible; or
- Unlikely

The duration of the effect is assessed within the following durations:

- Short (less than 2 years);
- Medium (2 – 5 years);
- Long term (more than 5 years); or
- Permanent

All direct and indirect impacts causing moderate or major effects are considered to be significant.

Table 1: Criteria for Assessing Receptor Sensitivity

Receptor Sensitivity	Description
High	Receptors with a low capacity to accommodate change, high value or condition and significant use, for example: • Receptor is an internationally or nationally designated site. • Surface / coastal water body supports sensitive aquatic ecological receptors e.g. freshwater pearl mussels. • Surface / coastal water body used for public water supply or large scale industrial/ agricultural abstractions. • Surface / coastal water body important for recreation directly related to water quality e.g. swimming, watersports, angling. • High or very high productivity aquifer. • Groundwater body supports public water supply or large scale industrial/ agricultural abstractions.
Medium	Receptors with a moderate capacity to accommodate change, medium value or condition and limited use, for example: • Receptor is not an internationally or nationally designated site. May be a locally designated site. • Salmonid species may be present and surface / coastal water body may be locally important for spawning. No other sensitive aquatic ecological receptors e.g. freshwater pearl mussels. • Surface / coastal water body used for private water supply or medium scale industrial/ agricultural abstractions. • Surface / coastal water body used for occasional or local recreation e.g. local angling clubs. • Navigable surface / coastal water body used by commercial or recreational vessels. • Moderate productivity aquifer. • Groundwater body supports identified private water supplies or medium scale industrial/ agricultural abstractions.
Low	Receptors with a high capacity to accommodate change, low value or poor condition and no significant uses, for example: • Receptor is not an internationally, nationally or locally designated site. • Not classified as a surface / coastal water body for the River Basin Management Plan (RBMP). • Surface / coastal water body not significant in terms of fish spawning and no other sensitive aquatic ecological receptors e.g. freshwater pearl mussels. • Surface / coastal water body not used for abstraction. • Surface / coastal water body not used for recreation directly related to water quality e.g. angling, swimming, watersports. • Surface / coastal water body not used by commercial or recreational vessels. • Low or very low productivity aquifer with no identified abstractions.

Table 2: Criteria for Assessing Impact Magnitude

Receptor Sensitivity	Description
Negligible	Very light change from baseline conditions. Change barely distinguishable, approximating to the 'no change' situation.
Low	Minor shift away from baseline conditions. Change arising from the loss/alteration will be discernible but underlying character/composition/attributes of the baseline condition will be similar to pre-development circumstances/patterns.
Medium	Loss or alteration to one or more key elements/features of the baseline conditions such that post-development character/ composition/ attributes of baseline will be partially changed.
High	Total loss or major alteration to key elements/features of the baseline (pre-development) conditions such that post-development character/composition/attributes will be fundamentally changed.

Table 3: Criteria for Assessing Effects

		Magnitude of Impact			
		Negligible Impact	**Low Impact**	**Medium Impact**	**High Impact**
Receptor Sensitivity	**High Sensitivity**	Negligible Effect	Moderate Effect	Major Effect	Major Effect
	Medium Sensitivity	Negligible Effect	Minor Effect	Moderate Effect	Major Effect
	Low Sensitivity	Negligible Effect	Minor Effect	Minor Effect	Moderate Effect

1.6 Assumptions and Limitations

The assessment of flood risk, presented as Appendix 9.3, assumes progression of consented development of the port site to a platform level exceeding the 1 in 200 year plus climate change extreme stillwater level of 4.24 mAOD or above, as per the consented design proposal, such that assessment of (baseline) coastal and land drainage flood risk accounts for this platform. No revised/repeat assessment of flood risk to the consented site is undertaken as part of this assessment.

The drainage impact assessment and associated drainage design proposals, presented as Appendix 9.4, similarly focusses on the extension site only, with no revised/repeat assessment of drainage for the consented site except where elements of drainage design proposals overlap the boundaries of both sites.

1.7 Assessor Information

Martin Nichols BSc (Hons) MSc MCIWEM C.WEM

Martin is an Associate Director with over 14 years consultancy experience in EIA, geomorphology, geology, hydrology and flood risk, within both the private and public sectors. Martin has geomorphology field survey experience in upland, river and coastal systems, and has undertaken hydraulic modelling in support of a range of projects, including river restoration and flood risk assessments. He has extensive GIS experience, including mapping, data, spatial and 3D analysis in relation to a range of projects, including large scale EIA development projects, renewable energy developments, river and peatland restoration, peat landslide risk assessments, peat management plans and coastal developments and quarry developments. Martin is a chartered water and environmental manager (C.WEM) through CIWEM, and an experienced project manager.

Jennifer Smith BSc (Hons) MSc MCIWEM

Jennifer Smith is a Senior Environmental Consultant with EnviroCentre. She has gained over 5 years' experience of consultancy whilst working on a range of projects including peat surveys and assessments, hydrological assessments, coastal assessments, EIA development projects surface water management and environmental monitoring. Jennifer has gained valuable skills in GIS, including spatial and 3D analysis techniques. Jennifer has undertaken various assessment and written several EIA chapters for a range of development including windfarms, OHL, pier and peat extraction sites. Jennifer is a non-chartered member of CIWEM.

Dr Iain Struthers BSc BEng (Hons) PhD

Iain has over 21 years of experience in hydrological and hydrodynamic model development and application within consultancy and academia in the UK, Australia and Japan. Iain has expertise in flood risk assessment, surface water management planning, sustainable drainage (SuDS) design, and the development and application of hydraulic models of rivers and sewer networks. In addition to leading technical delivery of large and small flooding projects, Iain has experience in project management, including client liaison and management, statutory consultation and reporting, in both flood risk management and multi-disciplinary projects.

Charlotte Hewson BSc (Hons) MSc

Charlotte is an Environmental Consultant with EnviroCentre. She has gained over 3 years' experience in consultancy and regulator roles, following a BSc in Oceanography & Coastal Processes and an MSc in Hydrology and Water Management. Charlotte has project experience in coastal and terrestrial EIAR's, coastal assessments, private water supply assessments, and peat assessments. Charlotte has developed skills in GIS including spatial and 3D analysis techniques, and has field survey experience including environmental monitoring, hydrology walkovers and peat surveys.

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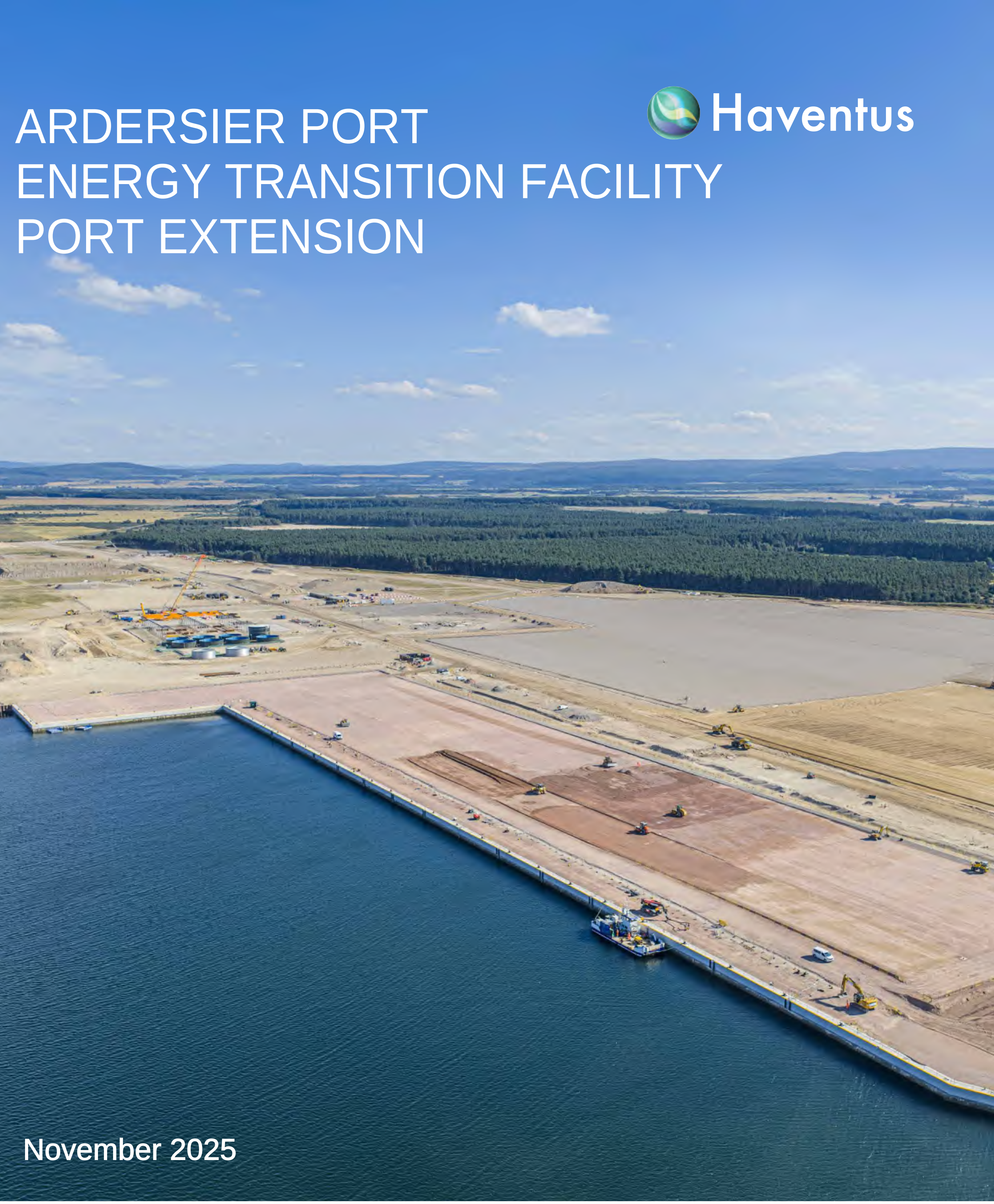

November 2025

Appendix 9.3 Ardersier Extension Site Flood Risk Assessment

Ardersier Extension Site
Flood Risk Assessment

October 2025

CONTROL SHEET

Client: Haventus
Project Title: Ardersier Extension Site
Report Title: Flood Risk Assessment
Document number: 15463
Project number: 681962

Issue Record

Issue	Status	Author	Reviewer	Approver	Issue Date
1	DRAFT	IS	MN	MN	21/08/2025
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1 INTRODUCTION

1.1 Terms of Reference

EnviroCentre Ltd were commissioned by Haventus to undertake a Flood Risk Assessment (FRA) for the proposed extension to the Ardersier Energy Transition Facility (Ardersier ETF), located on the Carse of Ardersier. The following report details the methodology and findings of the FRA and recommendations for flood risk management for the site.

1.2 Scope of Report

The report assesses flood risk to the site from all sources. Screening outcomes identify that coastal flood risk, as well as flood risk posed by land drainage channels within and adjacent to the site, are material considerations. As proposals will entail platforming over existing land drainage pathways, a critical element of flood risk assessment will be understanding the impact proposed development may have upon altering flood risk, to ensure that development does not cause flood risk detriment to any potential receptors.

1.3 Report Usage

The information and recommendations contained within this report have been prepared in the specific context stated above and should not be utilised in any other context without prior written permission from EnviroCentre Limited.

If this report is to be submitted for regulatory approval more than 12 months following the report date, it is recommended that it is referred to EnviroCentre Limited for review to ensure that any relevant changes in data, best practice, guidance or legislation in the intervening period are integrated into an updated version of the report.

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1.4 Terminology & Glossary

There are two ways of expressing the likelihood of a flood event with a certain magnitude: one is quantifying as a percentage using the concept of Annual Exceedance Probability (AEP) and the other method is to express flood risk using the concept of Return Period (RP) measured in years. The relationship between AEP and RP is presented in Appendix A. In this report the two concepts are used interchangeably, as appropriate.

The Council/THC	The Highland Council
CC	Climate change
GIS	Geographic Information System
LiDAR DTM	A digital terrain model (DTM) of gridded ground elevations, obtained by remotely sensed measurements of distance (usually by aircraft) using laser light (LiDAR)
NGR	National Grid Reference; a geographic grid reference system used in the UK, also referred to as British National Grid
mAOD	Elevation, in metres above Ordnance Datum (where the Ordnance Datum is the mean sea level at Newlyn in Cornwall)
NPF4	National Planning Framework 4 (Scottish Government, 2023)
OS	Ordnance Survey
SEPA	Scottish Environment Protection Agency

1.5 Regulatory Framework

1.5.1 National Planning Framework 4 (NPF4)

NPF4 was adopted by Scottish Ministers on 13 February 2023, replacing Scottish Planning Policy (2014). In relation to flood risk and water management, the intent of NPF4 is:

"To strengthen resilience to flood risk by promoting avoidance as a first principle and reducing the vulnerability of existing and future development to flooding."

Where development cannot avoid areas of flood risk, proposals 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 Local Development Plan (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.

In relation to surface water flood risk, 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 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.

For planning purposes, "at risk of flooding" and "in a flood risk area" means land or built form with an annual probability of being flooded of greater than 0.5% which must include an appropriate allowance for future climate change.

1.5.2 SEPA Guidance

SEPA's *Technical Flood Risk Guidance for Stakeholders* (v13) (SEPA, 2022)[1] details the requirements for undertaking flood risk assessments in relation to proposed developments. These requirements depend upon the complexity of the site, with more complex or high-risk sites requiring detailed assessments. In summary, FRAs must include the following:

- Background site data, including suitable plans and/or photographs;
- Historic flood information;
- Description of methodologies used;
- Identification of relevant flood sources;
- In case of river flooding: assessment of river flows, flood levels, depths, extents, displaced flood storage volumes, etc.;
- Assessment of culverts, sewers or other structures affecting flood risk;
- Consideration of climate change impacts;
- Details of required flood mitigation measures; and
- Conclusions on flood risk related to relevant national and local policies.

Technical guidance on Flood Estimation Handbook (FEH) (CEH, 2008) methodologies and on land raising and compensatory storage are also provided as part of this guidance.

[1] https://www.sepa.org.uk/media/162602/ss-nfr-p-002-technical-flood-risk-guidance-for-stakeholders.pdf

2 SITE DETAILS

2.1 Site Location & Water Features

The site is located on the Carse of Ardersier. The location and extents of the site are shown in Figure 2.1, along with land drain locations and a tidally influenced lagoon within the western area of the site. Land drains as shown on the map generally flow from south to north.

Figure 2.1: Site location, extents and terrestrial (i.e. non-coastal) water features

2.2 Topography

Figure 2.2 presents topography in the site vicinity, noting that ground elevation has been obtained from multiple sources (noting that sources later on the list are considered to supersede those earlier in the list, where coverage overlaps):

- LiDAR for Scotland Phase 1 DTM data (flown between 2011-12).
- A “Saltmarsh LiDAR Survey” (flown in 2024) of the eastern areas of the site, and areas beyond the eastern boundary.
- A “Woodland LiDAR Survey” (flown in 2024) of the central and southern area of the site.

- A "Complete Site LiDAR Survey" (flown in May 2025) of the full site, excluding the site access road (noting that this almost entirely supersedes the Woodland survey, excepting for small patches beyond the southern boundary of the site).

The area outwith the application site generally slopes from south to north towards the coastal boundary. The northern parts of the application site are elevated above southern areas of the application site as part of previously consented development for the port site within the site boundary, with a perimeter drain along the southern boundary of this platformed area, which discharges by culvert to coastal waters. The southeastern area also discharges by culvert, eastwards under the site access road and by further land drainage channels to eventually discharge into the lower-lying saltmarsh area to the east of the site.

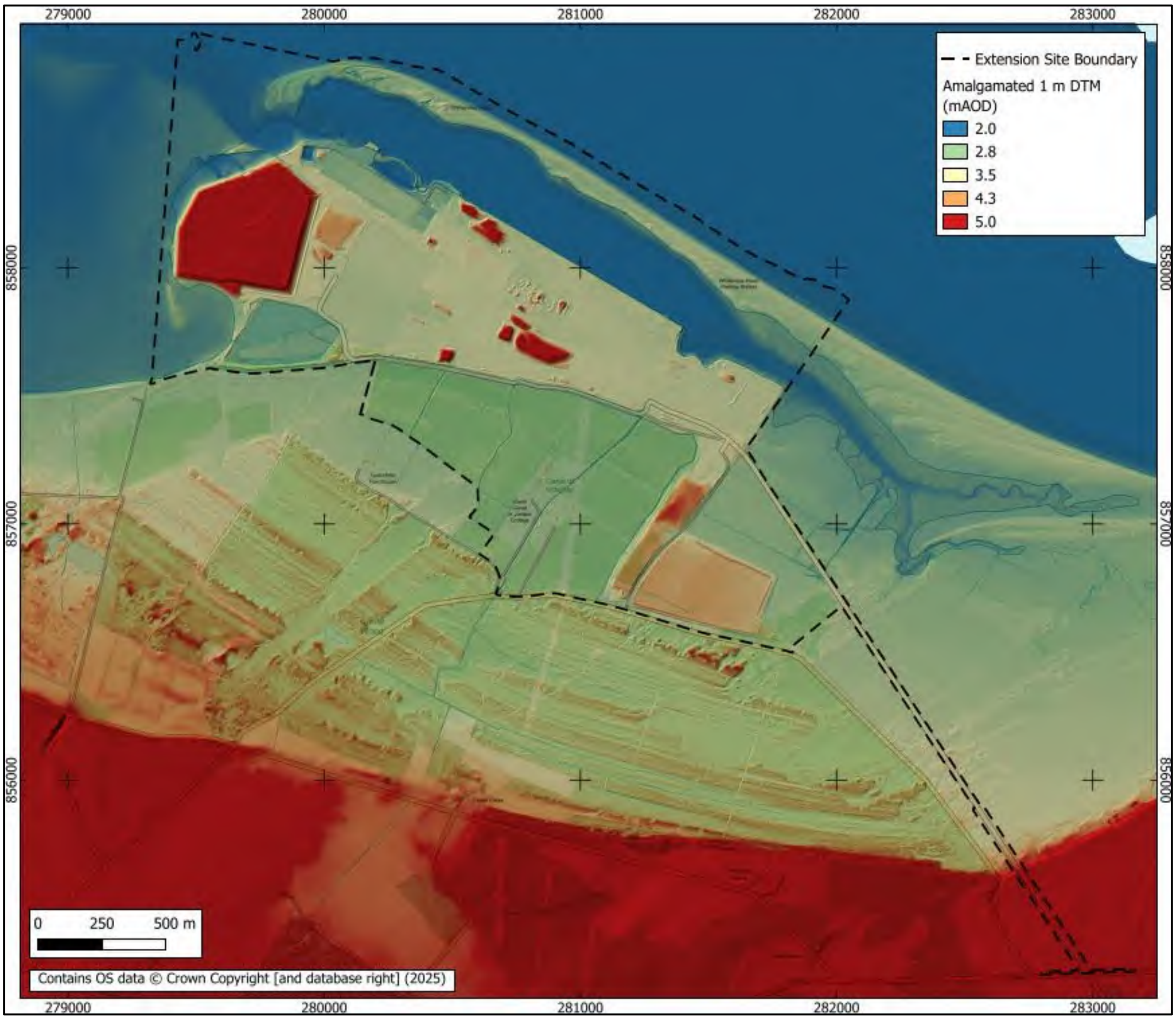

Figure 2.2: Amalgamated pre-development ground elevation model (as of May 2025)

3 FLOOD RISK SCREENING

SEPA's technical guidance (SEPA, 2022) advises that a site-specific FRA should be undertaken where any available information indicates there may be a risk of flooding (from any source) to the site, and/or where the development of the site may increase flood risk elsewhere. Where a site-specific FRA may be required, screening will determine the scope of the assessment and may also be used to inform an appropriate and proportionate approach for the assessment.

3.1 Screening By Source

3.1.1 Fluvial Flood Risk

SEPA flood mapping indicates fluvial flood risk impacting large areas of the western half of the application site. However, indicated extents are anomalous, and seem to be based on the incorrect assumption that local land drainage channels are watercourses discharging westwards into the Moray Firth; in reality, the land drainage channel network discharges via twin culvert pipes northwards into the Inner Harbour.

Flooding associated with land drainage channels is assessed in detail as part of surface water flood risk assessment.

3.1.2 Coastal Flood Risk

SEPA flood mapping indicates coastal flood risk impacting all but the previously consented port site element of the site. Further consideration of coastal flood risk is therefore required.

3.1.3 Surface Water / Land Drainage Flood Risk

SEPA's "Surface Water and Small Watercourses" flood mapping layer indicates a substantial number of disconnected small patches of flooding, as well as linear areas of flooding corresponding with land drainage channels within and adjacent to the application site.

The proposed development entails platforming the application site above design coastal flood levels, including infilling of existing land drainage channels within the application site. This will have the impact of protecting the site against externally-generated surface water flood risk, with internally-generated surface water flood risk to be managed via appropriate (infiltration) drainage provision. As such, the site will not itself be at risk of surface water / land drainage flooding.

However, infilling of existing land drainage channels will cut off existing pathways for drainage of land to the south of the application site, with the risk that development could therefore increase flood risk to areas external to the application site, including the public road which runs along the southern perimeter of the site boundary. As such, a detailed consideration of pre- and post-development flood risk is required in relation to those drains which serve an external area, which will include development and assessment of proposed diversion watercourse features to receive and convey land drainage from south of the application site and ensure no flood risk detriment is caused by development proposals.

3.1.4 Asset Failure Flood Risk

The SEPA Reservoirs Inundation Map[2] does not identify any reservoirs that could result in flooding of the application site in the event of failure.

3.1.5 Groundwater Flood Risk

Groundwater flooding, as a primary source, is uncommon in Scotland, due to the nature of the underlying geology. Groundwater levels tend to correspond with water levels in adjacent watercourses. This means that recommendations to mitigate against flood risk from coastal sources, such as setting minimum Finished Floor/Threshold Levels would be anticipated to provide adequate mitigation against potential groundwater flooding.

3.2 Scoping Summary

Table 3-1 presents the scoping outcomes for flood risk to the application site.

Table 3.1: Summary of Flood Risk Scoping

Flooding Source	Preliminary Risk Classification	Comments/Explanation	Scoping Outcome
Fluvial (River)	No risk	Parts of the application site are within SEPA-defined medium likelihood flood extents, but these are anomalous.	Not considered further
Coastal	Medium to High Risk	The majority of the application site, excepting the consented port element, are indicated to be at coastal flood risk.	Site-specific assessment required.
Surface Water / Land Drainage	Medium to High Risk	While SEPA mapping is inconclusive, site knowledge indicates land drainage pathways through the application site, receiving flows from areas further south. A site-specific assessment of pre- and post-development land drainage flood risk is required to ensure development does not cause detriment.	Site-specific assessment required.
Infrastructure	Low or No Risk	There are no reservoirs shown on the SEPA Reservoirs Inundation Map that could impact on the application site in the event of failure.	Not considered further.
Groundwater	Low or No Risk	Groundwater levels in Scotland tend to correspond with water levels in adjacent watercourses. This means that recommendations to mitigate against flood risk from coastal sources, would be anticipated to provide adequate mitigation against potential groundwater flooding.	Not considered further.

[2] https://map.sepa.org.uk/reservoirsfloodmap/Map.htm

4 COASTAL FLOOD RISK ASSESSMENT

4.1 Extreme Stillwater Level Estimation

Extreme sea levels have been predicted around the whole UK coastline and published by the Environment Agency and Department for Environmental Food and Rural Affairs (DEFRA)[3]. These extreme sea levels include the effect of both tides and storm surges but not the effect of amplification within estuaries or sea lochs. In order to provide better estimates around the Scottish coastline, the coastal estimates have been updated to account for amplification within estuaries.

Extreme sea levels are predicted at a point approximately 2.4 km offshore, north of the proposed development and are summarised in Table 4.1. The 1 in 200 year coastal flood level is 3.35 mAOD, whilst the 1 in 1,000 year level is 3.5 mAOD.

Table 4.1: Extreme sea levels at Ardersier Port (CFB dataset, UK Mainland chainage 3012)

Return Period (yrs)	Ordnance Datum (mAOD)	Chart Datum (mCD)
5	3.01	5.15
10	3.08	5.22
50	3.22	5.36
200	3.35	5.49
1,000	3.50	5.64

Based on the standard Coastal Flood Boundary (CFB) method, the estimated 1 in 200 year extreme stillwater coastal flood level at the nearest datapoint (UK Mainland chainage 3012) is 3.35 mAOD.

4.2 Sea Level Rise

SEPA's current guidance (as of June 2025)[4] advises that an 890 mm increase should be applied to coastal flood level estimates in the North Highland region to represent projected sea level rise due to climate change to the year 2100. Applied to the CFB estimate, the predicted 1 in 200 year stillwater coastal flood level accounting for climate change is therefore **4.24 mAOD**.

4.3 Predicted Pre-Development Coastal Flood Extents

Figure 4.1 indicates locations with existing ground levels (as per Figure 2.2) below 4.24 mAOD with direct connection to coastal waters, noting the following:

- Coastal flooding is predicted to inundate areas surrounding the application site on all sides, with exception of the raised site access road which has a minimum level exceeding 4.6 mAOD and remains flood-free.
- Coastal flooding is shown to inundate the port-side areas of the application site, noting that consent has already been granted to raise ground levels in these areas above coastal flood

[3] Environment Agency. (2018). Coastal Design Sea Levels – Coastal Flood Boundary Extreme Sea Levels
[4] https://www.sepa.org.uk/media/jjwpxuso/climate-change-allowances-guidance_v6.pdf

levels (with this platforming not yet complete at the time the latest survey was undertaken in May 2025).

- Southern areas of the application site are predicted to inundate from the west, noting that eastern areas of the application site are also at risk of coastal inundation via two existing culverts under the site access road.

