The Bakery & Confectionary Project, Newton Dee Flood Risk Assessment

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CONTROL SHEET

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1 INTRODUCTION

1.1 Terms of Reference

EnviroCentre Limited was commissioned by Ramsay and Chalmers to undertake a Flood Risk Assessment (FRA) for a proposed development at Newton Dee Community Campus.

1.2 Scope of Report

The scope of this report is to present a detailed assessment of fluvial flood risk to the site. Detailed assessment has been undertaken for the unnamed watercourse which runs along the western boundary of the site. Potential management measures would be recommended to mitigate any identified flood risk that would adversely impact the development. It is believed that such mitigation measures would be taken into account as part of the planning process by The Highland Council (THC).

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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.

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
SPP	Scottish Planning Policy (Scottish Government, 2014)

1.5 Regulatory Framework

1.5.1 Scottish Planning Policy

Prior to adoption of National Planning Framework 4 (NPF4) in February 2023, Scottish Government planning policy on flooding and drainage was provided by Scottish Planning Policy (SPP) paragraphs 254–268 (Scottish Government, 2014). This policy was based on the following principles:

- Developers and planning authorities must give consideration to the possibility of flooding from all sources;
- New development should be free from significant flood risk from any sources;
- In areas characterised as “medium to high” flood risk for watercourses and coastal flooding new development should be focused on built up areas and all development must be safeguarded from the risk of flooding;
- The storage capacity of functional flood plains should be safeguarded from further development. The functional flood plains comprise areas generally subject to an annual probability of flooding greater than 0.5% (1 in 200 year);
- Drainage is a material consideration and the means of draining a development should be assessed. Any drainage measures proposed should have a neutral or better effect on the risk of flooding both on and off the site.
- Sustainable Drainage Systems (SuDS) are required to avoid increased surface water flooding.

SPP specified a risk framework, to be used to guide development, which classified coastal and watercourse flood risk based on the following categories:

- **Little or no risk area** (annual probability of flooding less than 0.1%; 1:1000 years). No constraints to development due to flood risk.

- **Low to medium risk area** (annual probability of flooding between 0.1% and 0.5%; 1:1000 to 1:200 years). Suitable for most developments, excepting civil infrastructure (unless existing civil infrastructure within a low to medium risk area is being extended, or else if civil infrastructure must be placed within this risk area for operational reasons).

- **Medium to high risk area** (annual probability of flooding greater than 0.5%; 1:200 years). Suitable for residential, institutional, commercial and industrial development within built-up areas (provided adequate flood protection is planned or already exists). Generally not suitable for civil infrastructure or most vulnerable uses (such as schools and care homes) or for general development in undeveloped or sparsely developed areas (unless essential for operational reasons and alternative locations at lower flood risk are not viable).

With respect to surface water flood risk, SPP specified that infrastructure and buildings should generally be designed to be free from surface water flooding in rainfall events when the annual probability of occurrence is greater than 0.5% (1:200 years). Furthermore, surface water drainage measures should provide a neutral or better effect on the risk of flooding both on and off site, accounting for both rain falling on the site as well as run-off from adjacent areas.

1.5.2 National Planning Framework 4 (NPF4)

NPF4 was adopted by Scottish Ministers on 13 February 2023, replacing SPP (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 urban drainage systems (SUDS), which should form part of and integrate with proposed and existing blue-green infrastructure. All proposals should presume no surface water connection to the combined sewer;
iii. seek to minimise the area of impermeable surface.

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.

SEPA and local authority guidance is yet to be updated to reflect interpretation and application of NPF4 at the time of progressing this FRA, with all existing guidance therefore being based upon SPP (2014). The FRA will seek to be compliant with NPF4 in relation to defining flood risk and with existing SEPA and local authority guidance in all other aspects.

1.5.3 SEPA Guidance

SEPA has issued guidance in relation to preparing FRAs (“Technical Flood Risk Guidance for Stakeholders”, v13, (SEPA, 2022a). Technical requirements for FRAs depend on the complexity of the site with more complex or high-risk sites requiring detailed assessments. SEPA has also published a report checklist which must be submitted with a FRA as part of a planning application. 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.

In addition to reporting requirements, the document also provides technical guidance on Flood Estimation Handbook (FEH) (CEH, 2008) methodologies and on land raising and compensatory storage.

SEPA also provide *Flood Risk and Land Use Vulnerability Guidance* (SEPA, 2018), which gives further guidance regarding the interpretation and application of SPP in relation to the suitability of specific land use types within each flood risk category. In particular, this guidance differentiates between new development and redevelopment proposals, noting that vulnerable land uses are generally not suitable within areas of medium to high flood risk in the case of new development, but may be suitable within such areas in the case of redevelopment, provided the proposed land use is equal or less vulnerable than the existing land use. SEPA further require completion of a standard FRA checklist to accompany all FRAs; this is included as Appendix F.

1.6 Consultation

1.6.1 Aberdeen City Council

Aberdeen City Council were consulted by email on 31 July 2023 to obtain information on any historic flooding at the site and maintenance records of culverts or structures within the area. In a subsequent phone conversation, the Council confirmed that there are no specific records of flooding to the site location, although it was noted that as the area is undeveloped it is unlikely that flooding would be reported. The Council highlighted a number of flood risk records and known flooding issues that should be considered:

- Flooding of the Deeside Way path to the north of the site is a regular issue, likely compounded by poor functioning of existing drainage / soakaway features.
- Surface water runoff from the site is known to flow onto Old Ferry Road
- Out of bank flows from the unnamed watercourse west of the start has occurred in the past, resulting in flooding over North Deeside Road
- Out of bank or surface water runoff has resulted in flooding at the Newton Dee Craft Studio.

1.6.2 SEPA

SEPA were consulted on the 8th August 2023 to obtain information on any historic flooding at the site, maintenance records of culverts or structures within the area and also to request access to LiDAR topography data they hold for with coverage of the local area.

SEPA's response confirmed that their Observed Flood Event database holds two records of flooding within 500m of the site of interest. These occur at various locations on 30/04/2021 and 05/12/2021. Both records are associated with surface water (heavy rainfall) and the record of flooding from 30/04/2021 indicates that the Old Ferry Road Bridge over Deeside Way was affected.

In response to the request for LiDAR data, SEPA confirmed that the LiDAR they hold for the site of interest is under licence from Airbus on commercial terms and cannot be provided to third parties.

2 BACKGROUND

2.1 Site Location

The proposed development site is located to the west of Old Ferry Road on the outskirts of Aberdeen. The site is at approximate National Grid Reference (NGR) 387992, 802201. A location plan is presented in Figure 2.1.

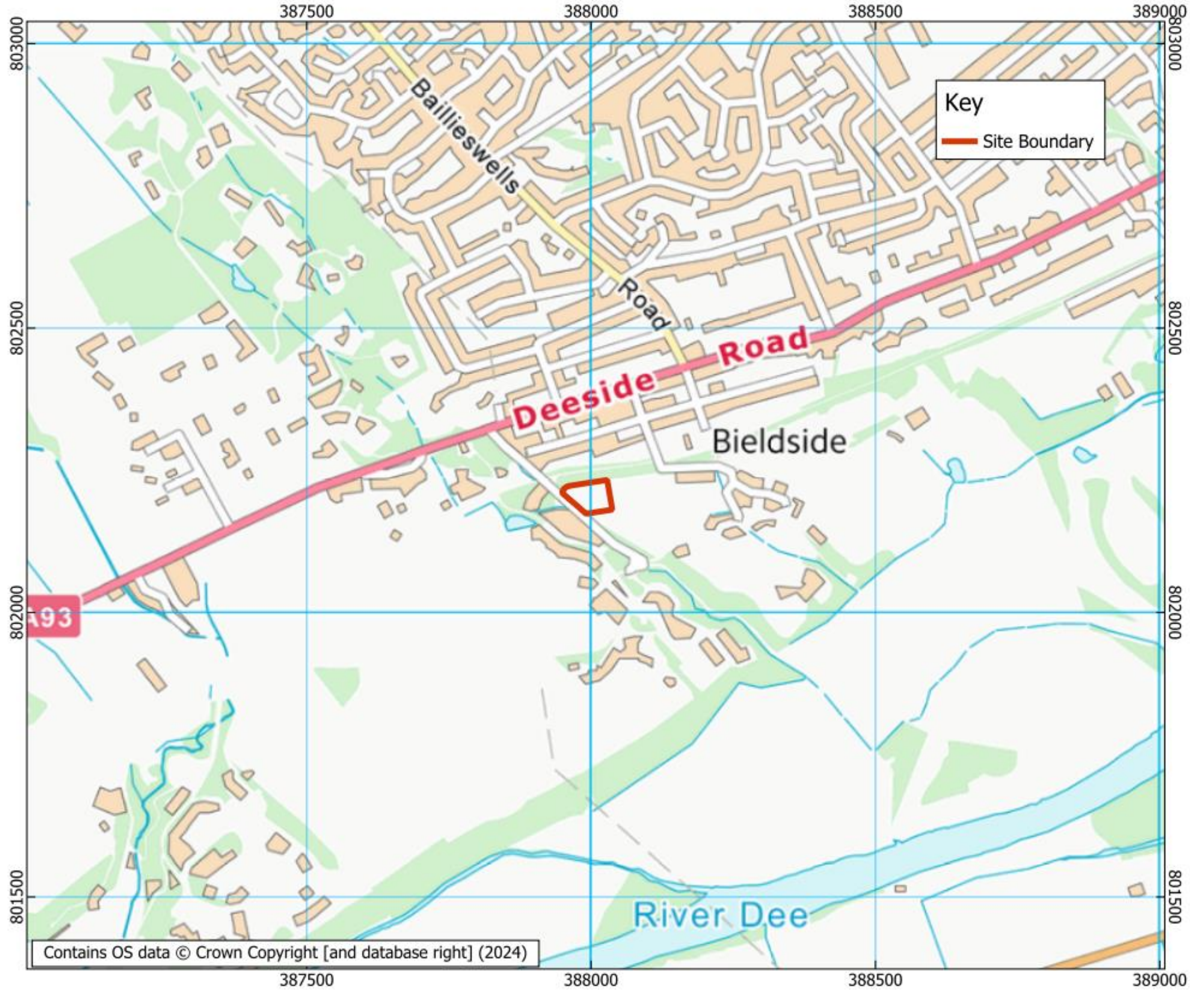


Figure 2.1 Site location

2.2 Proposed Development

The proposed development will be a new bakery, to serve the Newton Dee Camphill Community. The site will include bakery facilities, office rooms and a shop as well as parking and associated landscaping. The proposed development layout is illustrated in Figure 2.2.

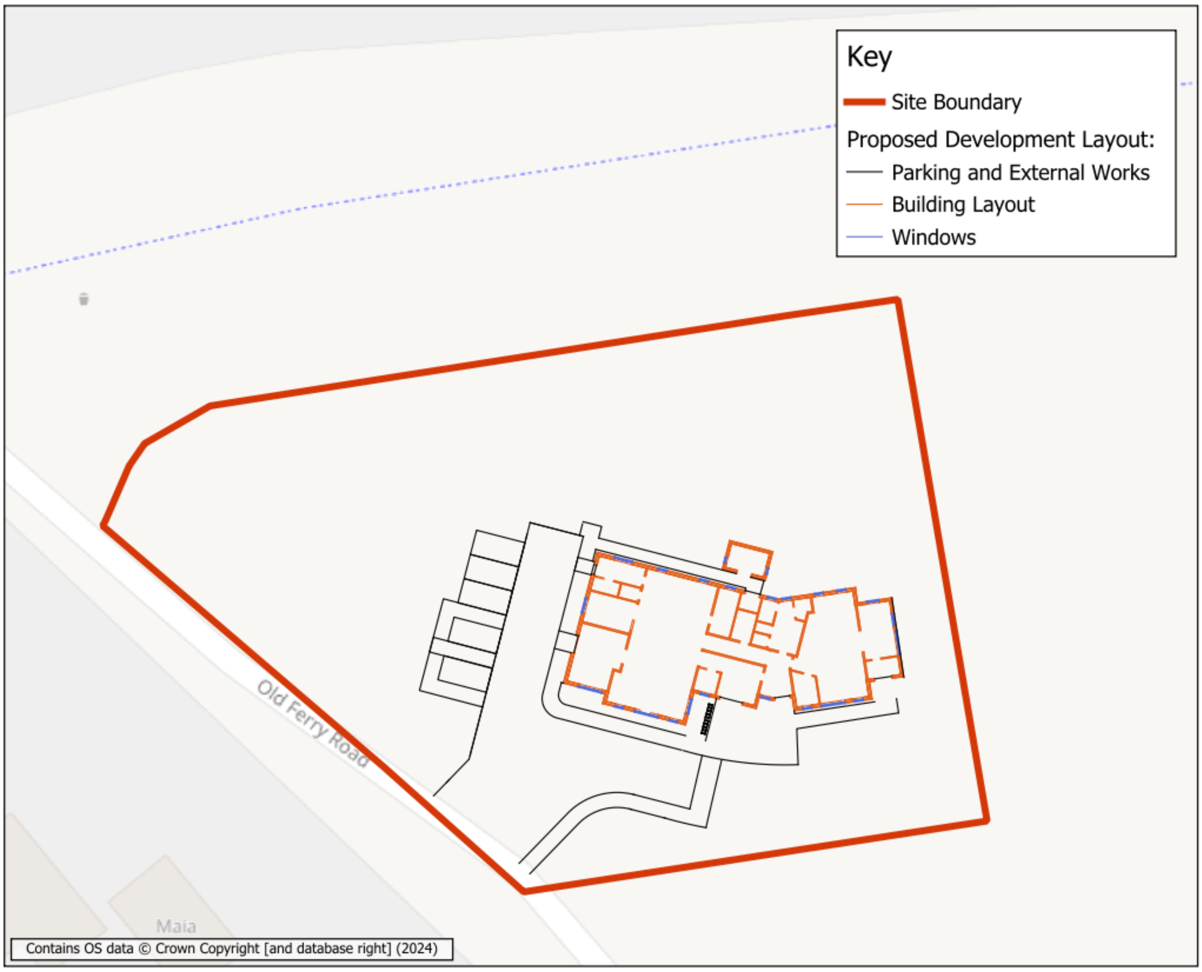


Figure 2.2 Proposed development layout

2.3 Site Context

The site is located within the Newton Dee Camphill Community campus. The western boundary of the site is Old Ferry Road. To the east and south of the site is undeveloped land used for grazing. The northern boundary if formed by the Deeside Way Footpath. The footpath sits within a topographic cut which was the route of the former Great North of Scotland Railway.