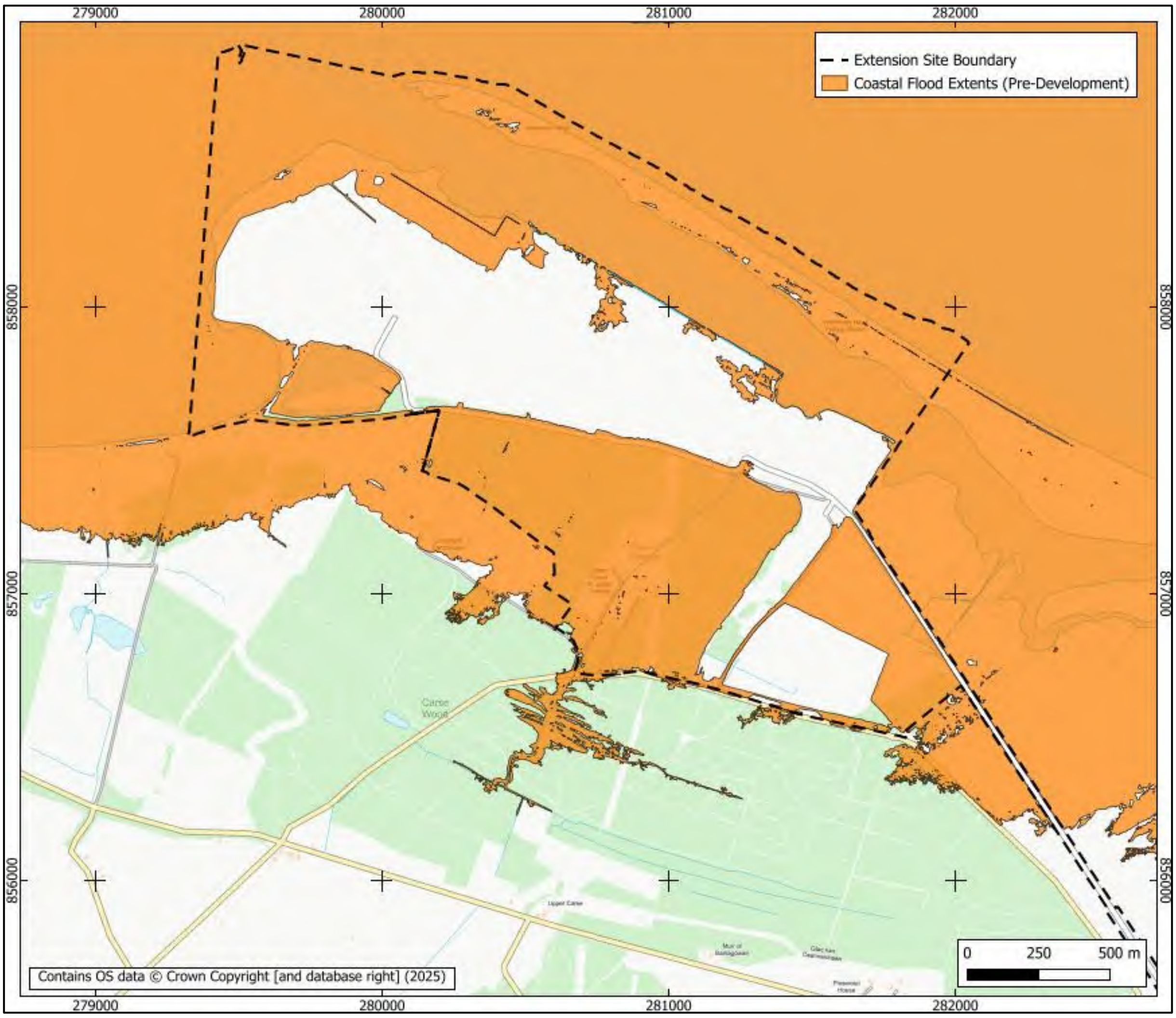

Figure 4.1: Projected design coastal flood extents, based on current ground elevations (as of May 2025)

4.4 Waves

Inundation mapping shown in Figure 4.1 does not account for wave action. Waves will act to cause transient increases in sea levels above the extreme stillwater level, with the potential to cause transient inundation (with associated risk of damage due to wave impact and spray) beyond the mapped extents in areas in close proximity to the coastal interface - particularly along the northern and northwestern edge of the mapped extents. Any future development in close proximity to these interfaces should be designed with consideration of the potential risk of wave action, by (for example):

- Setting development as far back from the interface as is practicable, allowing waves to break in the area between the interface and development.
- Placing any pedestrian access routes on the landward side of buildings.
- Avoiding or minimising window placement on the side of buildings facing the interface, and otherwise cladding the lower section of buildings near the interface to offer resilience against wave and spray impact.
- Designing post-development ground levels to fall away towards the coastal interface (such that building floor levels are raised above ground levels at the coastal interface, and to ensure any overtopping water passively returns to the sea).
- Avoiding creation of local topographic depressions in the vicinity of the interface, where overtopping waves may cause ponding.

4.5 Impact of Coastal Flood Risk Upon Development

Proposals entail platforming the majority of the application site to a level exceeding the 4.24 mAOD design coastal flood level, thereby protecting the application site from coastal inundation. Any future development in areas of the site platform in close proximity to the coastal interface should account for the risk of wave impact.

4.6 Impact of Development Upon Coastal Flood Risk

Landraising (platforming) of land in direct connection with the open coast is extremely unlikely to detrimentally impact coastal flood risk to surrounding areas and receptors via displacement. This principle was accepted for the consented port development component of the site and will also apply to the extension site.

Proposed amendments to ground levels may, however, alter connectivity between areas of low ground, with the potential to either increase or decrease the extent of coastal flooding associated with a given extreme sea level. Figure 4.2 through Figure 4.6 presents a comparison of pre- and post-development projected coastal flood extents associated with extreme sea levels of between 3 and 4 mAOD at 0.25 m elevation increments, with Figure 4.7 presenting a comparison for the design (1 in 200 year plus climate change) extreme sea level of 4.24 mAOD. All figures employ a transparency to the post-development layer, such that:

- Areas shaded yellow are only predicted to inundate for pre-development conditions.
- Areas shaded blue are only predicted to inundate for post-development conditions.
- Areas shaded green are predicted to inundate for both pre- and post-development conditions.

These maps indicate that:

- Development proposals will result in the lagoon inundating at lower sea levels, via lowered spill levels along the western perimeter of the lagoon (as proposals include restoration of historical coastal connectivity for the lagoon).
- Site platforming will generally reduce flood extents within the extension site, excepting along proposed diversion watercourses (see Chapter 9), which create an additional low-elevation pathway for coastal flood intrusion, unless the outlets to these watercourses employ flap valves (for the purpose of the presented maps, an open boundary is assumed, as this represents a worst-case).

- While proposed diversion watercourses create an additional pathway for coastal flood intrusion, the projected impact is limited to areas within the site boundary, with no detriment to areas outwith the site boundary.

On this basis, it is concluded that the development will not detrimentally impact coastal flood risk to areas outwith the site boundary.

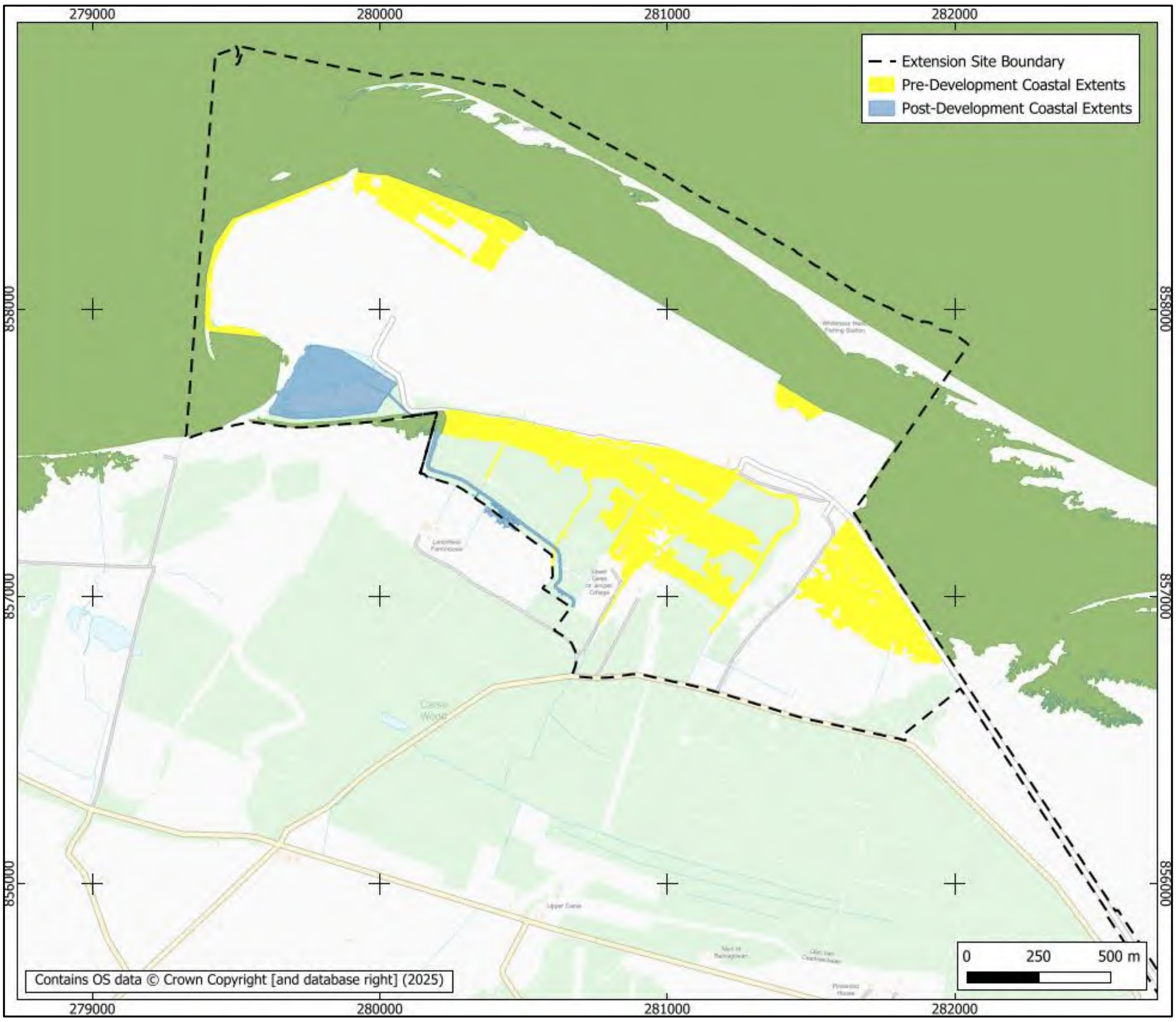

Figure 4.2: Projected pre- versus post-development coastal flood extents for a 3.00 mAOD sea level

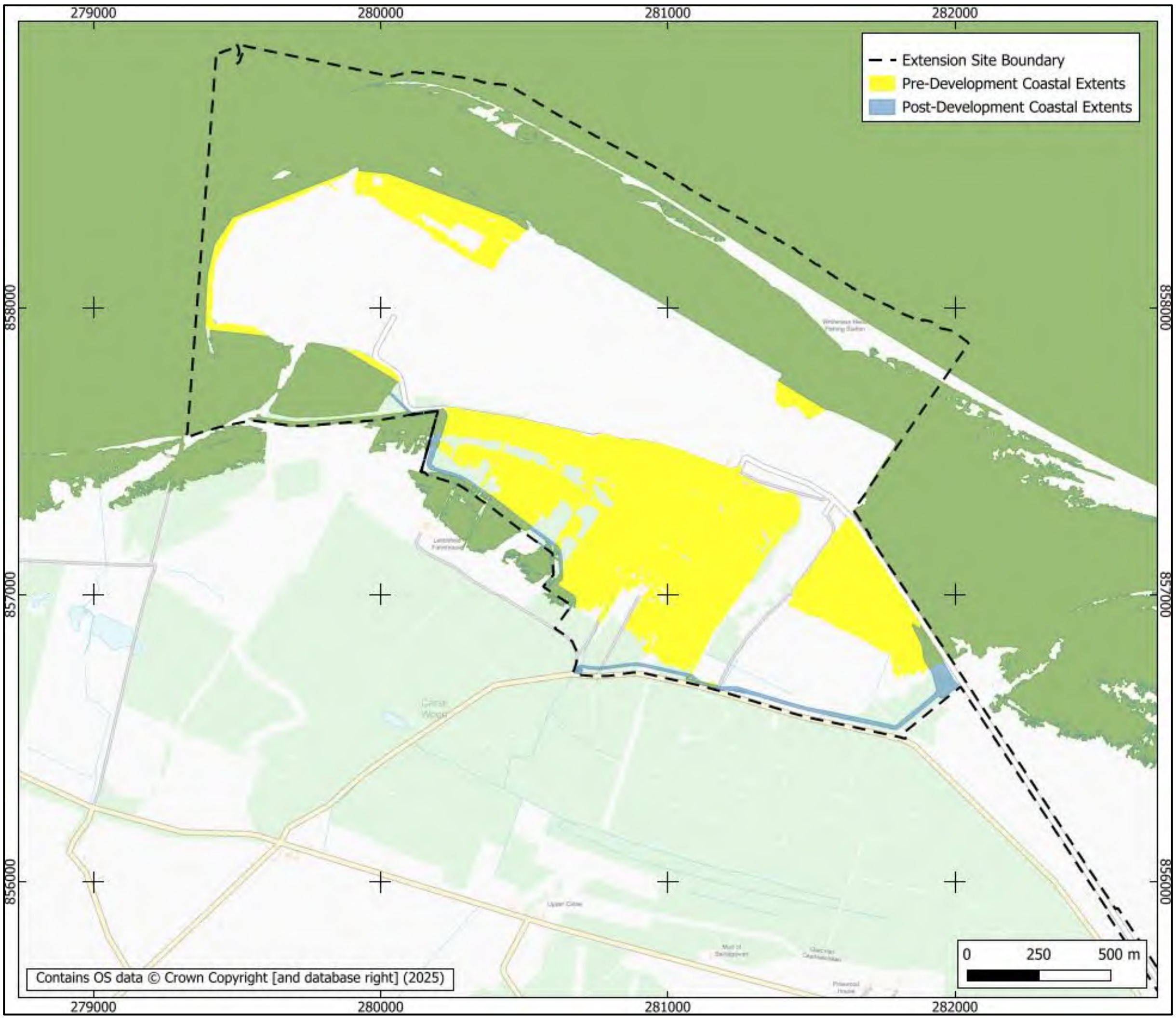

Figure 4.3: Projected pre- versus post-development coastal flood extents for a 3.25 mAOD sea level

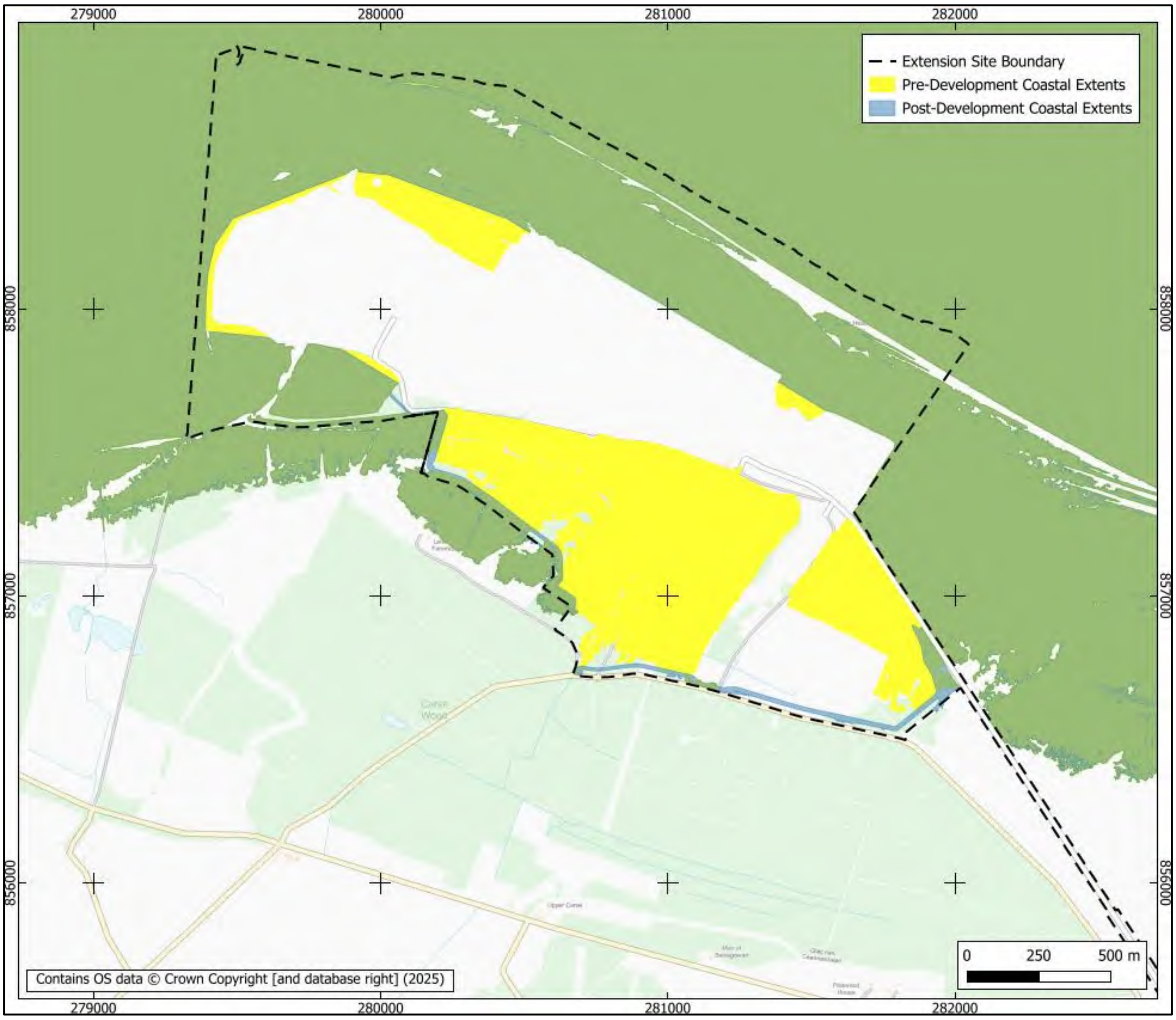

Figure 4.4: Projected pre- versus post-development coastal flood extents for a 3.50 mAOD sea level

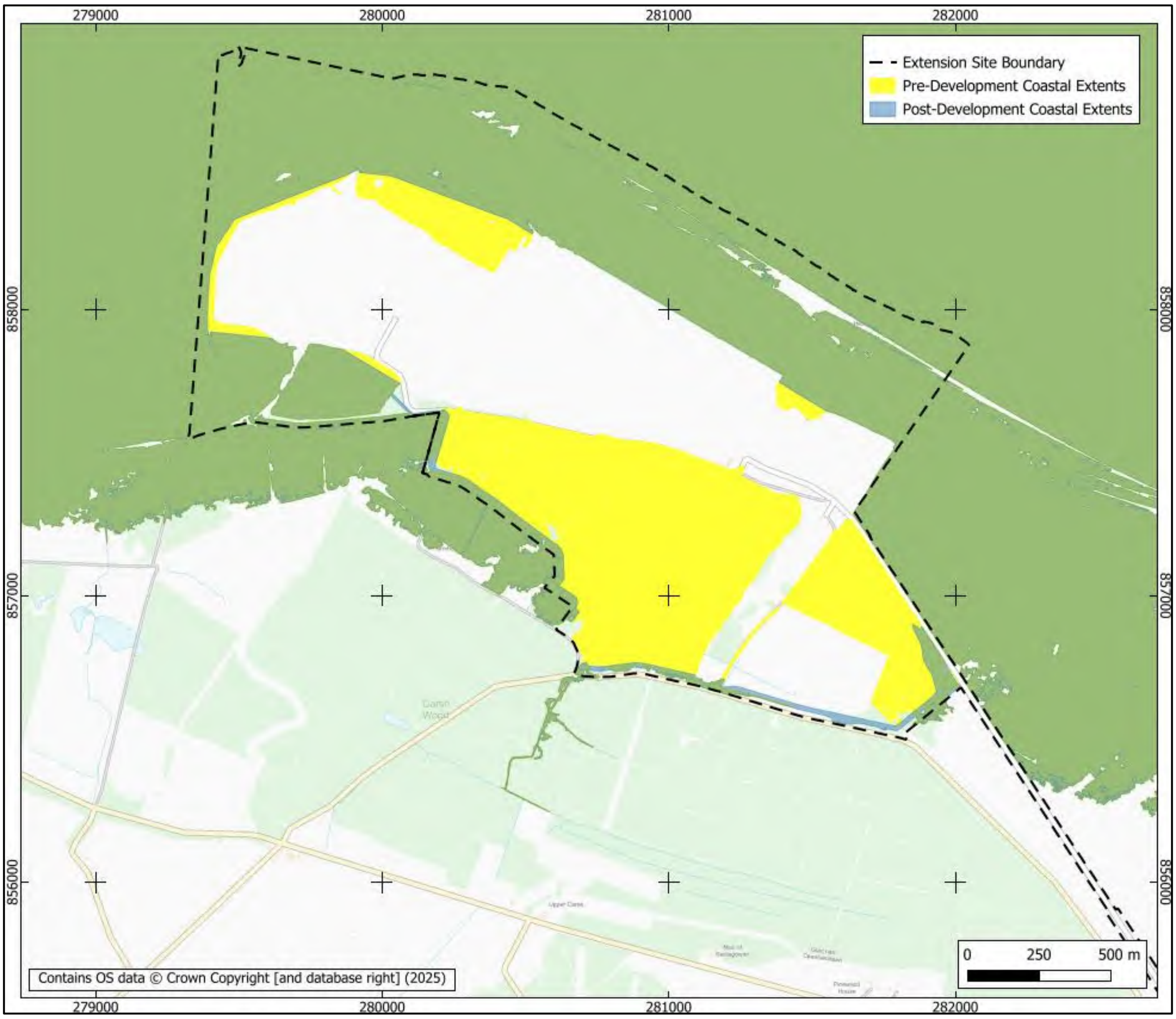

Figure 4.5: Projected pre- versus post-development coastal flood extents for a 3.75 mAOD sea level

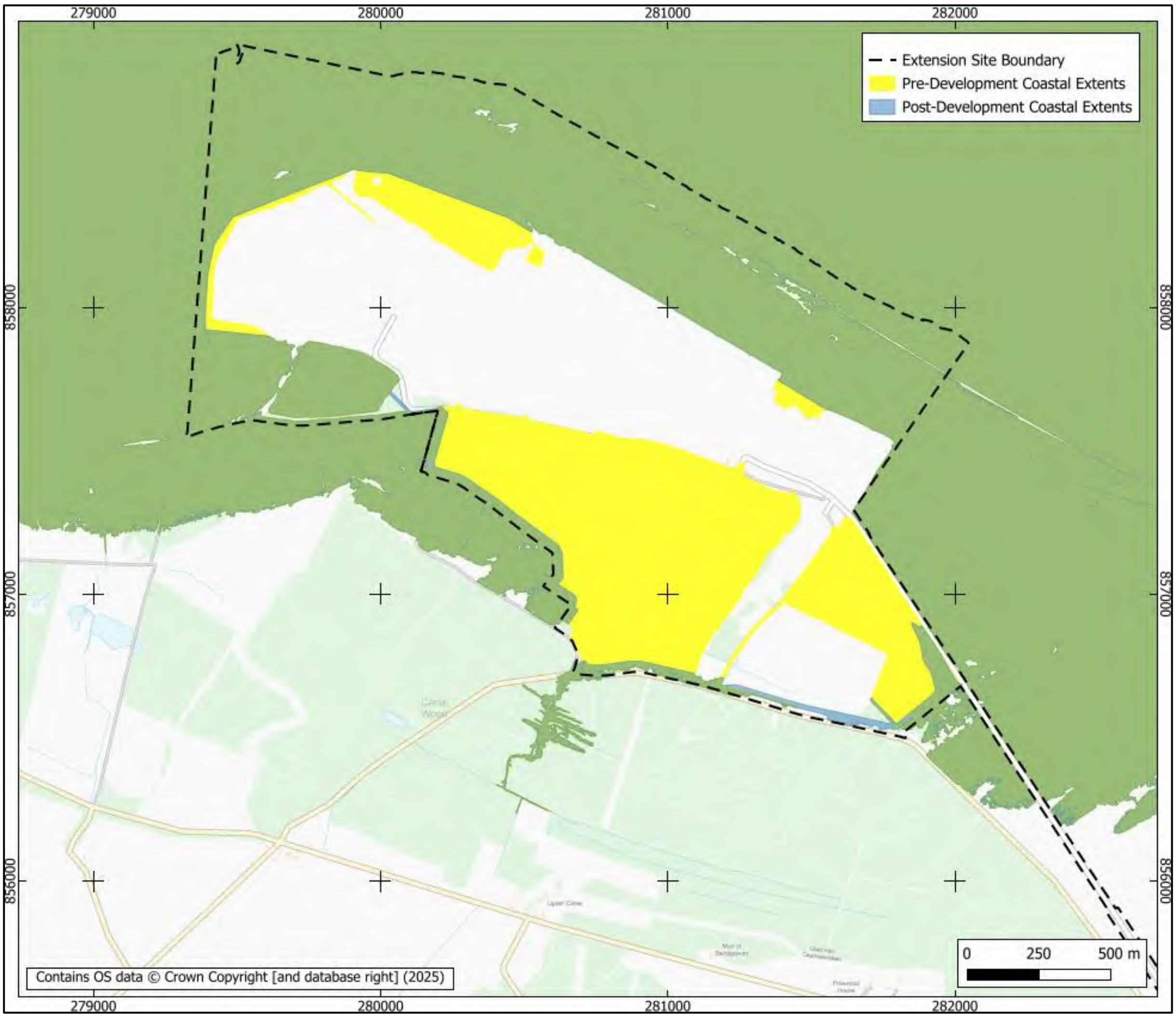

Figure 4.6: Projected pre- versus post-development coastal flood extents for a 4.00 mAOD sea level

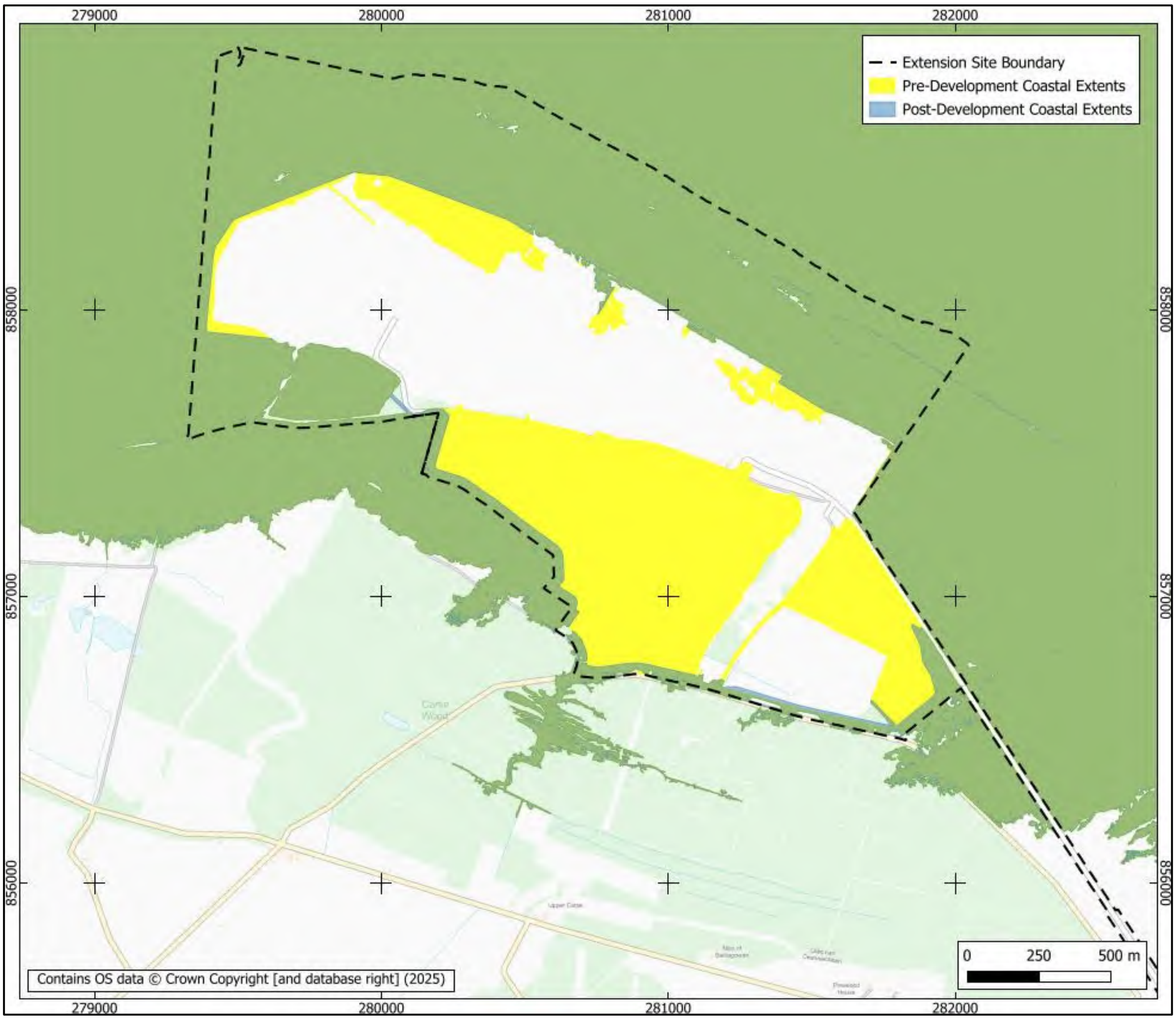

Figure 4.7: Projected pre- versus post-development coastal flood extents for a 4.24 mAOD sea level

5 PRE-DEVELOPMENT LAND DRAINAGE FLOOD RISK

5.1 Donor Catchment Hydrology

The FEH web service defines a 2.28 km^2 catchment approximately representative of the main land drain entering the southern boundary of the site (Figure 5.1). This catchment was used as a donor catchment for the derivation of design hydrology used in all subsequent modelling. Catchment descriptors for the donor catchment are presented in Appendix B.

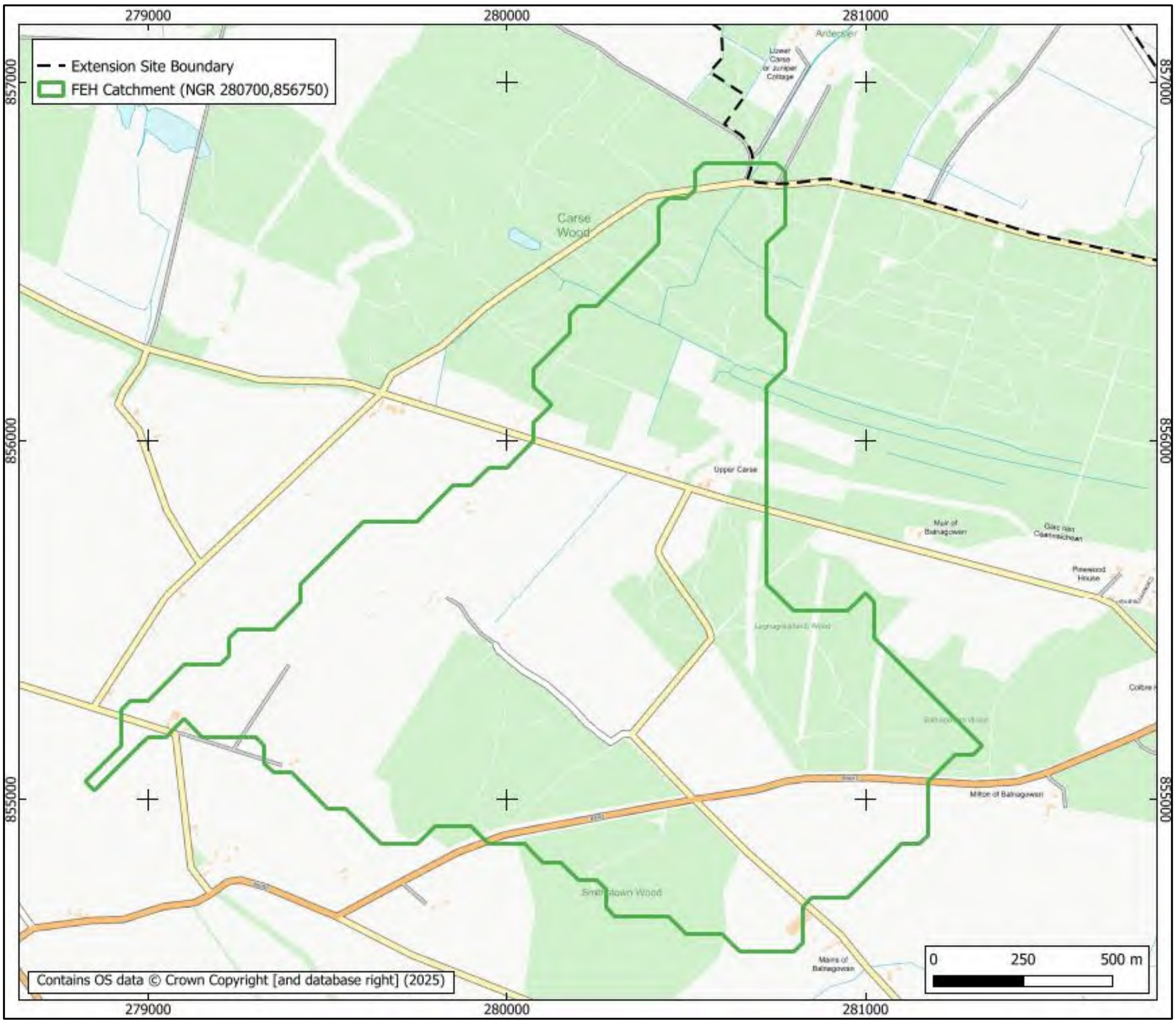

Figure 5.1: FEH catchment extent for the main land drain as it enters the southern boundary of the site

Standard ungauged methodologies were employed to estimate design 1 in 200 year plus climate change flows for the donor catchment:

- The FEH rainfall-runoff method, based on a calculated critical storm duration of 7.215 hrs (calculated using a 7.2 hr event at a 0.05 hr time interval).
- The Revitalised Flood Hydrograph (ReFH2) method, employing the latest FEH22 design rainfall and the default recommended storm duration of 6.5 hrs.

- As a small catchment in the North Highland region, a 42% uplift was applied to design rainfall used in calculations, to represent projected climate change to the year 2100.

Hydrological analysis input and output is presented in Appendix C, with predictions summarised in Table 5.1. The FEH rainfall-runoff method provides significantly more conservative design flow estimates in comparison to ReFH2 and is therefore used in all subsequent analysis.

Table 5.1: Donor catchment design flow estimation (m^3/s)

Method	200 yr (with climate change)
FEH RR	1.28
ReFH2	0.72

5.2 Catchment Delineation

The (sub)catchments associated with the main drain, and all other minor land drains, within and discharging through the application site were delineated using the following methodology:

- The LiDAR for Scotland Phase 1 DTM covering the application site was modified manually to account for culverted sections of land drain, and to join sections of drain separated by areas of poor coverage (usually associated with heavy vegetation cover). Modifications ensure that drain representation is continuous, prior to performing subsequent analysis steps.
- Sink filling, based on a very shallow gradient of 0.001 (given the lack of gradient, particularly within the extension site), was applied to the DTM. The “Fill Sinks (wang & liu)” tool within QGIS was used for this purpose.
- Channel networks and drainage basins were derived using the filled DTM, using the “Channel network and drainage basins” tool within QGIS.
- Individual drainage basin polygons were then grouped where they drain to a common point, to form a catchment. Catchments were delineated, as close as possible, to locations where land drains confluence.
- For catchments crossing the site boundary, catchments were split into internal catchments (which will be replaced by site surface water drainage provision) and external catchments (which will remain for post-development conditions).

Delineated subcatchments of the main drain are presented in Figure 5.2, with those of other land drains within and adjacent to the site boundary presented in Figure 5.3.

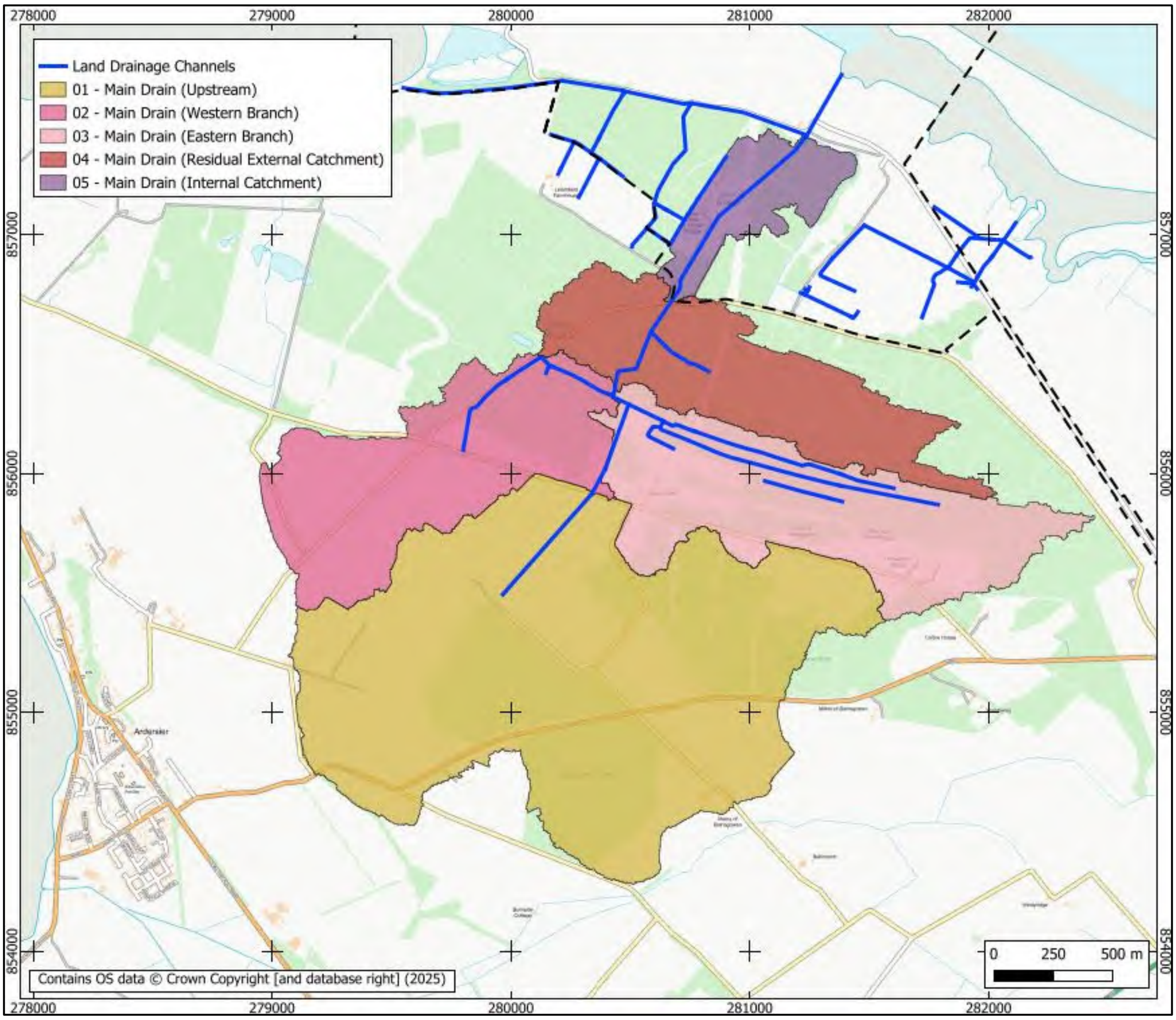

Figure 5.2: Subcatchments of the main land drainage channel through the site

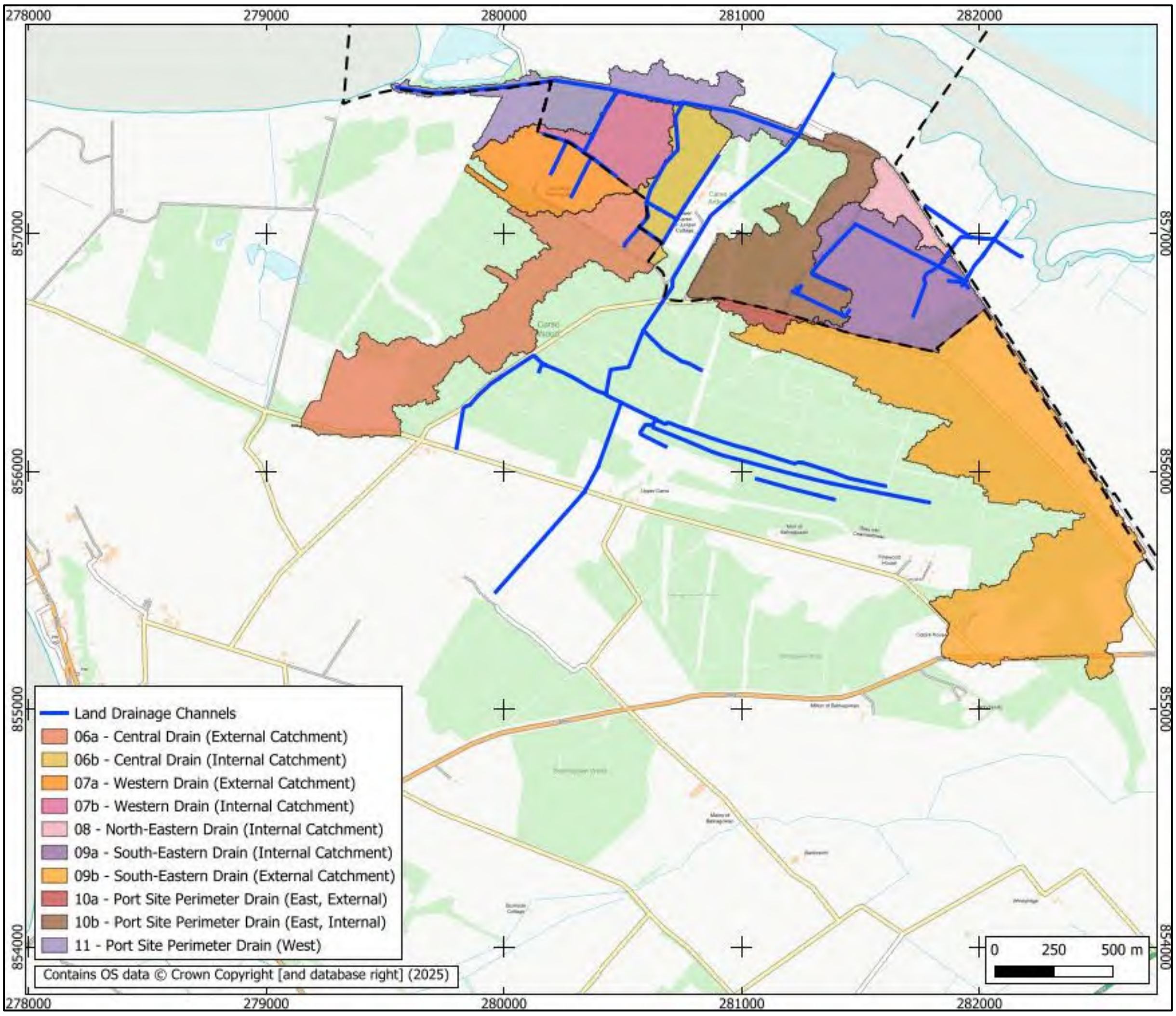

Figure 5.3: Subcatchments of other land drainage channels within and adjacent to the site

5.3 Design Flow Estimation

Design flows for the main drain were derived from donor descriptor (Section 5.1 and Appendix B) as follows:

- Area was replaced with the calculated total area of all subcatchments of the main drain (4.85 km^2).
- Catchment descriptor DPLBAR is considered to scale with area, with DPLBAR = $Area^x$. Solving for donor catchment area of 2.28 km^2 and DPLBAR of 1.91 km, and main drain area of 4.85 km^2, the scaled DPLBAR value is 3.45 km.
- The revised critical storm duration using these descriptors is 9.915 hrs (with a value of 9.9 hrs at a 0.05 hr interval used in calculations).
- Applying a 42% climate change uplift to the calculated 9.9 hr, 1 in 200 year rainfall depth of 72.99 mm yields a 1 in 200 year plus climate change rainfall depth of 103.6 mm and a 1 in 200 year plus climate change peak flow of **2.267 m^3/s** for the main drain. The design flow hydrograph for the full main drain catchment is presented in Figure 5.4.

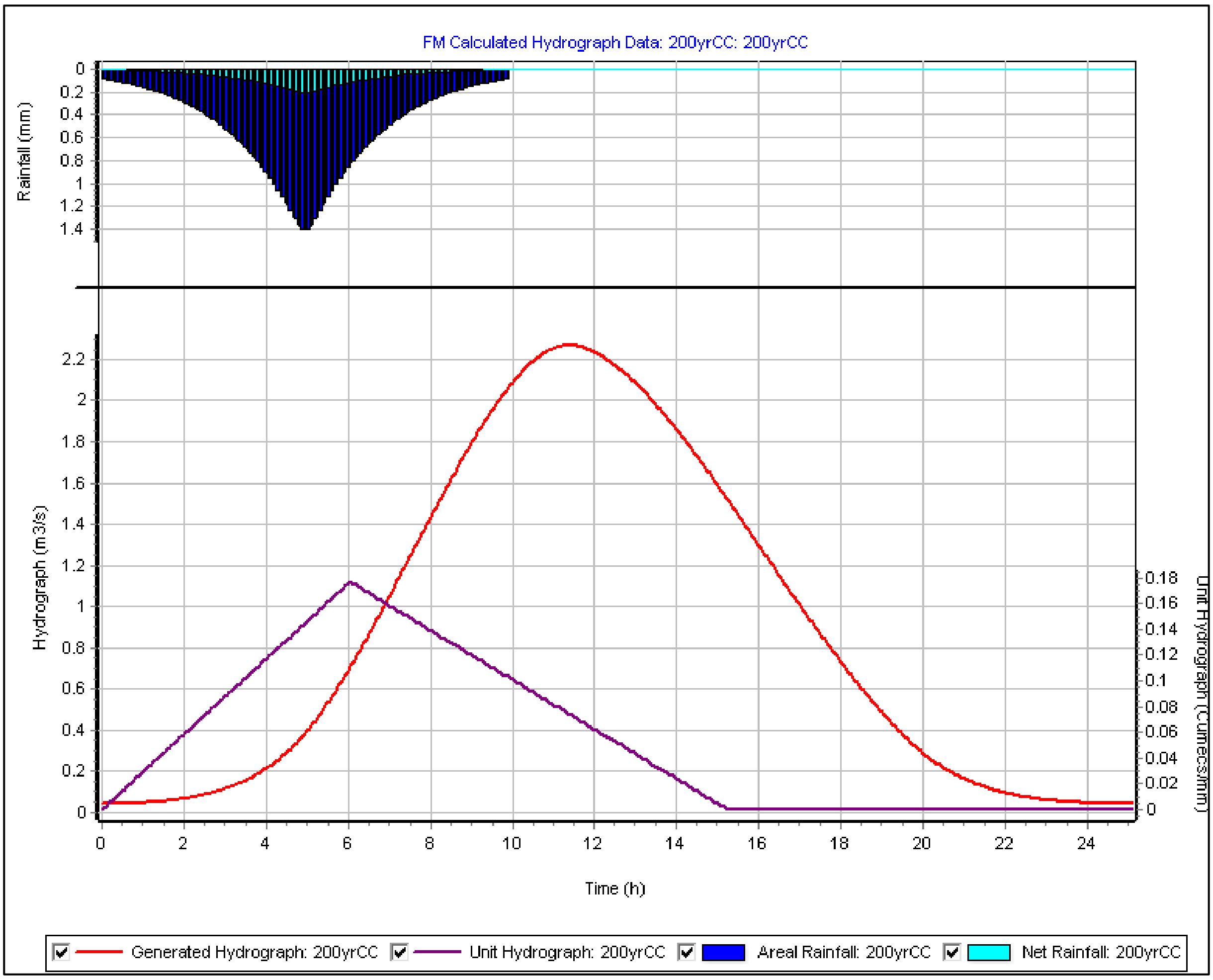

Figure 5.4: Design flow hydrograph for the full main drain catchment area of 4.85 km^2

Thereafter, in modelling, inflow hydrographs for each subcatchment were scaled by area from the design hydrograph presented in Figure 5.4.

Peak flows for the main drain subcatchments are presented in Table 5.2, with those of other land drains which confluence with the main drain before discharging (via existing twin culvert) northwards to coastal outfall presented in Table 5.3. Subcatchments in the eastern area of the application site discharge eastwards via existing access road culverts to ultimately discharge into the saltmarsh area further east; peak flows for these subcatchments are presented in Table 5.4.

Table 5.2: Peak flow values for subcatchments of the main drain

Subcatchment	Model Node	Area (km^2)	Peak 200 year plus climate change flow (m^3/s)
01 – Main Drain (Upstream)	MainUUS_000	2.455	1.147
02 – Main Drain (Western Branch)	M_W00	0.898	0.419
03 – Main Drain (Eastern Branch)	M_E00	0.827	0.386
04 – Main Drain (Residual External Catchment)	Main_Lat*	0.675	0.315
05 – Main Drain (Internal Catchment)	MainDS_Lat*	2.455	1.147
Total		**4.854**	**2.267**

** Indicates inflows that are input laterally (distributed over a reach length) within modelling.*

Table 5.3: Peak flow values for other subcatchments confluencing with the main drain

Subcatchment	Model Node	Area (km^2)	Peak 200 year plus climate change flow (m^3/s)
06a – Central Drain (External Catchment)	C_001	0.421	0.197
06b – Central Drain (Internal Catchment)	C_Lat*	0.108	0.051
07a – Western Drain (External Catchment)	W_S01	0.149	0.070
07b – Western Drain (Internal Catchment)	W_S_Lat	0.116	0.054
10a – Port Site Perimeter Drain (East, External)	SE_001	0.023	0.011
10b – Port Site Perimeter Drain (East, Internal)	SE_Lat*	0.242	0.113
11 – Port Site Perimeter Drain (West)	50% at W_001 50% at W_Lat*	0.217	0.101

* *Indicates inflows that are input laterally (distributed over a reach length) within modelling.*

Table 5.4: Peak flow values for subcatchments draining eastwards via the site access road culverts

Subcatchment	Model Node	Area (km^2)	Peak 200 year plus climate change flow (m^3/s)
08 – Northeastern Drain (Internal Catchment)		0.050	0.023
09a – Southeastern Drain (Internal Catchment)		0.278	0.130
09b – Southeastern Drain (External Catchment)		0.890	0.416

* *Indicates inflows that are input laterally (distributed over a reach length) within modelling.*

5.4 1D Model Construction

A site visit was undertaken to inform survey specification, with a 1D model constructed to represent all land drainage channels within and draining towards the application site, along the culverts and other structures within the modelled reach. To improve model stability, additional sections were added via interpolation from surveyed sections; as bank elevations are more variable between sections than bed levels and shape, bank levels were subsequently modified for interpolated sections to ensure tie-in with LiDAR ground levels in the bankside area.

5.4.1 Extents

Modelling was undertaken only for those land drains with channel elements external to the application site; namely the port site perimeter drain and its tributary drains, including the main drain. The eastern drainage system has not been modelled, as it does not receive flows from any identified land drain that will be "cut off" by proposed development, noting that areas external to the site boundary capable of contributing flows to the proposed Eastern Watercourse (via overland or subsurface pathways) are accounted for in post-development modelling of the proposed Eastern Watercourse presented in Chapter 9.