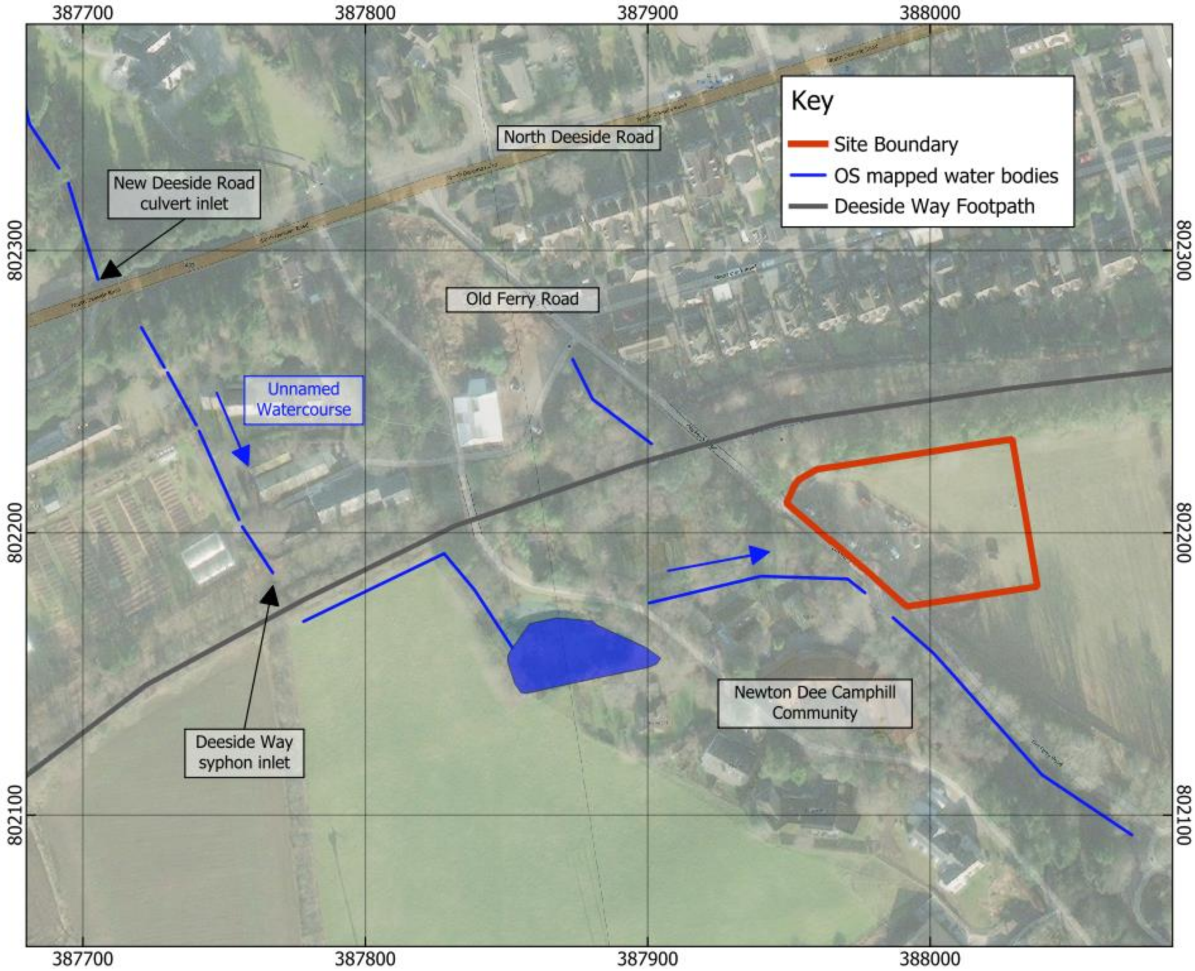


Figure 2.3 Site context

An unnamed watercourse flows in a southerly direction towards to the River Dee and passes close to the western boundary of the site.

The reach of the watercourse relevant to this assessment begins upstream of North Deeside Road. Here the watercourse flows south before entering a culvert which emerges in a wooded area at the back of properties within the Newton Dee Camphill community. The watercourse continues south beyond the site, passing beneath a number of small footbridges.

Approximately 100m downstream from the North Deeside Road culvert, the watercourse enters a siphon, which carries flow beneath the Deeside Way footpath. The channel re-emerges on the southern side of the footpath at a higher elevation than the base of Deeside Way. The watercourse changes direction to flow east before entering a pond. The outflow from the pond flows towards Old Ferry Road, and then south along the western boundary of Old Ferry Road and past the development site.

2.4 Site Walkover

A site walkover was undertaken on 4th August 2023. The site walkover confirmed the watercourse flows through a hydraulically complex system which includes numerous footbridges, culverted sections, a pond and a siphon.

Figure 2.4 View looking upstream at the downstream outlet of the culvert passing beneath North Deeside Road.

Figure 2.5 View looking upstream at the outlet face of the siphon which carries the watercourse beneath the Deeside Way footpath

Figure 2.6 View looking east from the siphon outlet. The channel is visible in the bottom right, and is elevated above the Deeside Way footpath visible on the left.

2.5 Topography

Topographic assessment within and adjacent to the site has been informed by numerous sources. As discussed in Section 1.6.2, EnviroCentre were unable to procure LiDAR data for the area. Therefore, site specific topography surveys collected data for the site location and a significant area surrounding the burn, including the local section of the Deeside Way footpath.

Additional topography data sets were purchased to inform areas not covered by the detailed survey, included the SEPA-recommended Blue Sky photogrammetry, Next Map 5m DTM and OS Terrain 5 data. OS Terrain 5 data was found to better correlate with survey data than the NextMap or Blue Sky photogrammetry data, and was therefore used in preference to these datasets for non-surveyed areas.

Figure 2.7 illustrates a composite DTM, showing the extent of the site specific topographic survey area with high colour saturation and the coarser OS terrain 5 DTM with a lower colour saturation/higher transparency.

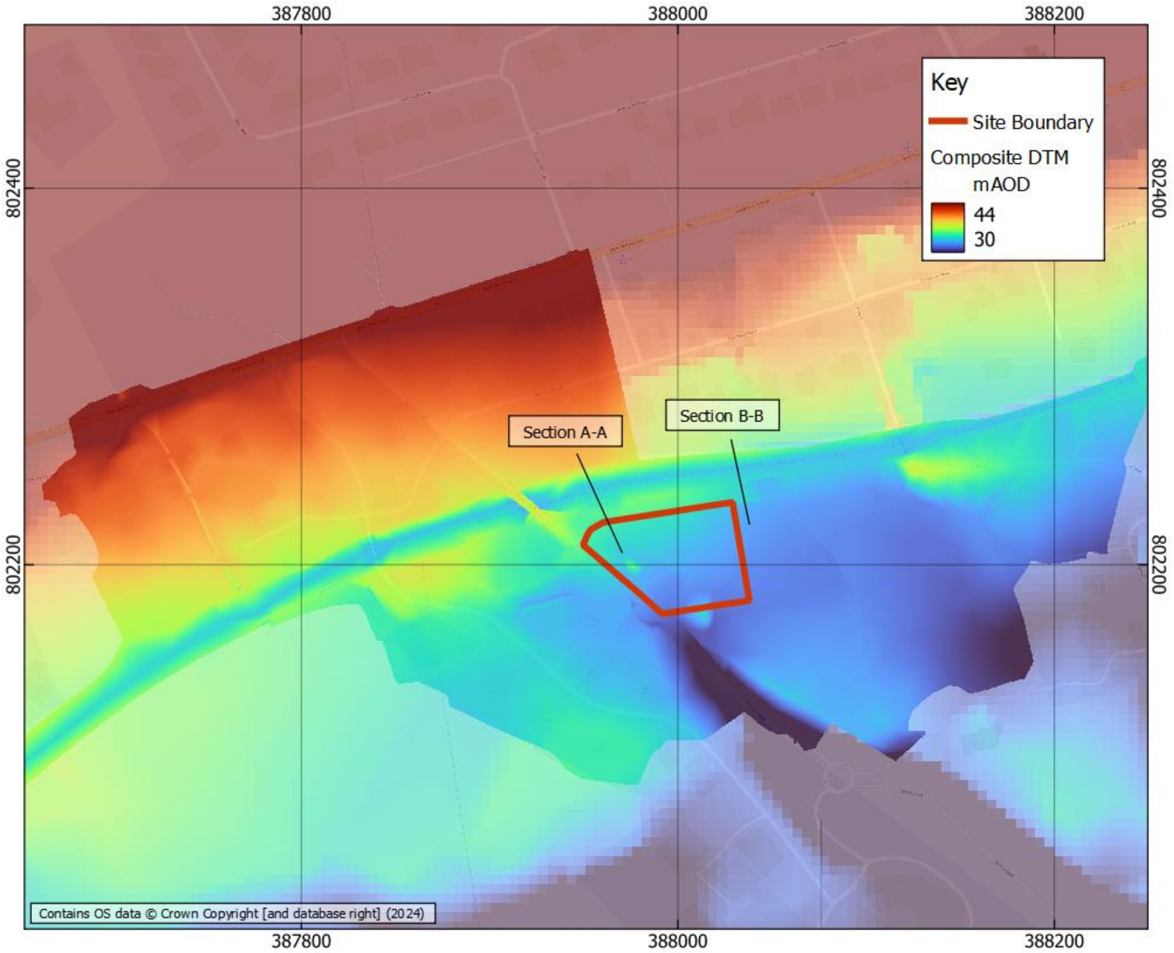


Figure 2.7 Composite DTM

The ground within the site has a general fall from north to south with levels ranging from approximately 35.6 mAOD in the north-east to 31.5 mAOD in the south-east.

Within the wider setting, there is a general north to south directional fall, with land sloping down towards the River Dee which is located 750 m south of the development site. The Deeside Way footpath sits within a topographic cut in the landscape. To the west of the site, this cut is pronounced with embankments either side of the footpath of 2 m or more. The cut is less pronounced in the west, as illustrated by comparative section profiles in Figure 2.8 and Figure 2.9.

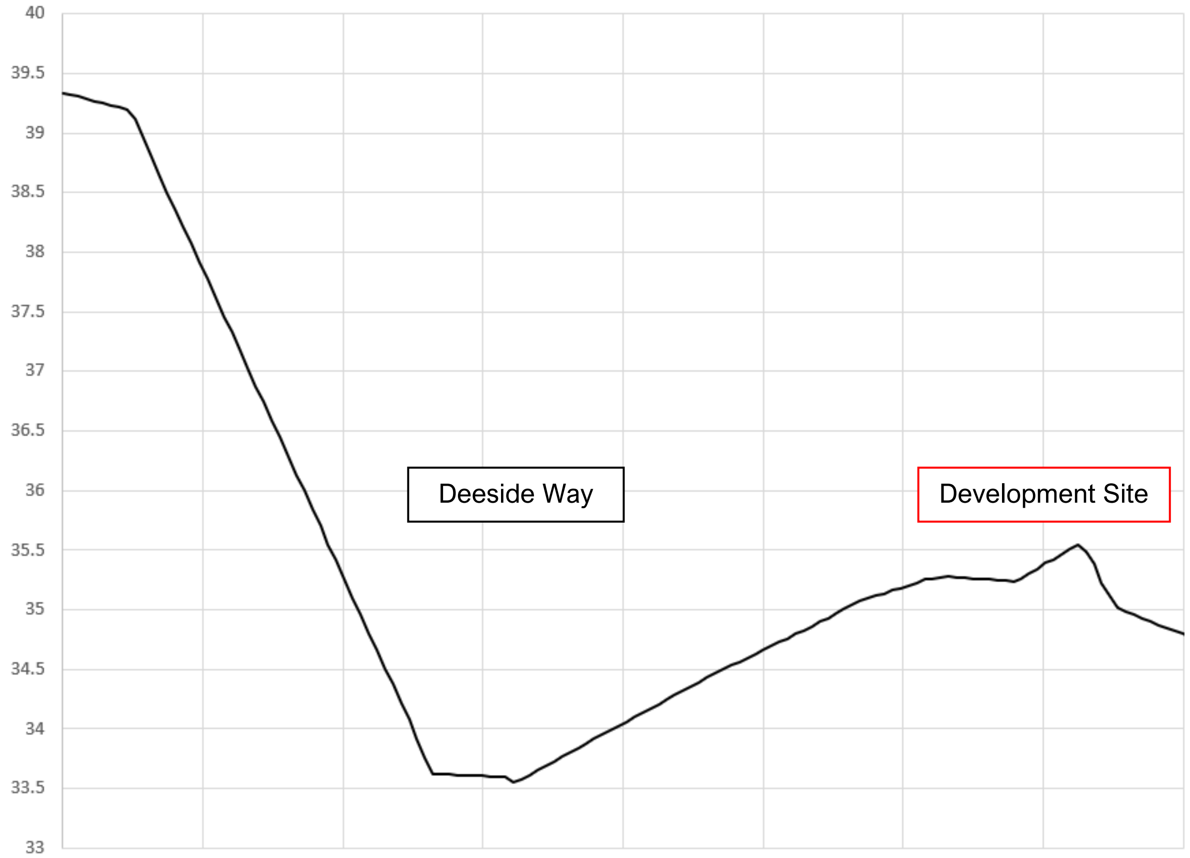


Figure 2.8 Section A-A, through Deeside Way and the adjacent field at the western end of the development site

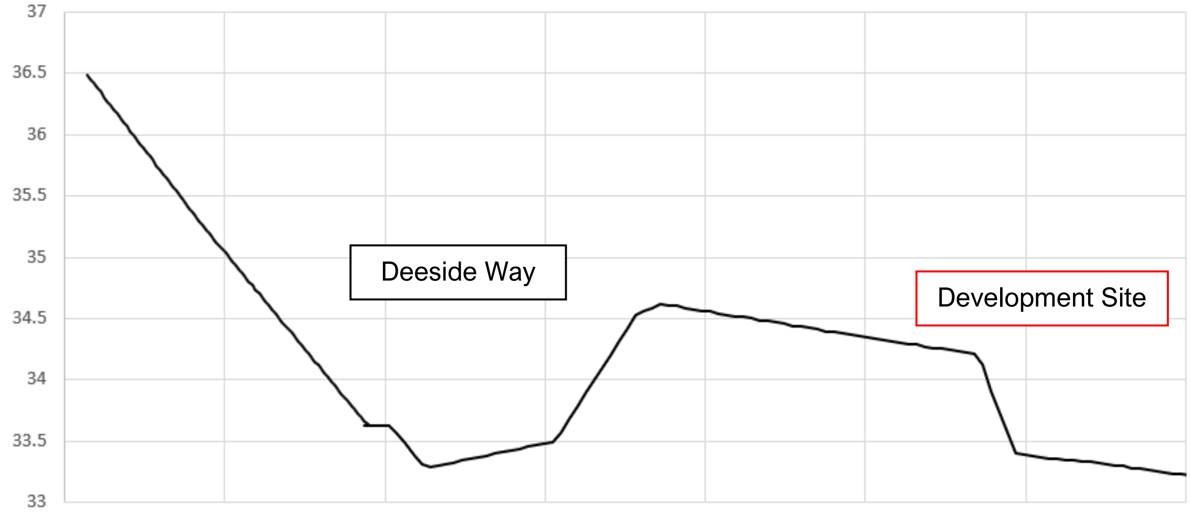


Figure 2.9 Section B-B, through Deeside Way and the adjacent field beyond the eastern end of the development site

3 SCOPING AND METHODOLOGY

3.1 Flood Risk Scoping

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.

3.1.1 Land Use Vulnerability Classification

The existing land use for the site is a undeveloped land and therefore classified as a Least Vulnerable use according to SEPA guidance (SEPA, 2018). The proposed development will be a mixed use recreational building including a bakery. The bakery will fall within the Least Vulnerable land use classification.

3.1.2 Scoping Summary

Table 3.1 presents the scoping outcomes for flood risk to the development site.