5.4.2 Model Roughness

Drainage channels within the modelled reach are, in all cases, excavated earthen channels with clean beds and banks, with negligible in-channel vegetation, with no meandering. A uniform Manning's roughness of 0.035 was therefore used for all in-channel areas.

Bankside areas are more variable, consisting of a mix of short grasses and scattered brush and trees. A uniform Manning's roughness of 0.055 was used for all out-of-bank areas within the 1D domain.

5.4.3 Model Boundaries

Inflow boundary conditions were applied at all model upstream boundaries, as described in Section 5.3. Inflows associated with non-headwater catchment areas are applied as lateral inflows along an appropriate reach of the model.

All drains share a common point of discharge, via the twin 1 m diameter culverts at the downstream end of the Main Drain. These culverts discharge into coastal waters, with a fixed level boundary applied at their downstream end, the value of which varies depending upon the scenario being simulated:

- A free-draining boundary condition was represented using a fixed downstream boundary level of 1.5 mAOD.
- Tidally-constrained scenarios employ a fixed downstream boundary level of 2.95 mAOD, corresponding to the mean high water spring (MHWS) tidal level inclusive of (0.89 m) sea level rise.

5.4.4 Representation of Structures

Based on pre-application advice from SEPA, existing structures upstream of the application site that may act to throttle flows, thereby reducing flows and hence flood risk in the vicinity of the site, were enlarged in modelling to ensure that they provide minimal throttling, to ensure that modelling is precautionary with respect to potential future resolution of these throttles. Specifically:

- A 600 mm diameter culvert under a public road at the upstream end of the modelled reach of the Main Drain was represented in modelling as a 1 m diameter orifice.
- A 300 mm diameter culvert immediately downstream of the aforementioned culvert, which runs for approximately 80 m under fields, was represented in modelling as a 1 m diameter orifice.

The following structures within and in close proximity to the application site were represented as surveyed:

- A 650 mm diameter culvert of the Main Drain on the under the public road which runs along the southern boundary of the site (represented with a Manning's roughness of 0.02 below axis and 0.01 above axis, to account for suspected debris intrusion into this culvert).
- The twin 1 m diameter culverts at the downstream end of the Main Drain, which drain flows from the Main Drain, Central Drain, Western Drain and Port Site Perimeter Drain (represented with Manning's roughness of 0.012).

Various minor footbridge and small culvert crossings within the application site were not represented within modelling; while some of these structures may impact local flooding behaviour within the application site, they will not impact flooding outwith or near the perimeter of the application site.

5.4.5 Model Schematic

An unlabelled schematic of the 1D pre-development model is presented in Figure 5.5, with the site boundary shown as a black dashed line.

Figure 5.5: Pre-development 1D model schematic, with LiDAR-based ground elevations

5.5 2D Model Construction

5.5.1 2D Model Extents

For computational efficiency, the 2D domain was limited to an “active area” polygon derived from preliminary iterative modelling, as shown in Figure 5.6. This area is sufficient to cover the predicted inundation extent for all modelled (pre-development) scenarios.

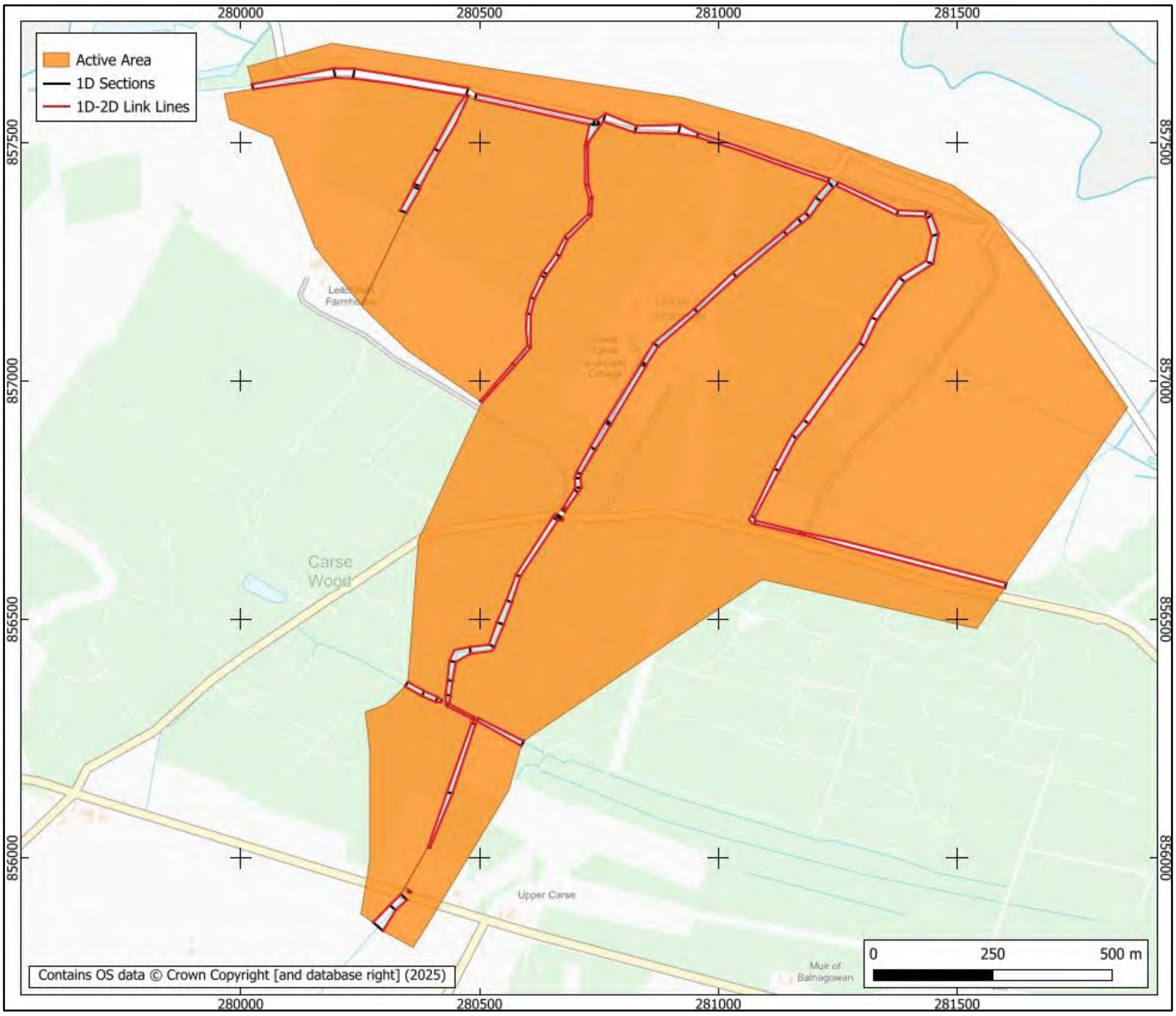

Figure 5.6: Pre-development 2D model extents, showing 1D-2D boundaries and 1D sections

5.5.2 2D Ground Elevation Representation

Pre-development ground elevations were based upon a mosaicked overlay of the following datasets, with the most recent data taking precedent in areas of overlapping coverage:

- LiDAR for Scotland Phase 1 DTM data (flown 2011-2012), which covers the full 2D active area and beyond.
- "Woodland Survey"; LiDAR survey of then-accessible areas of the extension site, flown in 2023-2024.
- "Saltmarsh Survey"; LiDAR survey of the salt marsh area to the east of the application site and eastern areas of the extension site, flown in 2023-2024.
- "Full Site Survey"; LiDAR survey of all landward areas of the application site excluding the existing site access road, flown in 2025.

Extents of the constituent datasets used to derive 2D ground elevations is illustrated in Figure 5.7.

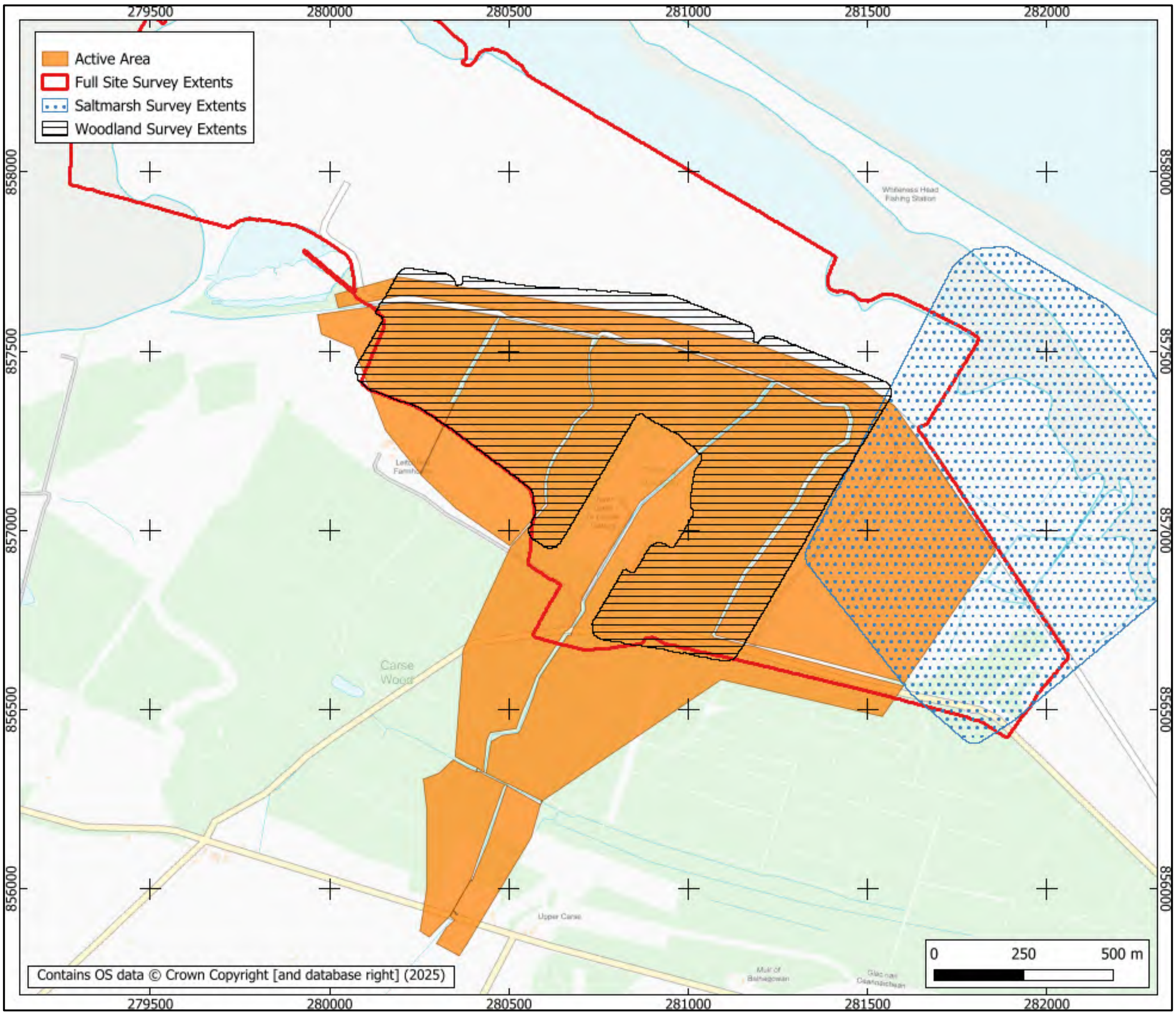

Figure 5.7: Extents of DTMs used to define ground elevations within the model's active area

5.5.3 2D Roughness

Surface roughness values for the 2D domain were derived from OS Open Map Local surface type information. This data source represents roads using a centre line only; roads and associated footpaths are assumed to have a 6 m width (i.e. 3 m buffer either side of the OS centre line) for the purpose of 2D roughness definition. Manning's roughness values used for each surface type are summarised in Table 5.5, with a default value of 0.03 (corresponding to the greenspace value) used for areas unallocated on the OS Open Map Local dataset. Surface types within the 2D domain are shown in Figure 5.8.

Table 5.5: 2D roughness parameterisation

Surface Type	Manning's n value
Road & Hardstand	0.016
Surface Water	0.022
Greenspace (default value)	0.030
Woodland	0.070
Buildings	3.000

Figure 5.8: Surface types used in 2D roughness parameterisation

5.5.4 1D-2D Linkage

The 1D and 2D domains of the model were dynamically linked using "link lines", which define a sloping spill or weir profile for exchange of water (in either direction) between the domains. Elevations for all link lines were sampled from the 2D ground model at the locations of link line ends. H-type links are considered most suitable for representing flooding over unwalled banks and were used in all cases. All link lines employed default parameterisation (i.e. weir discharge coefficient of 1.2 and modular limit of 0.9).

5.5.5 2D Model Boundaries

Default ("glass wall") boundary parameterisation was employed for the external boundaries of the active area (i.e. those boundaries not interfacing with the 1D model domain by link lines), noting that 2D flooding is not predicted to reach these boundaries for any modelled scenario.

5.6 Run Parameters

All simulations employ a 0.75 s 1D timestep and 0.375 s 2D timestep. Modelling employs a 5 m 2D grid resolution.

5.7 Model Scenarios

Three pre-development scenarios were modelled:

A. A free-draining scenario, in which the tidal downstream boundary of the model was fixed at 1.5 mAOD.
B. A tidally constrained scenario, in which the tidal downstream boundary of the model was fixed at 2.95 mAOD (i.e. the estimated MHWS+CC water level). It should be noted that predictions based upon a fixed tidal level are conservative, as tidal peaks will be transient, but this assumption avoids the need to perform iterative modelling to determine the critical time lag between inflow and tidal peaks producing worst-case peak water level predictions (which may vary within the tidally impacted extent of the model).
C. A free-draining scenario, as per Scenario A, in which the twin coastal outfall culverts are represented as partially (50%) blocked at their inlets.

While flood predictions will be sensitive to blockage of the public road culvert, this scenario was not considered in modelling, as an unblocked representation of this culvert represents a worst case for design of diversion watercourses and assessment of flood risk impact.

5.8 Model Predictions

For the free-draining scenario, design (1 in 200 year plus climate change) flows are predicted to largely remain within-bank, with exception of the following locations:

- The public road culvert surcharges, causing flooding over the local section of road as well as out-of-bank flows from the channel upstream (south) of the culvert, including out-of-bank flows from multiple feeder channels. Peak flood levels over the public road vary between 3.95 mAOD (at the western end of the section of flooded road) and 3.8 mAOD (at the eastern end of the section of flooded road).
- Flooding is predicted over the western bank in the reach of the main drain downstream (north) of Juniper Cottage.
- A small area of flooding is predicted in the vicinity of the twin outfall culverts, associated with transient culvert surcharge.

Peak inundation extents and depths for Scenario A are presented in Figure 5.9, with tabular peak predictions for this scenario presented in Appendix D. Predicted maximum velocities vary between 0.025 and 1.65 m/s, with Froude numbers between 0.015 and 0.821. Tabulated peak water level (stage) predictions for all pre-development scenarios are also presented in Appendix D.

Relative to Scenario A, the impact of tidally constrained discharge (i.e. Scenario B) substantially increases predicted flooding extents and depths (Figure 5.10), essentially inundating all areas adjoining the land drainage network with ground elevations below 3.15 mAOD. However, predicted flooding behaviour in the vicinity of the public road culvert and further upstream is unaltered, as flood levels in these locations are much higher than the (2.95 mAOD) tidal downstream boundary level and are not impacted by it.

Relative to Scenario A, partial blockage of the twin outfall culverts (i.e. Scenario C) increases predicted flood extents and depths within the application site (Figure 5.11). However, as for Scenario B, predicted flooding in the vicinity of the public road culvert and further upstream is unaltered.

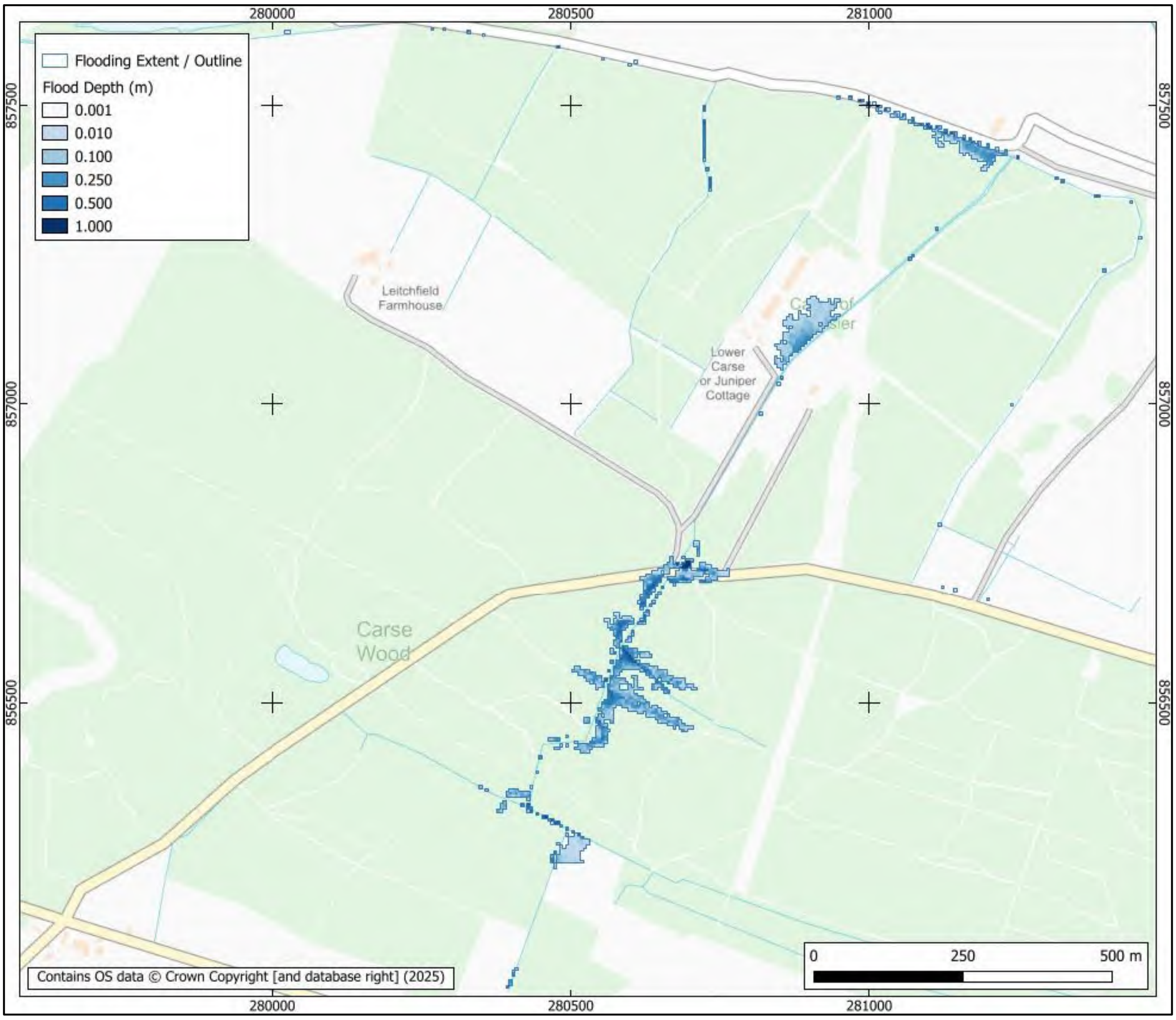

Figure 5.9: Scenario A predicted 2D flood extents and maximum depths

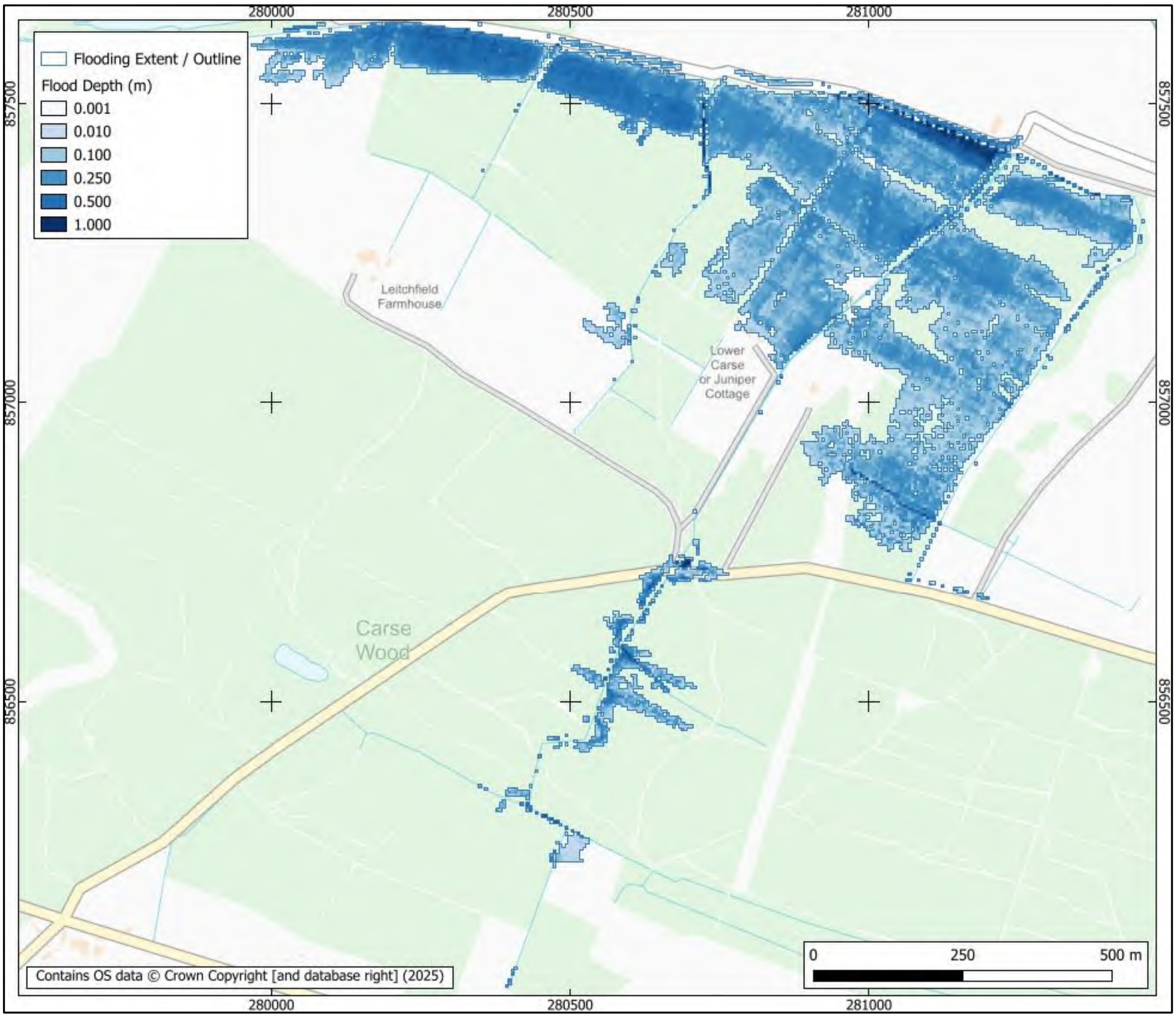

Figure 5.10: Scenario B predicted 2D flood extents and maximum depths

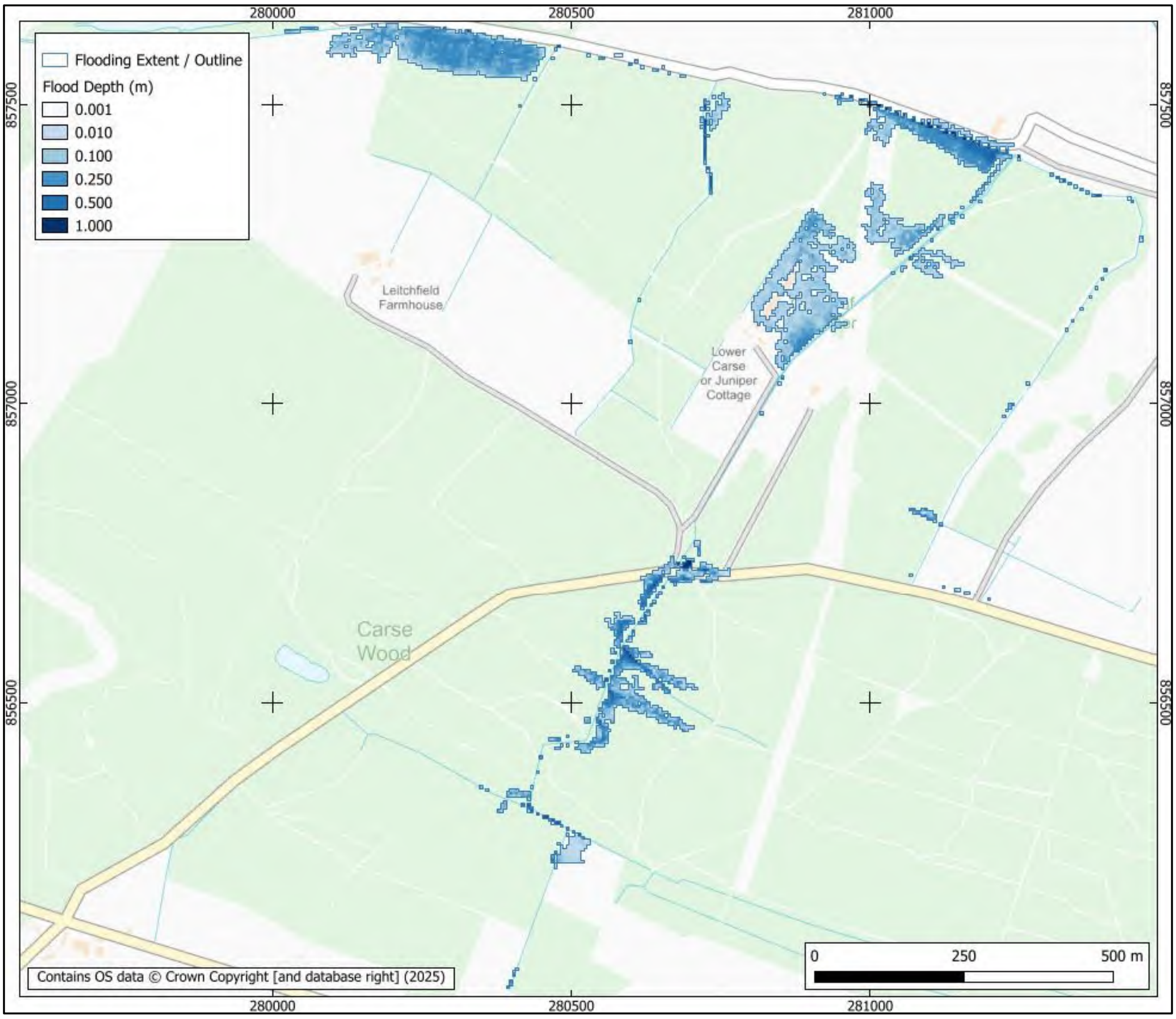

Figure 5.11: Scenario C predicted 2D flood extents and maximum depths

5.9 Mass Balance

The reported cumulative mass balance error for Scenario A is 454.5 m^3 or 2.61%. For Scenario C, the error is 353.5 m^3 or 1.26%. For Scenario B, the mass balance error increases beyond the predicted flood peak to excessive values (exceeding 8%); however, at the point predicted flood peaks (in the 1D and 2D domain) are reached (calculated at t=20 hrs into the 30 hr simulation run) the cumulative mass balance error is -191.7 m^3 or -0.19%.