Table 3.1 Summary of flood risk scoping

Flooding Source	Preliminary Risk Classification	Comments/Explanation	Scoping Outcome
Fluvial (River)	Medium risk	An unnamed minor watercourse flows to the west of the site on the opposite side of the road. Although no fluvial flood risk is identified on the SEPA flood maps, flood risk from this watercourse is not represented on SEPA mapping, due to its catchment area being less than 3 km^2. As elements of the site are classified in the Least Vulnerable use category, these must be proved to be safe from their lifetime from the 1 in 200 year event.	Further assessed in Section 5
Coastal	No risk	The site lies 8.3 km inland from the River Dee Estuary and the development areas are at a minimum elevation of 31.5 mAOD. Therefore, the site is significantly elevated above extreme coastal flood levels and coastal flood risk will not have any impact on the site.	Not considered further

Flooding Source	Preliminary Risk Classification	Comments/Explanation	Scoping Outcome
Surface Water (Pluvial)	Medium risk	A review of SEPA Flood Maps shows areas to the east of the site at risk of pluvial flooding. And medium risk within the proposed site with some areas of ponding to the south-east corner of the proposed site entrance. SEPA's surface water flood maps often indicate areas of flooding from watercourses of less than 3 km^2, which are not represented in their fluvial flood maps, such that this mapping may actually relate to fluvial flood risk. Alternatively, these may be associated with overland flow onto the site. Overland flow analysis will be carried out to define surface water catchments and qualitatively assess the risk of surface water flooding to the site.	Further assessed in Section 5
Infrastructure Failure	Little or no risk	There are no flood protection schemes serving the proposed development site. Review of the SEPA Reservoir Inundation Map[1] shows that there is no risk to the proposed development site from reservoir failure.	Not considered further
Groundwater	Low risk	There is indication of low groundwater flood risk on the SEPA Flood Maps. When running adjacent to site the watercourse is generally lower than the proposed development site. The cut of the Deeside Wat footpath to the north of the site will interrupt groundwater flows towards the development.	Not considered further

3.2 Methodology

Flood risk scoping has highlighted that there is a risk of fluvial and pluvial flooding to the site requiring further assessment.

The unnamed watercourse to the west has been assessed for fluvial flood risk using hydraulic modelling. Based on discussions with Aberdeen City Council, and observations made during the walkover, the primary risk to the development is fluvial flooding from out of bank flows upstream of the Deeside Way footpath, which would then act as a flow pathway towards the site. This is the flood pathway that impacts the site area shown on the SEPA surface water flood maps. A 1D-2D hydraulic model has been developed to assess fluvial flood risk from the upstream section of the unnamed watercourse and determine floodplain extents at the proposed site.

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

The watercourse downstream of the siphon underneath Deeside Way has not been explicitly modelled. Instead, a worst case scenario assessment has been undertaken using the downstream hydrograph from the upstream model, adjusted for Qmed, as a point inflow. Further details are presented in Section 5.4.

Pluvial flood risk has been assessed through review of the hydraulic modelling outcomes and flow path analysis.

4 HYDROLOGY

4.1 Catchment Delineation

The FEH Web Service has been used to assess the catchment of the unnamed tributary west of the site at NGR location [389150, 802450], which is downstream of the proposed development. GIS flow path analysis was undertaken using OS Terrain 5 data to assess the directional flow of the surrounding topography and confirm catchment draining to the proposed site area.

Figure 4.1 illustrates the delineated final catchment for the unnamed watercourse alongside the FEH delineated catchment, which have contributing areas of 1.95 km^2 and 3.35 km^2, respectively.

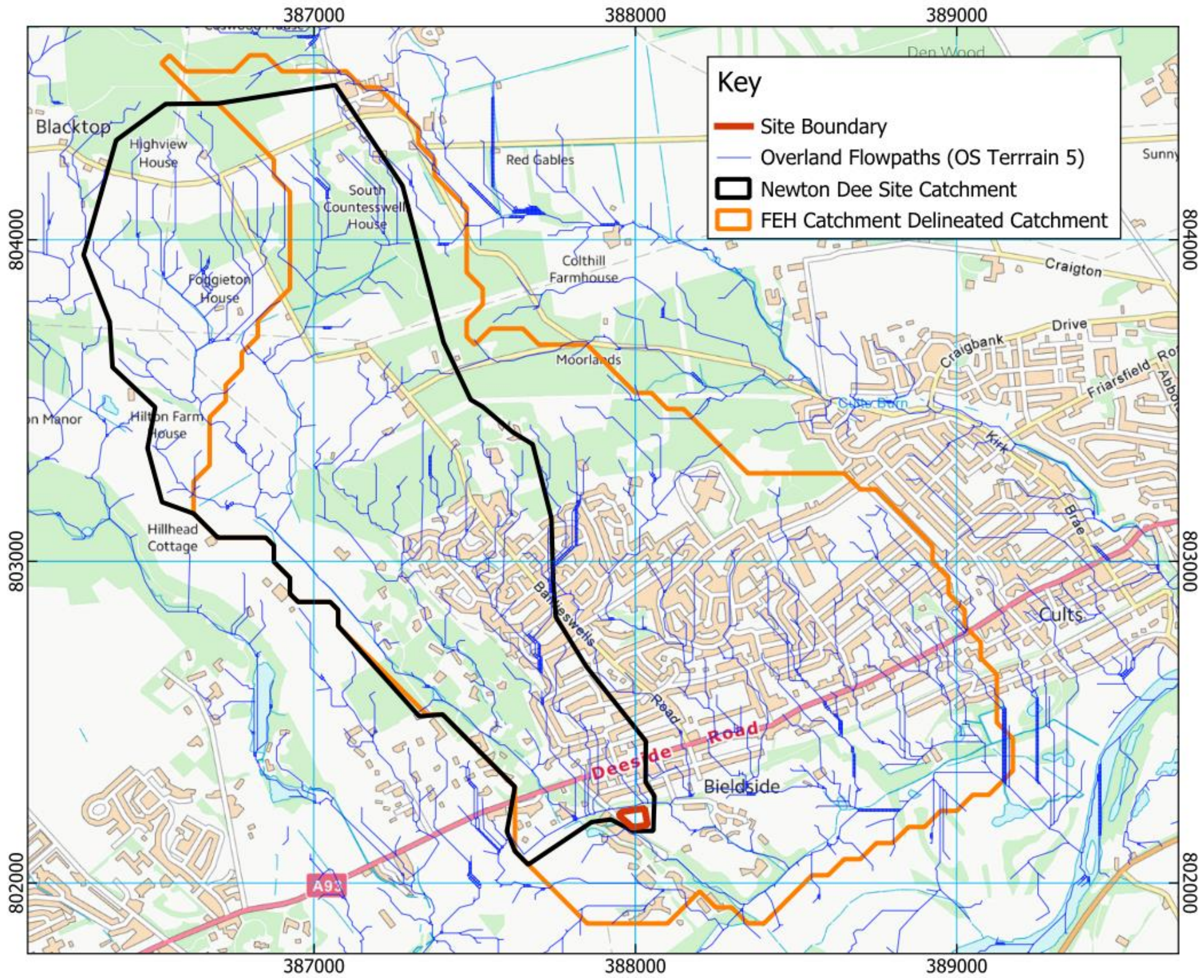


Figure 4.1 Catchment delineation

4.2 Hydrological Assessment

The watercourse is ungauged and design flows have been estimated using FEH methods appropriate for ungauged catchments, including the Revitalised Rainfall-Runoff Method, version 2.3 (ReFH2) with Scotland-specific calibration parameters, and the FEH Rainfall Runoff (RR) method.

For both methods the peak flows were derived using the relevant catchment as delineated on the FEH web service; descriptors are presented in Appendix B. The results were then scaled by catchment area to give the design inflows for the unnamed watercourse for the development site.

Table 4.1 summarises peak flow estimates derived for each method for the full FEH catchment and shows that the FEH-RR method gives the highest flow estimation. The FEH-RR flows will be taken forward as design flows to ensure the assessment is conservative.

Table 4.1 Pre-scaled peak flows for the FEH donor catchment

Method	**Design peak flow (m^3/s)**		
	1 in 2	**1 in 30**	**1 in 200**
REFH2	0.50	1.02	2.00
FEHRR	1.32	2.68	4.17

SEPA provide climate change allowances by region, based on UKCP18 (SEPA, 2022b). For fluvial flood modelling of watercourses in the North East Region with catchment area less than 30 km^2, a 34% uplift to design rainfall is advised.

The scaled peak flows for the design flood events are presented in Table 4.2.

Table 4.2 Fluvial design flows with accounting for climate change (m^3/s)

1 in 200 year	**1 in 200 year plus climate change**
2.43	3.58

5 FLOOD RISK ASSESSMENT

5.1 Upstream Hydraulic Model Build

A 1D-2D hydraulic model of the unnamed watercourse was developed using Flood Modeller software, Version 4.6. The 1D hydraulic model extent begins upstream of North Deeside Road and ends where the watercourse enters the siphon upstream of the Deeside Way footpath.

The 1D cross sections representing the watercourse and banks were developed using site specific surveyed cross section data, collected by Granite City Surveys in November 2023.

A total of 13 cross sections have been included in the 1D model with an inflow hydrograph as the upstream boundary and a normal depth unit and the downstream boundary. The hydrograph for fluvial inflows has been derived using an FEH inflow boundary hydrograph unit scaled to match the design peak flow estimated in Section 4.2.

Numerous structures are represented within the 1D model. The first structure in the model is the culverted section beneath North Deeside Road. Subsequently the watercourse passes underneath three small footpaths, which have each been represented in the model as USBPR bridge units. Finally, an orifice has been included at the downstream extent of the model to represent the inlet of the siphon.

Within the 1D model, in-channel roughness was set based on site observations to a Manning’s n value of 0.04, while bankside roughness was set to 0.06 to represent the vegetation lining the watercourse. A 1D model schematic is presented in Figure 5.1.

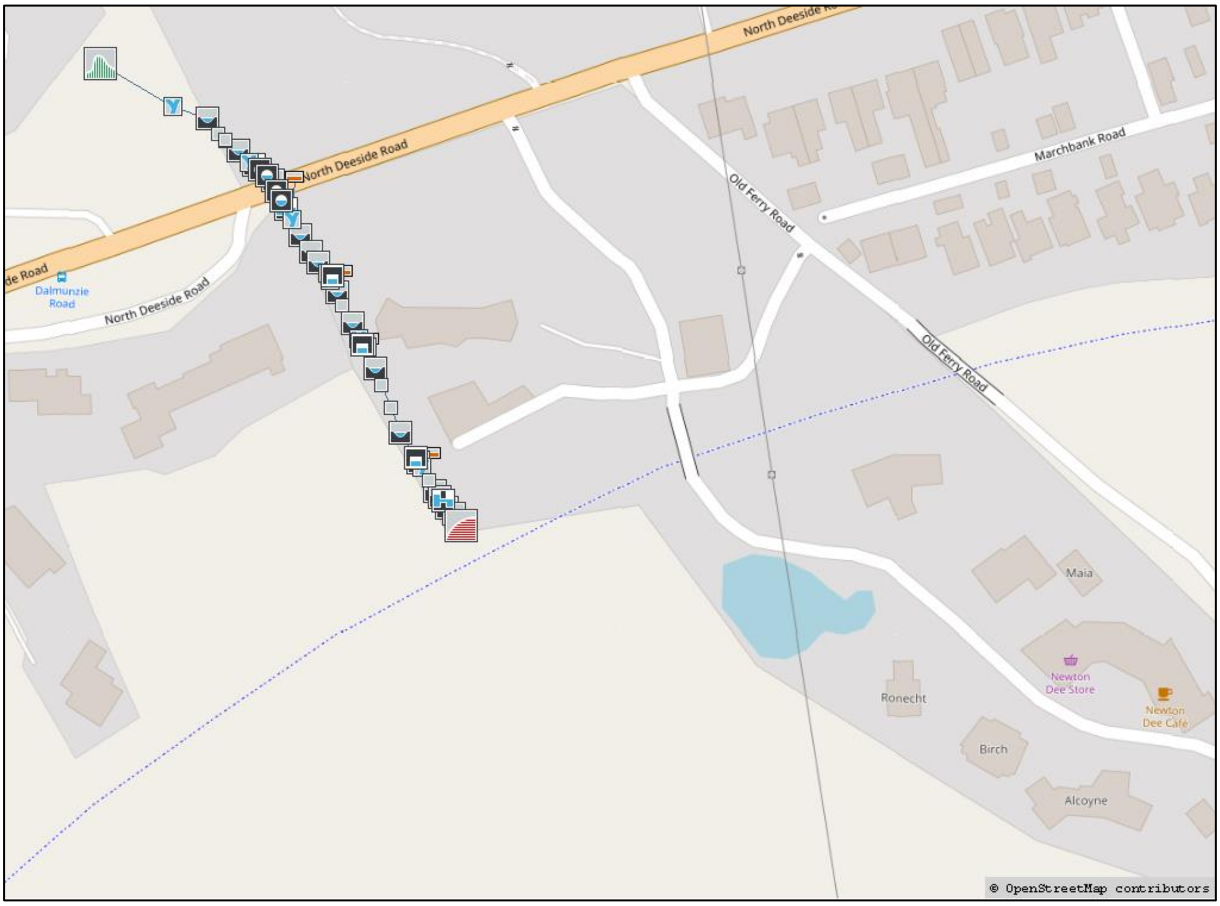


Figure 5.1 1D hydraulic model schematic

2D floodplain areas were represented using the composite DTM described in Section 2.5, with 1m horizontal resolution. The Deeside Way footpath is expected to be one of the predominant flood pathways relevant to the site. The DTM was modified to remove the obstruction caused by survey of the Old Ferry Road bridge over the pathway, as illustrated in Figure 5.2.