6 POST-DEVELOPMENT LAND DRAINAGE FLOOD RISK

6.1 Conceptual Approach

Following preliminary appraisal of options for intercepting and diverting land drainage flows around the site platform (to avoid the need for culverting under the application site or the retention of land drainage channels through the application site, which would inhibit the movement of heavy vehicles), the following conceptual approach for land drainage management was adopted:

- A newly created Western Watercourse will intercept and divert land drainage flows arriving at the site boundary to the west of the existing main drain for discharge into the existing lagoon, with preliminary analysis indicating that design flows from the main drain cannot be conveyed westwards due to the lack of hydraulic gradient between the public road culvert outlet of the main drain and lagoon levels without inducing flooding.
- A newly created Eastern Watercourse will intercept and divert land drainage flows from the main drain, as well as land drainage flows arriving at the site boundary to the east of this drain, for discharge via the existing site access road culverts and land drainage channels into the saltmarsh to the east of the application site. A wetland pond is proposed upstream of the existing site access road culverts, to provide wetland habitat and to facilitate settlement of any suspended and entrained material prior to discharge.

To comply with scoping response requirements, both created watercourses will employ a two-stage design, consisting of an inner channel sized to accommodate typical flows and an outer channel capable of accommodating design (1 in 200 year plus climate change) flows.

6.2 Eastern Watercourse Model

Proposed conceptual design details for the Eastern Watercourse are presented in Appendix E. Note that, while the conceptual design used for the purpose of hydraulic modelling uses straight reaches of consistent cross-section, the final design of this watercourse will incorporate meanders and other variations to achieve a more naturalised water feature without materially altering flood predictions.

6.2.1 1D Model Construction

A triangulated 3D ground model for post-development conditions, including representation of the Eastern Watercourse, was created by Fairhurst for use in analysis. A centreline was created following the lowest point of the proposed channel, extending from the outlet of the public road culvert of the main drain to the inlet of the proposed wetland pond, which was used within Flood Modeller to sample cross-sections at 100 m intervals to create a 1D cross-sectional representation of the watercourse.

The proposed wetland pond was represented as a reservoir unit, with elevation-area relationship derived from the 3D ground model. The pond is drained by the two existing (900 mm diameter concrete) site access road culverts, discharging into feeder channels within the salt marsh. A fixed level downstream boundary is applied, the value of which varies depending upon the scenario being simulated: either 1.5 mAOD for the free-draining scenarios (Scenario A and, with culvert blockage, Scenario C) or 2.95 mAOD for the tidally-constrained scenario (Scenario B), as per pre-development modelling (Section 5.4.3).

The main drain to the outlet of the public road culvert is retained in the model, along with all inflows to this point. Lateral contributing catchment areas and calculated design flows entering the Eastern Drain along its length are summarised in Table 6.1.

Table 6.1: Peak flow values for subcatchments discharging into the proposed Eastern Watercourse

Subcatchment	Model Node	Area (km^2)	Peak 200 year plus climate change flow (m^3/s)
10a – Port Site Perimeter Drain (East, External) + Portion of 09b – Southeastern Drain (External Catchment) entering in upper reach of drain	SE_001*	0.023 + 0.148	0.080
Remaining portion of 09b – Southeastern Drain (External Catchment) entering in upper reach of drain	SE_002*	0.742	0.347
08 – Northeastern Drain (Internal Catchment) + 09a – Southeastern Drain (Internal Catchment)	SE_003*	0.050 + 0.278	0.153

** Indicates inflows that are input laterally (distributed over a reach length) within modelling.*

The inner (low-flow) channel of the watercourse is represented to have a Manning's roughness of 0.035, with the bench and outer channel assumed to have a roughness of 0.05 to account for planting and vegetation growth outwith the low-flow channel.

The proposed site layout includes for two road crossings of the Eastern Watercourse:

- A secondary site access road.
- An access track to the existing wastewater pumping station.

These are assumed to be designed as clearspan bridge crossings, with design to be informed by model predictions, with the crossings themselves not constraining flow within the drain.

Figure 6.1: Eastern Watercourse 1D model schematic, with LiDAR-based ground elevations (external to site) and proposed platform elevations (within the site)

6.2.2 2D Model Construction

The 2D domain of the Eastern Watercourse model was constructed using the same methods and assumptions as for the pre-development model (Section 5.5), with 2D extents indicated in Figure 6.2. The site platform, beyond the northern bank of the channel, is too elevated to be at risk of flooding and therefore is not included within the active area. Note the following additional complexity in relation to representation of the salt marsh area to the east of the site access road:

- For free-draining scenarios (Scenarios A and C), the downstream 2D boundaries will also be free-draining into the tidal salt marsh channel, represented as a normal boundary condition with assumed gradient of 0.2.
- For the tidally-constrained scenario (Scenario B), for computational efficiency/stability, the 1D-2D link lines to the east of the access road are deactivated, thereby also deactivating the portion of the active area to the east of the access road.

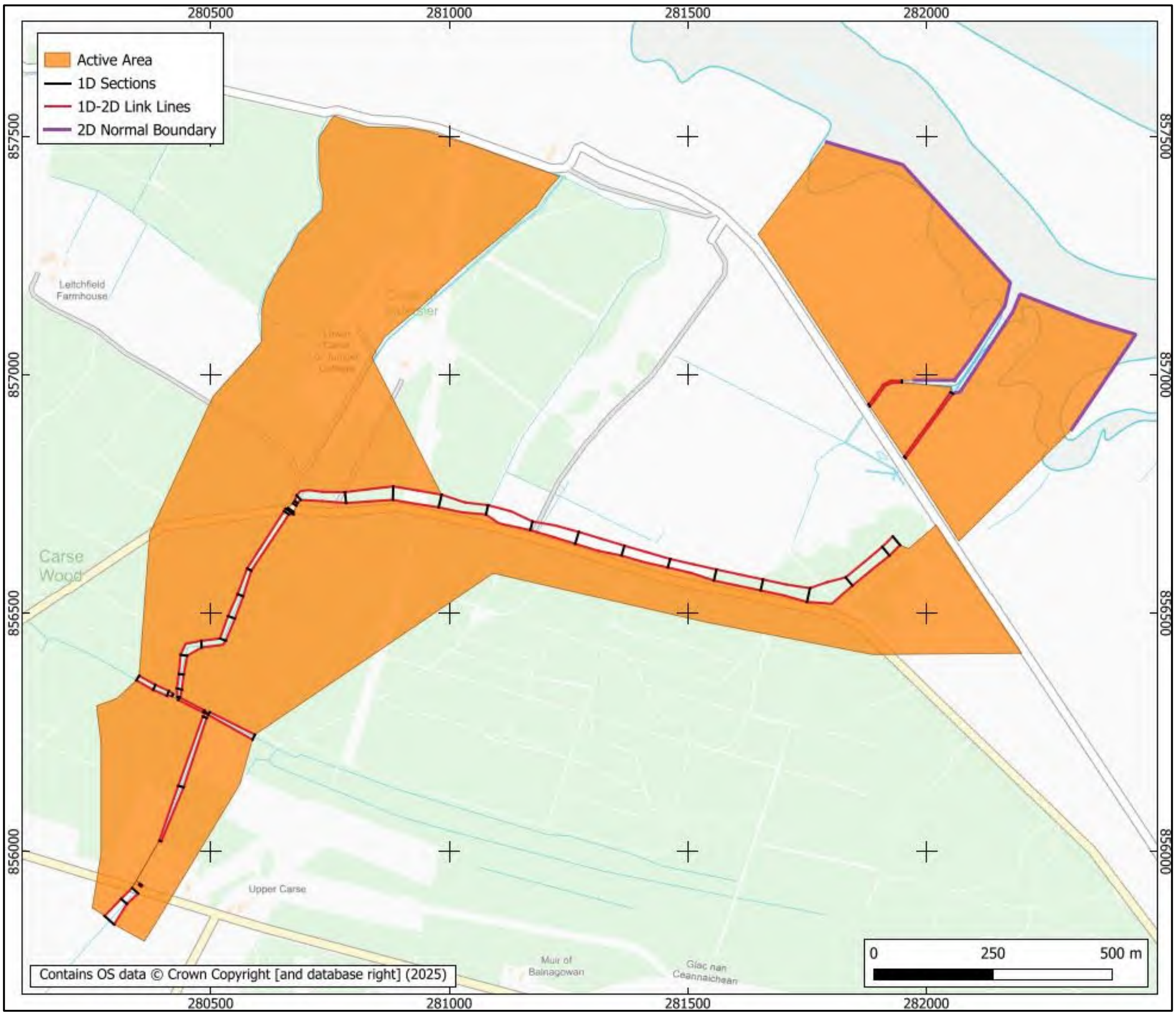

Figure 6.2: Eastern Watercourse 2D model extents, showing 1D-2D boundaries, 1D sections and 2D boundaries within the salt marsh

6.2.3 Model Scenarios & Run Parameters

The Eastern Watercourse model was run using the same parameters as the pre-development model (Section 5.6) and for the same scenarios (Section 5.7), to allow comparative assessment of predicted flooding. Note that, for the purposes of this comparison, Scenario C is based upon 50% blockage of both site access road culverts for post-development conditions.

6.2.4 Model Predictions

Predicted peak 1 in 200 year plus climate change flood depths and extents are presented for Scenarios A, B and C as Figure 6.3, Figure 6.4 and Figure 6.5, respectively. The following tabulated output is also presented in Appendix F:

- Peak predictions of 1D stage, flow, velocity and Froude number for Scenario A.
- Comparative values of predicted 1D peak stage for Scenarios B and C relative to A.
- Comparative values of predicted 1D peak stage upstream of the public road for all scenarios relative to equivalent pre-development scenarios (noting that only the reach upstream of the public road is common to pre- and post-development scenarios).

The spatial pattern of flooding at and upstream of the public road culvert is indistinguishable from the pre-development scenario, with 1D peak stage predictions varying between -1 mm and +2 mm relative to equivalent pre-development predictions (Appendix D); given the high degree of similarity, a comparative assessment of predictive differences in 2D flood predictions was undertaken and is presented in Section 6.2.5. For Scenarios A and C, out-of-bank flooding is predicted downstream of the northern site access road culvert, noting that the area of predicted inundation is outwith the designated saltmarsh site.

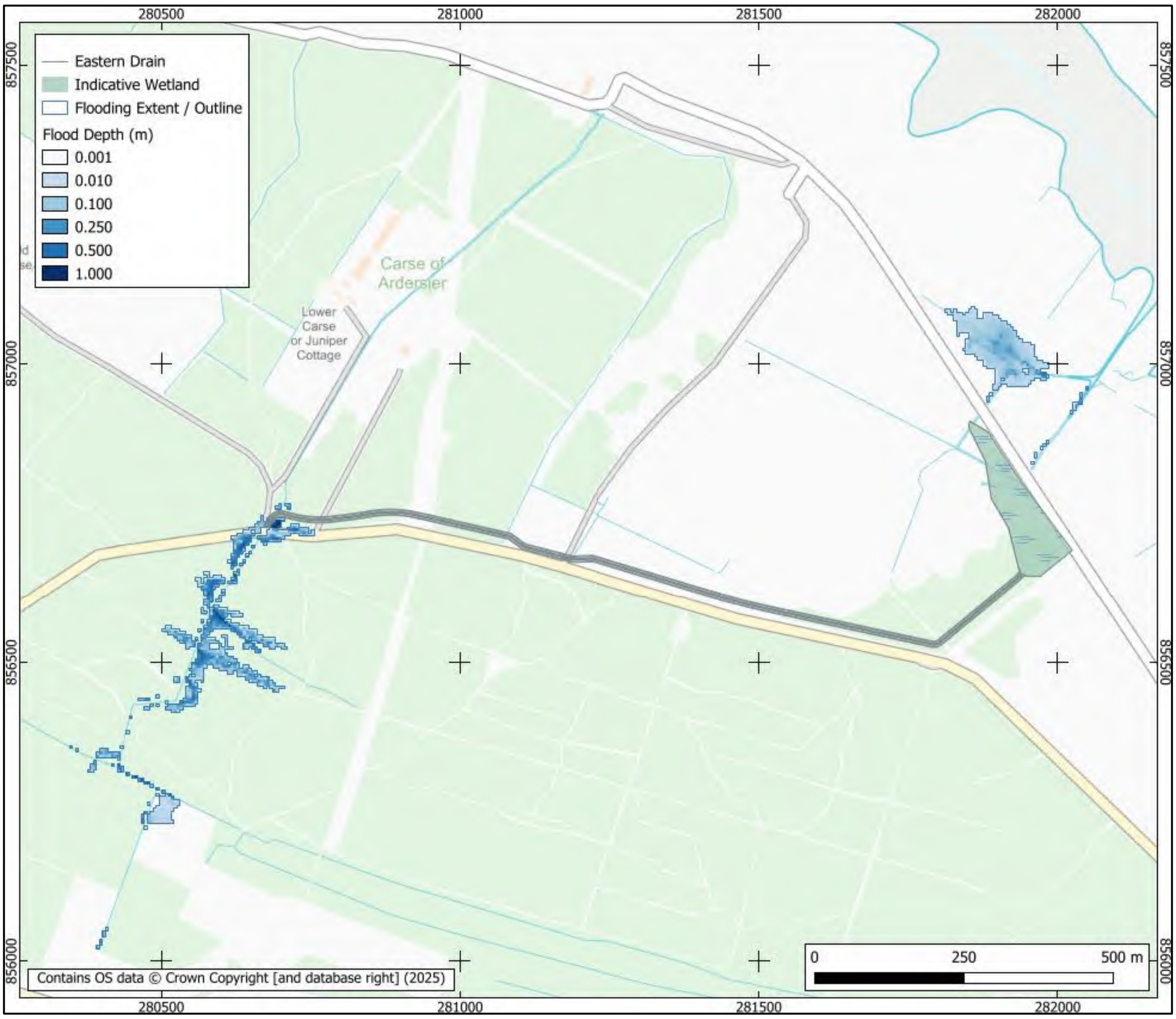

Figure 6.3: Scenario A predicted 2D flood extents and maximum depths

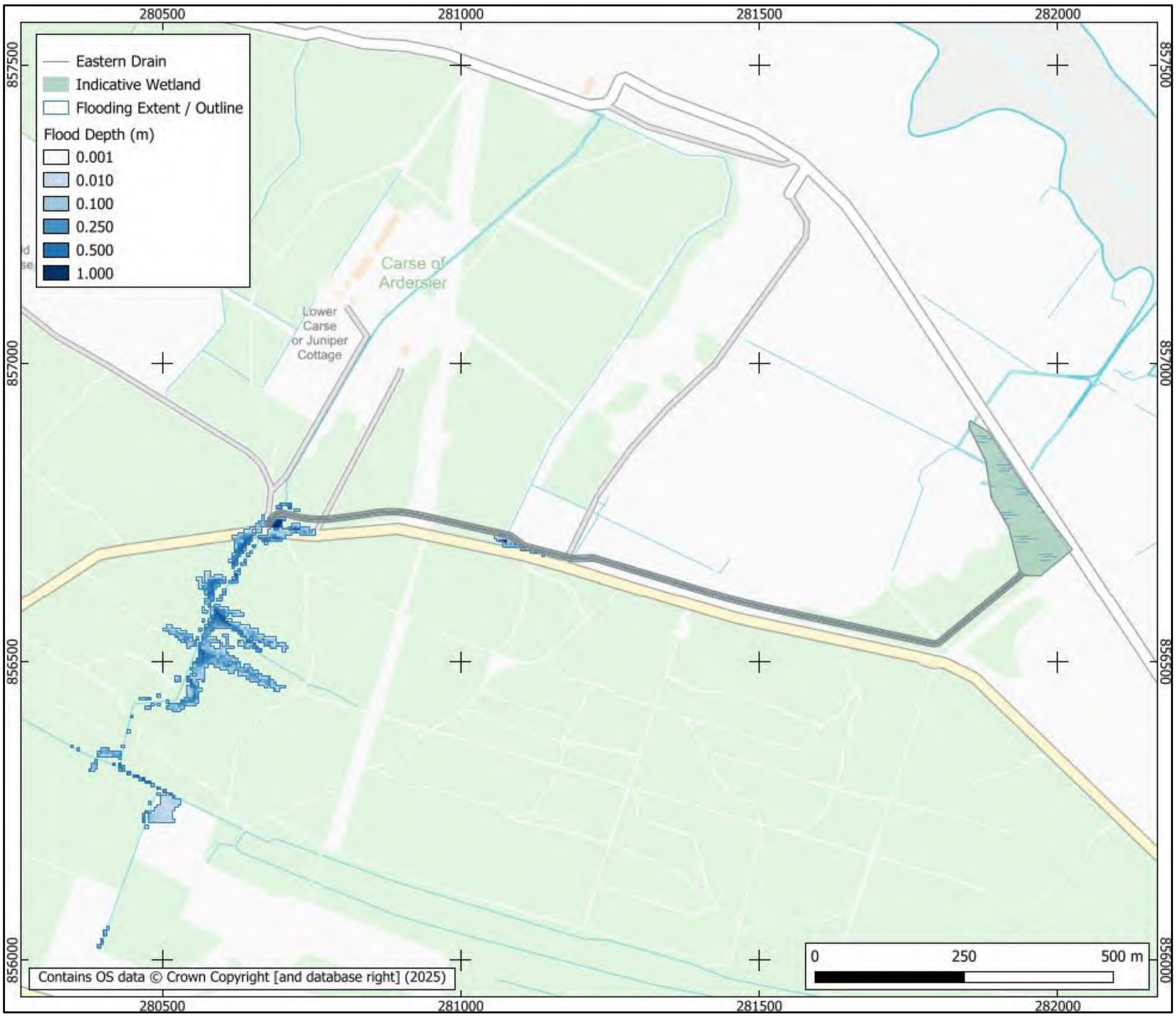

Figure 6.4: Scenario B predicted 2D flood extents and maximum depths (noting that flooding to the east of the site access road was not simulated for this scenario)

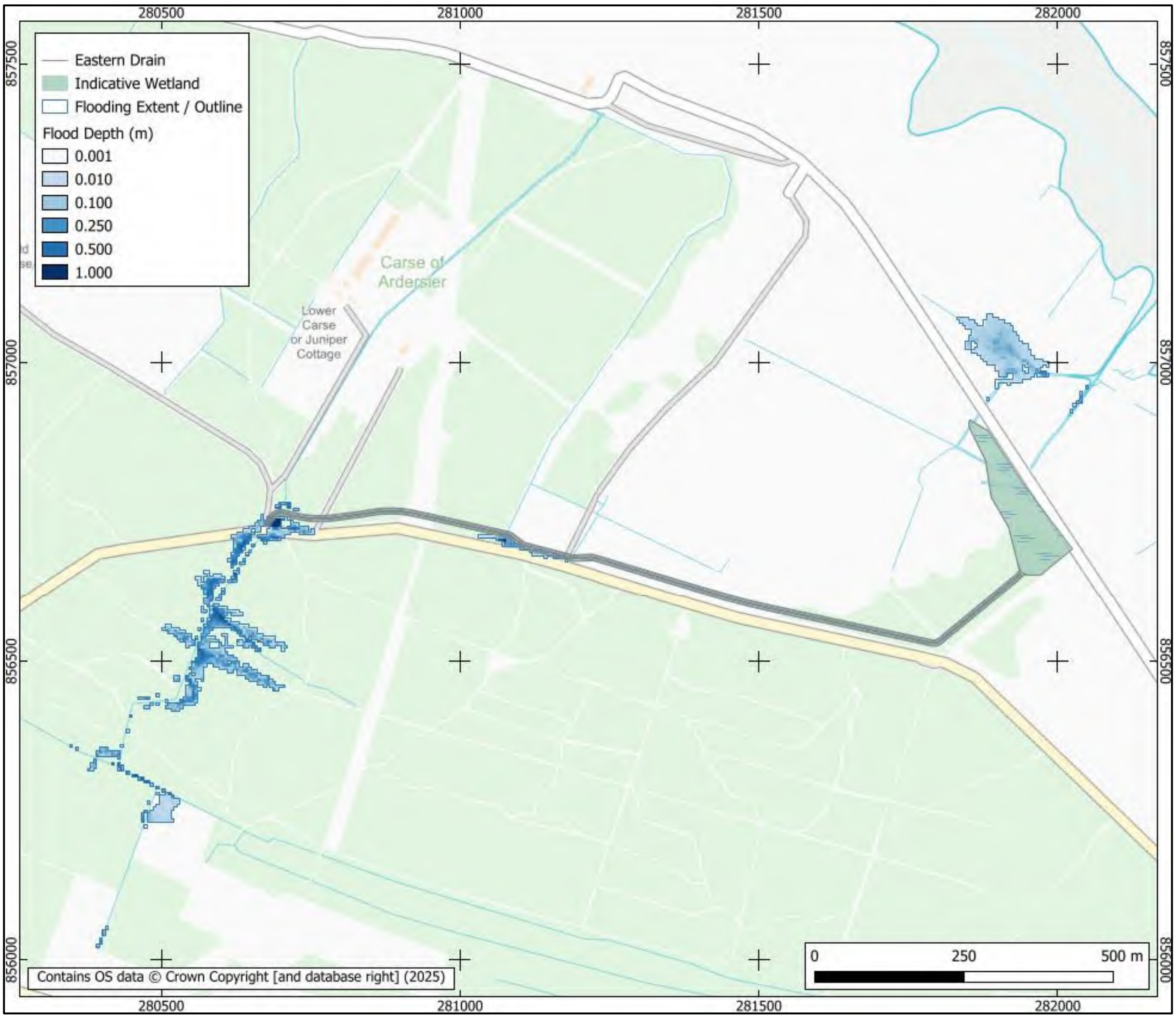

Figure 6.5: Scenario C predicted 2D flood extents and maximum depths

6.2.5 Flood Risk Impact

The impact of development proposals (including land drainage diversion) upon altering predicted flood risk was assessed by subtracting peak post-development flood levels from pre-development flood levels, to generate difference maps for each modelled scenario:

- For Scenario A, development is predicted to have no impact upon predicted flooding at and upstream of the public road culvert, with some minor reductions in predicted peak flood depths upon the inundated section of road (Figure 6.6).
- For Scenario B, development is predicted to have negligible impact upon predicted flooding at and upstream of the public road culvert, albeit with some isolated numerical instability causing small areas of new flooding or slightly deeper flooding around the edges of the inundated extent (Figure 6.7). A small area of flooding is predicted over the southern bank of the diversion watercourse near the WWPS, but this flooding (to levels of ~3.6 mAOD) remains below the level of the public road (~3.7 mAOD). Additional scenarios testing employing a more realistic time-varying tidal downstream boundary with the same 2.95 mAOD peak (not presented) predicts peak flows approximately 300 mm lower at this location, with flows remaining within-bank.

- For Scenario C, as for Scenario B, development is predicted to have negligible impact upon predicted flooding at and upstream of the public road culvert, albeit with some isolated numerical instability causing small areas of new flooding or slightly deeper flooding around the edges of the inundated extent (Figure 6.8). A small area of flooding is predicted over the southern bank of the diversion watercourse near the WWPS, with predicted flood levels marginally below adjacent road levels (~3.7 mAOD). Additional scenarios testing (not presented) indicates design (200 year plus climate change) flows remain within-bank at this location where the proportion of blockage is below 30%.

It is concluded that the proposed eastern diversion watercourse is capable of achieving neutral flood risk impact, or even potential reduction in flood risk compared to existing conditions, subject to the following recommendations:

- As part of proposed works, the inlets of the existing site access road culverts should be screened to protect against blockage by debris (noting that the proposed wetland upstream of the inlets will provide protection against entrained debris, by reducing flow velocities upstream of the culvert inlets, but floating debris may still pose a blockage risk without appropriate inlet screening).
- Flap valves should be installed at the culvert outlets, to reduce the risk of coastal flood inundation to the public road via culvert backflow, noting that flooding to the road may still occur where extreme tides are coincident with high land drainage flows (noting that such conditions will pose flood risk to the road for both pre- and post-development conditions).

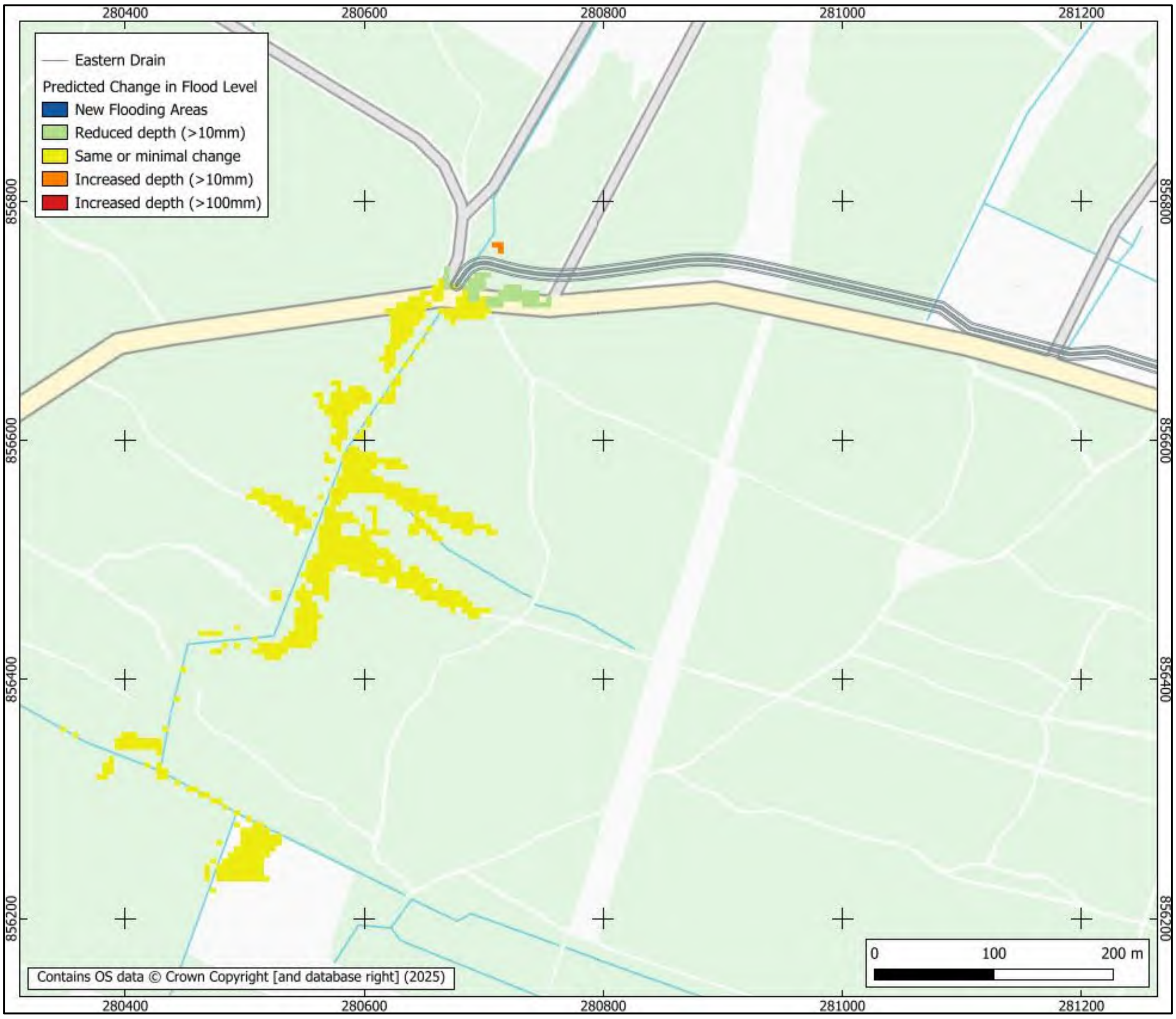

Figure 6.6: Change in predicted peak flood level due to proposals (Scenario A)

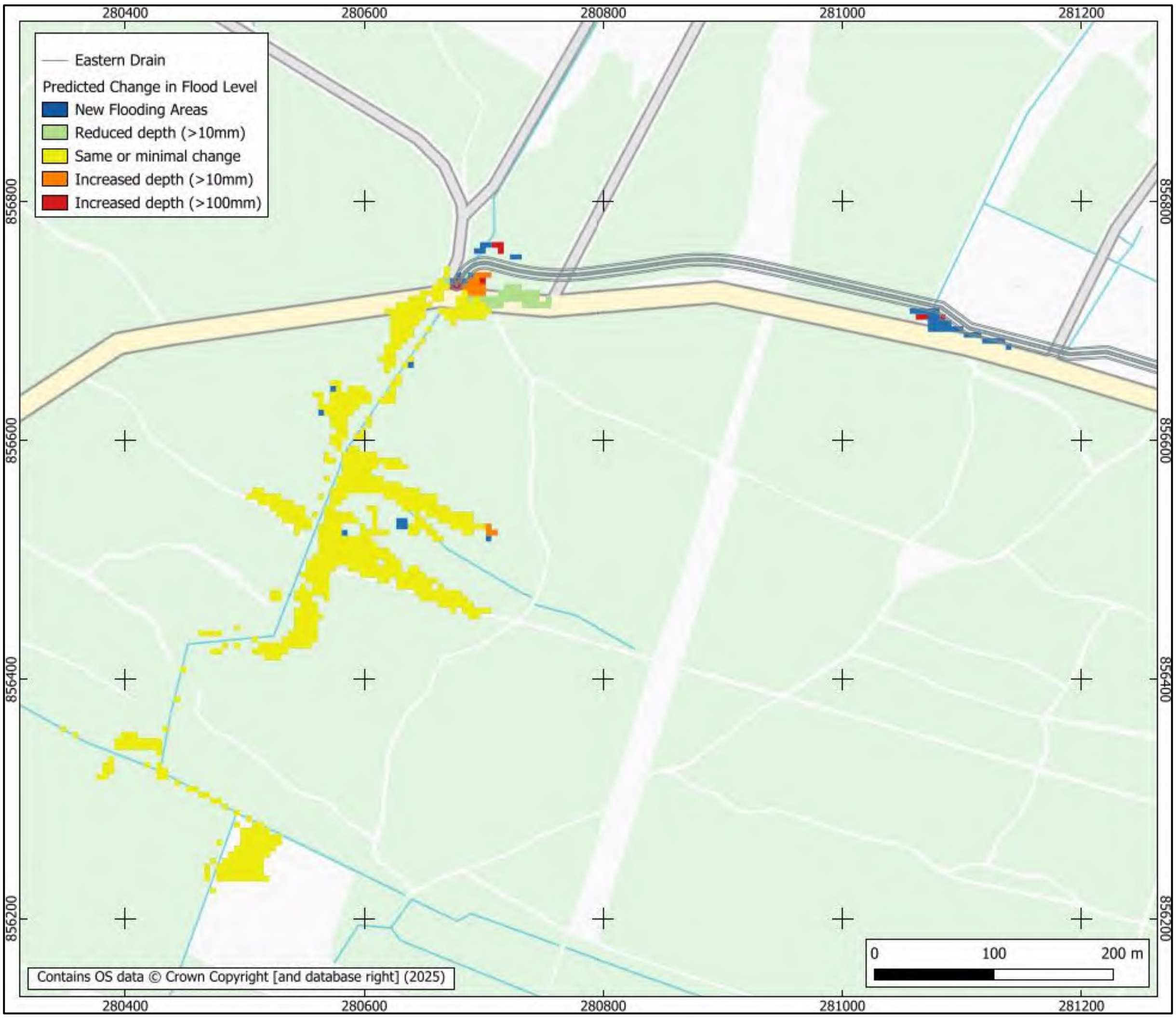

Figure 6.7: Change in predicted peak flood level due to proposals (Scenario B)

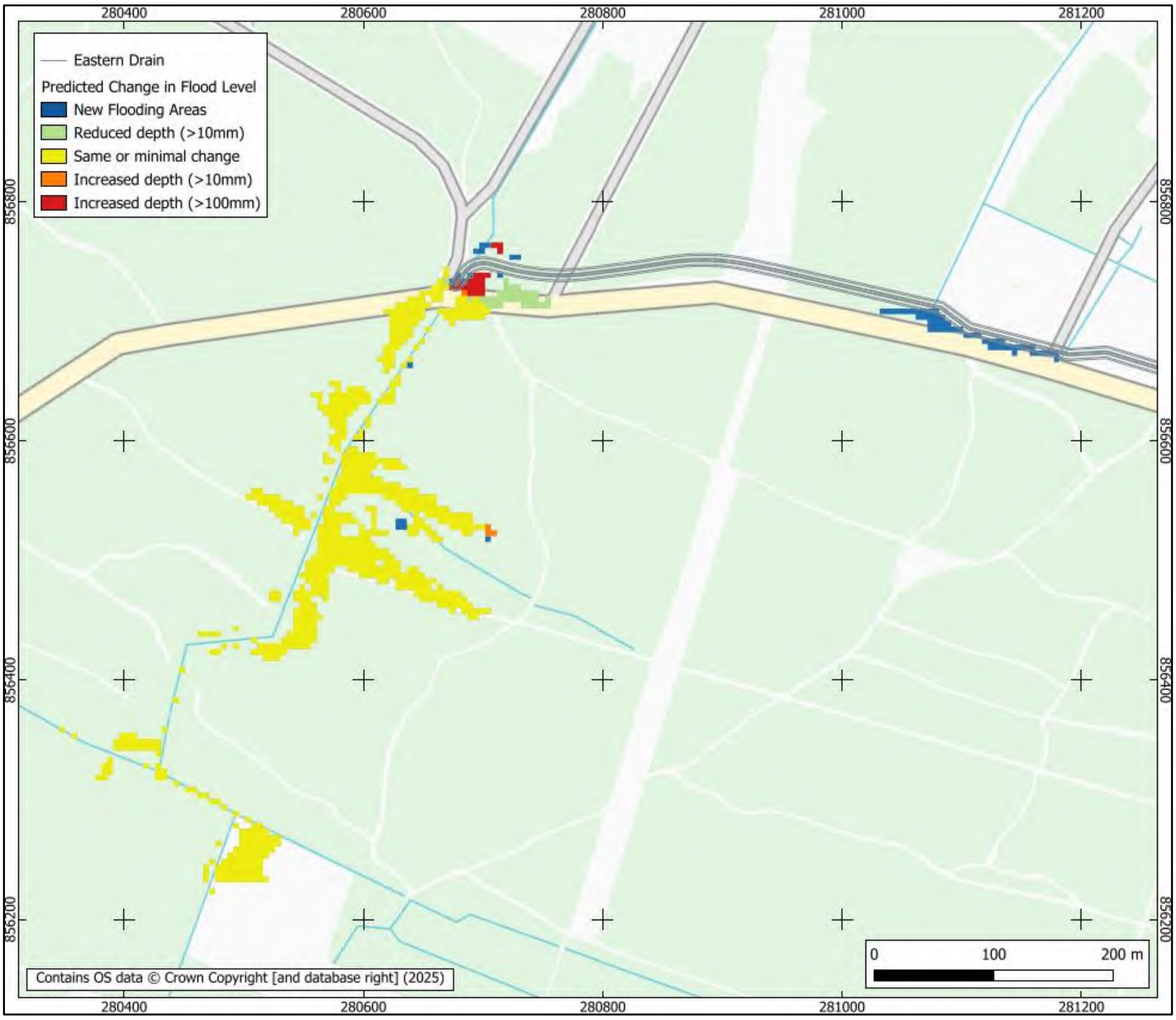

Figure 6.8: Change in predicted peak flood level due to proposals (Scenario C)

6.3 Western Watercourse Model

Proposed design details for the Western Watercourse are presented in Appendix E. Note that, while the conceptual design used for the purpose of hydraulic modelling uses straight reaches of consistent cross-section, the final design of this watercourse will incorporate meanders and other variations to achieve a more naturalised water feature without materially altering flood predictions.

6.3.1 1D Model Construction

A triangulated 3D ground model for post-development conditions, including representation of the Western Watercourse, was created by Fairhurst for use in analysis. A centreline was created following the lowest point of the proposed channel, extending from the southeasternmost extent of the Central Drain system westwards around the site perimeter to drain into the existing lagoon, which was used within Flood Modeller to sample cross-sections at 50 m intervals to create a 1D cross-sectional representation of the watercourse.

The downstream end of the watercourse is assumed to connect to the lagoon via a (nominal) 1 m x 1 m rectangular orifice plate with invert level of 2.16 mAOD. The downstream boundary condition varies for the modelled scenarios as detailed in Section 6.3.3.

Flows from the external catchment of the Central Drain will discharge into the head of the Western Watercourse, with flows from the external catchment of the Western Watercourse entering approximately halfway along the length of the watercourse. Modelling assumes the western portions of the Port Site Perimeter Drain (West) catchment may contribute flows at the downstream end of the watercourse. Modelled inflows are summarised in Table 6.2.

Table 6.2: Peak flow values for subcatchments discharging into the proposed Western Watercourse

Subcatchment	Model Node	Area (km^2)	Peak 200 year plus climate change flow (m^3/s)
06a – Central Drain (External Catchment)	C_001	0.421	0.197
07a – Western Drain (External Catchment)	W_0_012	0.149	0.070
11 – Approximately 50% of Port Site Perimeter Drain (West) Catchment	W_0_022	0.108	0.050

The inner (low-flow) channel of the watercourse is represented to have a Manning's roughness of 0.035, with the bench and outer channel assumed to have a roughness of 0.05 to account for planting and vegetation growth outwith the low-flow channel.

There are no proposed crossings along the length of the watercourse.

Figure 6.9: Western Watercourse 1D model schematic, with LiDAR-based ground elevations (external to site) and proposed platform elevations (within the site)

6.3.2 2D Model Construction

The 2D domain of the Eastern Watercourse model was constructed using the same methods and assumptions as for the pre-development model (Section 5.5), with 2D extents indicated in Figure 6.10. The site platform, beyond the northern bank of the watercourse, is too elevated to be at risk of flooding and therefore is not included within the active area.

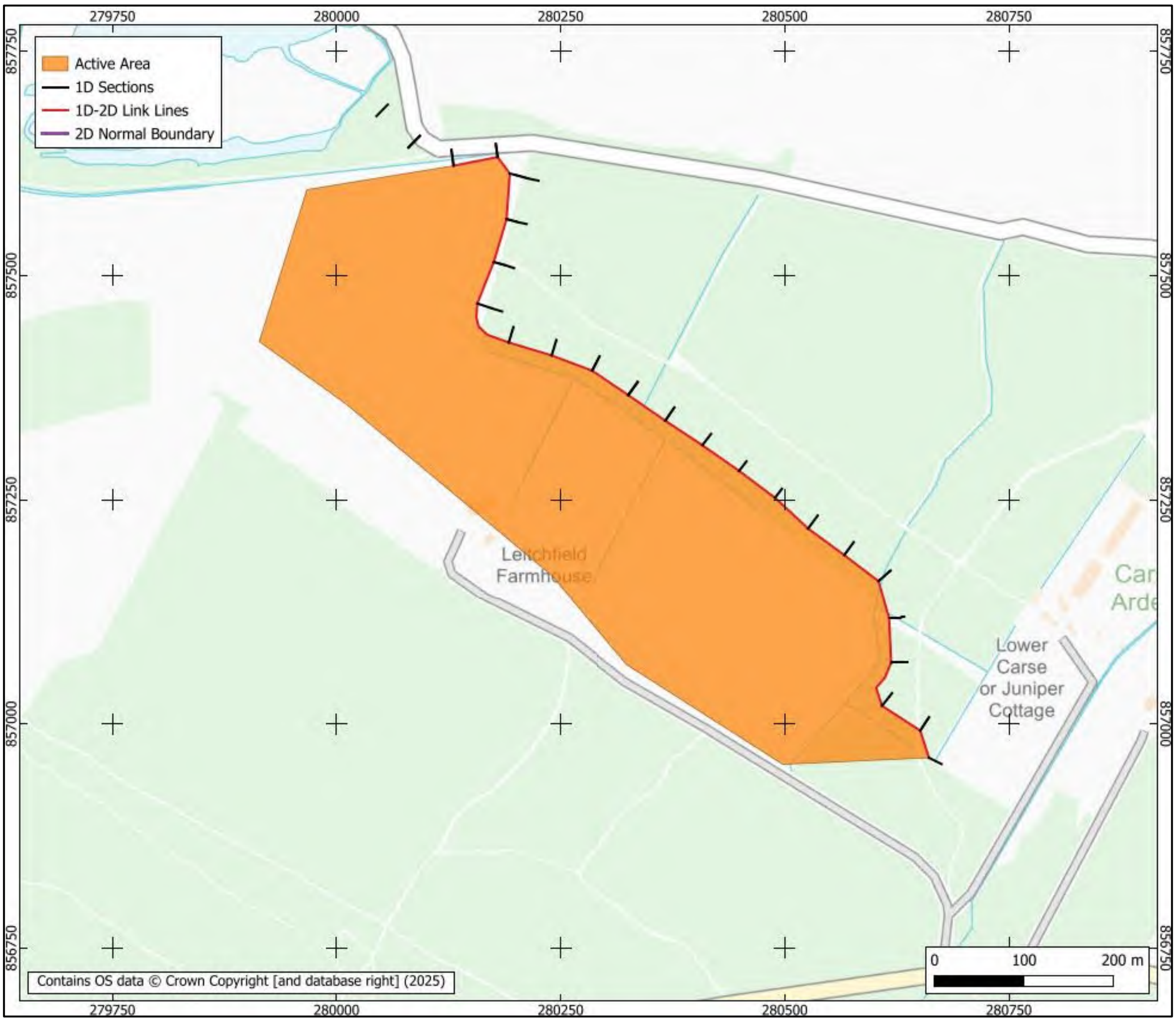

Figure 6.10: Western Watercourse 2D model extents, showing 1D-2D boundaries and 1D sections

6.3.3 Model Scenarios & Run Parameters

The Western Watercourse model was run using the same parameters as the pre-development model (Section 5.6). Two scenarios were assessed:

A. A free-draining scenario, in which the tidal downstream boundary of the model was fixed at 2.4 mAOD, as per pre-development modelling.
B. A tidally constrained scenario, in which the tidal downstream boundary of the model was fixed at 2.95 mAOD (i.e. the estimated MHWS+CC water level).

There are no proposed culverts along the length of the Western Watercourse, such that no culvert blockage scenario was undertaken.

6.3.4 Model Predictions

For Scenario A, predicted peak water levels remain within-bank at all modelled cross-sections, such that there are no predicted 2D flood extents. Figure 6.11 through Figure 6.20 illustrates the peak water level prediction for every second cross-section (i.e. at 100 m intervals along the Western Watercourse) for this scenario, with tabulated 1D peak predictions for both scenarios presented in Appendix G.

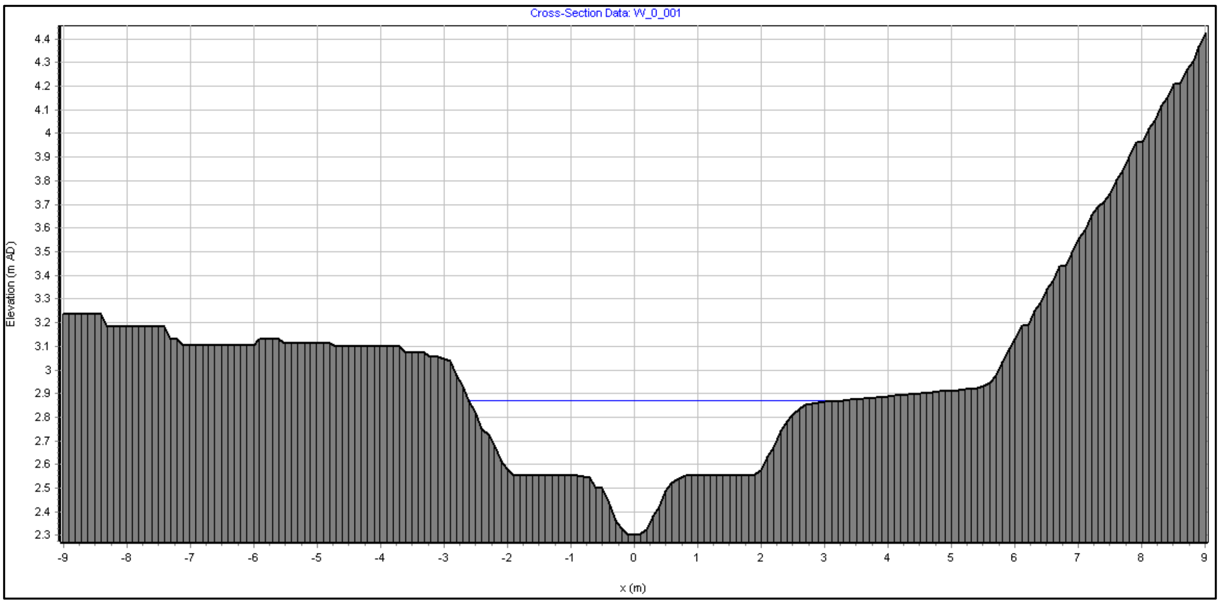

Figure 6.11: Scenario A predictions (Section W_0_001)

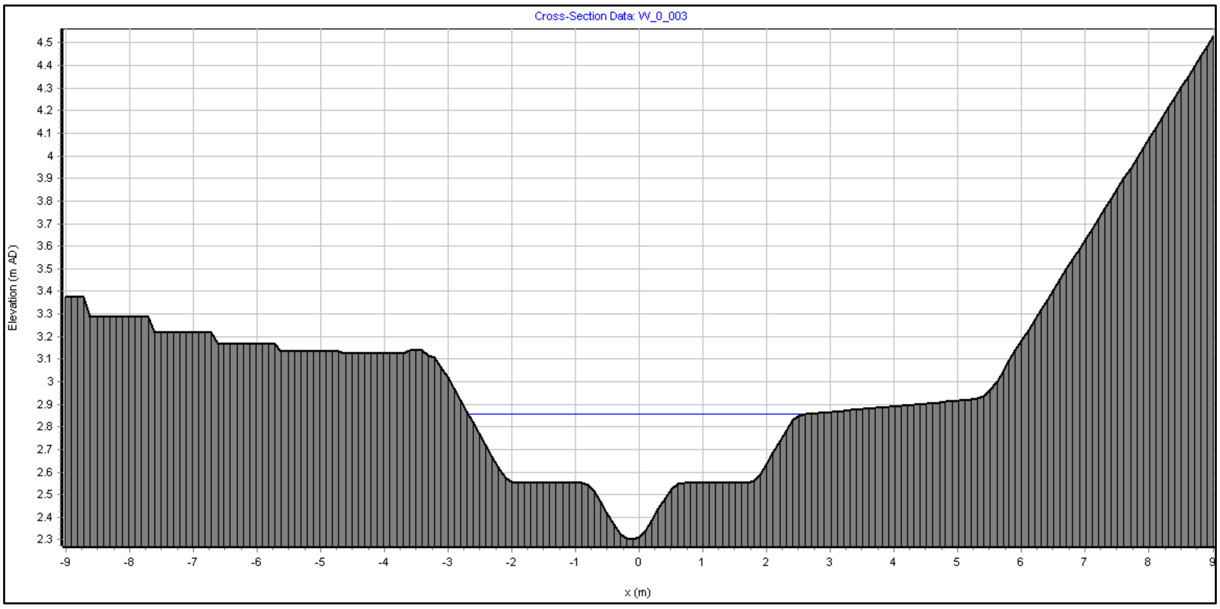

Figure 6.12: Scenario A predictions (Section W_0_003)

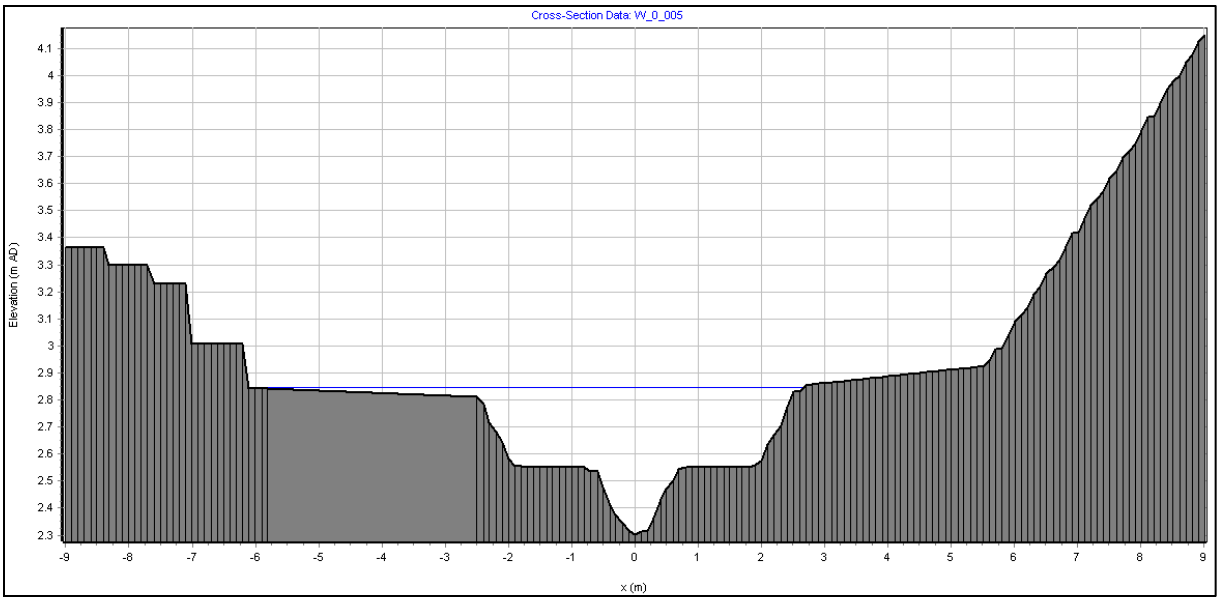

Figure 6.13: Scenario A predictions (Section W_0_005)