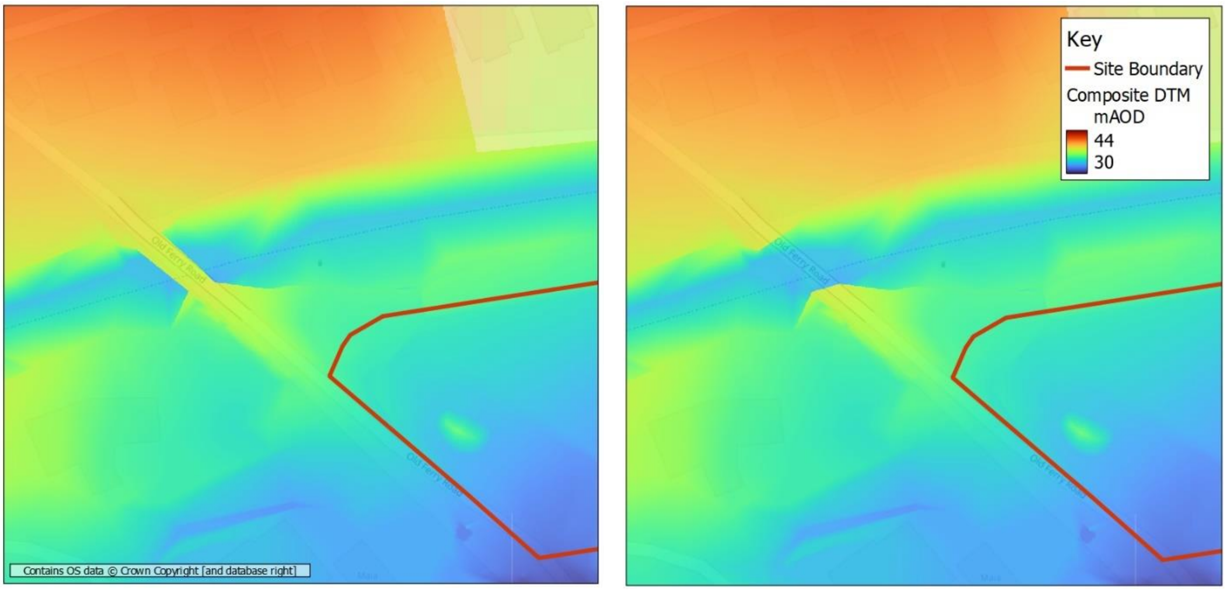


Figure 5.2 2D ground model alterations

The 2D modelled areas represent land that is predominately pasture therefore a roughness of 0.035 was applied. Roughness was modified in certain locations to represent roads and woodland, with roughness values of 0.025 and 0.08 used respectively. A model schematic is presented in Figure 5.3

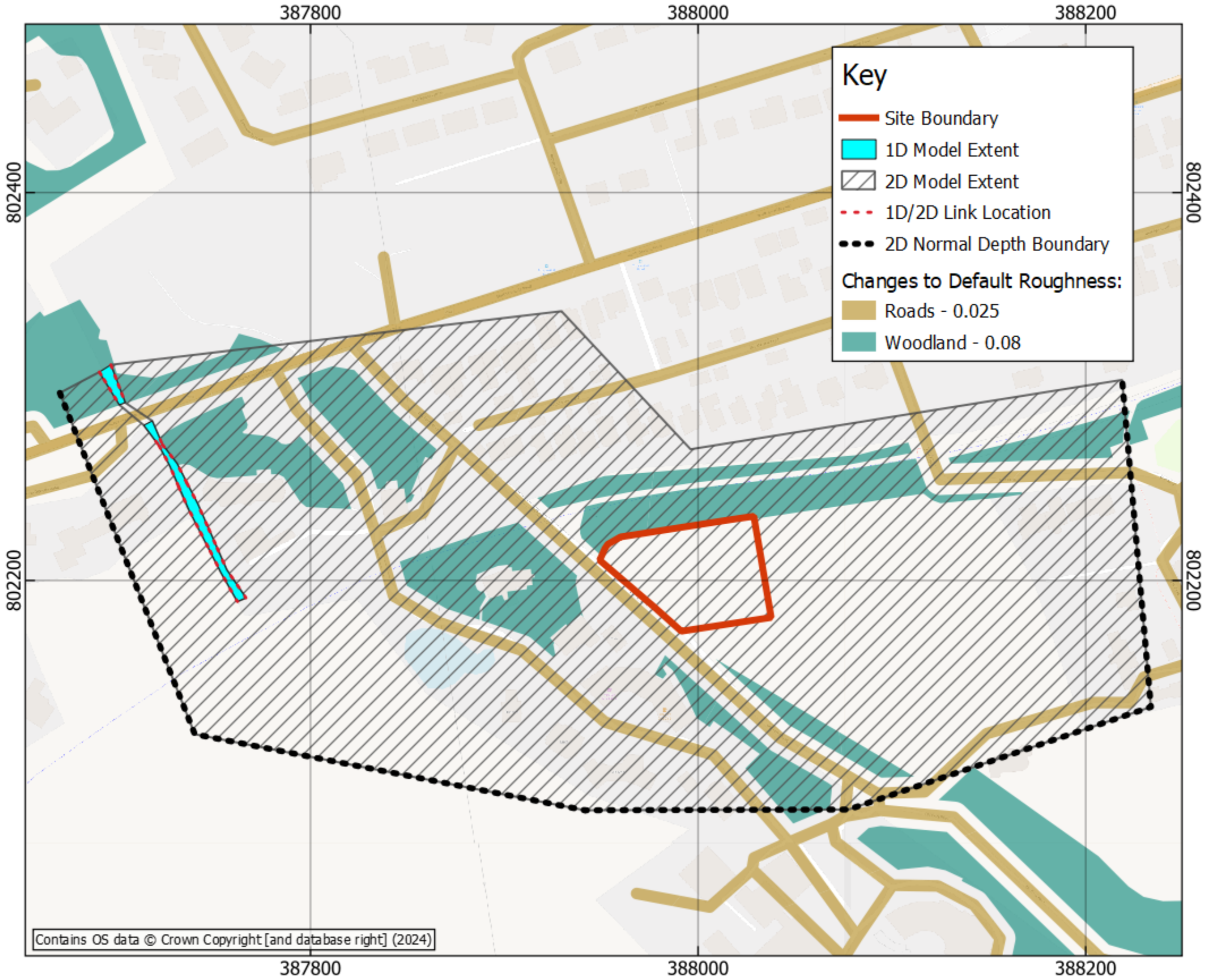


Figure 5.3 2D hydraulic model schematic

5.2 Modelled Scenarios

Table 5.1 details the scenarios simulated using the upstream hydraulic model.

Table 5.1: Modelled scenarios

Scenario	Description	Detail	Purpose
Baseline	Present day flood risk (1 in 200 year flood event)	Current site conditions under 1 in 200 year flow scenario. Hydrograph derived using the FEH Rainfall-Runoff Method.	To identify the extent of the present day flood risk
Climate Change	1 in 200 year + Climate Change (CC) event	As above but with peak rainfall intensity increased by 34% to account for climate change.	To identify flood levels and extents under a future climate change scenario, and to inform developable area and finished floor levels.
Blockages	1 in 200 year plus climate change with blockage scenario	50% blockage scenario on the North Deeside Road culvert	To assess the impact a blockage of the bridge might have on the site
Sensitivity	Roughness	20% increase in 1D channel roughness for the 1 in 200 year CC flow scenario	To assess the sensitivity of the model to uncertainty in roughness values
Sensitivity DSB	Downstream boundary	20% decrease in downstream gradient for the 1 in 200 year CC flow scenario	To assess the sensitivity of the model to uncertainty in the downstream boundary

5.3 Results

Tabulated predictions of peak water levels for all scenarios are presented in Appendix E.

5.3.1 1 in 200 year Baseline

Model predictions for the 1 in 200 year baseline scenario are presented in Figure 5.4.

The results show flood water spilling out of bank at the upstream inlet of the culvert beneath North Deeside Road. Out of bank flows spill out from the left hand bank and travel in a southernly direction, before reaching the topographic depression of Deeside Way footpath. The footpath is inundated and directs flows in both eastern and western directions. The eastern flow path along Deeside Way diverts south at an area of lower ground, entering the field adjacent to the proposed development. The floodplain spills further south before splitting again due to higher intervening ground. Some flows are directed west towards Old Ferry Road, others east.

The proposed development site is not impacted by the spilling floodplain.

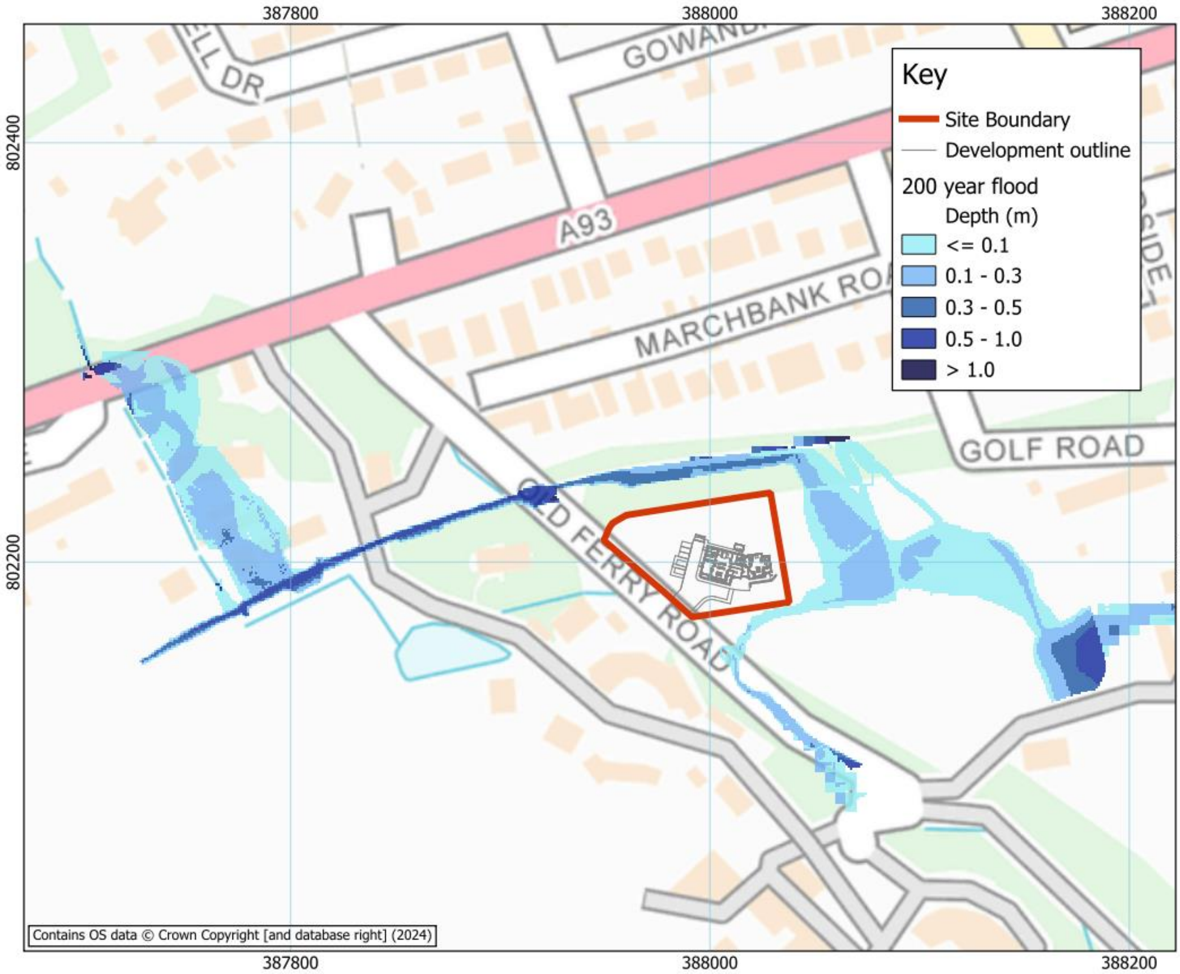


Figure 5.4 Predicted 1 in 200 year flood extents and depths

5.3.2 1 in 200 year plus Climate Change

For the 1 in 200 year plus climate change event, modelling predicts similar local flooding depths and extents as those for the same event without climate change, albeit with slightly more extensive inundation, as illustrated in Figure 5.5. Additional spilling is noted at the location of a footbridge downstream of North Deeside Road, and out of bank flows on the right hand back are predicted. Again, inundation is noted in the adjacent field however the proposed development is not shown to be at risk.

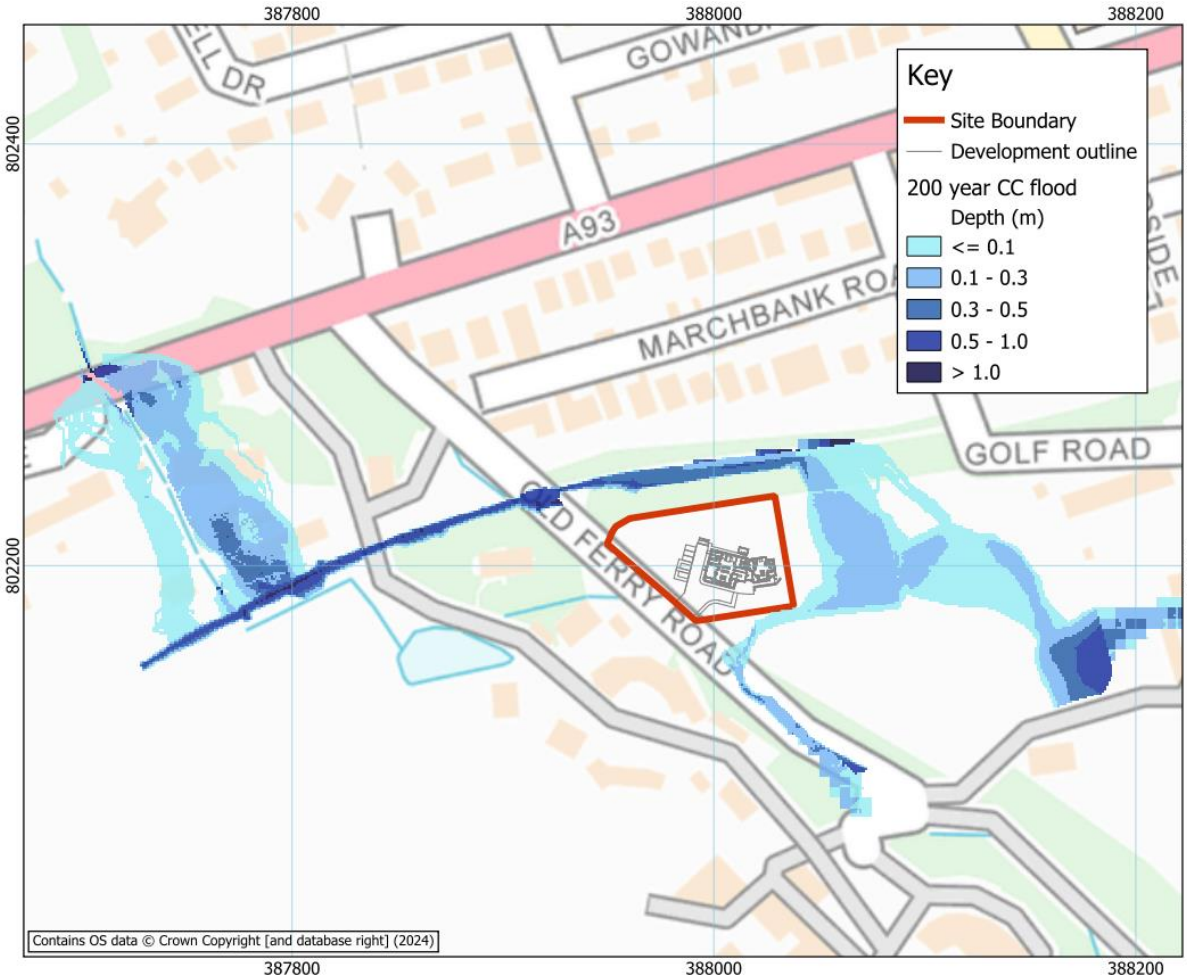


Figure 5.5 Predicted 1 in 200 year plus climate change flood extents and depths

5.3.3 1 in 200 year plus Climate Change with Blockage

To test the sensitivity of predictions to structural blockage, a 50% blockage scenario was carried out for the culvert the passes beneath North Deeside Road.

Predictions, shown in Figure 5.6, indicate that partial blockage of this culvert would cause minor changes to the levels and extent of local flooding with no material impact upon the proposed development site.