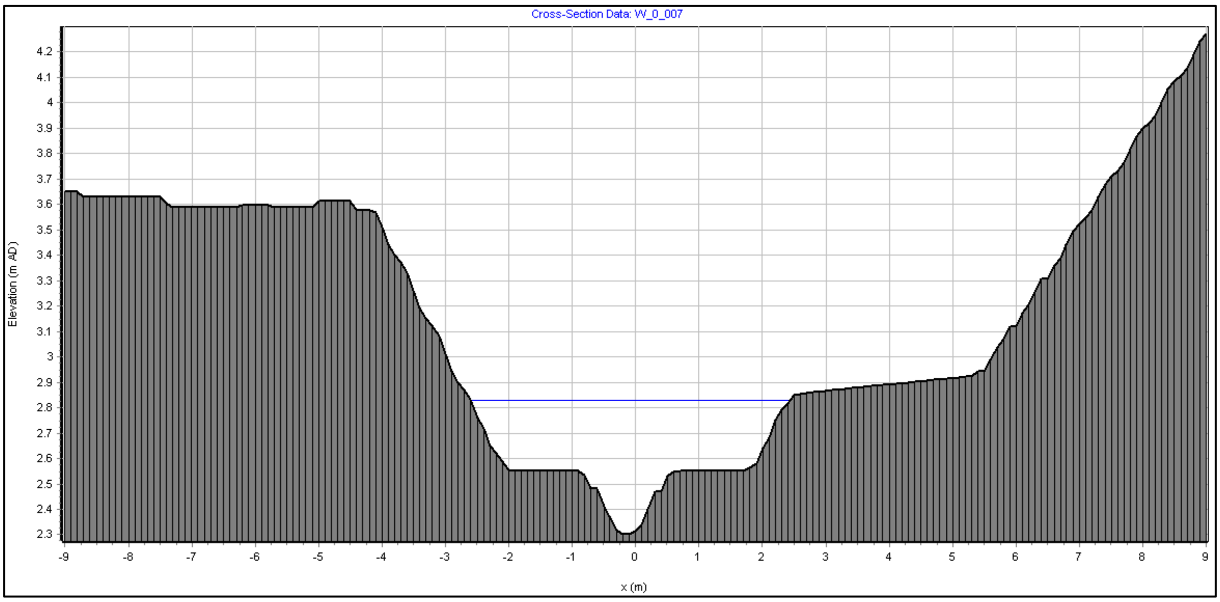

Figure 6.14: Scenario A predictions (Section W_0_007)

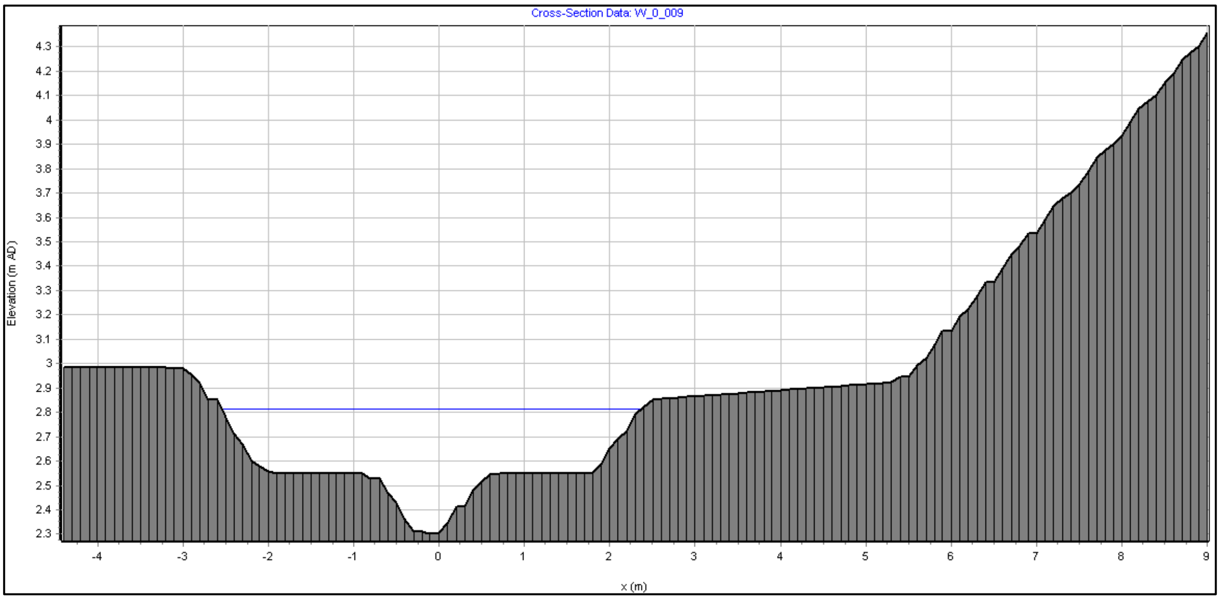

Figure 6.15: Scenario A predictions (Section W_0_009)

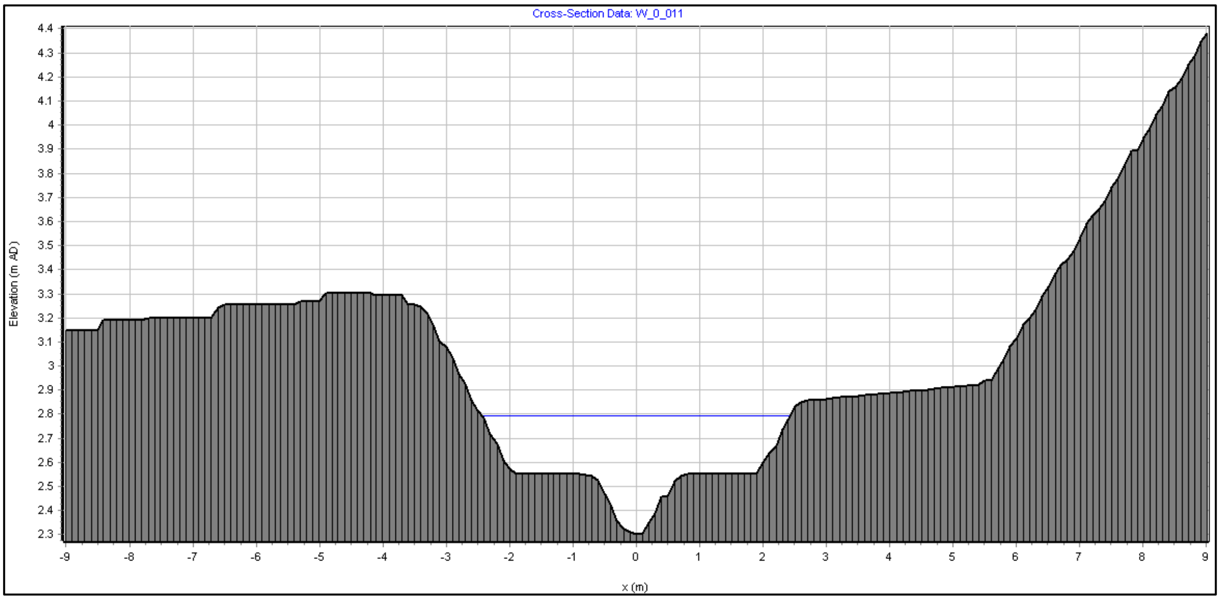

Figure 6.16: Scenario A predictions (Section W_0_011)

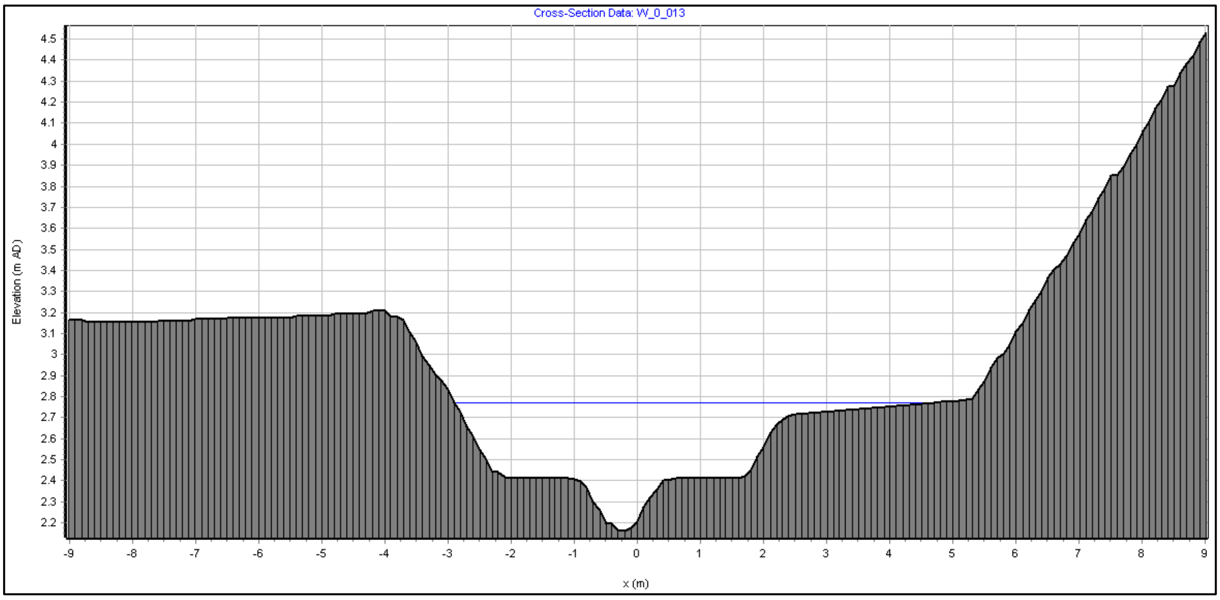

Figure 6.17: Scenario A predictions (Section W_0_013)

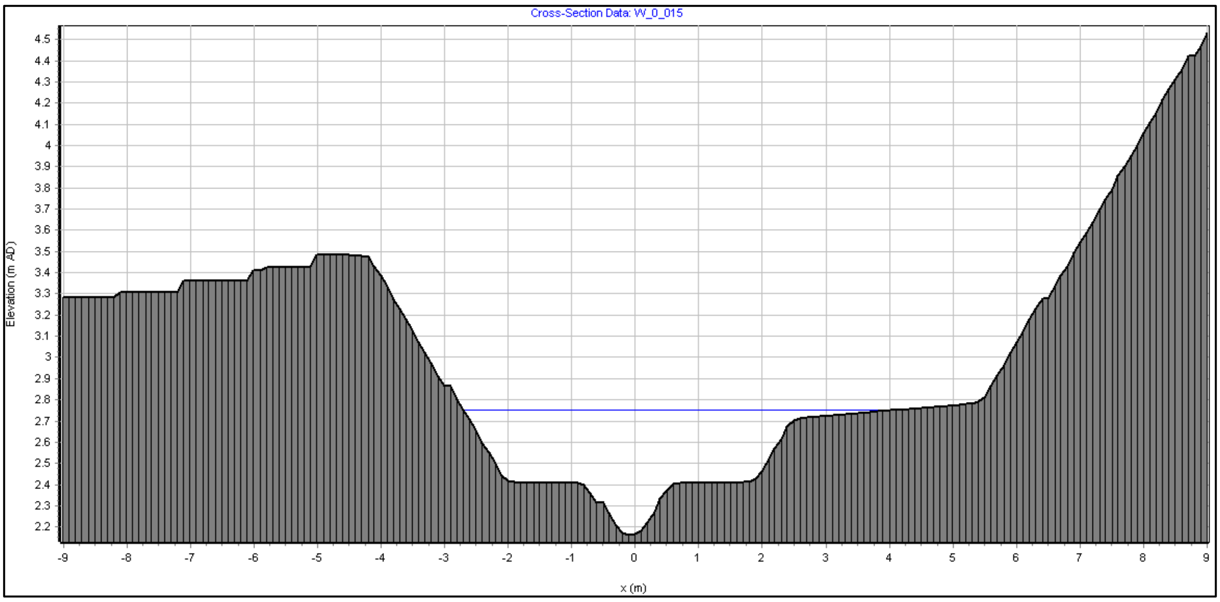

Figure 6.18: Scenario A predictions (Section W_0_015)

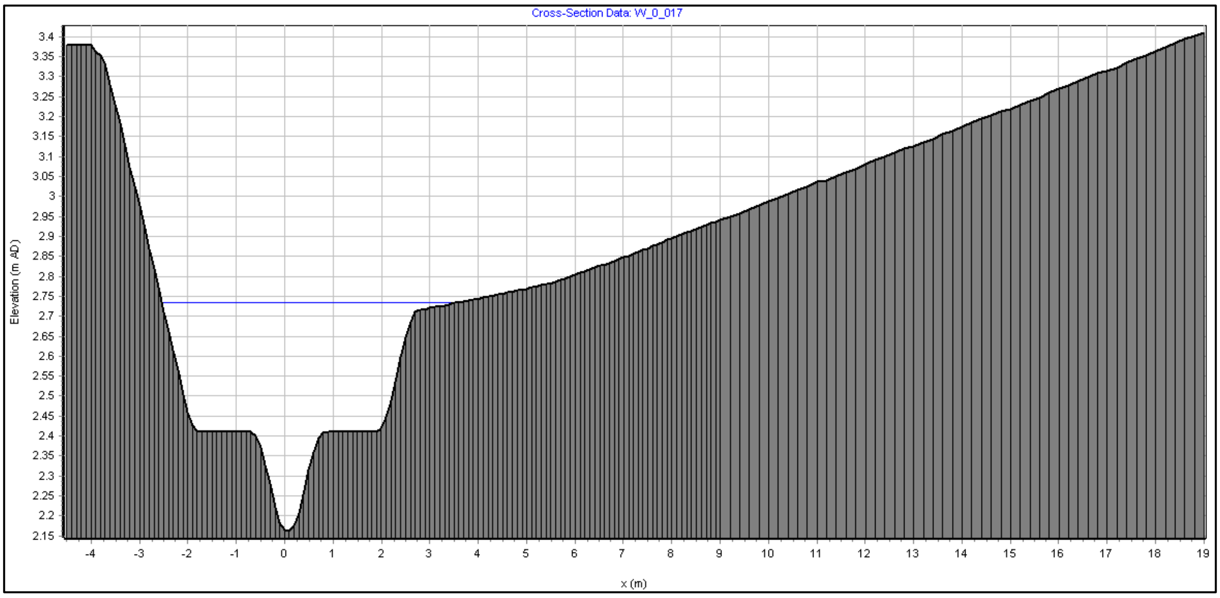

Figure 6.19: Scenario A predictions (Section W_0_017)

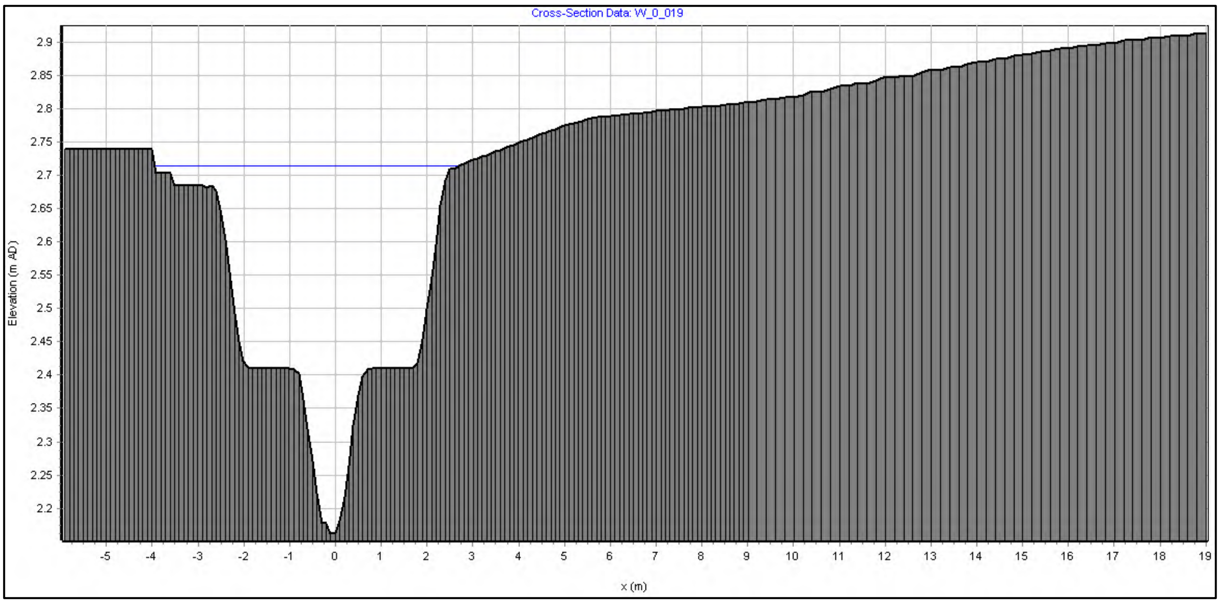

Figure 6.20: Scenario A predictions (Section W_0_019)

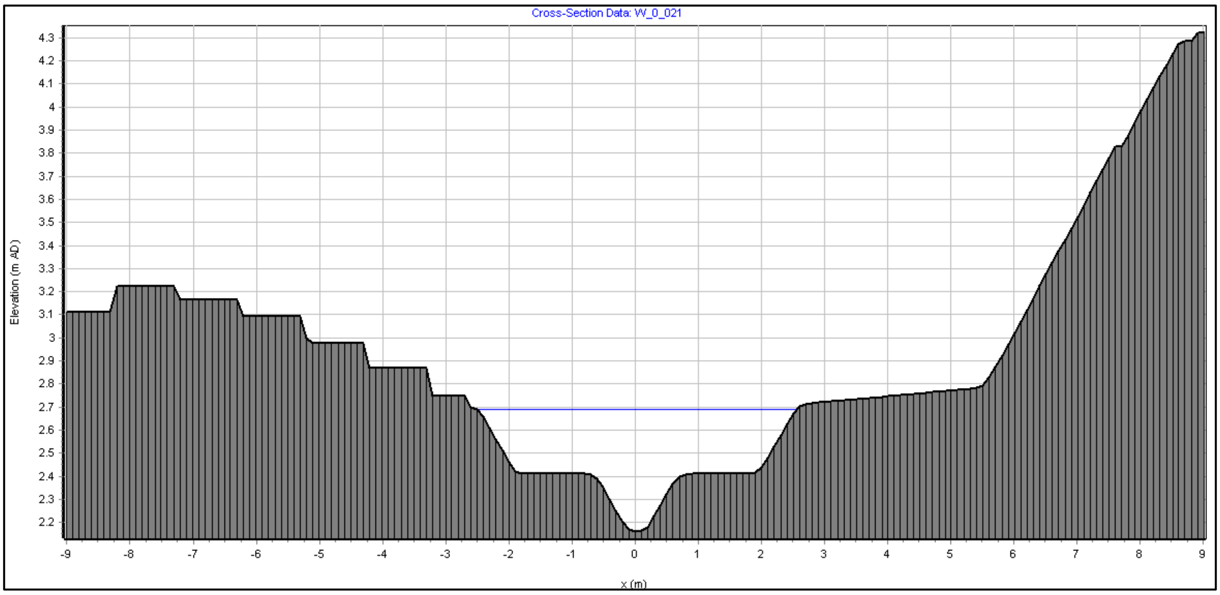

Figure 6.21: Scenario A predictions (Section W_0_021)

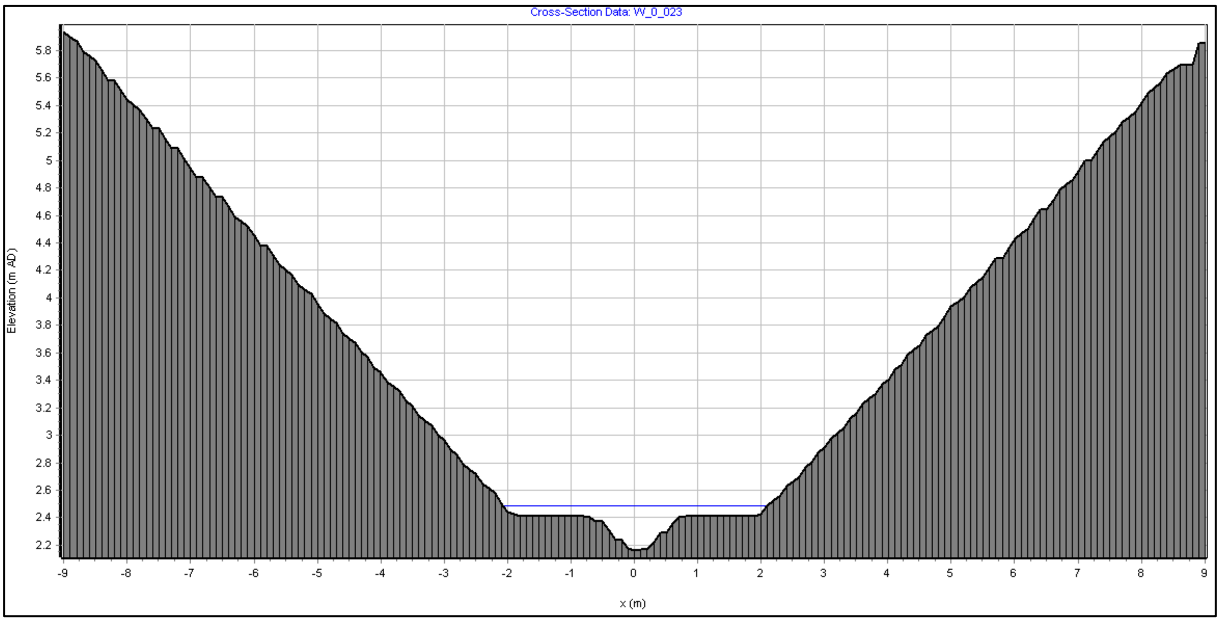

Figure 6.22: Scenario A predictions (Section W_0_023)

For Scenario B, peak water levels remain within-bank at most locations, except in the vicinity of W_0_019, near the final bend on the watercourse before its outfall into the lagoon, where flooding over the western bank is predicted (Figure 6.23). Predicted flooding in this location is less extensive and shallower than for equivalent pre-development conditions (i.e. Figure 5.10), with local peak flood levels of approximately 2.98 mAOD compared to 3.15 mAOD for pre-development conditions.

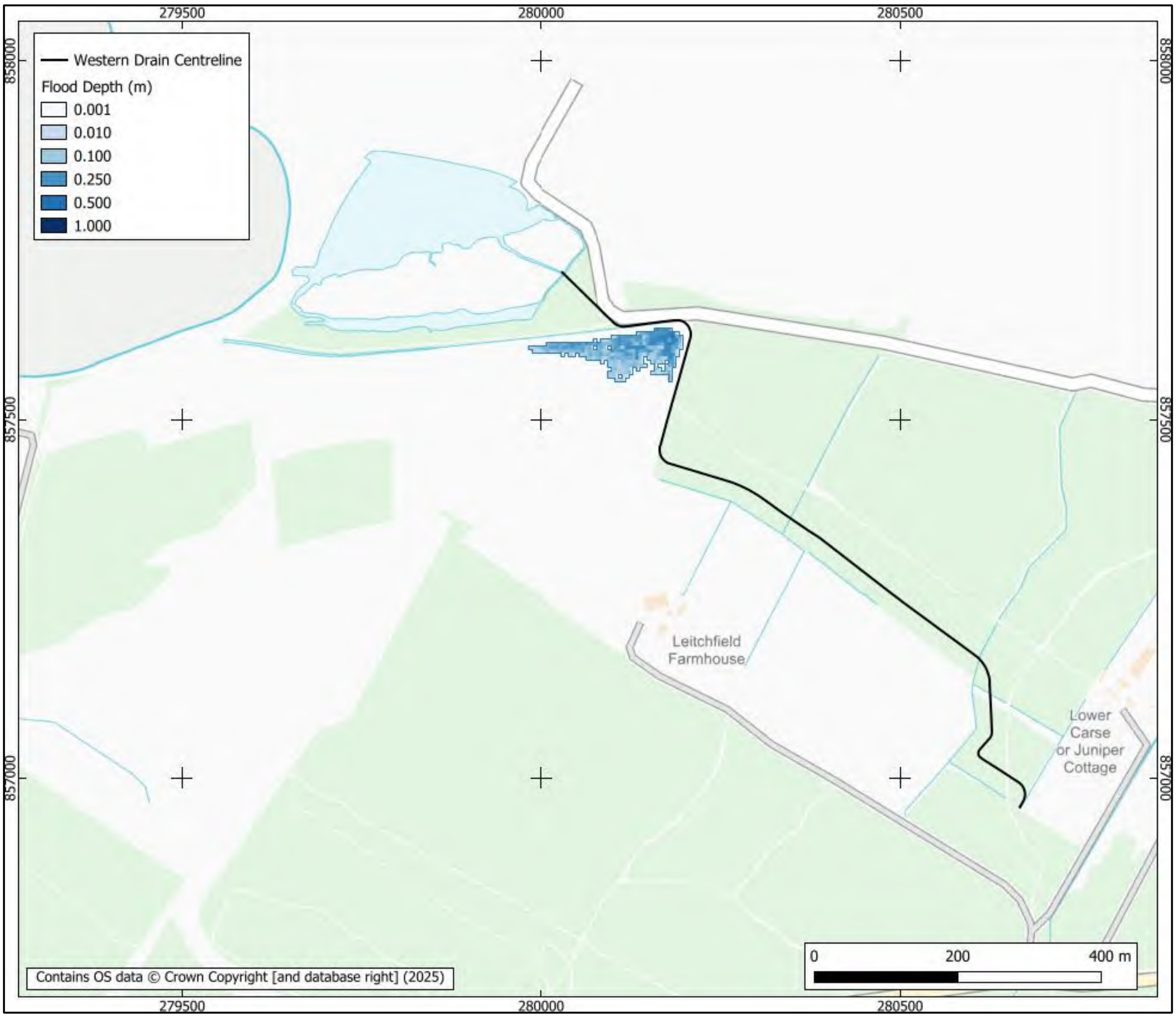

Figure 6.23: Scenario B predicted 2D flood extents and maximum depths

6.3.5 Flood Risk Impact

It is concluded that the proposed western diversion watercourse is capable of achieving neutral flood risk impact, or even potential reduction in flood risk, compared to existing conditions. A flap valve should be installed at the discharge point from the watercourse into the lagoon, to reduce the risk of coastal flood inundation via backflow, noting that extreme tides coincident with high land drainage flows may induce out-of-bank flows over the western and southern banks of the watercourse and thereby pose flood risk external to the application site (although such conditions will pose flood risk for both pre- and post-development conditions).

7 FLOOD RISK IMPACT & MANAGEMENT

7.1 Impact of Flood Risk Upon the Development

Table 7.1 provides a summary of flood risk from all sources, incorporating the outcomes of site-specific assessment of flood risk and proposed management measures within development proposals. The proposed development will be elevated above coastal flood risk (with exception of wave action along the northern and western site boundary) and will not otherwise be at risk of flooding. Proposed diversion watercourses around the site perimeter are demonstrated by modelling to be capable of conveying land drainage from areas south of the application site, ensuring that the development causes no detrimental increase in flood risk to other potential receptors.

Table 7.1: Summary of flood risk

Flood source or mechanism	Post-Development Risk Classification	Proposed Management Measures
Fluvial	No risk	None
Coastal	Low risk (wave action only)	The site will be platformed to above the estimated 1 in 200 year plus climate change extreme stillwater sea level (4.24 mAOD). This will protect the application site against direct coastal inundation, although the northern and western perimeters will be exposed to wave action during extreme sea level conditions.
Surface Runoff	Little or no risk	Proposed watercourse features will direct existing land drainage which drains towards the southern site boundary either eastwards (to discharge via existing culverts under the site access road towards the saltmarsh area) or westwards (to discharge into the lagoon). It is recommended that diversion watercourse outlets are fitted with non-return (flap) valves, to offer protection against backflow from extreme tides. In relation to the Eastern Watercourse, it is recommended that inlet trash screens (or pre-screens) are installed at or upstream of the existing site access road culvert inlets to protect against blockage by floating debris. Runoff due to rainfall onto the site platform will be managed by infiltration SuDS, as described in the accompanying Drainage Impact Assessment.
Infrastructure Failure	Little to no risk	None
Groundwater	Little or no risk	None

7.2 Compliance with Development Management Guidance

7.2.1 Flood Risk Context

Development proposals are considered essential infrastructure[5], which must be located adjacent to the consented port for operational reasons, associated with offshore wind generation. As such, proposals satisfy exception (i) of NPF4 Policy 22(a), and may be located within a flood risk area.

7.2.2 Flood Impacts

Screening responses indicate that The Highland Council and SEPA accept that platforming is required to adequately protect the application site from coastal inundation, with this not considered to pose a risk of displacement and consequent detriment to other receptors.

It is also accepted that diversion of external land drains that currently discharge into the application site is necessary, with proposed diversion watercourses demonstrated by this assessment to be adequate for conveying flows from events up to and including the 1 in 200 year plus climate change event without causing flood risk detriment to external receptors relative to pre-development conditions.

7.2.3 Access and Egress

There is no requirement to achieve flood-free access and egress for essential infrastructure proposals. Nonetheless, the primary and secondary access routes to the application site are not predicted to be at flood risk.

7.2.4 Freeboard

There is no requirement to achieve freeboard above predicted flood levels for essential infrastructure proposals. However, to protect against risk from exceedance events and/or wave action, it would be advisable to set any water-sensitive development or assets back from the coastal (northern and western) site boundaries at levels elevated above the general platform level if possible.

7.2.5 Summary

The proposed development is compliant with SEPA's Development Management Guidance on Flood Risk (2018a) and is compliant with National Planning Framework 4, as an exception under Policy 22(a) (i), in terms of flood risk.

[5] https://www.sepa.org.uk/media/ht3bsekc/land-use-vulnerability-guidance.docx

REFERENCES

CEH (2008). *Flood estimation handbook (five volumes)*. Wallingford: Centre for Ecology & Hydrology.

Scottish Government (2014). Scottish Planning Policy. Edinburgh: Scottish Government.

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SEPA (2022). Technical Flood Risk Guidance for Stakeholders. SEPA.

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APPENDICES

A ANNUAL EXCEEDANCE PROBABILITY – RETURN PERIOD CONVERSION

Flood Frequency Statistics

The magnitudes of flood flows are typically expressed in terms of their long-term average frequency of recurrence, as ‘return periods’ (e.g. 1 in 200 year flood) or ‘annual exceedance probabilities’ (e.g. 0.5% AEP).

The return period (or recurrence interval) of a flood is the long-term average period between flood conditions of such magnitude (or greater). The annual exceedance probability of particular flood conditions is the chance these conditions (or more severe) occur in any given year.

Relationship between return periods and annual exceedance probability

Return period, T (year)	Annual exceedance probability, AEP (%)	Probability of occurrence over a 50 year period (%)	Comment
2	50	100	Median annual flood (also known as **QMED**). In the long-term this occurs every other year, on average. As a rule of thumb, this flow generally equates to ‘bankfull’ conditions in most natural channels.
5	20	100	
10	10	99	
20	5	92	
30	3.3	82	Typical design standard for urban drainage systems.
50	2	64	
100	1	39	
200	0.5	22	Typical design standard for river or coastal flooding for most developments. NPF4 defines “flooding areas” based on this event, with inclusion of climate change uplift.
500	0.2	10	
1,000	0.1	4.9	Typical design conditions standard for sensitive or vulnerable developments/contexts.

Lifetime Probabilities, or Design Life Probabilities

The probability of a flood event occurring at least once over a set period of time (e.g. an individual’s lifetime or the design life of a built structure) can be evaluated against the following table.

Age, or Design Period (years)	Flood Return period (years)				
	2	10	30	200	1000
10	100%	65%	29%	5%	1%
25	100%	93%	57%	12%	2%
80	100%	100%	93%	33%	8%
100	100%	100%	97%	39%	10%

B DONOR CATCHMENT DESCRIPTORS

VERSION	"FEH CD-ROM" Version 5.0.1 exported at 10:09:03 GMT Fri 27-Sep-24
CATCHMENT	GB 280700 856750 NH 80700 56750
CENTROID	GB 280278 855468 NH 80278 55468
AREA	2.2825
ALTBAR	13
ASPBAR	4
ASPVAR	0.31
BFIHOST	0.888
BFIHOST19	0.874
DPLBAR	1.91
DPSBAR	18.4
FARL	1
FPEXT	0.1667
FPDBAR	0.763
FPLOC	0.612
LDP	3.3
PROPWET	0.42
RMED-1H	8.5
RMED-1D	30.2
RMED-2D	39.7
SAAR	640
SAAR4170	587
SPRHOST	14.83
URBEXT1990	0
URBEXT2000	0
C	-0.02191
D1	0.38429
D2	0.43806
D3	0.27942
E	0.27505
F	2.20091
C(1 km)	-0.021
D1(1 km)	0.381
D2(1 km)	0.424
D3(1 km)	0.3
E(1 km)	0.275
F(1 km)	2.199

C DONOR CATCHMENT HYDROLOGY

FEH rainfall-runoff method (200yr plus climate change)

```
                                                              FILE=35A6.dat Flood Modeller VER=4.5.1.6163
************************************************************
Flood Modeller
************************************************************

HYDROLOGICAL DATA

Catchment: 200yrCC
************************************************************
Catchment Characteristics
************************************************************
Easting        :    280700 Northing       :    856750
Area           :     2.283 km2
DPLBAR         :     1.910 km
DPSBAR         :    18.400 m/km
PROPWET        :     0.420
SAAR           :   640.000 mm
Urban Extent   :     0.000
c              :     0.000
d1             :     0.000
d2             :     0.000
d3             :     0.000
e              :     0.000
f              :     0.000
SPR            :    14.830 %
************************************************************
Summary of estimate using Flood Estimation Handbook rainfall-runoff method
************************************************************
Estimation of T-year flood
==========================
Unit hydrograph time to peak   :     4.399 hours
Instantaneous UH time to peak  :     4.374 hours
Data interval                  :     0.050 hours
Design storm duration          :     7.200 hours
Critical storm duration        :     7.215 hours
Return period for design flood :     0.000 years
requires rain return period    :     0.000 years
ARF                            :     0.000
Design storm depth             :    95.664 mm
CWI                            :    93.200
Standard Percentage Runoff     :    14.830 %
Percentage runoff              :    14.381 %
Snowmelt rate                  :     0.000 mm/day
Unit hydrograph peak           :     0.114 (m3/s/mm)
Quick response hydrograph peak :     1.262 m3/s
Baseflow                       :     0.020 m3/s
Baseflow adjustment            :     0.000 m3/s
Hydrograph peak                :     1.282 m3/s
Hydrograph adjustment factor   :     1.000

Flags
=====
Unit hydrograph flag           : FSRUH
Tp flag                        : FEHTP
Event rainfall flag            : OBSER
Rainfall profile flag          : WINRP
Percentage Runoff flag         : FEHPR
Baseflow flag                  : F16BF
CWI flag                       : FSRCW
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ReFH2 method (200yr plus climate change)

UK Design Flood Estimation

Generated on 13 May 2025 14:06:01 by DHALL
Printed from the ReFH2 Flood Modelling software package, version 4.0.8560.23190

Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH2)

Site details Checksum: 0F6A-547A

Site name: FEH_Catchment_Descriptors_280700_856750_v5_0_1

Easting: 280700

Northing: 856750

Country: Scotland

Catchment Area (km²): 2.28

Using plot scale calculations: No

Model: 2.3

Site description: None

Model run: 200 year 1.42 CC

Summary of results

Rainfall - FEH22 (mm):	120.31	Total runoff (ML):	16.49
Total Rainfall (mm):	79.69	Total flow (ML):	53.08
Peak Rainfall (mm):	15.54	Peak flow (m³/s):	0.72

Parameters

Where the user has overriden a system-generated value, this original value is shown in square brackets after the value used.
** Indicates that the user locked the duration/timestep*

Rainfall parameters (Rainfall - FEH22)

Name	Value	User-defined?
Duration (hh:mm:ss)	06:30:00	No
Timestep (hh:mm:ss)	00:30:00	No
SCF (Seasonal correction factor)	0.68	No
ARF (Areal reduction factor)	0.97	No
Seasonality	Winter	No
Climate change factor	1.42	Yes

Loss model parameters

Name	Value	User-defined?
Cini (mm)	45.34	No
Cmax (mm)	939.83	No
Use alpha correction factor	No	No
Alpha correction factor	n/a	No

Routing model parameters

Name	Value	User-defined?
Tp (hr)	4.17	No
Up	0.65	No
Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	0	No
BL (hr)	30.33	No
BR	2.22	No

Urbanisation parameters

Name	Value	User-defined?
Sewer capacity (m^3/s)	0	No
Exporting drained area (km^2)	0	No
Urban area (km^2)	0	No
Urbext 2000	0	No
Impervious runoff factor	0.7	No
Imperviousness factor	0.4	No
Tp scaling factor	0.75	No
Depression storage depth (mm)	0.5	No

Appendix

Catchment descriptors

Name	Value	User-defined value used?
Area (km^2)	2.28	No
ALTBAR	13	No
ASPBAR	4	No
ASPVAR	0.31	No
BFIHOST	0.89	No
BFIHOST19	0.87	No
DPLBAR (km)	1.91	No
DPSBAR (mkm^{-1})	18.4	No
FARL	1	No
LDP	3.3	No
PROPWET	0.42	No
RMED1H	8.5	No
RMED1D	30.2	No
RMED2D	39.7	No
SAAR (mm)	640	No
SAAR4170 (mm)	587	No
SPRHOST	14.83	No
Urbext2000	0	No
Urbext1990	0	No
URBCONC	0	No
URBLOC	0	No
DDF parameter C	-0.02	No
DDF parameter D1	0.38	No
DDF parameter D2	0.44	No
DDF parameter D3	0.28	No
DDF parameter E	0.28	No
DDF parameter F	2.2	No
DDF parameter C (1km grid value)	-0.02	No
DDF parameter D1 (1km grid value)	0.38	No
DDF parameter D2 (1km grid value)	0.42	No
DDF parameter D3 (1km grid value)	0.3	No
DDF parameter E (1km grid value)	0.28	No
DDF parameter F (1km grid value)	2.2	No

D PRE-DEVELOPMENT TABULAR PREDICTIONS

Predicted peak state variables for Scenario A

System	Label	Stage (mAOD)	Flow (m^3/s)	Velocity (m/s)	Froude
Main Drain	MainUUS_000	8.217	1.147	0.442	0.221
	MainUUS_001	8.146	1.147	0.649	0.558
	MainUUS_002	8.098	1.147	0.596	0.286
	M_001	7.522	1.147	0.826	0.361
	M_002	7.456	1.147	0.927	0.421
	M_003	6.980	1.147	0.610	0.240
	M_004	5.712	1.149	1.650	0.821
	M_005	4.233	1.023	0.660	0.378
	M_005us	4.221	1.024	0.653	0.470
	M_005ds	4.221	1.583	0.819	0.365
	M_006us	4.165	1.581	0.490	0.179
	M_006ds	4.165	1.888	0.566	0.204
	M_006	4.164	1.891	0.404	0.173
	M_007	4.125	1.993	0.676	0.267
	M_007_1	4.100	2.019	0.531	0.223
	M_007_2	4.084	2.051	0.352	0.185
	M_007_3	4.045	2.082	0.560	0.207
	M_007_4	4.013	1.956	0.400	0.180
	M_008	3.984	2.054	0.313	0.154
	M_009	3.976	1.525	0.288	0.129
	MainCulv_000	3.936	2.211	0.330	0.158
	MainCulv_003	3.943	0.916	0.113	0.067
	MainCulv_005	3.944	0.742	0.210	0.113
	MainCulv_012	3.558	0.742	0.649	0.561
	MainCulv_015	3.552	1.345	0.446	0.213
	M_010us1	3.484	2.499	0.620	0.255
	M_010us2	3.477	2.455	0.572	0.251
	M_010us3	3.456	2.439	0.649	0.286
	M_010us4	3.442	2.413	0.707	0.249
	M_010us5	3.379	2.412	0.708	0.261
	M_010	3.321	2.407	0.686	0.271
	M_011	3.313	2.405	0.737	0.299
	M_012	3.113	2.402	0.809	0.349
	M_013	3.083	2.401	1.009	0.442
	M_013_1	3.039	2.318	0.508	0.315
	M_013_2	2.931	2.373	0.616	0.302
	M_014	2.807	2.382	0.748	0.266
	M_014_1	2.653	2.391	0.748	0.297
	M_014_2	2.617	2.392	0.715	0.298
	M_014_3	2.606	2.392	0.683	0.312
	M_014_4	2.583	2.389	0.612	0.288
	M_015	2.565	2.391	0.561	0.257
Western Drain	W_001	2.597	0.050	0.025	0.015
	W_001_1	2.597	0.052	0.038	0.024
	W_001_2	2.597	0.056	0.042	0.027
	W_001_2In1	2.597	0.072	0.052	0.036
	W_001_2In2	2.596	0.085	0.067	0.047
	W_002us	2.596	0.098	0.087	0.066
	W_002	2.596	0.196	0.169	0.135

System	Label	Stage (mAOD)	Flow (m^3/s)	Velocity (m/s)	Froude
	W_002In1	2.595	0.209	0.151	0.123
	W_002In2	2.593	0.218	0.130	0.097
	W_002_1	2.592	0.231	0.117	0.073
	W_003	2.592	0.421	0.203	0.110
	W_003_1	2.591	0.423	0.204	0.111
	W_003_2	2.587	0.435	0.210	0.115
	W_003_3	2.582	0.451	0.215	0.115
	W_003_4	2.579	0.459	0.218	0.117
	W_003_4In1	2.574	0.478	0.226	0.122
	W_003_4In2	2.569	0.492	0.231	0.131
	W_004	2.565	0.538	0.278	0.233
Southwestern Drain	W_S01	2.600	0.070	0.063	0.033
	W_S02	2.598	0.083	0.318	0.263
	W_S03	2.598	0.083	0.084	0.058
	W_S04	2.598	0.100	0.062	0.029
	W_S04In1	2.597	0.113	0.086	0.046
	W_S05	2.596	0.109	0.129	0.092
Central Drain	C_001	3.296	0.197	0.660	0.461
	C_002	2.858	0.197	0.393	0.230
	C_002_1	2.788	0.202	0.380	0.236
	C_003	2.729	0.208	0.257	0.156
	C_003_1	2.707	0.210	0.356	0.215
	C_004	2.668	0.214	0.400	0.310
	C_005	2.665	0.214	0.301	0.156
	C_005_1	2.648	0.218	0.325	0.172
	C_005_2	2.634	0.220	0.347	0.196
	C_006	2.613	0.225	0.355	0.220
	C_006_1	2.605	0.226	0.341	0.215
	C_006_2	2.601	0.228	0.324	0.203
	C_006_3	2.594	0.231	0.233	0.151
	C_006_4	2.593	0.232	0.211	0.139
	C_007	2.592	0.234	0.150	0.080
Southeastern Drain	SE_001	3.287	0.068	0.142	0.188
	SE_001In1	3.173	0.068	0.150	0.189
	SE_001In2	3.060	0.068	0.160	0.190
	SE_001In3	2.949	0.068	0.179	0.195
	SE_001In4	2.866	0.068	0.171	0.175
	SE_002	2.811	0.068	0.198	0.140
	SE_003	2.803	0.068	0.234	0.166
	SE_003_1	2.704	0.080	0.235	0.181
	SE_003_2	2.684	0.083	0.236	0.184
	SE_004	2.613	0.096	0.213	0.173
	SE_004_1	2.589	0.103	0.217	0.177
	SE_004_2	2.583	0.108	0.222	0.181
	SE_004_2In1	2.574	0.117	0.223	0.191
	SE_004_3	2.570	0.124	0.197	0.176
	SE_004_4	2.569	0.136	0.196	0.180
	SE_004_5	2.567	0.158	0.182	0.165
	SE_004_6	2.567	0.174	0.163	0.163
	SE_004_7	2.566	0.189	0.153	0.162
	SE_005	2.566	0.199	0.132	0.159
	SE_005_1	2.566	0.201	0.133	0.152
	SE_005_2	2.566	0.215	0.121	0.117
	SE_006	2.565	0.247	0.103	0.047

Predicted peak stage for pre-development scenarios (increase relative to Scenario A)

System	Label	Scenario A	Scenario B	Scenario C
Main Drain	MainUUS_000	8.217	8.217 (0.000)	8.217 (0.000)
	MainUUS_001	8.146	8.146 (0.000)	8.146 (0.000)
	MainUUS_002	8.098	8.098 (0.000)	8.098 (0.000)
	M_001	7.522	7.522 (0.000)	7.522 (0.000)
	M_002	7.456	7.456 (0.000)	7.456 (0.000)
	M_003	6.980	6.980 (0.000)	6.980 (0.000)
	M_004	5.712	5.712 (0.000)	5.712 (0.000)
	M_005	4.233	4.233 (0.000)	4.233 (0.000)
	M_005us	4.221	4.221 (0.000)	4.221 (0.000)
	M_005ds	4.221	4.221 (0.000)	4.221 (0.000)
	M_006us	4.165	4.166 (0.001)	4.166 (0.001)
	M_006ds	4.165	4.166 (0.001)	4.166 (0.001)
	M_006	4.164	4.164 (0.000)	4.164 (0.000)
	M_007	4.125	4.125 (0.000)	4.125 (0.000)
	M_007_1	4.100	4.100 (0.000)	4.100 (0.000)
	M_007_2	4.084	4.084 (0.000)	4.084 (0.000)
	M_007_3	4.045	4.045 (0.000)	4.045 (0.000)
	M_007_4	4.013	4.013 (0.000)	4.013 (0.000)
	M_008	3.984	3.984 (0.000)	3.984 (0.000)
	M_009	3.976	3.976 (0.000)	3.976 (0.000)
	MainCulv_000	3.936	3.936 (0.000)	3.936 (0.000)
	MainCulv_003	3.943	3.943 (0.000)	3.943 (0.000)
	MainCulv_005	3.944	3.944 (0.000)	3.944 (0.000)
	MainCulv_012	3.558	3.564 (0.006)	3.555 (-0.003)
	MainCulv_015	3.552	3.557 (0.005)	3.546 (-0.006)
	M_010us1	3.484	3.497 (0.013)	3.484 (0.000)
	M_010us2	3.477	3.490 (0.013)	3.478 (0.001)
	M_010us3	3.456	3.471 (0.015)	3.457 (0.001)
	M_010us4	3.442	3.456 (0.014)	3.443 (0.001)
	M_010us5	3.379	3.398 (0.019)	3.381 (0.002)
	M_010	3.321	3.346 (0.025)	3.323 (0.002)
	M_011	3.313	3.340 (0.027)	3.315 (0.002)
	M_012	3.113	3.185 (0.072)	3.126 (0.013)
	M_013	3.083	3.177 (0.094)	3.100 (0.017)
	M_013_1	3.039	3.151 (0.112)	3.064 (0.025)
	M_013_2	2.931	3.158 (0.227)	2.988 (0.057)
	M_014	2.807	3.144 (0.337)	2.919 (0.112)
	M_014_1	2.653	3.148 (0.495)	2.871 (0.218)
	M_014_2	2.617	3.149 (0.532)	2.864 (0.247)
	M_014_3	2.606	3.141 (0.535)	2.862 (0.256)
	M_014_4	2.583	3.158 (0.575)	2.857 (0.274)
	M_015	2.565	3.139 (0.574)	2.854 (0.289)
Western Drain	W_001	2.597	3.205 (0.608)	2.859 (0.262)
	W_001_1	2.597	3.151 (0.554)	2.859 (0.262)
	W_001_2	2.597	3.142 (0.545)	2.859 (0.262)
	W_001_2In1	2.597	3.145 (0.548)	2.859 (0.262)
	W_001_2In2	2.596	3.153 (0.557)	2.859 (0.263)
	W_002us	2.596	3.149 (0.553)	2.859 (0.263)
	W_002	2.596	3.149 (0.553)	2.859 (0.263)
	W_002In1	2.595	3.141 (0.546)	2.859 (0.264)
	W_002In2	2.593	3.152 (0.559)	2.858 (0.265)
	W_002_1	2.592	3.157 (0.565)	2.858 (0.266)
	W_003	2.592	3.157 (0.565)	2.858 (0.266)

System	Label	Scenario A	Scenario B	Scenario C
	W_003_1	2.591	3.164 (0.573)	2.858 (0.267)
	W_003_2	2.587	3.173 (0.586)	2.857 (0.270)
	W_003_3	2.582	3.160 (0.578)	2.856 (0.274)
	W_003_4	2.579	3.159 (0.580)	2.856 (0.277)
	W_003_4In1	2.574	3.167 (0.593)	2.855 (0.281)
	W_003_4In2	2.569	3.291 (0.722)	2.855 (0.286)
	W_004	2.565	3.139 (0.574)	2.854 (0.289)
Southwestern Drain	W_S01	2.600	3.226 (0.626)	2.860 (0.260)
	W_S02	2.598	3.183 (0.585)	2.859 (0.261)
	W_S03	2.598	3.195 (0.597)	2.859 (0.261)
	W_S04	2.598	3.177 (0.579)	2.859 (0.261)
	W_S04In1	2.597	3.140 (0.543)	2.859 (0.262)
	W_S05	2.596	3.149 (0.553)	2.859 (0.263)
Central Drain	C_001	3.296	3.337 (0.041)	3.300 (0.004)
	C_002	2.858	3.186 (0.328)	2.915 (0.057)
	C_002_1	2.788	3.184 (0.396)	2.894 (0.106)
	C_003	2.729	3.174 (0.445)	2.880 (0.151)
	C_003_1	2.707	3.163 (0.456)	2.877 (0.170)
	C_004	2.668	3.177 (0.509)	2.870 (0.202)
	C_005	2.665	3.201 (0.536)	2.870 (0.205)
	C_005_1	2.648	3.210 (0.562)	2.867 (0.219)
	C_005_2	2.634	3.170 (0.536)	2.864 (0.230)
	C_006	2.613	3.170 (0.557)	2.861 (0.248)
	C_006_1	2.605	3.168 (0.563)	2.860 (0.255)
	C_006_2	2.601	3.144 (0.543)	2.859 (0.258)
	C_006_3	2.594	3.164 (0.570)	2.858 (0.264)
	C_006_4	2.593	3.160 (0.567)	2.858 (0.265)
	C_007	2.592	3.157 (0.565)	2.858 (0.266)
Southeastern Drain	SE_001	3.287	3.290 (0.003)	3.287 (0.000)
	SE_001In1	3.173	3.171 (-0.002)	3.173 (0.000)
	SE_001In2	3.060	3.161 (0.101)	3.060 (0.000)
	SE_001In3	2.949	3.166 (0.217)	2.949 (0.000)
	SE_001In4	2.866	3.174 (0.308)	2.893 (0.027)
	SE_002	2.811	3.172 (0.361)	2.877 (0.066)
	SE_003	2.803	3.170 (0.367)	2.875 (0.072)
	SE_003_1	2.704	3.152 (0.448)	2.863 (0.159)
	SE_003_2	2.684	3.150 (0.466)	2.862 (0.178)
	SE_004	2.613	3.151 (0.538)	2.858 (0.245)
	SE_004_1	2.589	3.158 (0.569)	2.857 (0.268)
	SE_004_2	2.583	3.153 (0.570)	2.857 (0.274)
	SE_004_2In1	2.574	3.151 (0.577)	2.856 (0.282)
	SE_004_3	2.570	3.163 (0.593)	2.855 (0.285)
	SE_004_4	2.569	3.167 (0.598)	2.855 (0.286)
	SE_004_5	2.567	3.156 (0.589)	2.854 (0.287)
	SE_004_6	2.567	3.152 (0.585)	2.854 (0.287)
	SE_004_7	2.566	3.156 (0.590)	2.854 (0.288)
	SE_005	2.566	3.171 (0.605)	2.854 (0.288)
	SE_005_1	2.566	3.181 (0.615)	2.854 (0.288)
	SE_005_2	2.566	3.189 (0.623)	2.854 (0.288)
	SE_006	2.565	3.139 (0.574)	2.854 (0.289)