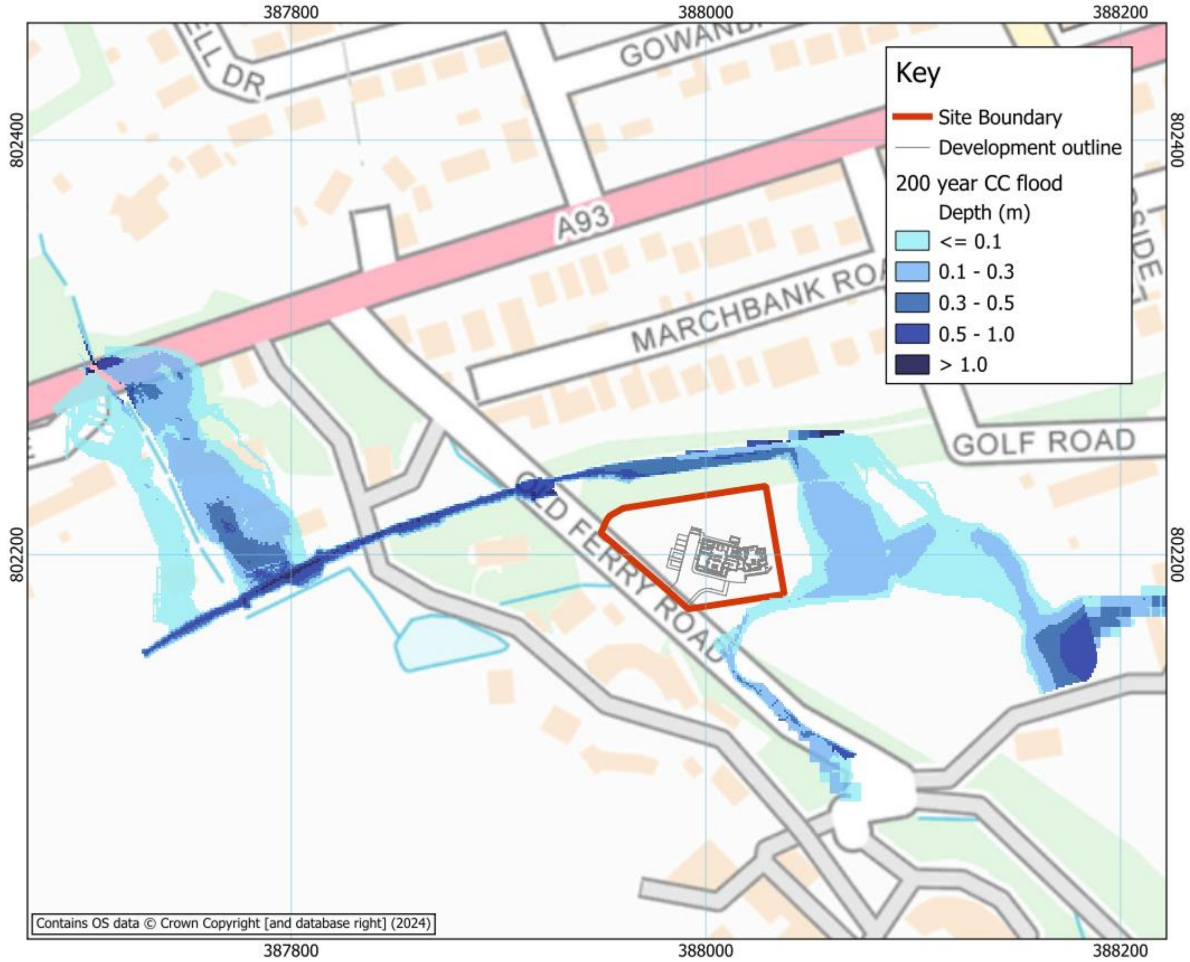


Figure 5.6 Predicted 1 in 200 year plus climate change with 50% blockage flood extents and depths

5.3.4 Roughness Sensitivity

To test the sensitivity of predictions to assumed roughness parameterisation, the Manning's *n* value was increased by 20% across the 1D model extent; the bed roughness was increased from 0.035 to 0.042, and the floodplain roughness was increased from 0.06 to 0.072. 2D roughness values were maintained.

Appendix E presents predicted flood levels for 1 in 200 year plus climate change event for the roughness sensitivity scenario, showing an average change in predicted peak water levels of +0.017m relative to the baseline scenario. Model predictions therefore have a low sensitivity to uncertainty in roughness parameterisation.

5.3.5 Downstream Boundary Sensitivity

To test the sensitivity of predictions to downstream boundary parameterisation, the downstream slope was reduced by 20% within the 1D model extent from 0.05 to 0.04.

Appendix E presents predicted flood levels for 1 in 200 year plus climate change event for the downstream boundary sensitivity scenario, showing no significant change in predicted peak water levels relative to the baseline scenario, expect at the most downstream section where there is an increase of 0.04m. Model predictions therefore have a low sensitivity to uncertainty in roughness parameterisation.

5.4 Downstream Flood Risk

The watercourse downstream of the Deeside Way siphon has not been explicitly modelled. However, additional flood risk sensitivity testing has been undertaken to understand potential flood risk from the watercourse downstream of Deeside Way.

A conservative estimate of potential flooding from spilling of the downstream channel has been obtained based on the following assumptions:

- The predicted downstream boundary hydrograph of the upstream 1D-2D model presented in Section 5.1 is assumed to represents the inflow into the downstream watercourse.
- Flows up to Qmed (median annual maximum flows; or 2 year return period flows) are assumed to remain in bank, while all flows exceeding this value are assumed to spill onto the floodplain.

Therefore, the downstream hydrograph of the upstream model for a 1 in 200 year plus climate change event was taken and reduced by Qmed, 0.8m^3/s. This was applied as a point inflow at several potential spilling locations. Note that this modelling is extremely pessimistic, in assuming the channel only has capacity for Qmed flows and not accounting for attenuation within the channel network, particularly the attenuation that would be provided by the large pond to the west of Old Ferry Road.

Figure 5.7 provides a comparison between the design inflow hydrograph, the downstream model hydrograph, and the point inflow hydrograph. This shows that over 60% of the design peak flow is lost upstream of Deeside Way.

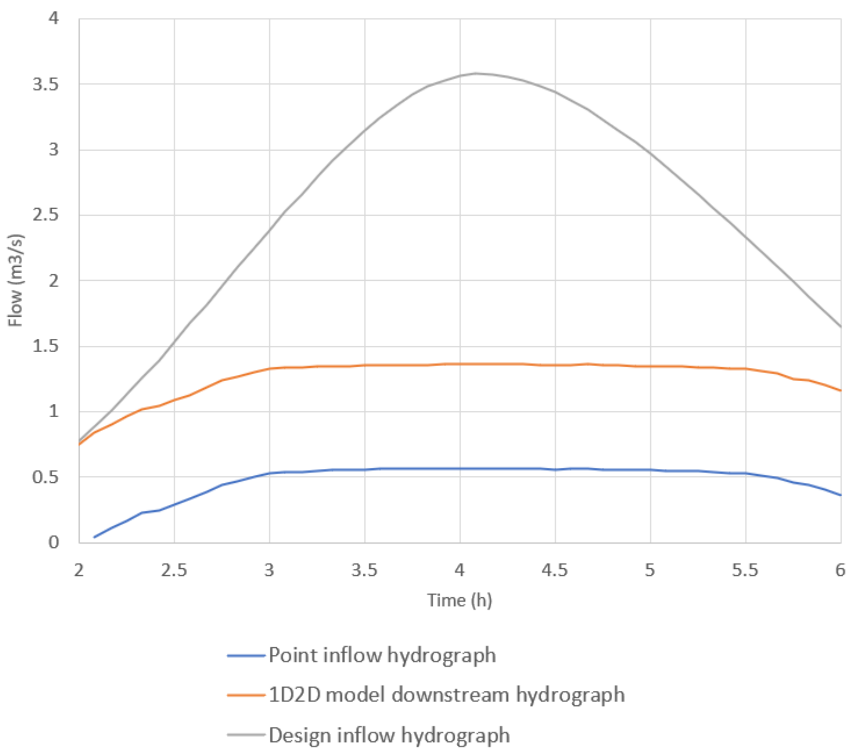


Figure 5.7 Comparison of upstream, downstream, and point inflow hydrographs.

A number of locations were assessed as spilling points for out of bank flows within the downstream network, as illustrated in Figure 5.8.

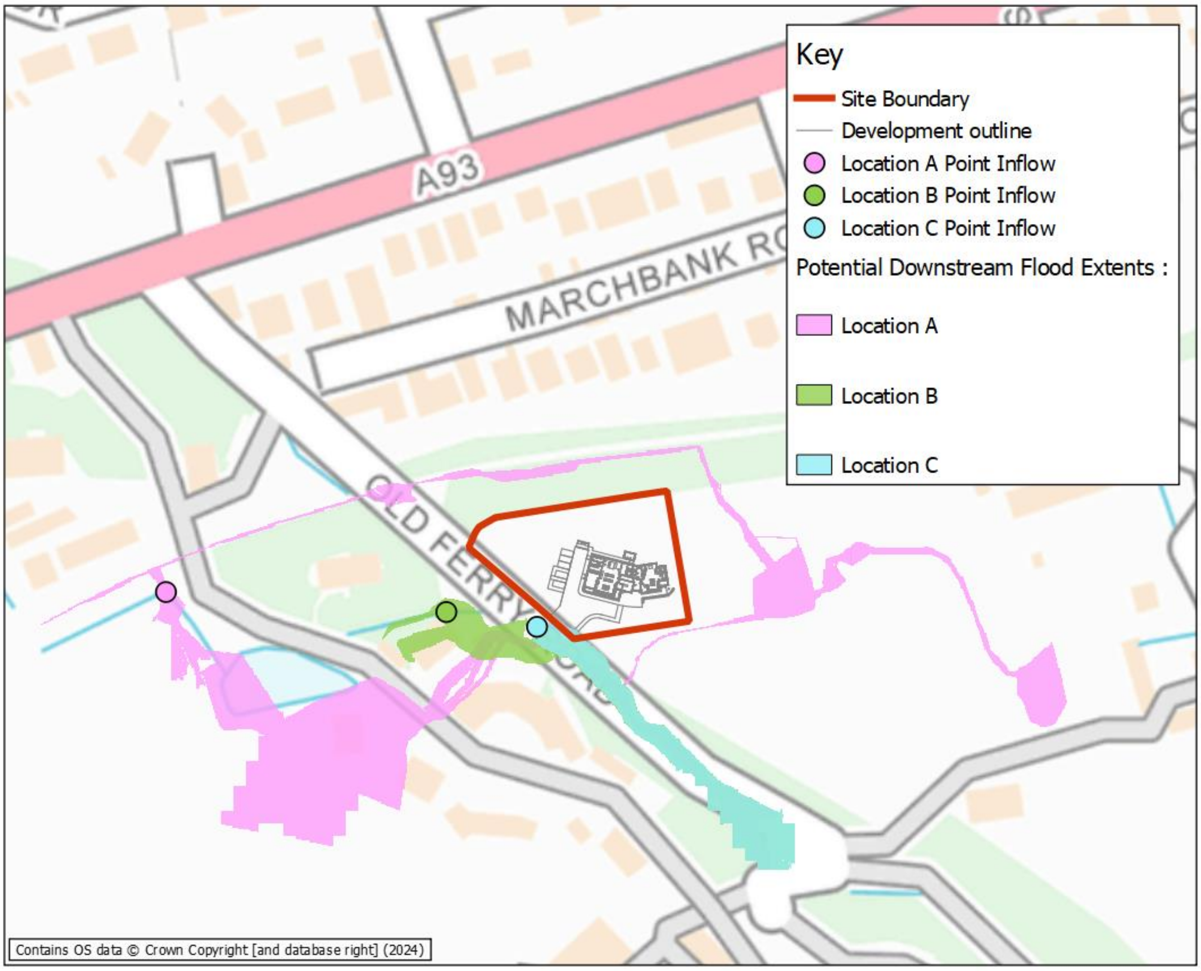


Figure 5.8 Potential downstream flood risk

The results confirm that the proposed development site would be largely unaffected by out of bank flow from the watercourse downstream of the siphon.

The assessment does not rule out some inundation at entrance of the development. Applying the point inflow hydrography at Location C provided the worst case flood outline, with a more detailed illustration of the results for Location C presented in Figure 5.9.

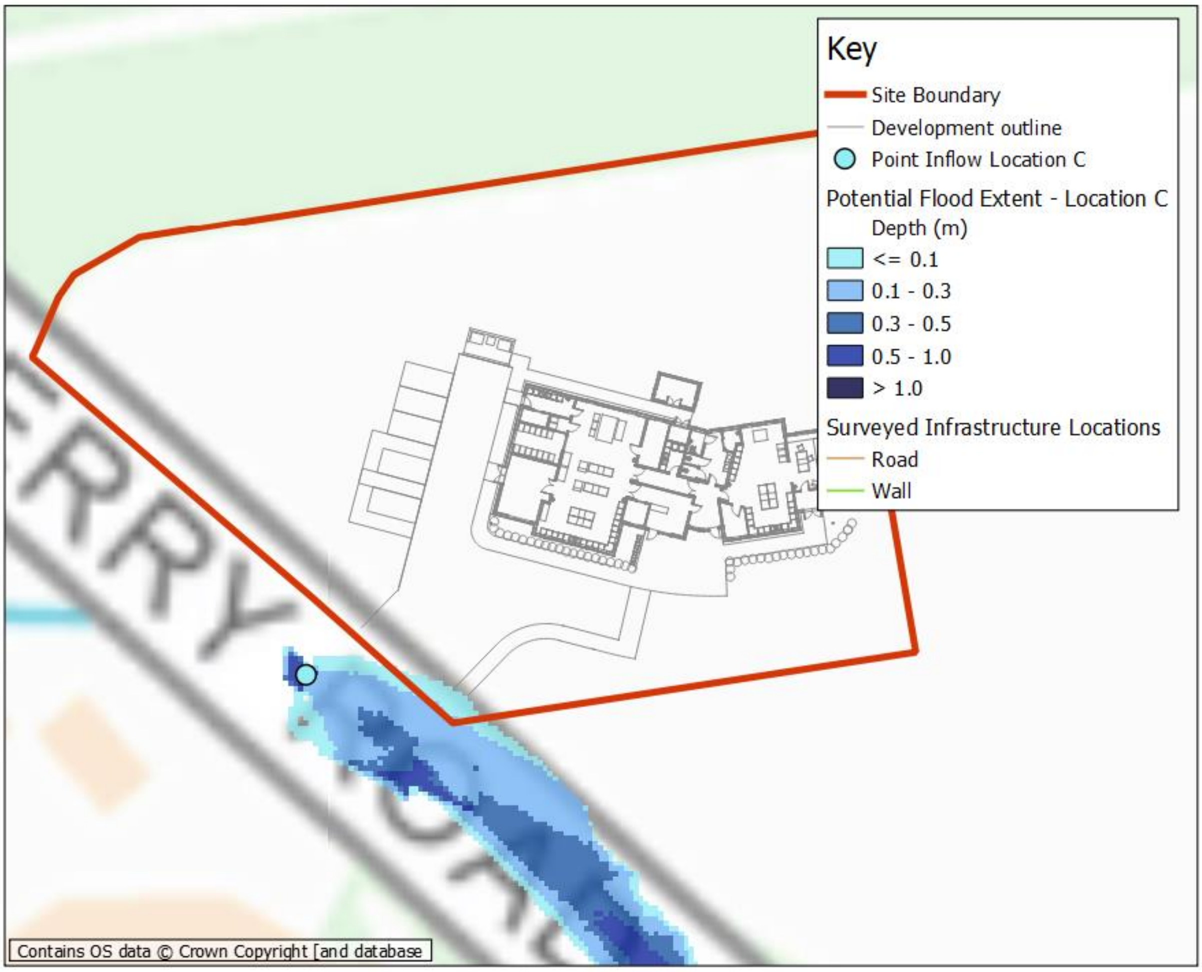


Figure 5.9 Potential downstream flood risk due to point inflow at Location C

A 4.5 m wide corridor up to the entrance, associated with a passing place, is confirmed to remain flood-free. It is also noted that, at the access and egress location, the road slopes steeply to the south as illustrated in Figure 5.10. Any inundation at this location will be shallow and temporary, with depths adjacent to the site entrance shown to be less than 0.3 m and generally less than 0.1m. There is no risk of ponding or prolonged flooding on the road at the entrance. Based on this, it is not considered that flood risk from the watercourse presents a significant risk to access and egress. It would nonetheless be beneficial to provide a flood-free secondary pedestrian access/ egress route to the north of the proposed development.

Figure 5.10 Photo looking south along Old Ferry Road from the proposed site entrance.

5.5 Pluvial Flood Risk

Catchment flow path analysis presented in Figure 5.11 shows overland flows from north of the site are diverted by Deeside Way.

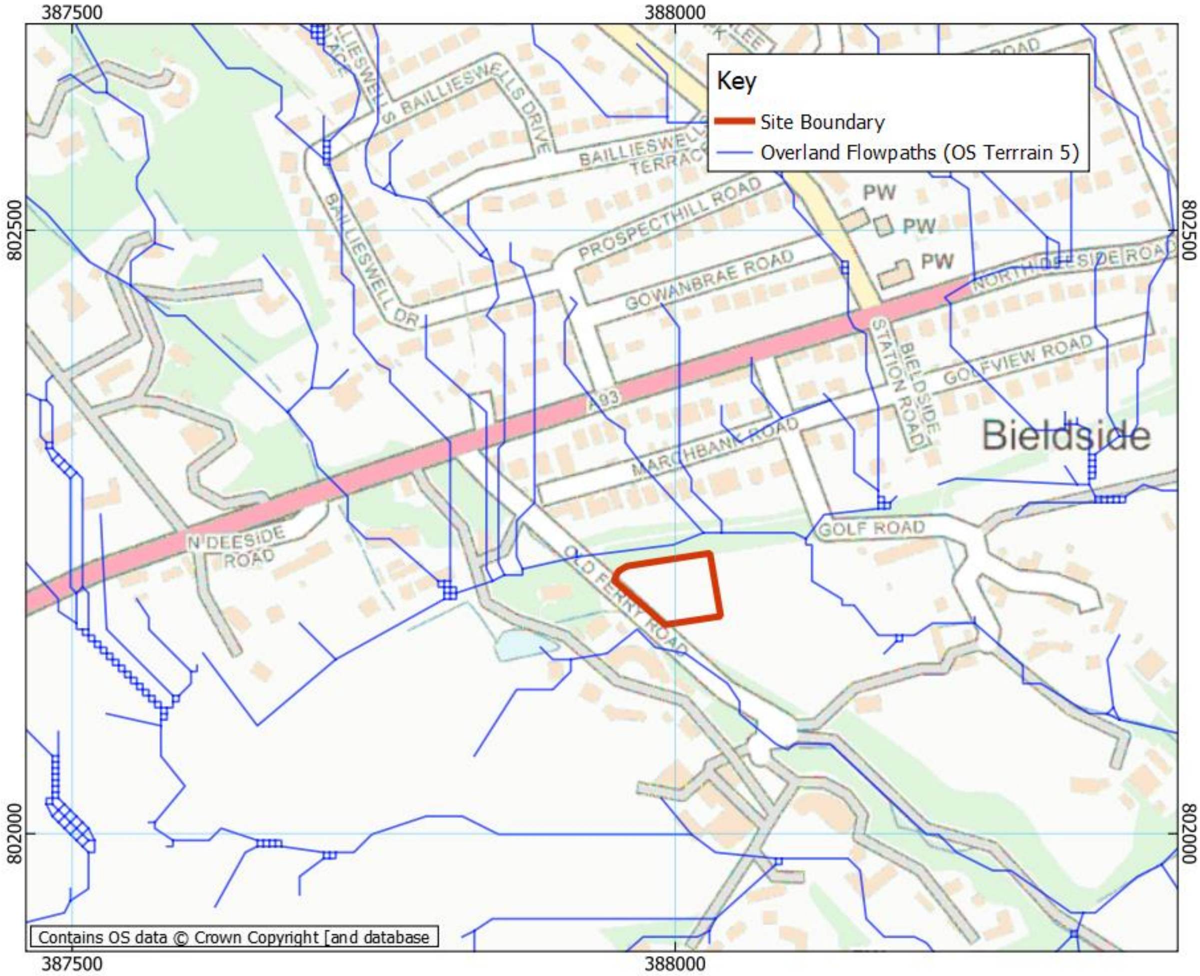


Figure 5.11 OS Terrain 5 overland flows local to the development site.

Review of the design flood modelling outcomes in Figure 5.5 also confirms any fluvial or pluvial flows from higher catchment areas north beyond the site will be deflected by Deeside Way to flow beyond the eastern edge of the site. There is no upstream catchment that could impact the site south of Deeside Way.

6 FLOOD RISK IMPACT AND MANAGEMENT

6.1 Impact of Flood Risk on the Development

Table 6.1: Flood risk overview

Flood Source or Mechanism	Risk Classification	Comments	Proposed Management Measures
Fluvial	Low to medium risk	For the 1 in 200 year plus climate change event, no inundation of the site is predicted. Provided development avoids the areas shown to inundate, fluvial flooding otherwise poses no risk to the site.	Outlined in Section 6.2
Coastal	No risk	The site lies 8.3 km inland from the River Dee Estuary and the development areas are at a minimum elevation of 31.5 mAOD. Therefore, the site is significantly elevated above extreme coastal flood levels and coastal flood risk will not have any impact on the site.	Not considered further
Surface Runoff	Low risk	Catchment flow path analysis confirms any flows from higher catchment areas will be deflected by Deeside Way to flow beyond the eastern edge of the site. There is no upstream catchment that could impact the site south of Deeside Way. Surface water flood risk from runoff falling directly onto the site can managed by a suitably designed drainage system.	Site design and SuDS design should account for locally generated runoff.
Infrastructure Failure	Little to no risk	There are no flood schemes or reservoirs on the SEPA register within close proximity to the site or in the wider area.	Not considered further
Groundwater	Little or no risk	There is no indication of significant groundwater flood risk on the SEPA Flood Maps. Sloping topography will prevent any significant accumulation of groundwater above ground level.	Not considered further

6.2 Outline Flood Management Recommendations

The following recommendations are made to support future development design in terms of flood risk:

1. The site layout is recommended to avoid construction within the flood risk areas, in order to minimise impacts on the development and surrounding area. The need to avoid areas at flood risk will have no impact upon development of the site, as predicted inundation extents do not impact the site location.

2. It is recommended that development proposals should ensure that the access and egress routes to and from the site would be safe from flooding during a design flood event, although this is not a requirement for Least Vulnerable development types. Worst-case flood predictions for the downstream section of the unnamed watercourse indicated that Old Ferry Road may inundate. It is noted that flooding by this mechanism is predicted to be shallow and dissipate quickly given the southerly fall of the road. A footpath from the north of the proposed development connecting to Old Ferry Road should be considered to provide flood-free pedestrian access/egress.

3. SEPA typically recommend a minimum freeboard of 600mm above the design flood level. Flooding from the upstream watercourse passes along Deeside Way at elevations higher than some ground elevations within the development site, such that providing freeboard to 600mm above 200 year plus climate change water levels is unlikely to be reasonable. This floodwater is separated from the site by higher intervening ground. Flood waters thereafter pass to the east of the site with adjacent flood levels below ground levels at the proposed building location. Flooding from the adjacent reach of the watercourse may impact Old Ferry Road but will be shed southwards without posing any flood risk to the proposed building. We therefore recommend a 300 mm building upstand above surrounding ground levels as a flood resilience measure where possible, with a minimum upstand of 150 mm. This will protect the building from potential flooding due to events exceeding the 1 in 200 year plus climate change event or else flooding associated with blockage/failure of the site drainage system.

4. Overland flows will be generated within the development area. It will be possible to mitigate surface water flood risk through landscaping, appropriate design of the site layout, raising of finished floor levels above surrounding ground and adequate SuDS design. The drainage design should consider working with existing natural flow paths.

7 CONCLUSIONS

A Flood Risk Assessment has been undertaken for a proposed bakery development at Newton Dee in the west of Aberdeen. An unnamed watercourse has been assessed in terms of fluvial flood risk, as have overland flow paths.

Design flows were derived from the FEH Rainfall-Runoff method. A 1D-2D hydraulic model of the unnamed watercourse upstream of Deeside Way was developed using up to date topographic survey. Model predictions indicate that the unnamed watercourse poses no flood risk to the site, with 1 in 200 year plus climate change predicted flood extents spilling over the adjacent field to the east of the site without intruding into the red line boundary of the proposed development.

Sensitivity assessment of risk from the watercourse downstream of Deeside Way confirms there is no risk of fluvial inundation of the site. There is the potential for partial, temporary and shallow inundation at the access road entrance to the site, however this water will shed southwards with the fall of Old Ferry Road and does not pose a risk to the site itself.

Review of the model results and overland flow path analysis confirms that any overland flows from the hillslopes upstream of the development would flow onto Deeside Way, which would “deflect” flows eastwards along this incised footpath, to then flow southwards to the east of the site.

The site layout should ensure there is no development or landscaping within areas predicted to flood. It is recommended that a building upstand of 300 mm is employed to protect against residual flooding (due to an exceedance flood event or failure/blockage of site drainage). It would be beneficial to provide a clear flood-free pedestrian access/egress route from the north of the development onto Old Ferry Road, although this is not a requirement. It is also recommended that the final site layout and levels take due consideration of overland flow paths, with site landscaping ensuring that no local topographic depressions are created which may lead to floodwater ponding within the site.

Following implementation of these recommendations, the proposed development will be adequately protected from flood risk for its lifetime and therefore it is considered there is no overriding impediment to the proposals being granted planning permission on the grounds of flood risk.

APPENDICES

A ANNUAL EXCEEDANCE PROBABILITY – RETURN PERIOD CONVERSION

Flood Frequency Statistics

The magnitude of flood flows are typically presented 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. Defines "functional floodplain" under Scottish Planning Policy.
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

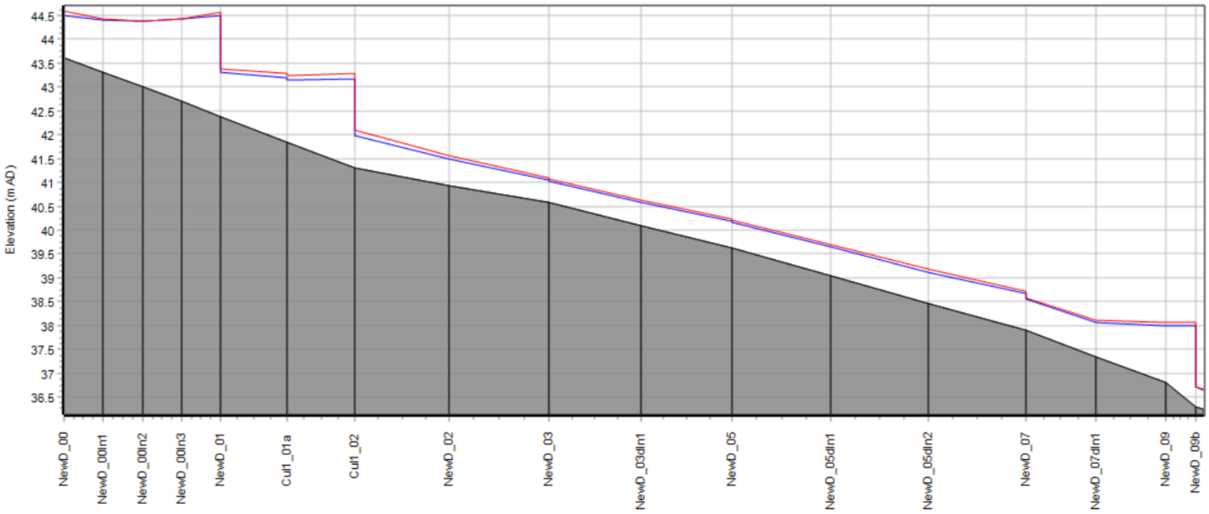
The probability of a flood event occurring at least once over a set period of time (e.g. an individual's lifetime or the design life of a built structure) can be evaluated against the following table.

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 FEH CATCHMENT DESCRIPTORS

Parameter	Value
AREA	3.3525
ALTBAR	79
ASPBAR	166
ASPVAR	0.7
BFIHOST	0.718
BFIHOST19	0.718
DPLBAR	2.3
DPSBAR	59.4
FARL	0.959
FPEXT	0.0828
FPDBAR	1.305
FPLOC	0.654
LDP	5.29
PROPWET	0.42
RMED-1H	8.1
RMED-1D	35
RMED-2D	46.9
SAAR	818
SAAR4170	890
SPRHOST	23.51
URBCONC1990	0.576
URBEXT1990	0.0805
URBLOC1990	0.671
URBCONC2000	0.894
C	0.1555
D1	0.717
D2	-0.01033
D3	0.4814
E	0.40683
F	0.27575
C(1 km)	0.22817
D1(1 km)	2.21418
D2(1 km)	-0.01
D3(1 km)	0.485
E(1 km)	0.415
F(1 km)	0.276

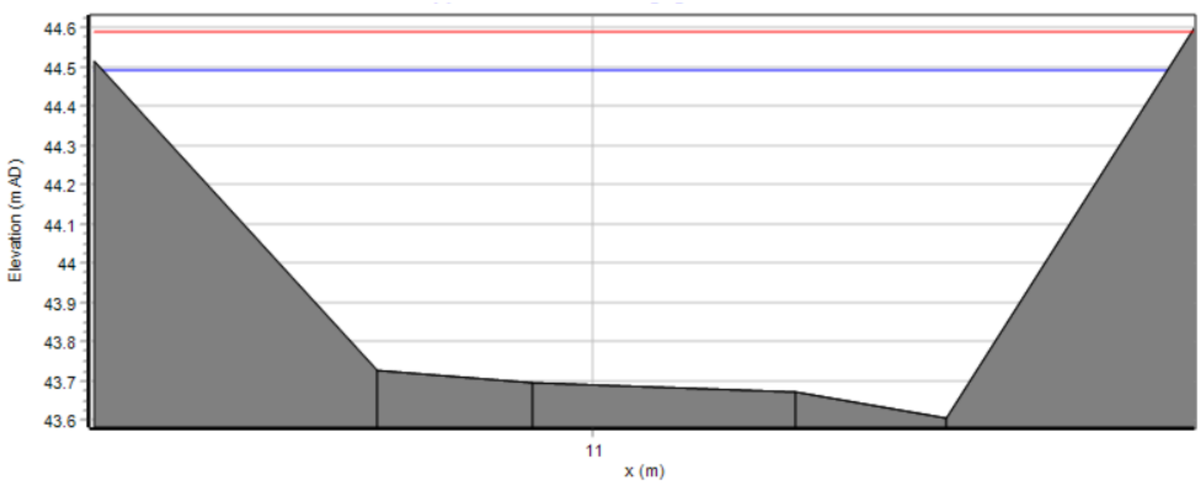
C MODELLED LONG SECTION



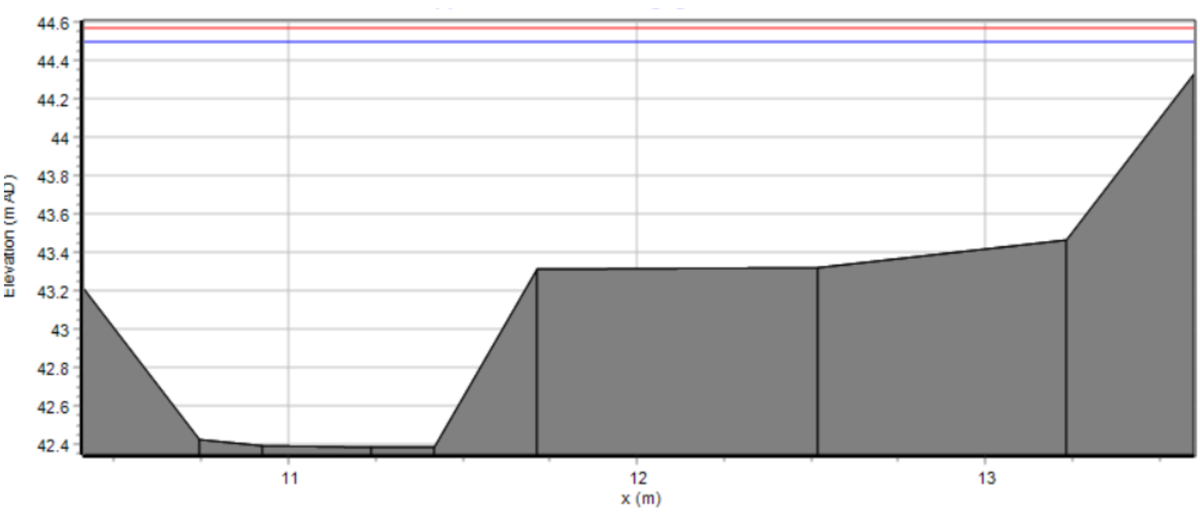
D MODELLED CROSS SECTIONS

Peak flood levels from the upstream model of the unnamed watercourse for 1 in 200 year (blue) and 1 in 200 year plus climate change (red).

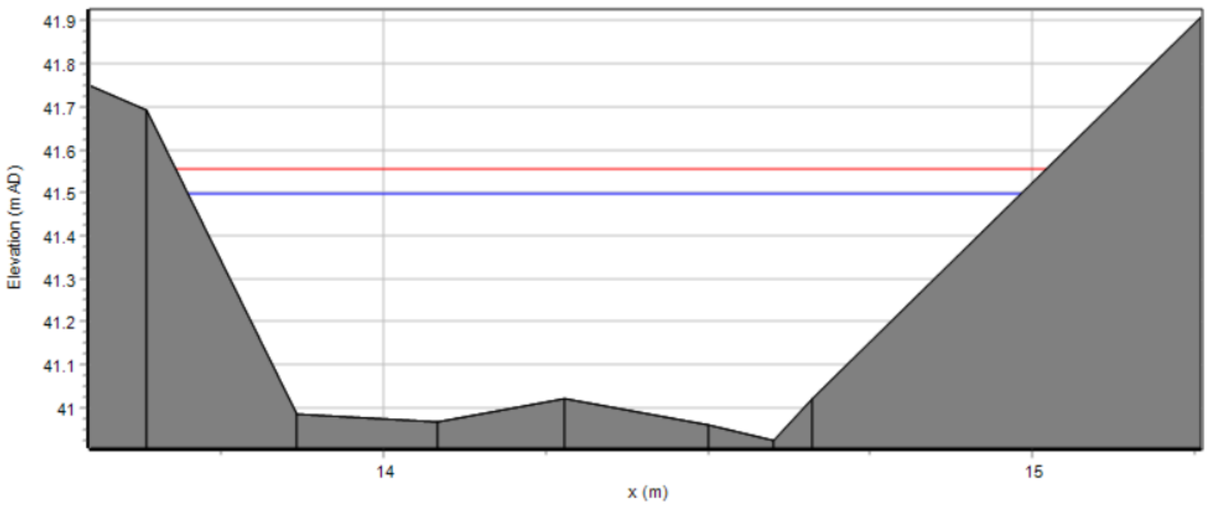
NewD_00



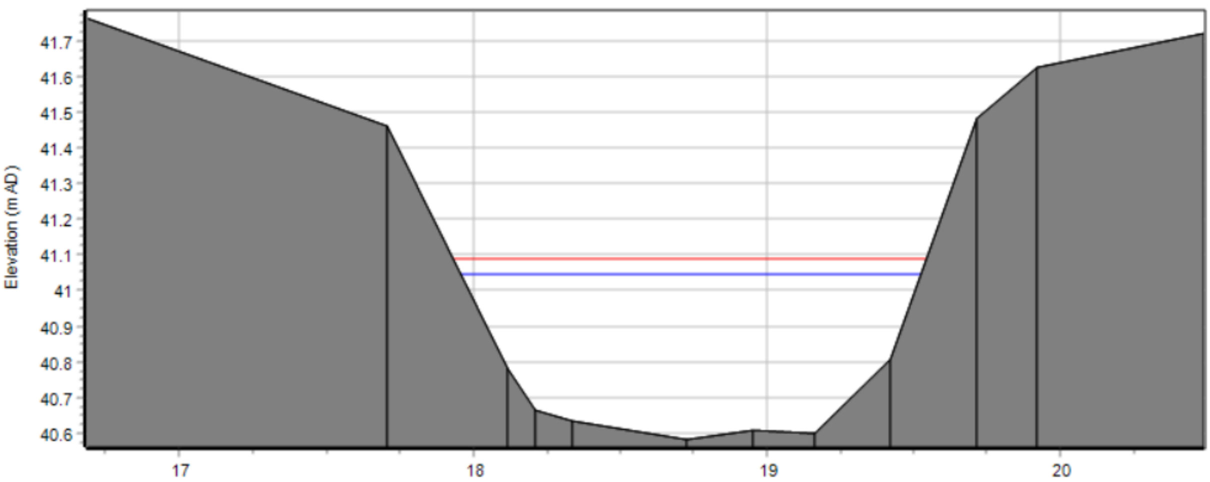
NewD_01



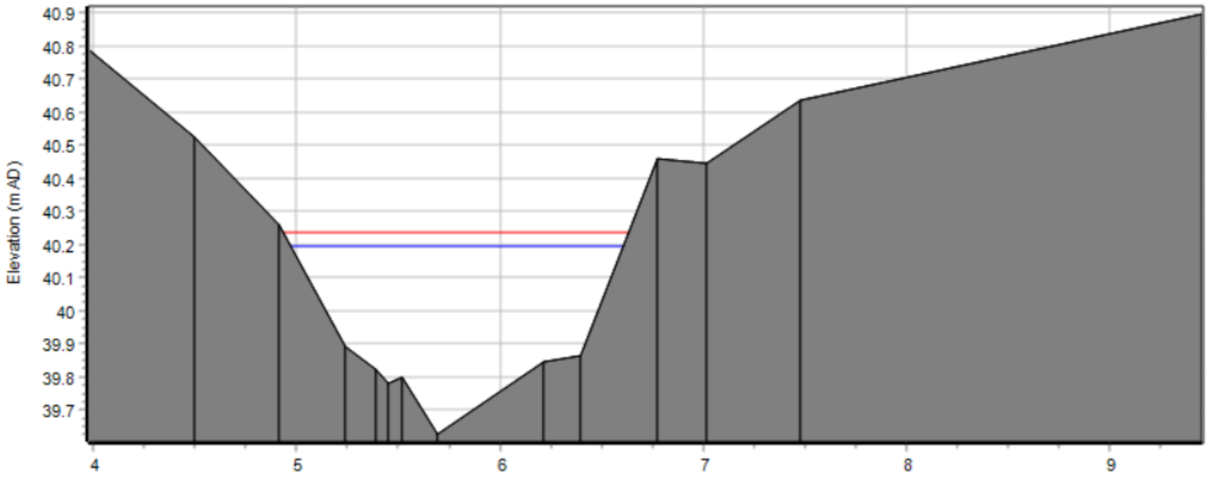
NewD_02



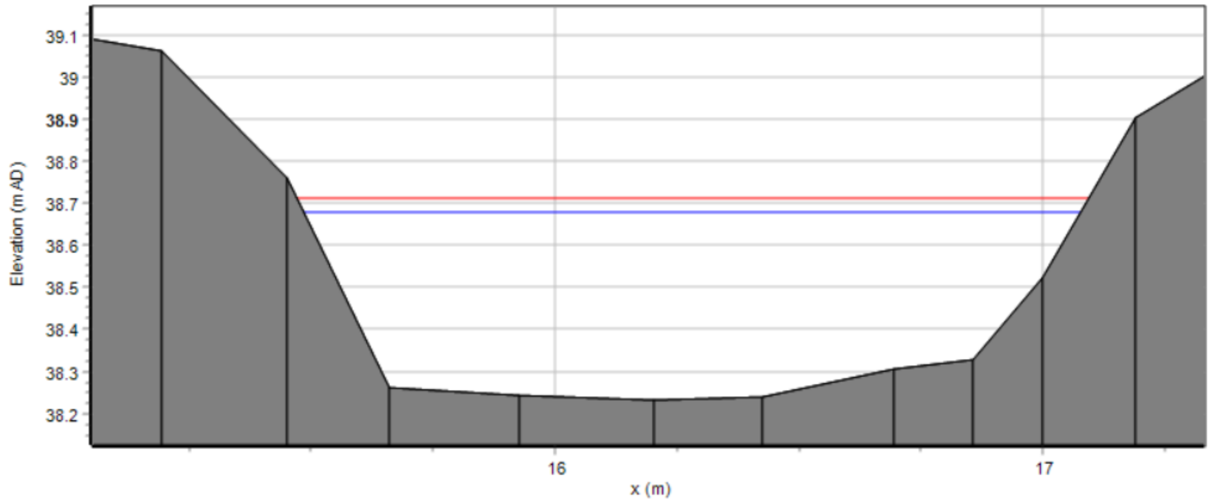
NewD_03



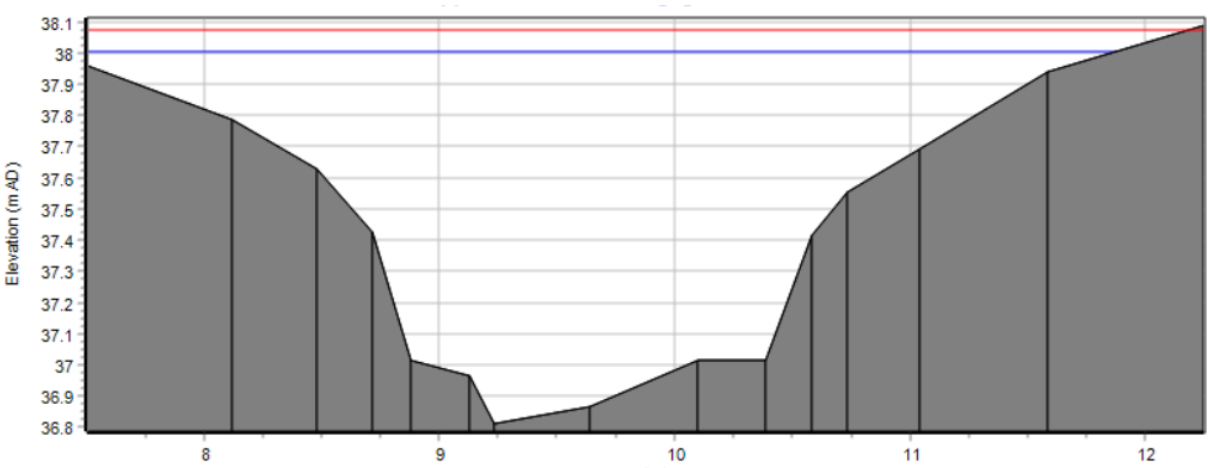
NewD_05



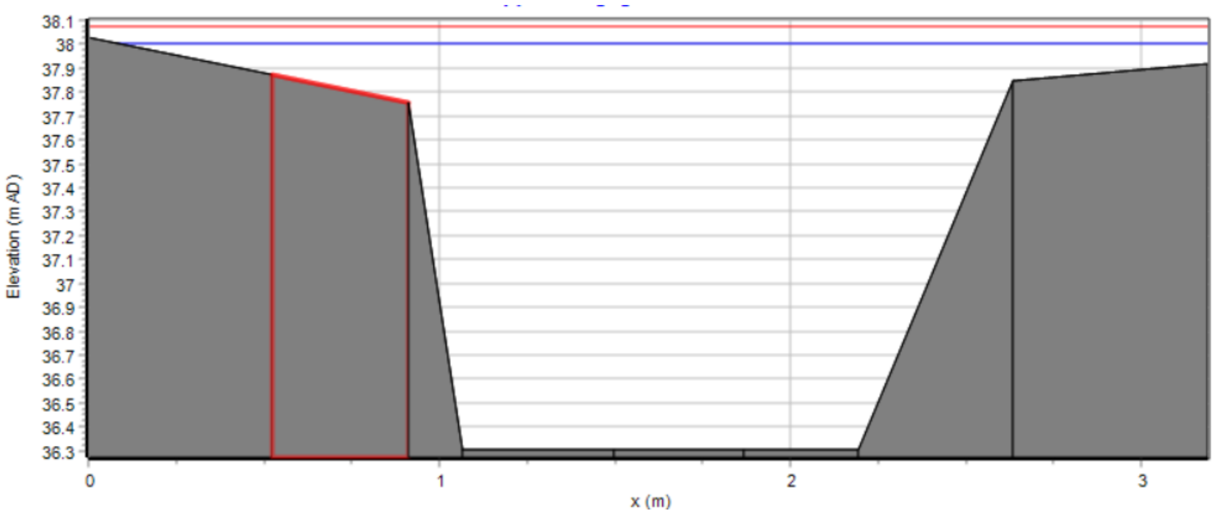
NewD_07

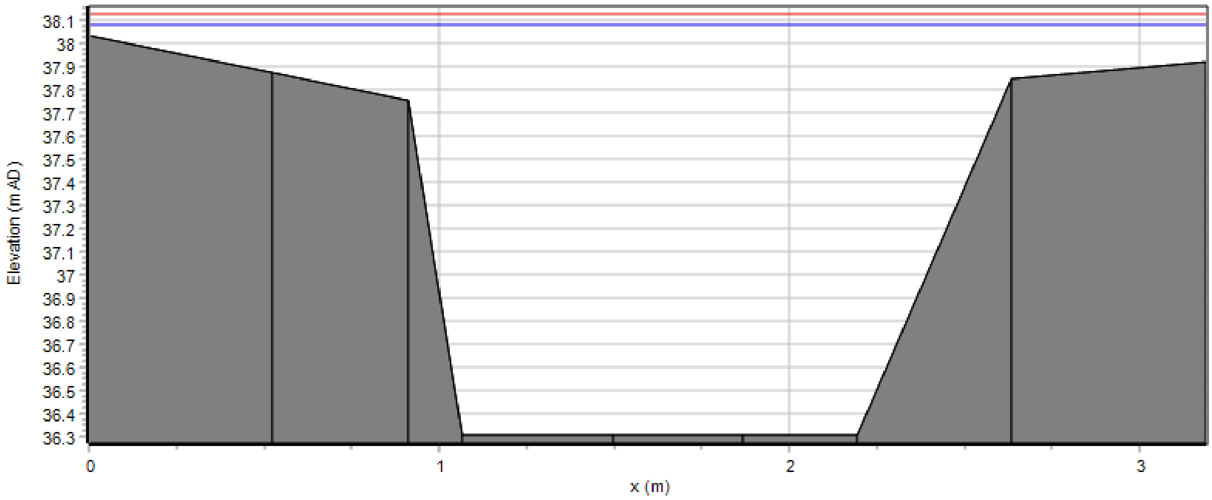


NewD_09

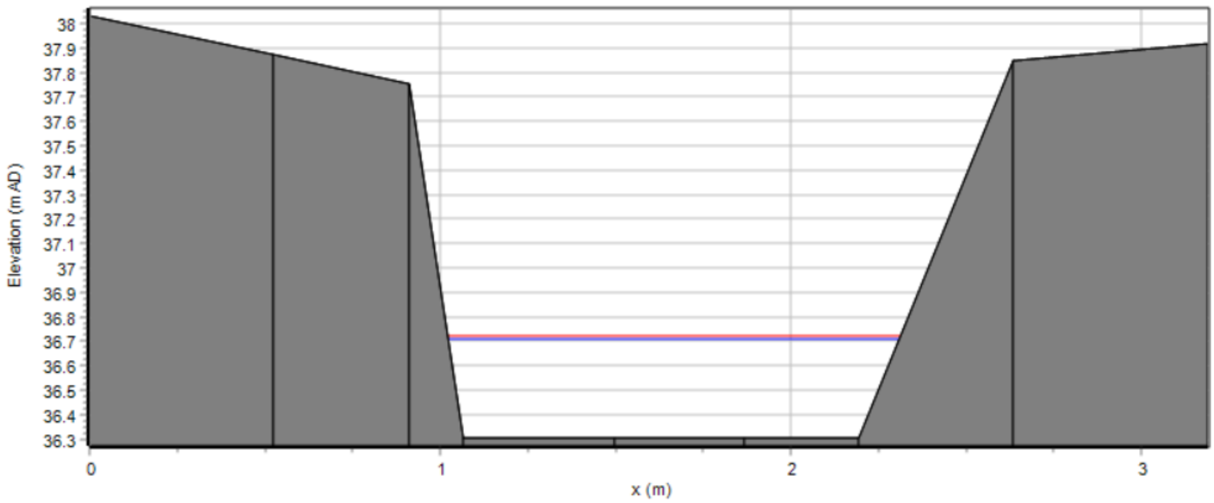


NewD_09b





NewD_DS



E TABULATED MODEL RESULTS

Maximum Water Levels (mAOD)					
Cross-section	200 year	200 year + Climate Change	200 year CC with 50% Blockages	200 year CC with Manning's n +20%	200 year CC with Downstream slope -20%
NewD_00	44.49	44.59	44.59	44.65	44.59
NewD_01	44.49	44.57	44.58	44.56	44.57
NewD_02	41.51	41.59	41.52	41.63	41.59
NewD_03	41.06	41.10	41.04	41.13	41.10
NewD_05	40.20	40.25	40.18	40.28	40.24
NewD_07	38.69	38.72	38.69	38.69	38.71
NewD_09	38.01	38.08	37.81	38.08	38.08
NewD_09b	38.00	38.08	37.82	38.08	38.08
NewD_DS	36.66	36.67	36.64	36.72	36.71

Maximum Velocity (m/s)					
Cross-section	200 year	200 year + Climate Change	200 year CC with 50% Blockages	200 year CC with Manning's n +20%	200 year CC with Downstream slope -20%
NewD_00	2.902	3.727	3.745	3.433	3.727
NewD_01	0.827	0.83	0.442	0.831	0.83
NewD_02	2.351	2.494	2.212	2.251	2.482
NewD_03	2.283	2.492	2.244	2.284	2.469
NewD_05	2.286	2.493	2.232	2.231	2.475
NewD_07	2.209	2.483	2.112	2.57	2.473
NewD_09	2.055	2.055	2.053	1.853	2.055
NewD_09b	0.762	0.762	0.763	0.762	0.762
NewD_DS	2.466	2.483	2.419	2.186	2.238

Froude Number					
Cross-section	200 year	200 year + Climate Change	200 year CC with 50% Blockages	200 year CC with Manning's n +20%	200 year CC with Downstream slope -20%
NewD_00	1.567	1.57	1.572	1.393	1.57
NewD_01	0.373	0.373	0.204	0.373	0.373
NewD_02	1.234	1.256	1.179	1.1	1.26
NewD_03	1.193	1.25	1.188	1.124	1.245
NewD_05	1.234	1.307	1.217	1.153	1.301
NewD_07	1.169	1.276	1.16	1.346	1.273
NewD_09	1.764	1.76	1.793	1.649	1.76
NewD_09b	0.265	0.265	0.265	0.265	0.265
NewD_DS	1.291	1.291	1.291	1.08	1.085

F SEPA CHECKLIST

Flood Risk Assessment (FRA) Checklist

(SS-NFR-F-001 - Version 16 - Last updated 27/08/2019)

This document must be attached within the front cover of any Flood Risk Assessments issued to Local Planning Authorities (LPA) in support of a development proposal which may be at risk of flooding. The document will take only a few minutes to complete and will assist SEPA in reviewing FRAs, when consulted by LPAs. This document should not be a substitute for a FRA.

Development Proposal Summary

Site Name:		The Elderflower Project, Newton Dee				
Grid Reference:	Easting:	387992	Northing:	802201		
Local Authority:		Aberdeen City Council				
Planning Reference number (if known):						
Nature of the development:		Commercial	If residential, state type:			
Size of the development site:		0.35	Ha			
Identified Flood Risk:	Source:	Fluvial	Source name:			

Land Use Planning

Is any of the site within the functional floodplain? (refer to SPP para 255)		No	If yes, what is the net loss of storage?	0	m^3	
Is the site identified within the local development plan?		No	Local Development Plan Name:	Development Plan (2019)	Year of Publication:	2019
			Allocation Number / Reference:	2.8.9 Potential Community Plan Settlements		
If yes, what is the proposed use for the site as identified in the local plan?		Residential	If Other please specify:			
Does the local development plan and/or any pre-application advice, identify any flood risk issues with or requirements for the site.		No	If so, please specify:			
What is the proposed land use vulnerability?		Least Vulnerable	Do the proposals represent an increase in land use vulnerability?	No		

Supporting Information

Have clear maps / plans been provided within the FRA (including topographic and flood inundation plans)?		Yes		
Has sufficient supporting information, in line with our Technical Guidance, been provided? For example: site plans, photos, topographic information, structure information and other site specific information.		Yes		
Has a historic flood search been undertaken?		Yes	If flood records in vicinity of the site please provide details:	on the Deeside Way footpath
Is a formal flood prevention scheme present?		No	If known, state the standard of protection offered:	
Current / historical site use:		Agriculture		
Is the site considered vacant or derelict?		Yes		

Development Requirements

Freeboard on design water level:		0.3	m		
Is safe / dry access and egress available?		Pedestrian Only	Min access/egress level:	Varies	m AOD
Design levels:	Ground level:	Varies	m AOD Min FFL:	Varies	mAOD

Mitigation

Can development be designed to avoid all areas at risk of flooding?		Yes
Is mitigation proposed?		Yes
If yes, is compensatory storage necessary?		No
Demonstration of compensatory storage on a "like for like" basis?		No
Should water resistant materials and forms of construction be used?		No

Flood Risk Assessment (FRA) Checklist

(SS-NFR-F-001 - Version 16 - Last updated 27/08/2019)

Hydrology

Is there a requirement to consider fluvial flooding?	Yes			
Area of catchment:	1.95	km^2	Is a map of catchment area included in FRA?	Yes
Estimation method(s) used (please select all that apply):	Pooled Analysis ☐		If Pooled analysis have group details been included?	
	Single Site Analysis ☐			
	Enhanced Single Site ☐			
	ReFH2 ☑			
	FEH RRM ☑			
	Other ☐		If other (please specify methodology used):	
Estimate of 200 year design flood flow:	2.43	m^3/s		
Qmed estimate:	0.8	m^3/s	Method:	
Statistical Distribution Selected:			Reasons for selection:	

Hydraulics

Hydraulic modelling method:	Linked 1D 2D		Software used:	Flood Modeller
			If other please specify:	
Number of cross sections:	13			
Source of data (i.e. topographic survey, LiDAR etc):	Topographic survey		Date obtained / surveyed:	Nov-23
Modelled reach length:	160	m		
Any changes to default simulation parameters?	No		If yes please provide details:	
Model timestep:	1s			
Model grid size:	1m			
Any structures within the modelled length?	Combination		Specify, if combination:	Bridges and Culvert
Maximum observed velocity:	3.74	m/s		
Brief summary of sensitivity tests, and range:				
variation on flow (%)	47	%	Please specify climate change scenario considered:	
variation on channel roughness (%)	20	%		
blockage of structure (range of % blocked)	20	%		
boundary conditions:	**Upstream**			**Downstream**
(1) type	Flow			Normal depth
Specify if other			Specify if other:	
(2) does it influence water levels at the site?	Yes			No
Has model been calibrated (gauge data / flood records)?	No	None available		
Is the hydraulic model available to SEPA?	Yes			
Design flood levels: 200 year	Varies	m AOD	200 year plus climate change	Varies m AOD
Cross section results provided?	Yes	*(Model previously reviewed by SEPA; flooding of interest is all within 2D domain)*		
Long section results provided?	Yes			
Cross section ratings provided?	No			
Tabular output provided (i.e. levels, velocities)?	Yes			
Mass balance error:	0.01	%		

Coastal

Is there a requirement to consider coastal / tidal flooding?	No			
Estimate of 200 year design flood level:		m AOD		
Estimation method(s) used:	Select from List		If other please specify methodology used:	
Allowance for climate change (m):		m		
Allowance for wave action etc (m):		m		
Overall design flood level:		m AOD		

Comments

Any additional comments:	
Approved by:	**Kate Lucey**
Organisation:	**EnviroCentre Ltd**
Date:	**24/01/2024**

Note: Further details and guidance is provided in 'Technical Flood Risk Guidance for Stakeholders' which can be accessed here:- CLICK HERE

Flood Risk Assessment (FRA) Checklist

(SS-NFR-F-001 - Version 16 - Last updated 27/08/2019)

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Development Proposal Summary

Site Name:		The Bakery & Confectionary Project, Newton Dee		
Grid Reference:	Easting:	387992	Northing:	802201
Local Authority:		Aberdeen City Council		
Planning Reference number (if known):				
Nature of the development:		Commercial	If residential, state type:	
Size of the development site:		0.35	Ha	
Identified Flood Risk:	Source:	Fluvial	Source name:	

Land Use Planning

Is any of the site within the functional floodplain? (refer to SPP para 255)	No	If yes, what is the net loss of storage?	0	m^3	
Is the site identified within the local development plan?	No	Local Development Plan Name:	Development Plan (2019)	Year of Publication:	2019
		Allocation Number / Reference:	2.8.9 Potential Community Plan Settlements		
If yes, what is the proposed use for the site as identified in the local plan?	Residential	If Other please specify:			
Does the local development plan and/or any pre-application advice, identify any flood risk issues with or requirements for the site.	No	If so, please specify:			
What is the proposed land use vulnerability?	Least Vulnerable	Do the proposals represent an increase in land use vulnerability?	No		

Supporting Information

Have clear maps / plans been provided within the FRA (including topographic and flood inundation plans)?	Yes		
Has sufficient supporting information, in line with our Technical Guidance, been provided? For example: site plans, photos, topographic information, structure information and other site specific information.	Yes		
Has a historic flood search been undertaken?	Yes	If flood records in vicinity of the site please provide details:	on the Deeside Way footpath
Is a formal flood prevention scheme present?	No	If known, state the standard of protection offered:	
Current / historical site use:	Agriculture		
Is the site considered vacant or derelict?	Yes		

Development Requirements

Freeboard on design water level:		0.3	m		
Is safe / dry access and egress available?		Pedestrian Only	Min access/egress level:	Varies	m AOD
Design levels:	Ground level:	Varies	m AOD Min FFL:	Varies	mAOD

Mitigation

Can development be designed to avoid all areas at risk of flooding?	Yes
Is mitigation proposed?	Yes
If yes, is compensatory storage necessary?	No
Demonstration of compensatory storage on a "like for like" basis?	No
Should water resistant materials and forms of construction be used?	No

Flood Risk Assessment (FRA) Checklist

(SS-NFR-F-001 - Version 16 - Last updated 27/08/2019)

Hydrology

Is there a requirement to consider fluvial flooding?	Yes			
Area of catchment:	1.95	km^2	Is a map of catchment area included in FRA?	Yes
Estimation method(s) used (please select all that apply):	Pooled Analysis	☐	If Pooled analysis have group details been included?	
	Single Site Analysis	☐		
	Enhanced Single Site	☐		
	ReFH2	☑		
	FEH RRM	☑		
	Other	☐	If other (please specify methodology used):	
Estimate of 200 year design flood flow:	2.43	m^3/s		
Qmed estimate:	0.8	m^3/s	Method:	
Statistical Distribution Selected:			Reasons for selection:	

Hydraulics

Hydraulic modelling method:	Linked 1D 2D		Software used:	Flood Modeller
			If other please specify:	
Number of cross sections:	13			
Source of data (i.e. topographic survey, LiDAR etc):	Topographic survey		Date obtained / surveyed:	Nov-23
Modelled reach length:	160	m		
Any changes to default simulation parameters?	No		If yes please provide details:	
Model timestep:	1s			
Model grid size:	1m			
Any structures within the modelled length?	Combination		Specify, if combination:	Bridges and Culvert
Maximum observed velocity:	3.74	m/s		
Brief summary of sensitivity tests, and range:				
variation on flow (%)	47	%	Please specify climate change scenario considered:	
variation on channel roughness (%)	20	%		
blockage of structure (range of % blocked)	20	%		
boundary conditions:	**Upstream**			**Downstream**
(1) type	Flow			Normal depth
Specify if other			Specify if other:	
(2) does it influence water levels at the site?	Yes			No
Has model been calibrated (gauge data / flood records)?	No	None available		
Is the hydraulic model available to SEPA?	Yes			
Design flood levels: 200 year	Varies	m AOD	200 year plus climate change	Varies m AOD
Cross section results provided?	Yes	*(Model previously reviewed by SEPA; flooding of interest is all within 2D domain)*		
Long section results provided?	Yes			
Cross section ratings provided?	No			
Tabular output provided (i.e. levels, velocities)?	Yes			
Mass balance error:	0.01	%		

Coastal

Is there a requirement to consider coastal / tidal flooding?	No			
Estimate of 200 year design flood level:		m AOD		
Estimation method(s) used:	Select from List		If other please specify methodology used:	
Allowance for climate change (m):		m		
Allowance for wave action etc (m):		m		
Overall design flood level:		m AOD		

Comments

Any additional comments:	
Approved by:	**Kate Lucey**
Organisation:	**EnviroCentre Ltd**
Date:	**24/01/2024**

Note: Further details and guidance is provided in 'Technical Flood Risk Guidance for Stakeholders' which can be accessed here:- CLICK HERE